Development of an Adult Urgent Care Escalation Index (UCEI):

Multivariable Models Predicting Escalation to an ED visit, Observation Stay, or Inpatient Admission Within 7 Days of an Urgent or Convenient Care Encounter

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Background

- Acute care patients can clinically deteriorate shortly after an urgent/convenient care (UC/CC) visit, and identifying which patients may worsen may improve clinical outcomes.
- Models exist for ED, inpatient, and longitudinal outpatient risk prediction, but UC/CC-specific short-term escalation models are lacking.

Abstract

- **Objective**: Develop machine-learning models estimating the probability of escalation to a higher level of care within a week of UC/CC visits.
- **Design**: Retrospective multisite EHR registry study, Jan 2022–Dec 2023; adults ≥18 with in-person UC/CC visit and ≥3/5 vital signs.
- **Outcomes**: Composite escalation (ED visit, observation stay, or inpatient admission) within 1 day, 2–7 days, and 1 week; secondary: 15- and 30-day mortality.
- **Models**: XGBoost with Optuna hyperparameter tuning; 75/25 train/validation split; evaluated with AUROC, AUPRC, Brier score, and SHAP; 7-day XGBoost-Cox survival model.
- **Results**: AUROC 0.889 (1d) and 0.758 (2–7d); AUPRC 0.337 and 0.062; survival (from escalation) C-index 0.844, AUROC (1d) 0.892 and 0.816 for 15- and 30-day mortality.
- **Conclusion**: UCEI models provide clinically meaningful risk stratification for escalation within 1 week and are strongly associated with mortality within 30 days.

Model	UCEI 1D	UCEI 2-7D	UCEI Survival Model
AUROC (95% CI)	0.889 (0.883-0.895)	0.758 (95% CI 0.747-768)	0.845 at 7 days (0.840-0.850)
AUPRC (95% CI)	0.337 (0.321-0.353), 13.07x lift	0.062 (0.056-0.069) 3.91x lift	-
Brier Score (95% CI)	0.0463 (0.0456-0.0469)	0.0464 (0.0461-0.0466)	-
C-Index (95% CI)	-	-	0.844 (0.838-0.849)

Table 1. Discrimination and Calibration Performance of UCEI Models.
Abbreviations: AUPRC, area under the precision-recall curve; AUROC, area under the receiver operating characteristic curve; CI, confidence interval; C-index, concordance index

Methods

- **Data source:** Mercy Health Epic EHR (2022–2023), multisite UC/CC registry study for model derivation and internal validation.
- **Inclusion**: Adults ≥18; in-person UC/CC encounter; ≥3/5 vitals (SBP, HR, RR, SpO_2, temp); ≥1 prior encounter in past 2 years.
- **Exclusion**: Workers' compensation visits; hospice or palliative care at index visit.
- **Variables**: Curated across 7 domains: vitals, sociodemographics, current medications, healthcare utilization, diagnoses, comorbidities, and care-setting attributes.
- **Modeling**: Gradient-boosted trees (XGBoost) with stratified 5-fold cross-validation; Optuna hyperparameter tuning to optimize AUPRC.
- **Validation**: Stratified 75% training / 25% validation split.
- **Performance**: AUROC (C-index)/AUPRC/Brier; interpretability via SHapley Additive exPlanations (SHAP); 7-day time-to-escalation via XGBoost-Cox survival.

Results

- N=680,703 adult UC/CC encounters.
- **Escalation prevalence:** 2.58% at 1 day; 1.59% at 2–7 days.
- **Mortality Prevalence:** 0.02% at 15-days; 0.03% at 30-days.
- **Strongest predictors:** Diagnoses and chief complaint, medication class (narcotic analgesics, antiemetics, and anticoagulants), vital signs (HR, SBP, a simplified National Early Warning Score [NEWS] score, temp., and SpO2), and care setting attributes (see figure 1).
- **Model Performance:** Summarized in table 1. UCEI Survival (from Escalation) Model demonstrated clear Kaplan-Meier separation (see figure 2).
- **Early Escalations:** More likely to have vital sign abnormalities, alcohol use, MO residence.
- **Later escalations:** Slightly older, higher comorbidity burden, current anticoagulants, calcium channel blockers, and corticosteroids, and more ED use and Observation stays.
- **Mortality Discrimination:** UCEI scores were strongly associated with short-term mortality, with AUROC 0.892 and 0.816 (1-day model) and 0.821 and 0.780 (2–7-day model) for 15- and 30-day mortality., respectively.

Discussion

- UCEI models achieved high discrimination for near-term (1-day) escalation and meaningful discrimination at 1 week.
- Models also strongly associated with mortality discrimination within 30-days.
- Potential applications: point-of-care decision support, targeted post-visit outreach, and care coordination workflows.

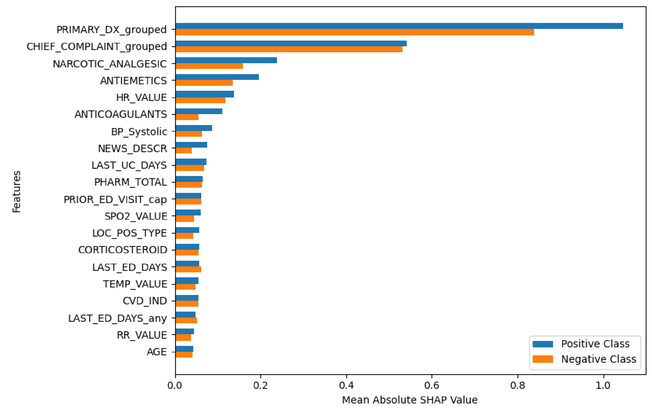

Figure 1. Comparison of SHAP Values between Classes on Test Set.

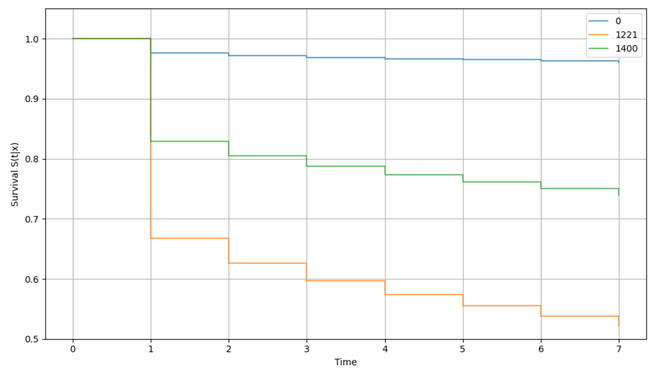

Figure 2. Example Subject Survival Curves (step functions)

Conclusion

- Developed and internally validated UC/CC-specific models to predict short-term escalation within 1 week.
- Models provide actionable risk stratification and are associated with mortality within 30 days.
- Future work should focus on workflow deployment to improve outcomes.