Development and Implementation of a COVID-19 Risk Prediction Tool: Rapidly translating evidence into practice using a learning health system model

Emily Westbrook[1], David Arterburn[1], Yates Coley[1], Robert Frazier[1], Sharon Fuller[1], Paula Lozano[1], Roy Pardee[1], Tyler Ross[1], Sophia Mun[1], Kristine Rogers[1], Paul Thottingal[2], and Tolani Mwatha[2]

1. Kaiser Permanente Washington Health Research Institute; 2. Washington Permanente Medical Group

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Background

Paxlovid is the most effective oral treatment for preventing hospitalization and death in patients with severe illness from COVID-19 but is unlikely to alter symptom course for mild to moderate infections, especially in people 18 to 64 years old. It is costly, has side effects, and may require pharmacist management. Treatment guidelines are broad. **Health systems need rapid, evidence-based methods to identify patients most likely to benefit from Paxlovid.** This project leveraged the Learning Health System (LHS) Program at Kaiser Permanente Washington (KPWA) to develop, validate and implement a prediction model for estimating risk of hospitalization or death following COVID-19 infection in adults. KPWA now uses the model in clinical care settings to inform conversations between patients and providers about possible risk of severe outcomes and the likelihood that a patient will benefit from Paxlovid treatment. It can also be used to inform outreach efforts to members at high risk of severe infection.

Model development

KPWA researchers and clinical leaders partnered to develop and implement a COVID-19 risk model for the KPWA patient population. We used logistic regression with LASSO to identify predictors of hospitalization or death based on data from:

65,910 infections & 1,340 14-day hospitalizations or deaths among KPWA patients 18+ (training & validation sample), and

52,365 infections and 560 hospitalizations or deaths among patients 18-64 (performance measures sample, 4/1/2020 - 9/30/22)

19 predictors in the KPWA risk model

COVID vaccination	No COVID vaccination ever; Number of COVID vaccinations in past year; Only COVID vaccination past year in prior 2 weeks;
Age	Age (continuous); Age >=80 (categorical)
Race/ethnicity	Recorded race/ethnicity not non-Hispanic white
BMI	BMI >=30
Utilization	>10 ambulatory visits in past year
ACG score	12-month IP risk
Diagnoses (n=10)	Immunosuppressed, dementia, diabetes, peripheral vascular disease, congestive heart failure, autoimmune, chronic kidney disease, hepatitis, chronic lung disease
Documentation	Infection documented in EMR by a Dx code

Findings and implementation

The resulting model had an area-under-the-curve (AUC) of 0.80. When flagging those in the top 10% of risk, the model had 45% sensitivity. The model was integrated into KPWA's Epic instance in August 2023 to: 1) identify high-risk patients who could benefit from Paxlovid, and 2) allow providers to have data-informed conversations with patients who were unlikely to benefit. It took 10 months to develop, validate, and implement the model with provider education and operational dashboards for ongoing monitoring.

KPWA is currently using the model in primary care and urgent care service lines. All patients aged 65 and older are recommended for Paxlovid treatment, so risk thresholds and cutpoints were set for use among patients 18-64. However, the tool calculates a valid risk score for all patients and can also be used to estimate risk for patients 65 or older. **The operational dashboard is updated weekly** to track COVID encounters, frequency of model use, Paxlovid order rates, and severe COVID outcomes. These visualizations can be stratified by date, age group, COVID risk group, and provider department.

KPWA risk tiers (among 18-64 post omicron sample)

High risk: Recommended for Paxlovid treatment

- **Top 10%** of infections (risk score above 90th percentile)
- **Threshold >.85%** absolute risk
- **1.2%** event rate
- Captures an estimated **26% of events**

Lower risk: Not recommended for Paxlovid treatment

- All other infections are considered "low risk"
- **< 0.4%** event rate

Sample scripting for lower risk patients

"I do not recommend Paxlovid for you. Antiviral medication is intended to reduce the risk of hospitalization. (It does not make the symptoms go away any sooner or get any better.) It will not shorten your period of isolation. Your risk of hospitalization is less than 1% based on the history that I see in your chart. Paxlovid would reduce that by 80%, so an absolute benefit of 0.8% or less. I would not recommend this medication for you unless you have severe immunocompromise that we don't know about."

Consideration of health equity

Initial COVID-19 outpatient treatment patterns indicated that patients from minoritized racial and ethnic backgrounds were less likely to receive Paxlovid treatment — prompting us to explicitly consider health equity impacts throughout prediction model development and validation. When estimating the prediction model, we chose to include an indicator of minoritized racial and ethnic identity in our final model. This variable was not initially selected by the LASSO procedure, but we decided to include it in collaboration with health system partners. This factor was associated with increased risk of hospitalization and death, and **its inclusion leads to higher rates of Paxlovid treatment in communities experiencing health disparities.** When validating the model, we examined performance measures in racial and ethnic subgroups and found similar performance across all groups.

Implications for D&I science

To rapidly integrate evidence into practice, researchers and health systems need to partner closely. This project demonstrates a successful example of research-care delivery partnership that used established LHS infrastructure consisting of a team with expertise in transforming data into action. This led to a rigorously developed risk model that was made widely available across the health system in 10 months to support judicious use of Paxlovid. This partnership model and infrastructure can be emulated by other systems to speed the pace of evidence-to-practice integration.

Contact: Emily Westbrook Emily.O.Westbrook@kp.org

Learn more at act-center.org.

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