Using CLI admissions as an indicator: how reliable is it for COVID Regions with fewer admissions?

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IDPH monitors daily COVID-like Illness (CLI) hospitalizations in Illinois' COVID regions to determine the necessity of introducing new mitigation measures

What Could Cause a Region to Become More Restrictive?

- Sustained increase in 7-day rolling average (7 out of 10 days) in the positivity rate
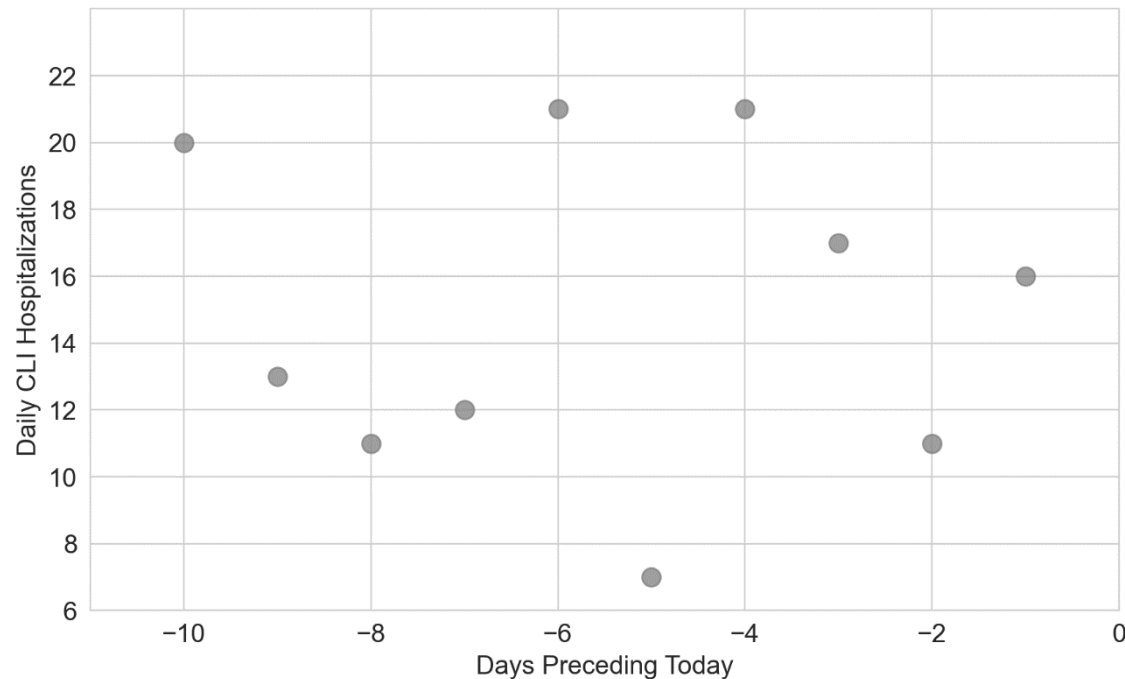
  AND ONE OF THE FOLLOWING:

- Sustained 7-day increase in hospital admissions for a COVID-19 like illness

- Reduction in hospital capacity threatening surge capabilities (ICU capacity or medical/surgical beds under 20%)

OR

- Three consecutive days averaging greater than or equal to 8% positivity rate

Resurgence criteria as of Aug 3, IDPH website

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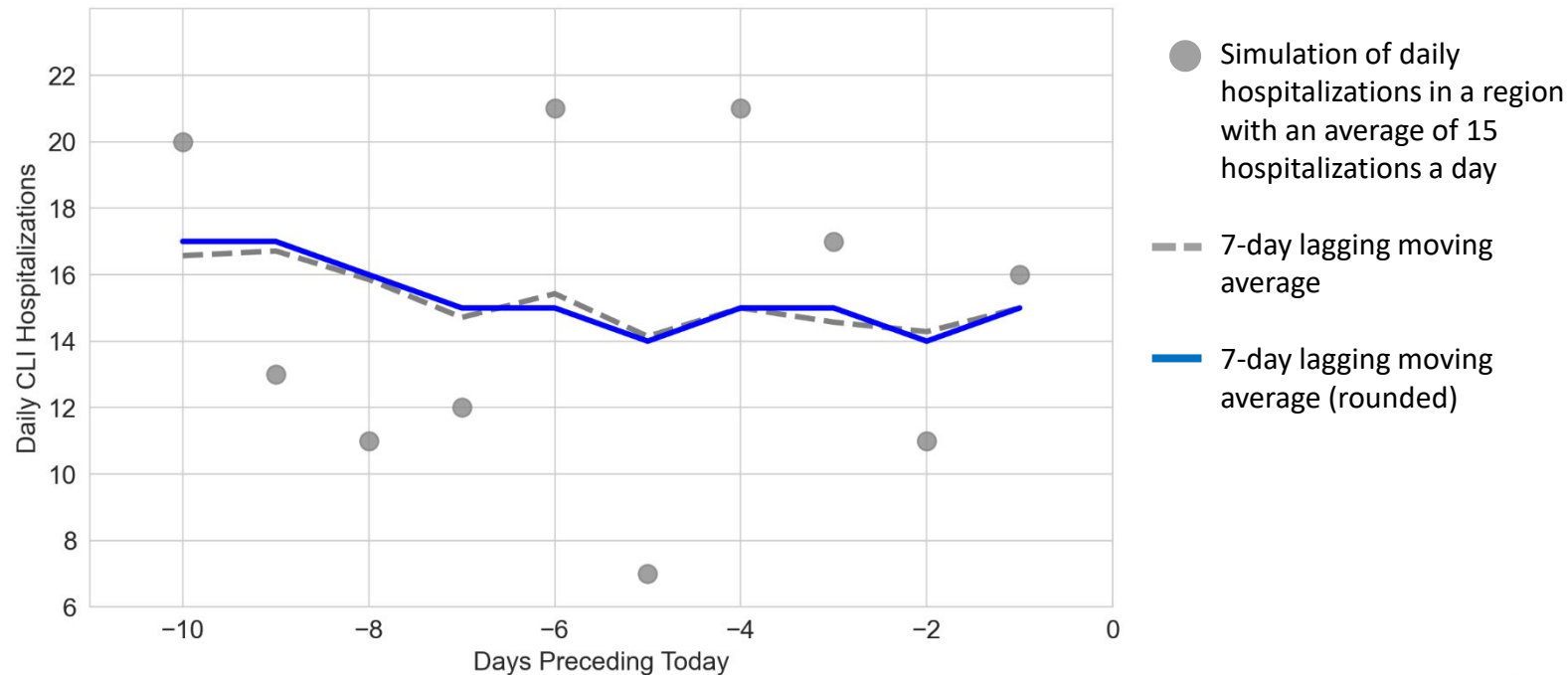# Specifically, IDPH looks at recent daily CLI admissions…

Simulation of daily hospitalizations in a region with an average of 15 hospitalizations a day

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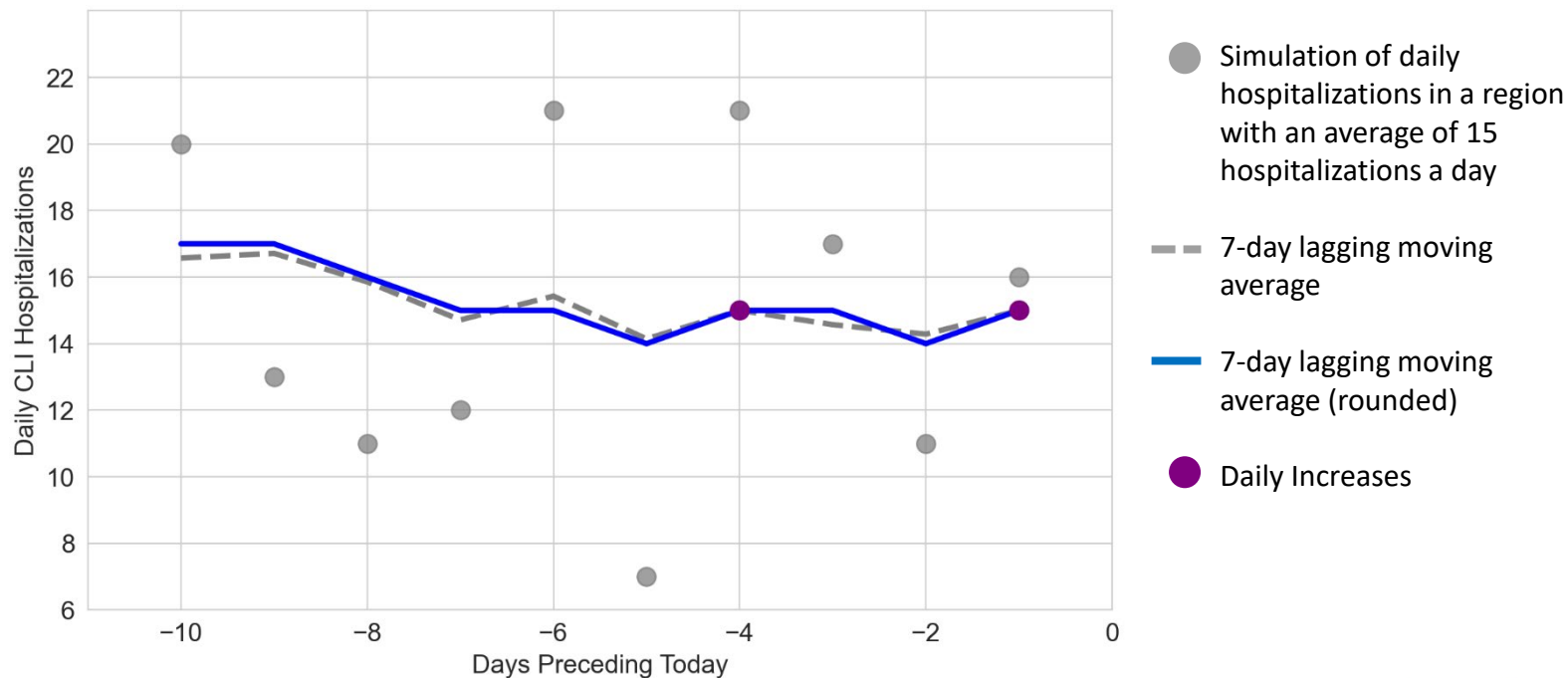# Specifically, IDPH looks at recent daily CLI admissions, takes the rolling average over a seven-day lagging window…

Simulation of daily hospitalizations in a region with an average of 15 hospitalizations a day

7-day lagging moving average

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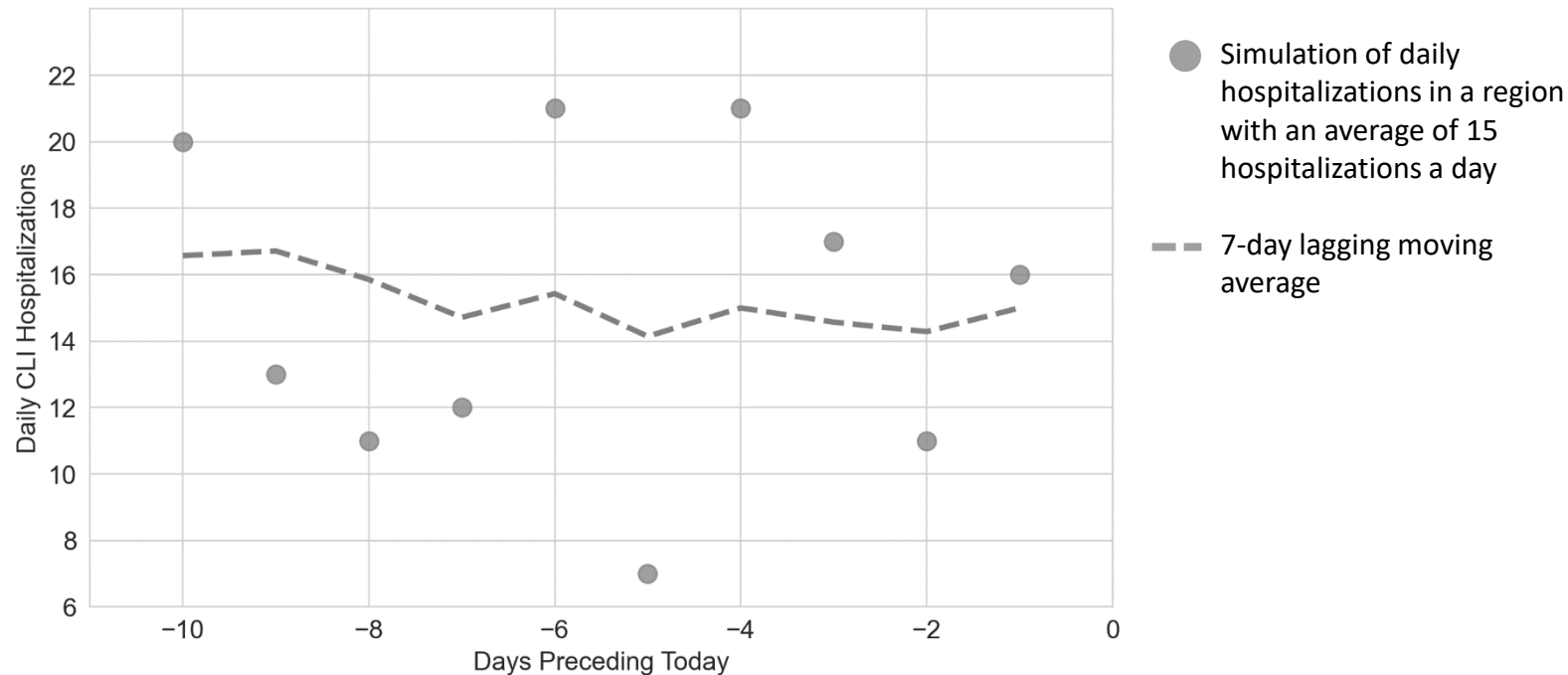
Specifically, IDPH looks at recent daily CLI admissions, takes the rolling average over a seven-day lagging window, rounds to the nearest whole number…

Specifically, IDPH looks at recent daily CLI admissions, takes the rolling average over a seven-day lagging window, rounds to the nearest whole number, and counts the number of daily increases in this figure over the last 10 days
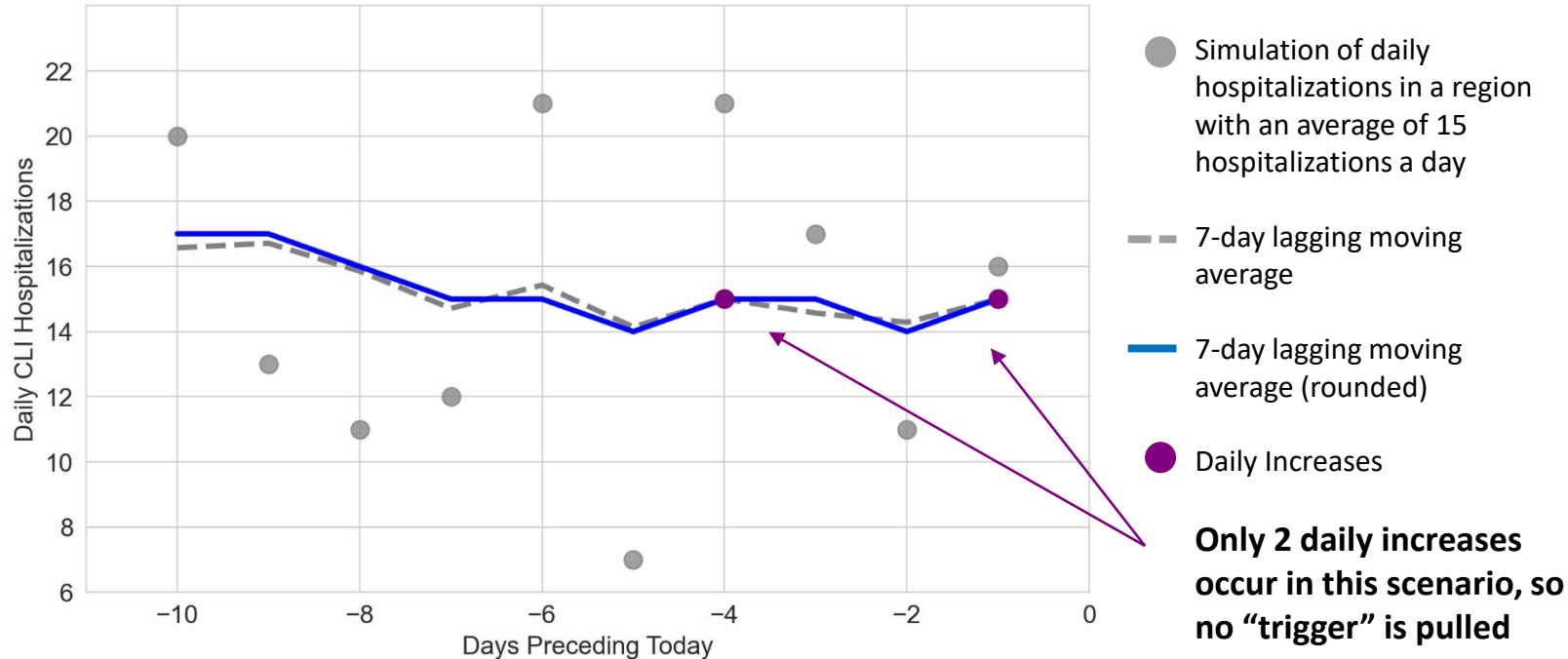
Specifically, IDPH looks at recent daily CLI admissions, takes the rolling average over a seven-day lagging window, rounds to the nearest whole number, and counts the number of daily increases in this figure over the last 10 days
An increase on **7 or more of the last 10 days** is the warning threshold

Simulation of daily hospitalizations in a region with an average of 15 hospitalizations a day

7-day lagging moving average

7-day lagging moving average (rounded)

Daily Increases

Only 2 daily increases occur in this scenario, so no "trigger" is pulled

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Will this criterion reliably capture a dangerous increase in hospital admission rate in every region?

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Hospital admissions are **noisy**, meaning that daily admissions can vary quite a bit even when the daily average remains the same

In each of the scenarios below, the underlying hospitalization rate increases by **50%** week over week (hospital admissions will double every ~12 days), **yet the "trigger" is never pulled**

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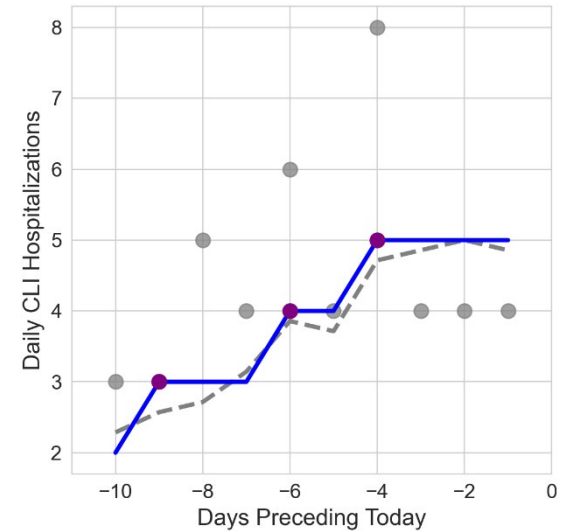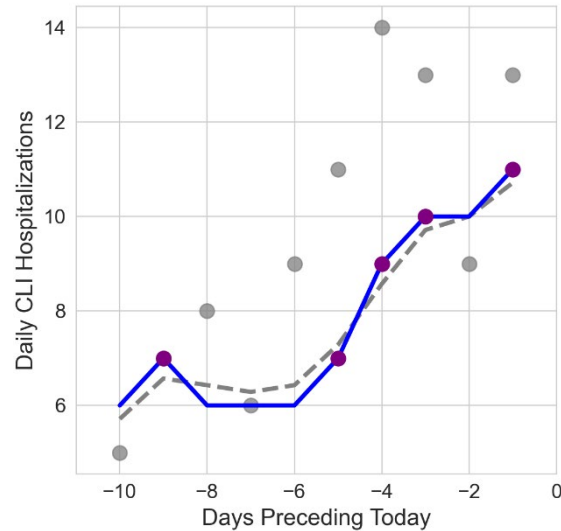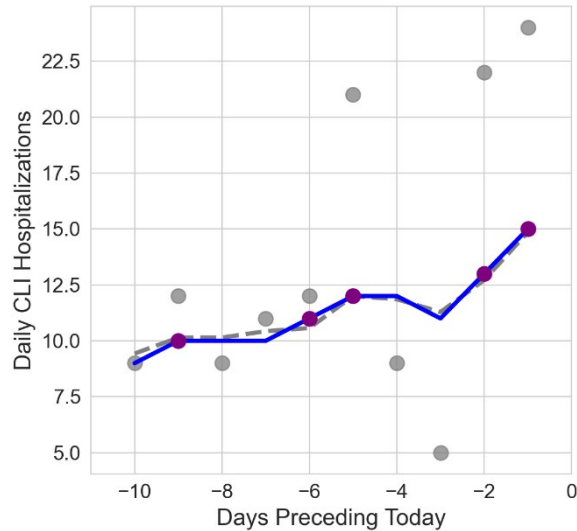
The metric is even less sensitive for regions with fewer daily admissions

In COVID Regions 1-6, each Region experiences an average of fewer than **7 admissions/day**

In each of the scenarios below, each region is experiencing an underlying hospitalization rate increase of **50%** week over week, but still no triggers are pulled

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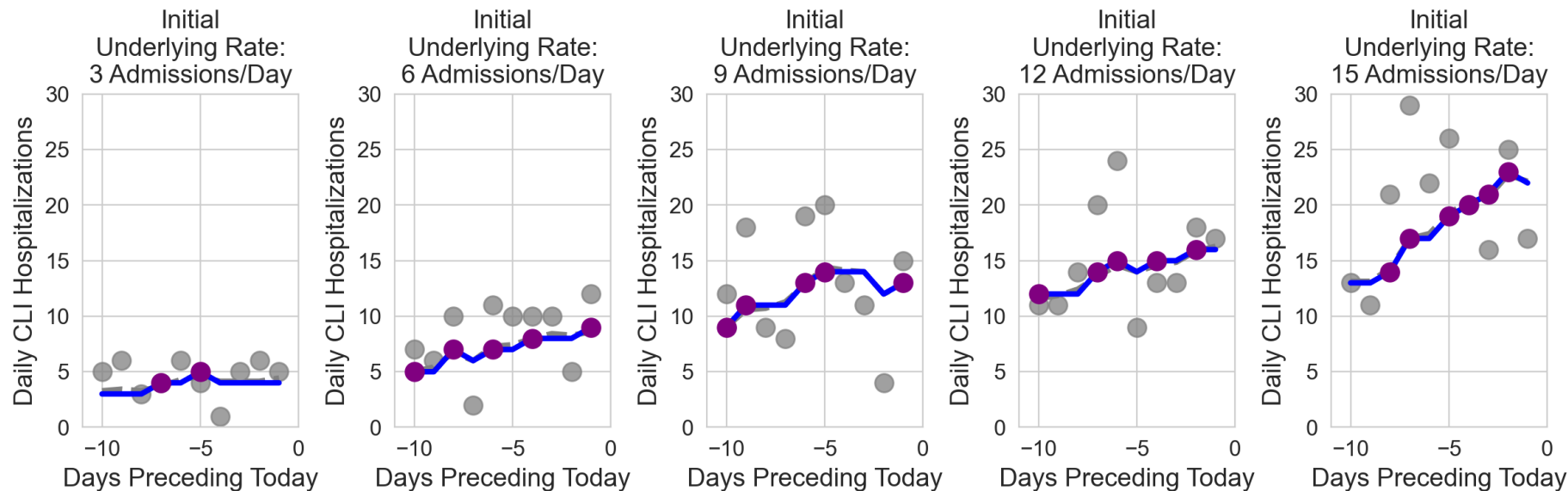
Given an underlying week-over-week relative increase in hospitalization rate, and the mean daily hospitalization level, we can assess the probability of the trigger being pulled

Grey region represents current range of average daily admissions for Regions 1-6: **very low probability of flagging a 50% week over week increase** using current criteria

Probability curve for an underlying week-over-week hospitalization rate increase of **50%** (doubling time ~12 days)
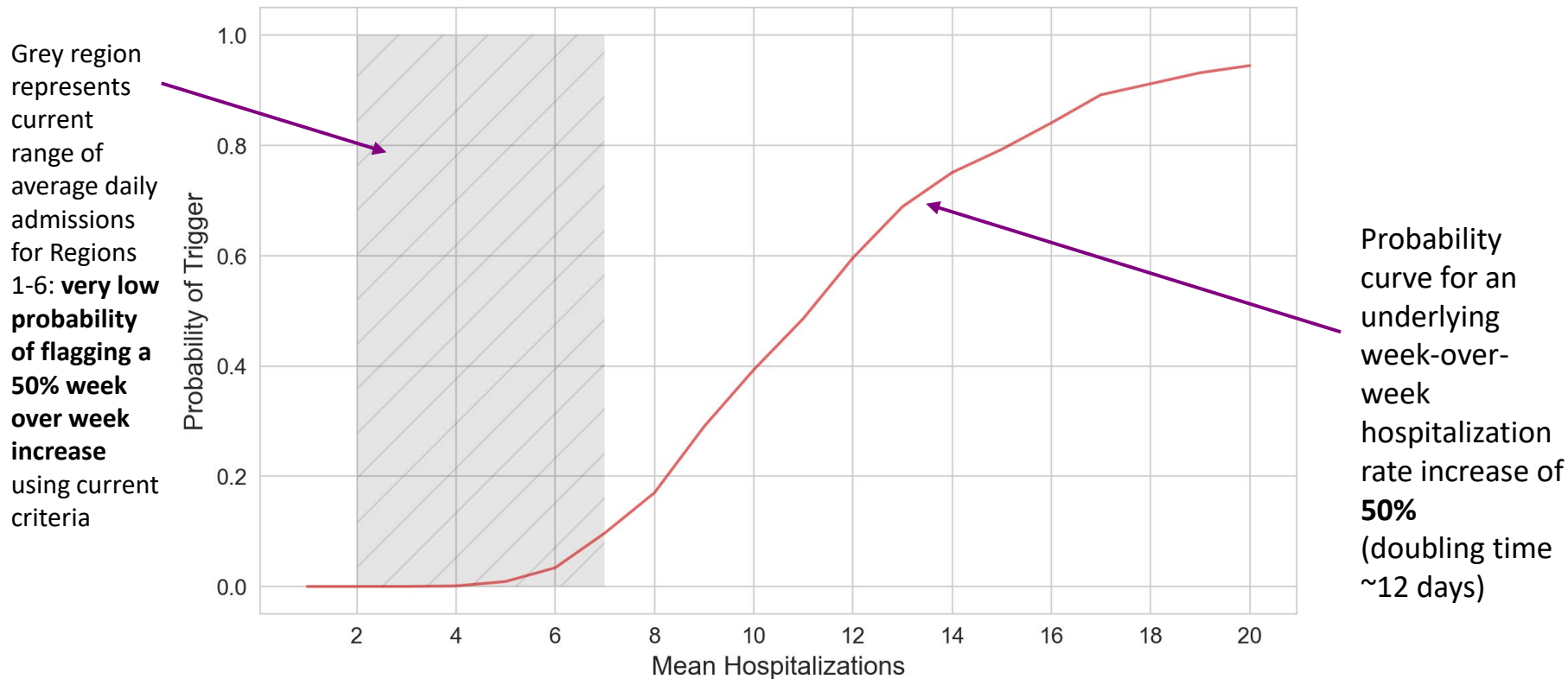
We can then calculate these same probabilities over a variety of week-over-week hospitalization rate increases

Current range of avg daily admissions, Regions 1-6

Underlying relative week-over-week increase in hospitalization rates
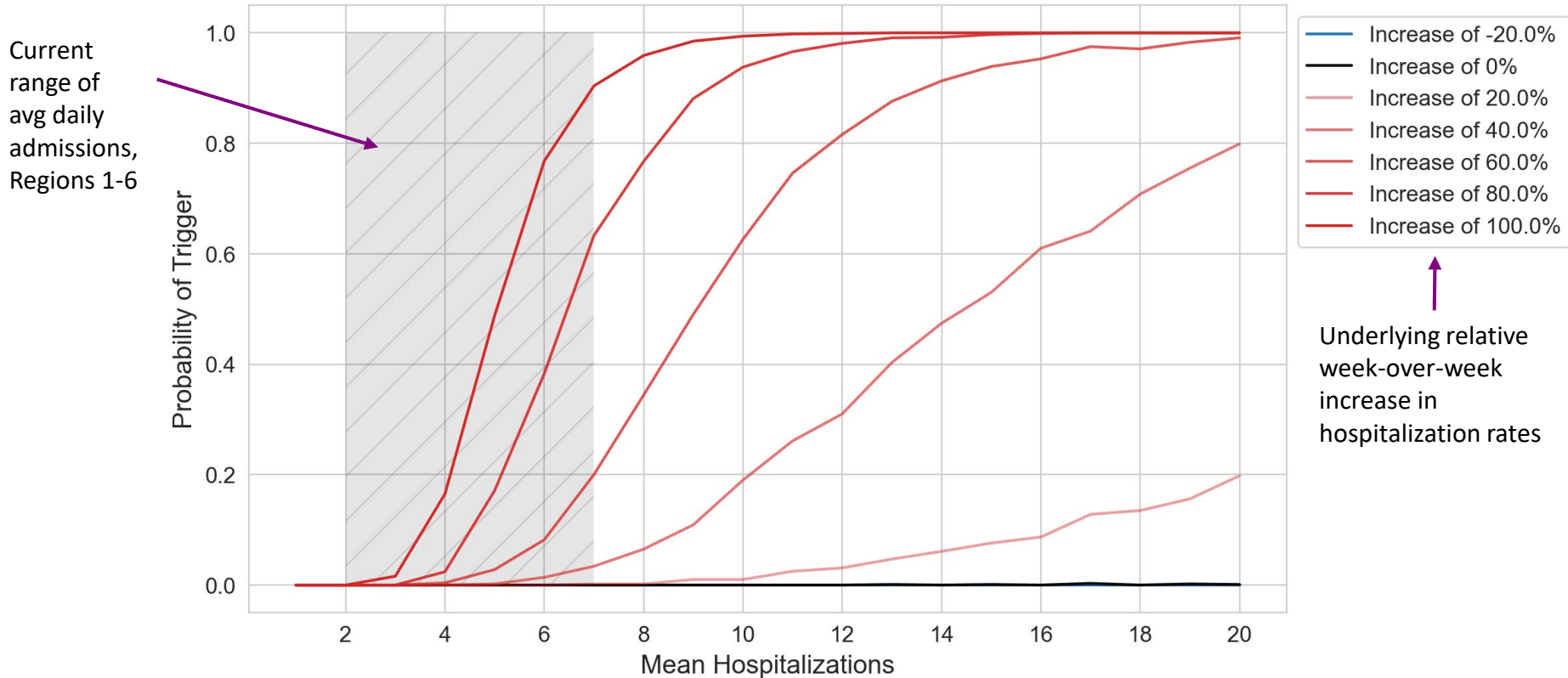
The metric in its current form is largely unresponsive to dangerous increases in the underlying rate of hospitalizations, especially for regions with fewer daily admissions
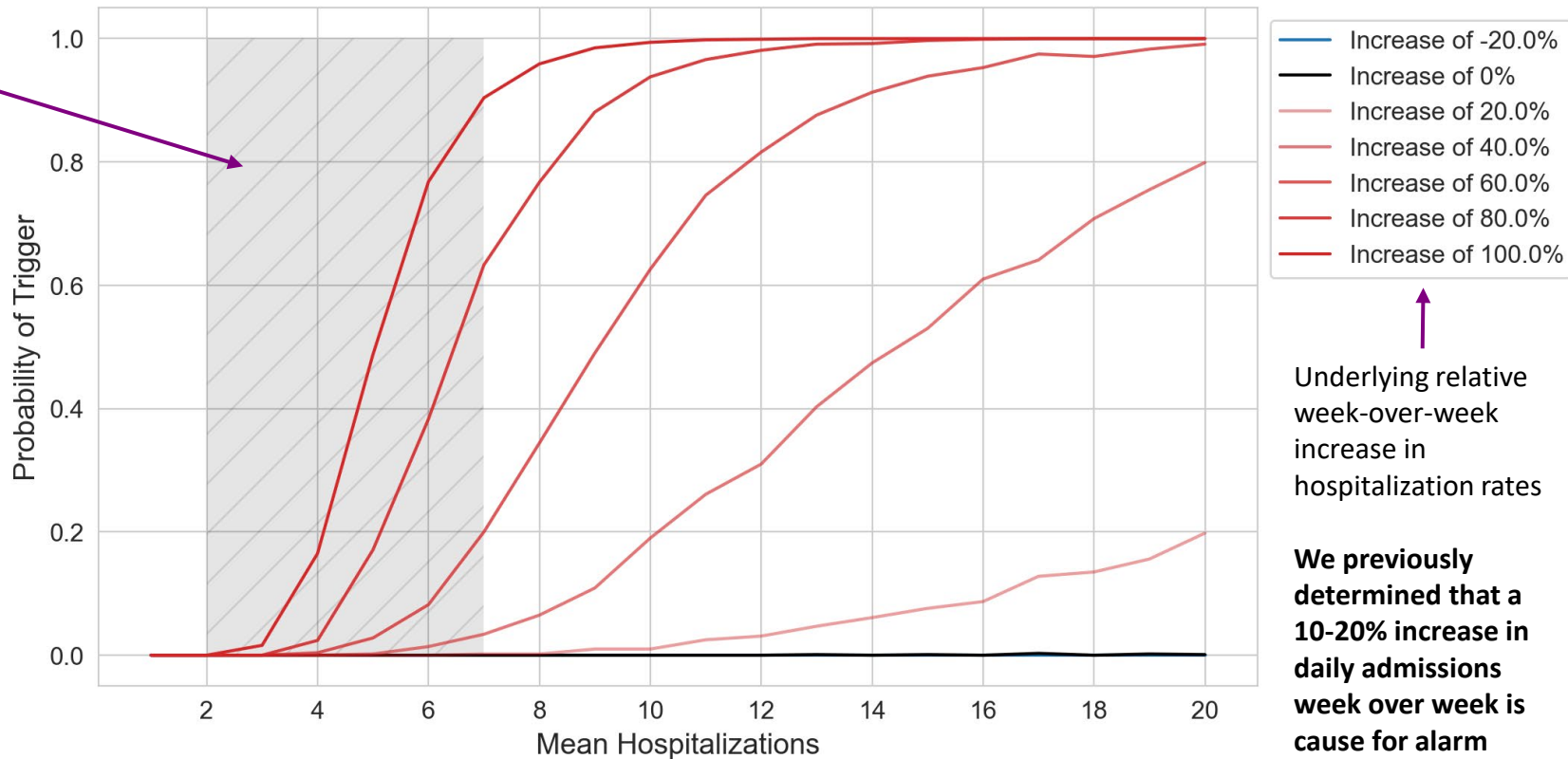

Current range of avg daily admissions, Regions 1-6

Dangerous increases in daily admission rate are rarely captured by this metric

Underlying relative week-over-week increase in hospitalization rates

We previously determined that a 10-20% increase in daily admissions week over week is cause for alarm

Legend:
- Increase of -20.0%
- Increase of 0%
- Increase of 20.0%
- Increase of 40.0%
- Increase of 60.0%
- Increase of 80.0%
- Increase of 100.0%

X-axis: Mean Hospitalizations
Y-axis: Probability of Trigger

How good is the current method at detecting increases?

- Using the current criterion, a region with a daily average of 4 CLI admissions (comparable to COVID Regions 1-6) would need to experience a **140% week-over-week increase in hospitalizations** for this trigger to be pulled more than 60% of the time

- This is equivalent to a doubling time of **~5.5 days**

- Since hospitalizations are lagging infections by ~2-3 weeks, this means **infections could have increased ~10-fold** in the intervening period

- By this point, a regional resurgence would be well underway and IDPH would have little time to introduce new mitigations to prevent capacity overflow

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Are there alternatives to the current hospital admissions criterion that can more reliably capture a dangerous increase in hospital admission rate in every region?

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Method 0: The current method

Increase in rolling mean of daily CLI admissions (rounded) on 7 of the last 10 days
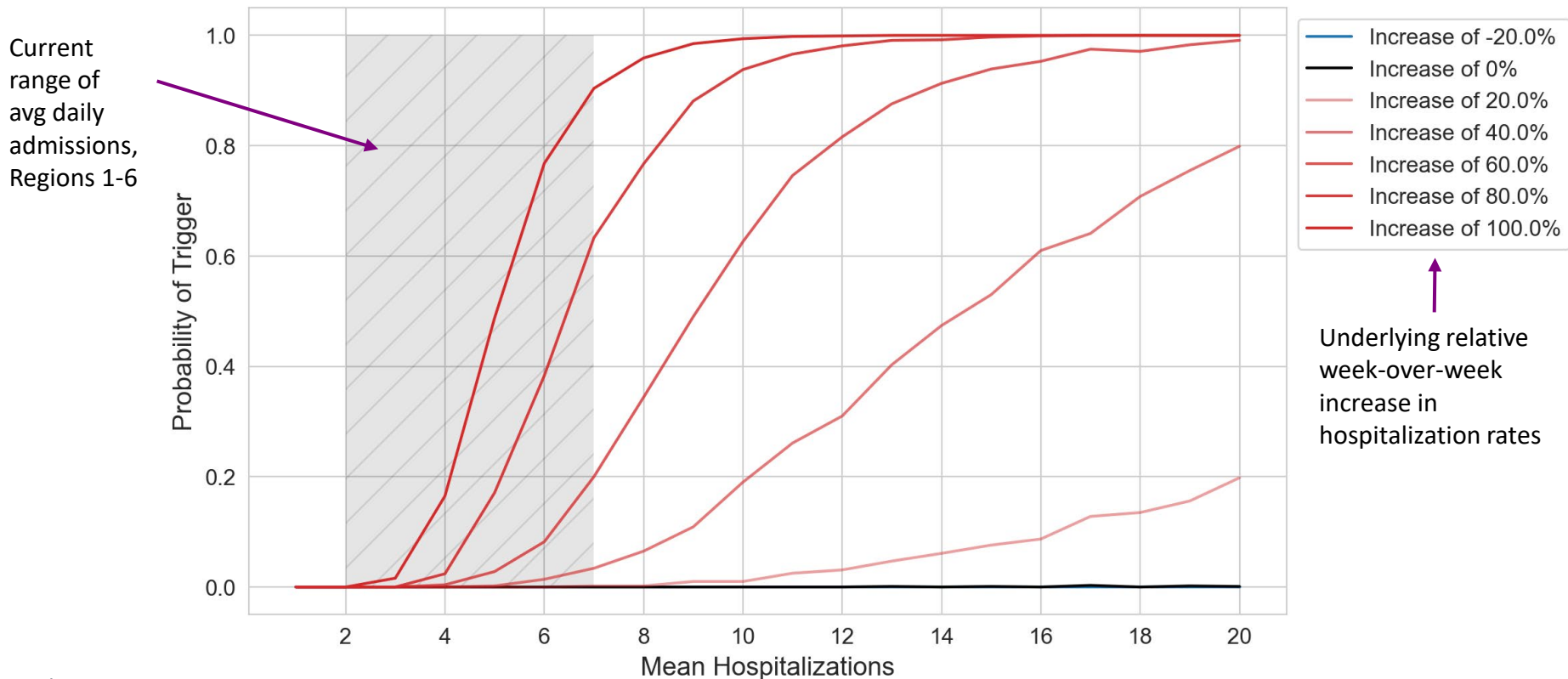
Current range of avg daily admissions, Regions 1-6

Underlying relative week-over-week increase in hospitalization rates

Alternative 1: The current method, without rounding
Increase in rolling mean of daily CLI admissions on 7 of the last 10 days

Current range of avg daily admissions, Regions 1-6

Legend:
- Increase of -20.0%
- Increase of 0%
- Increase of 20.0%
- Increase of 40.0%
- Increase of 60.0%
- Increase of 80.0%
- Increase of 100.0%

Y-axis: Probability of Trigger

X-axis: Mean Hospitalizations

Simply by removing rounding, sensitivity is greatly improved.
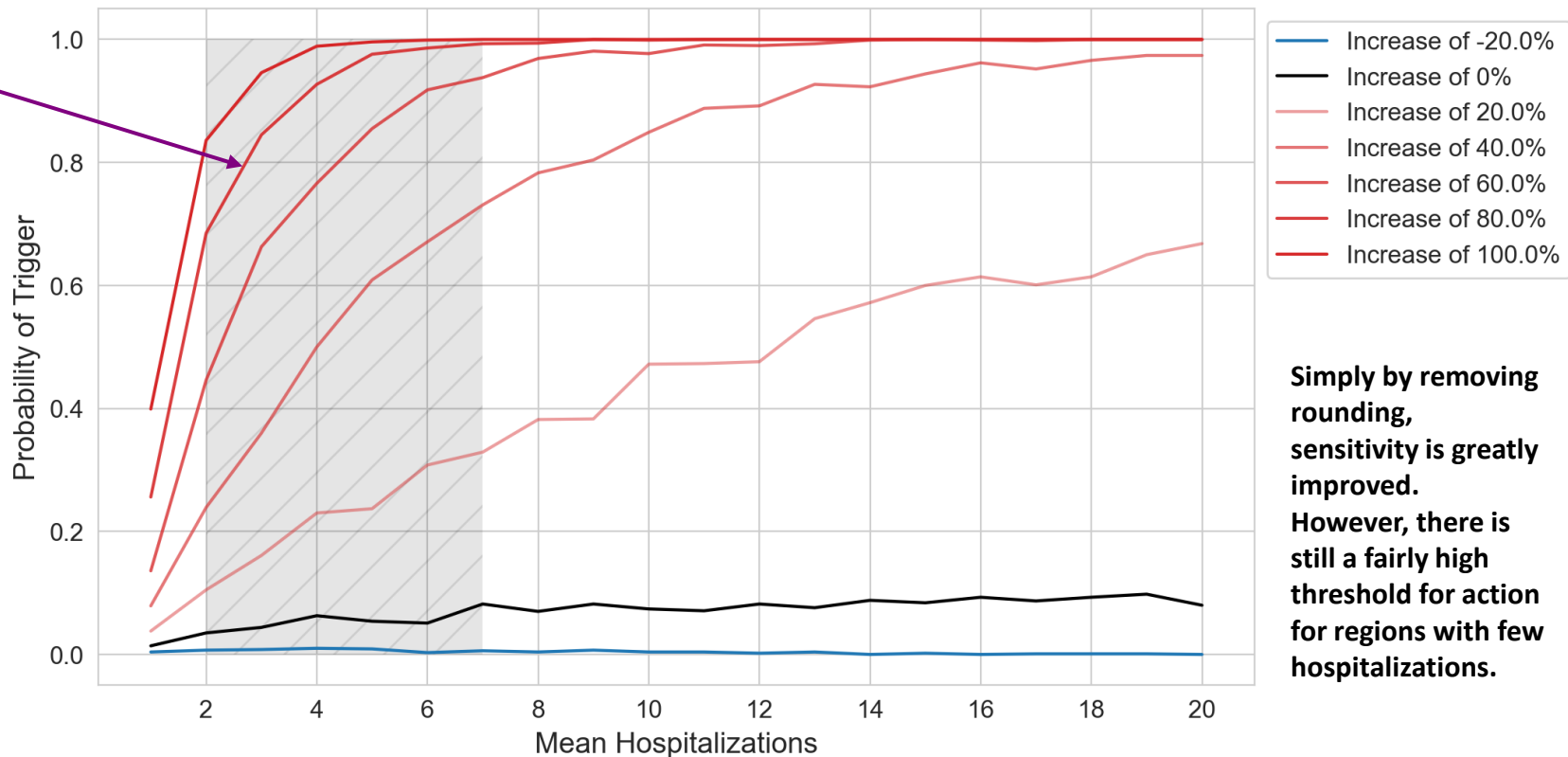**However, there is still a fairly high threshold for action for regions with few hospitalizations.**

# Alternative 1: The current method, without rounding
Increase in rolling mean of daily CLI admissions on 7 of the last 10 days

- Simply by removing rounding, a region with a daily average of 4 CLI admissions would only need to experience a **47% week-over-week increase in hospitalizations** for this trigger to be pulled more than 60% of the time (doubling time of **~12.6 days**) (compare to Method 0's **5.5 days**)

- Although a definite improvement on Method 0, Alternative 1 still leaves a lot of room for dangerous increases to occur before the trigger is reliably pulled

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Alternative 2a: 7-day linear fit

Linear fit of 7-day rolling mean of daily hospitalizations over last **7 days** shows a week-over-week increase of >15%

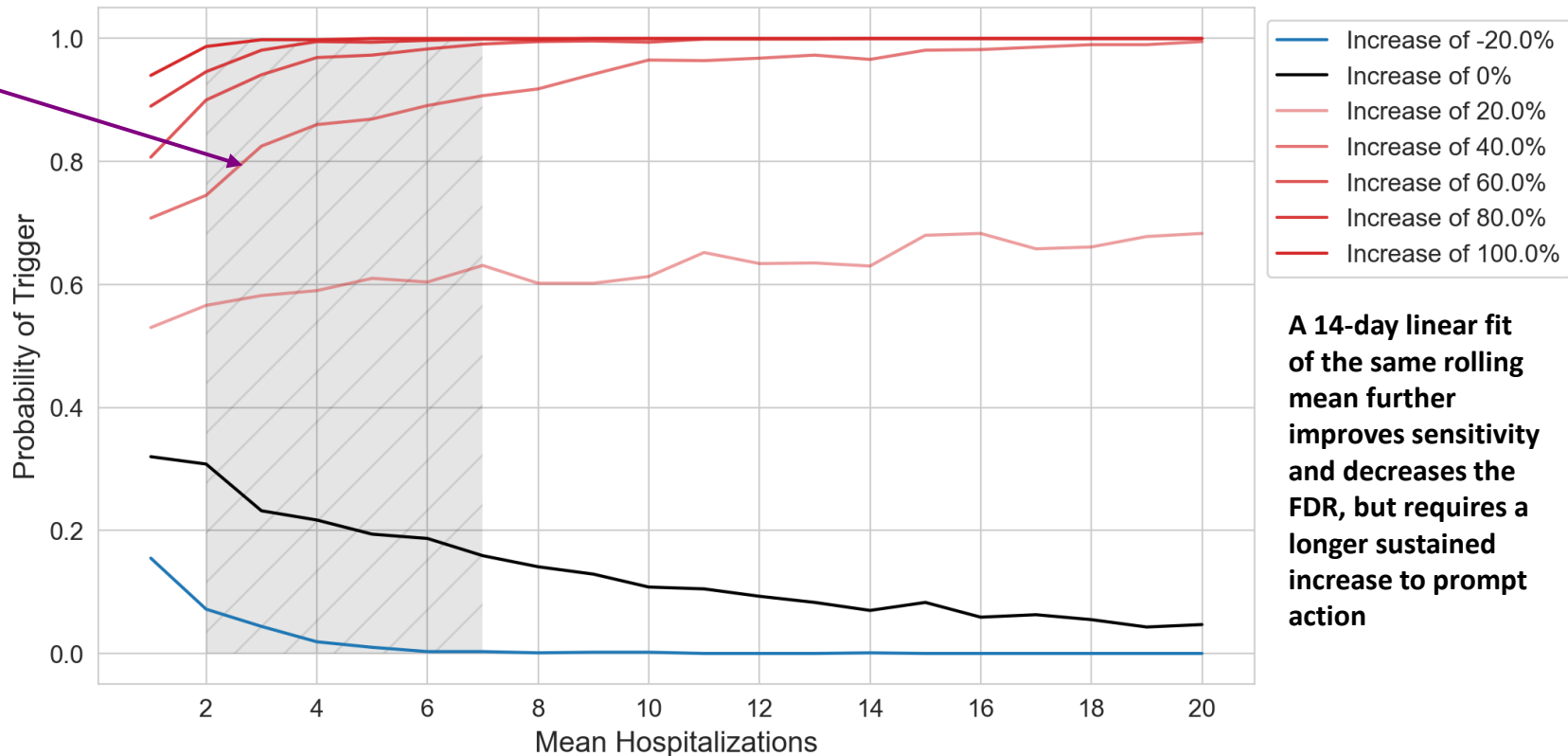Current range of avg daily admissions, Regions 1-6
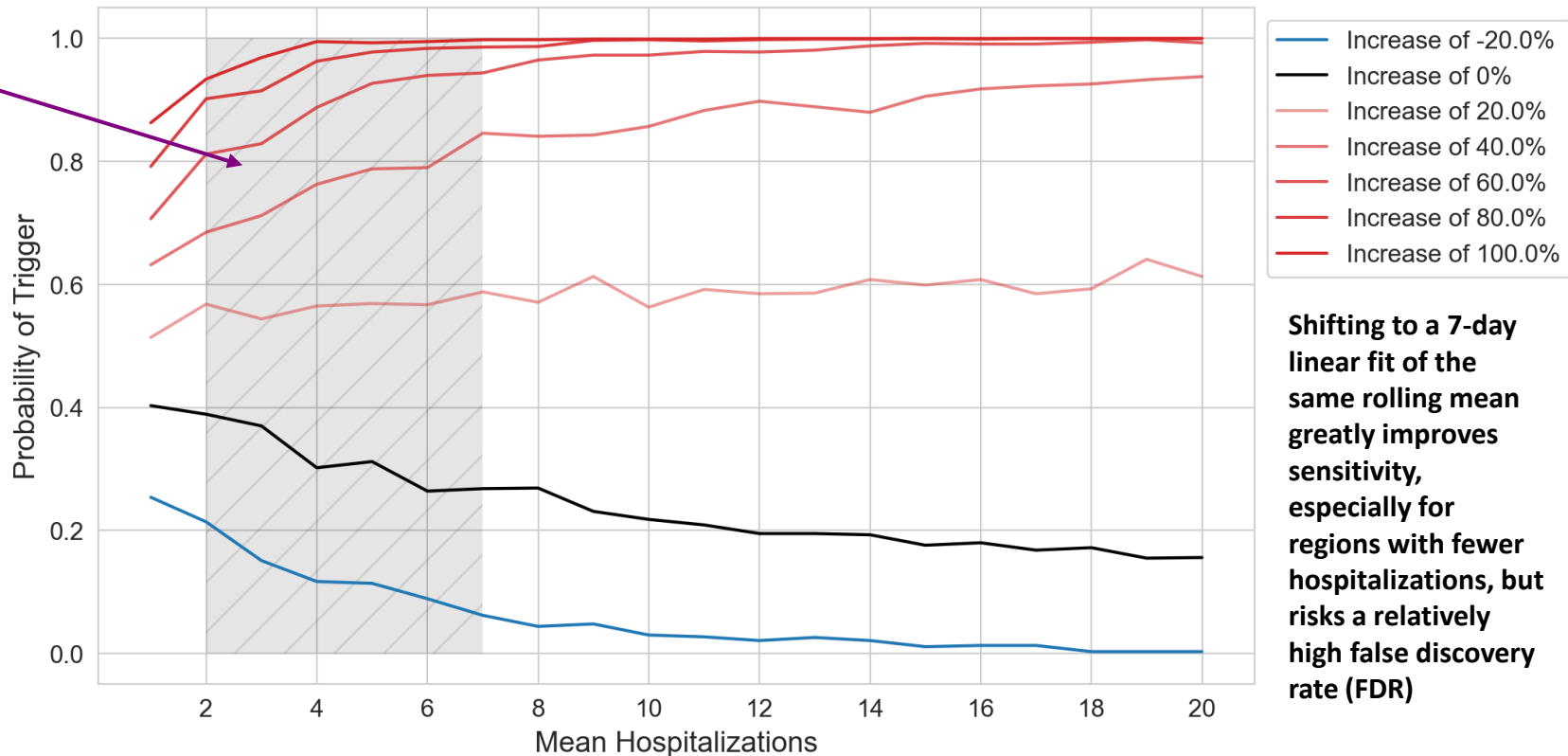
Shifting to a 7-day linear fit of the same rolling mean greatly improves sensitivity, especially for regions with fewer hospitalizations, but risks a relatively high false discovery rate (FDR)

Alternative 2b: 14-day linear fit

Linear fit of 7-day rolling mean of daily hospitalizations over last **14 days** shows a week-over-week increase of >15%

Current range of avg daily admissions, Regions 1-6

Legend:
- Increase of -20.0%
- Increase of 0%
- Increase of 20.0%
- Increase of 40.0%
- Increase of 60.0%
- Increase of 80.0%
- Increase of 100.0%

A 14-day linear fit of the same rolling mean further improves sensitivity and decreases the FDR, but requires a longer sustained increase to prompt action
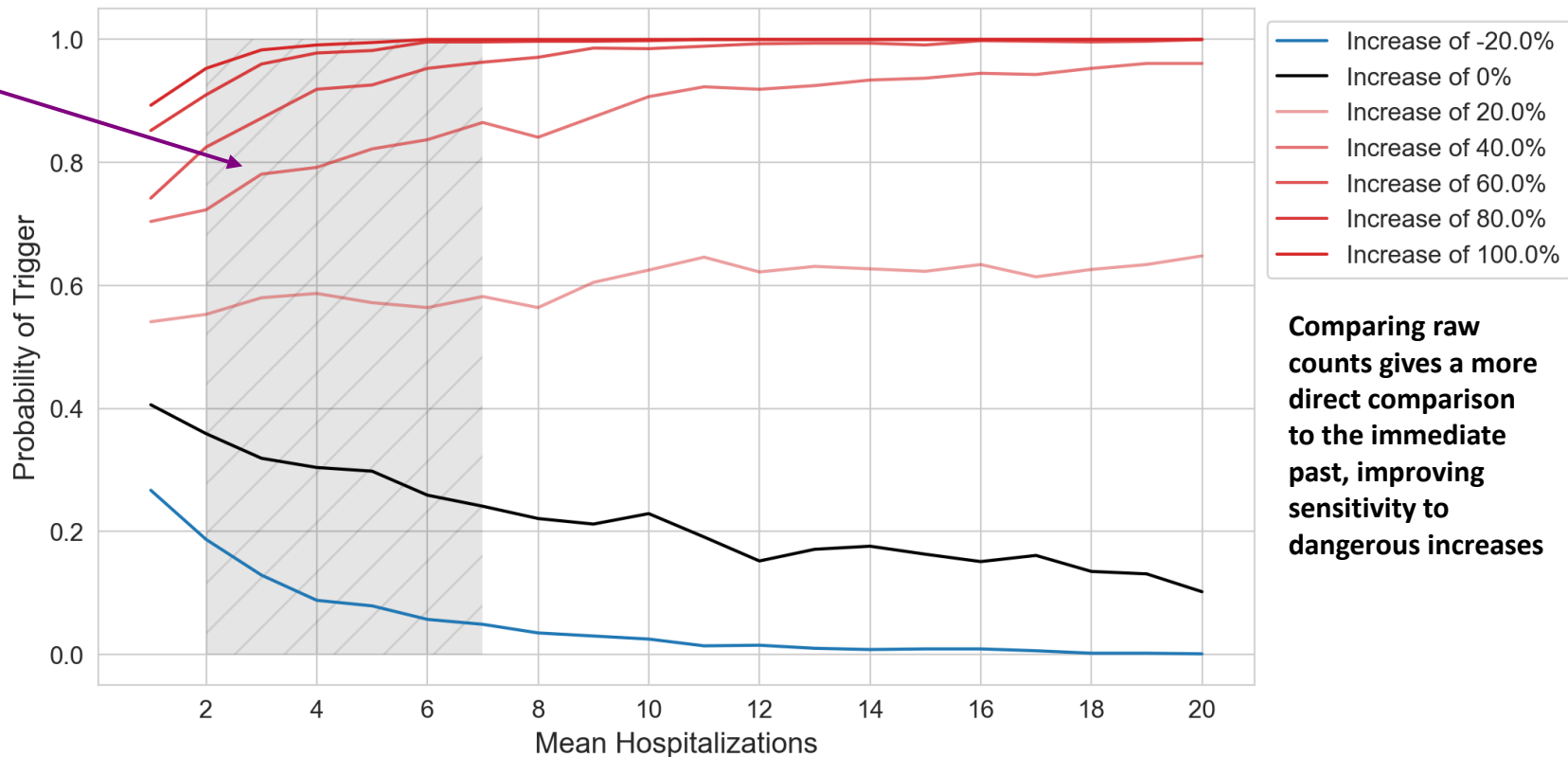
Alternatives 2a & 2b: linear fit

Linear fit of 7-day rolling mean of daily hospitalizations over last **7 days** or last **14 days** shows a week-over-week increase of >15%

- With Alternative 2a, a region with a daily average of 4 CLI admissions would need to experience a **25.0% week-over-week increase in hospitalizations** for the trigger to be pulled more than 60% of the time (doubling time of **~21.7 days**)

- With Alternative 2b, a region with a daily average of 4 CLI admissions would need to experience a **21.0% week-over-week increase in hospitalizations** for the trigger to be pulled more than 60% of the time (doubling time of **~25.5 days**)

- Alternative 2b is more sensitive than Alternative 2a, but requires a longer period of sustained increase to sound the alarm

- Although these alternatives risk a higher FDR in the case of no actual underlying increase, this could be mitigated by the inclusion of other indicators in the overall assessment (as IDPH already does)

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Alternative 3a: Comparing last week's counts to this week's

Sum of hospitalizations this week exceeds that of previous week by **>15%**

Current range of avg daily admissions, Regions 1-6

Probability of Trigger

Mean Hospitalizations

Legend:
- Increase of -20.0%
- Increase of 0%
- Increase of 20.0%
- Increase of 40.0%
- Increase of 60.0%
- Increase of 80.0%
- Increase of 100.0%

Comparing raw counts gives a more direct comparison to the immediate past, improving sensitivity to dangerous increases

Alternative 3b: Comparing last week's counts to this week's

Sum of hospitalizations this week exceeds that of previous week by **>20%**

Current range of avg daily admissions, Regions 1-6

Legend:
- Increase of -20.0%
- Increase of 0%
- Increase of 20.0%
- Increase of 40.0%
- Increase of 60.0%
- Increase of 80.0%
- Increase of 100.0%

Increasing the warning threshold from 15% to 20% decreases the FDR, but hurts sensitivity, which could cause some dangerous increases to be missed

Probability of Trigger

Mean Hospitalizations

Alternatives 3a & 3b: Comparing last week's counts to this week's
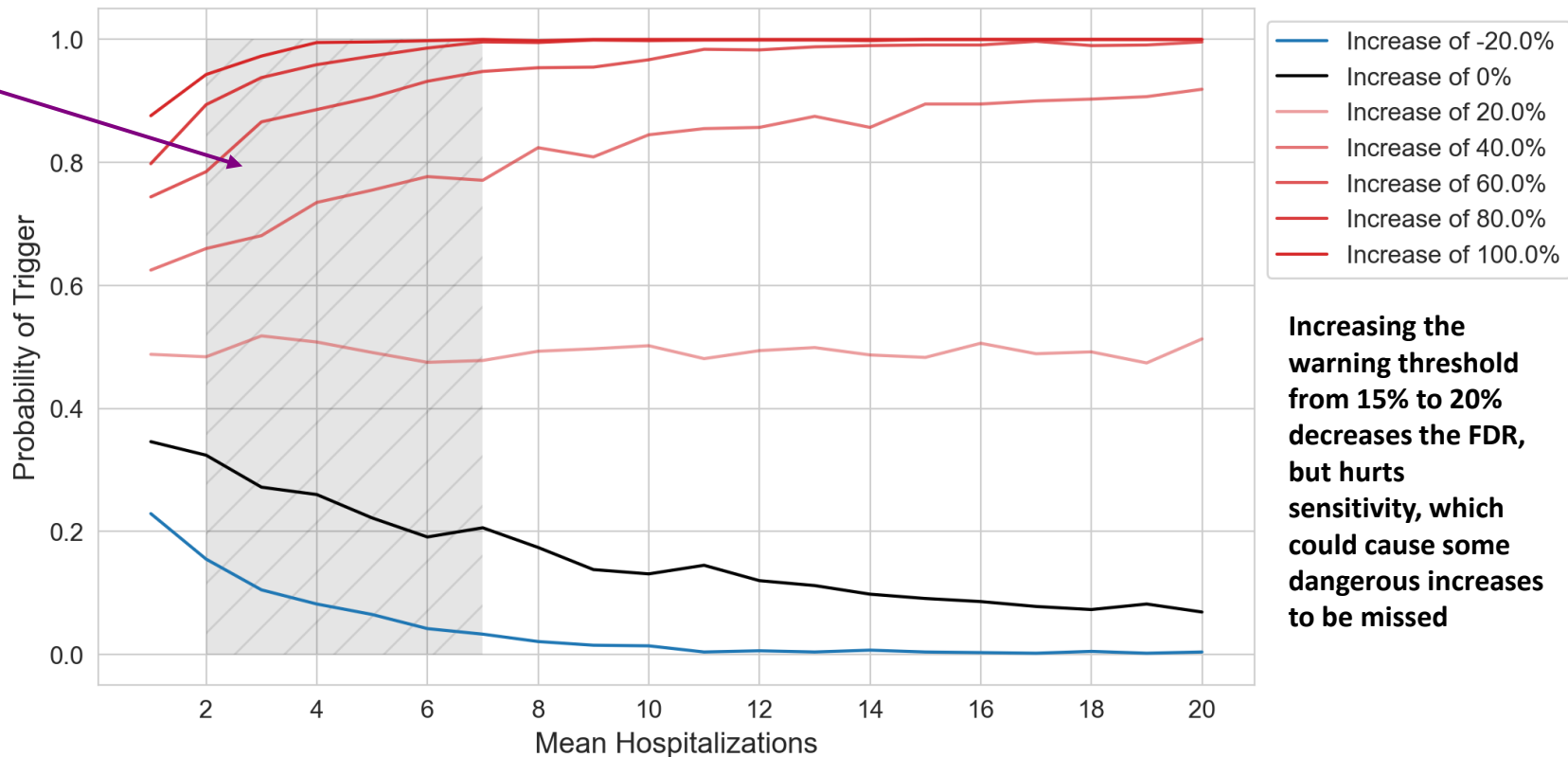Sum of hospitalizations this week exceeds that of previous week by **>15%** or **>20%**

- With Alternative 3a, a region with a daily average of 4 CLI admissions would need to experience a **22.5% week-over-week increase in hospitalizations** for the trigger to be pulled more than 60% of the time (doubling time of **~23.9 days**)

- With Alternative 3b, a region with a daily average of 4 CLI admissions would need to experience a **28.3% week-over-week increase in hospitalizations** for the trigger to be pulled more than 60% of the time (doubling time of **~19.5 days**)

- Although these alternatives also risk a higher FDR in the case of no actual underlying increase, this again can be mitigated by the inclusion of other indicators in the overall assessment (i.e. employ a "gating signal" to reduce the impact of false positives)

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Preliminary Conclusions

- We are trying to capture minute changes in the underlying distribution of a discrete random variable with a finite number of observations

- The current resurgence criterion based upon admissions is not sensitive enough to capture dangerous increases in hospital admission rates in **any region, but especially in COVID Regions 1-6**

- We previously demonstrated that reducing response time to increases like these by just a week could avert **hundreds of deaths**—the current criterion could delay response by several weeks

- The are alternative criteria that are far more sensitive to increases and would give IDPH much more time to react, especially in non-NE regions

- We recommend **Alternative 3a** as a substitute for the current criterion

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