

## **Title: Interactive Visual Analytics with Causal Explanations to Support Clinicians to Understand Opioid Risk of Patients with Machine Learning**

**Overview/Abstract:** The opioid epidemic is the leading cause of death for those under 45 years old<sup>1</sup> and kills more than 130 Americans daily<sup>2</sup>. Although non-medical opioid use among 15-64 year-olds is problematic<sup>1</sup>, 18-25 year olds have the highest rates (7.8-8.5%) of non-medical prescription opioid use with past-year initiation in ~585,000<sup>3-5</sup>. However, due to stigma and low symptom severity, they are clinically seen infrequently, may underreport the extent of use<sup>6</sup>, yet are at high risk for developing OUD and sequelae<sup>7,8</sup>. Suffolk County had the most fatal ODs of any county in New York in 2017<sup>9</sup>, and in 2022, 92% were opioid-related<sup>10</sup>. Inadequate identification of high risk patients is a major unaddressed pathway for the development of OUD and opioid OD nationally<sup>11,12</sup>. Clinical opioid administration offers an opportunity for identifying at-risk patients, and a potential prevention opportunity for emerging adults and others at high risk. It is critical to identify those at highest risk for developing OUD or OD in acute care settings such as the ER where opioids are often administered or initiated.

Rigorous epidemiologic research has delivered no specific evidence-based prevention intervention for non-medical opioid use, so a major pathway for OUD onset and OD remains unaddressed.<sup>11,12</sup> In emergency department (ED)-based opioid exposure, tablet quantity and opioid prescription intervals predict transition to chronic opioid use,<sup>13</sup> itself a risk factor for progression to OUD and OROD,<sup>14</sup> so highly accurate opioid risk assessments and clinical decision support (CDS) when considering initiating opioid treatment are essential. Among patients ≥15 years old with SB Cerner EHR clinical encounters from 6/1/19 to 5/31/22, 103,300 had medical opioid exposure, 38.4% (39,660) via the ED; among the 88,230 15-to-25 year-olds, 8,740 (9.9%) were opioid-exposed, 58.2% (5,090) via the ED.

Deep learning (DL), a powerful AI paradigm for building effective prediction models for healthcare use, leverages large scale EHR data and reveals the hidden relationships among data elements<sup>15</sup>. Different from inferential models, DL-based modeling is like a black-box for understanding the predictions<sup>16</sup>, so the numerous and at times non-mechanistic features used may be difficult for clinicians to interpret, impeding adoption into clinical decision support (CDS). As a major disconnect between developers, clinicians and patients needed to be addressed, we developed an iterative feedback strategy called Stakeholder-in-the-loop (SITL) to optimize predictive models that are: reduced in potential bias and stigma, clinically valid, useful, relevant, and potentially implementable for routine CDS. Building on our prior DL modeling approach to opioid risk<sup>17</sup>, this OVPR seed grant study will develop, validate and conduct pilot implementation of a novel information display method<sup>18</sup>, whereby the high-importance input features of a validated DL opioid-risk prediction model can be manipulated individually or in face-valid sets as to their relative contribution to a risk determination, to reveal a relational visual construct that reveals causal models, even for non-clinically intuitive features. The data can be represented at the population- or the patient- level for directly-observable comparison, which can build needed trust in the DL model during a clinical encounter.

**Specific Aim 1: Develop Visual Analytics Tool with Causal Explanations for Clinicians to Understand Patients' Opioid Risk**

**Specific Aim 2: Engage Clinicians for Iterative Evaluation and Refinement of the Tool**