Project CODE-PRO

Capturing Opioid Use Disorder Electronically and Patient Reported Outcomes

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Yale SCHOOL OF MEDICINE

National Drug Abuse Treatment Clinical Trials Network

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Contents

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2. Project Overview, Goals and Objectives

The goal of Project CODE-PRO (Capturing Opioid Use Disorder Electronically and Patient Reported Outcomes) was to build clinical data research infrastructure that will begin to enhance capacity to use electronic health record (EHR) data and patient reported outcomes measures (PROs) to conduct opioid-related research in emergency departments (EDs). The project builds data capacity for research in four main areas, including standardized collection of standardized clinical data, collection of participant-provided information, linking of clinical and other data for research, and use of clinical data for research in ED settings. As such, the project included three distinct tasks and objectives, including:

1. Identifying existing or potential common data elements (CDEs) for OUD that are relevant to the ED setting (Task 1)
2. Demonstrating that CDEs from the EHRs can be transmitted or integrated into the American College of Emergency Physicians (ACEP) Clinical Emergency Data Registry (CEDR) (Task 2)
3. Exploring the feasibility and acceptability of collecting PRO measures electronically in patients with non-medical opioid use in the ED setting (Task 3)

Together, these tasks were designed to improve interoperability and linkages between EHRs, research networks and registries for research relevant to the opioid epidemic. Enhanced clinical data research infrastructure in ED settings has the potential to facilitate research to address key strategic priorities, such, as improving access to treatment and recovery services, promoting use of overdose-reversing drugs, providing support for cutting edge research on addiction and pain, and advancing better practices for management of OUD and pain.

3. Background

There are challenges in using EHR data for research and to optimize patient outcomes in the field. The inclusion of opioid relevant CDEs in clinical data registries and EHRs would improve the quality of research in the field. Researchers in the field need to be able to use outcome data points that are already in the EHR, collected as a part of clinical practice. EHR vendors have been slow to incorporate CDEs related to OUDs and clinical data on OUDs is not being collected in a uniform format. Inconsistencies abound in terminology and the types of information recorded about patients.

Therefore, this project was designed to enhance capacity to conduct patient-centered research focused on tracking and improving the quality of care at this important point of contact with persons with OUD. Enhanced EHR data infrastructure could provide benchmarking data and answer questions, such as how many providers provide naloxone or initiate buprenorphine for OUD or whether improving initiation of treatment or focusing on quality metrics can improve readmission rates or treatment referral. Potential end users of this research include researchers, research networks, registry representatives, ED physicians, and entire health systems.

Below is a list of objectives and deliverables included in this project, which were accomplished between May 2018 and February 2021.

Objective	**Deliverables**
Task 1: Identify OUD-relevant CDEs for ED setting	• Conduct literature review and environmental scan • Develop data dictionary for EHRs • Develop compendium of CDE and PROs • Develop technical report of findings
Task 2: Integrate OUD CDEs into ACEP CEDR	• Map OUD data elements to VSAC • Test CEDR OUD CDE • Develop OUD data dictionary • Develop report on OUD CDEs and CEDR
Task 3: Explore feasibility of electronic PROs	• Pilot PRO measures in ED setting, including protocol development, creation of electronic module, testing of EHR data integration, and demonstration of PRO module prototype • Deploy PROs and feasibility testing in ED setting • Develop implementation guide • Develop manuscript for publication

4. Methodology

Overall, this project employed a variety of strategies to enhance capacity to use EHR data to conduct opioid related clinical research in the ED. Task 1 included a comprehensive literature review and environmental scan to identify CDEs relevant to OUD. Task 2 included the mapping, integration and testing of electronic OUD data elements in select test sites involved in the ACEP CEDR registry. Task 3 included a pilot feasibility study to collect PROs electronically from patients with OUD in an ED setting. Major accomplishments for each of these tasks are outlined below.

5. Major Accomplishments

5.1 Literature Review and Environmental Scan

To identify CDEs relevant to OUD, a systematic literature review of publications was conducted in Medline, Embase and the Web of Science using a combination of at least one term related to OUD and EHR. An environmental scan was also conducted of publicly available data systems and dictionaries used in national informatics and quality measurement or policy initiatives. Opioid-related data elements identified within the environmental scan were compared with related data elements contained within nine common health data code systems and each element was graded for alignment with match results categorized as “exact”, “partial”, or “none.”

A complete description of results is available in our publication below but in short, the literature review identified 5186 articles for title search, of which 75 abstracts were included for review and 38 articles were selected for full-text review. Full-text articles yielded 237 CDEs, only 12 (5.06%) of which were opioid-specific. The environmental scan identified 379 potential data elements and value sets across 9 data systems and libraries, among which only 84 (22%) were opioid-specific. We found substantial variability in the types of clinical data elements with limited overlap and no single data system included CDEs across all major data element types such as substance use disorder, OUD, medication and mental health. Relative to common health data code systems, few data elements had an exact match (< 1%), while 61% had a partial match and 38% had no matches.

Despite the increasing ubiquity of EHR data standards and national attention placed on the opioid epidemic, we found substantial fragmentation in the design and construction of OUD-related CDEs and little OUD-specific CDEs in existing data dictionaries, systems and literature.

Task findings were initially compiled in a technical report and compendium, which was submitted to NIDA, and then adapted to a manuscript published July 2020 in the Journal of Addiction Science &

Clinical Practice. The compendium is available on the NIDA Drug Abuse Treatment Clinical Trials Network (CTN) Dissemination Library.

5.2 Integration with ACEP CEDR

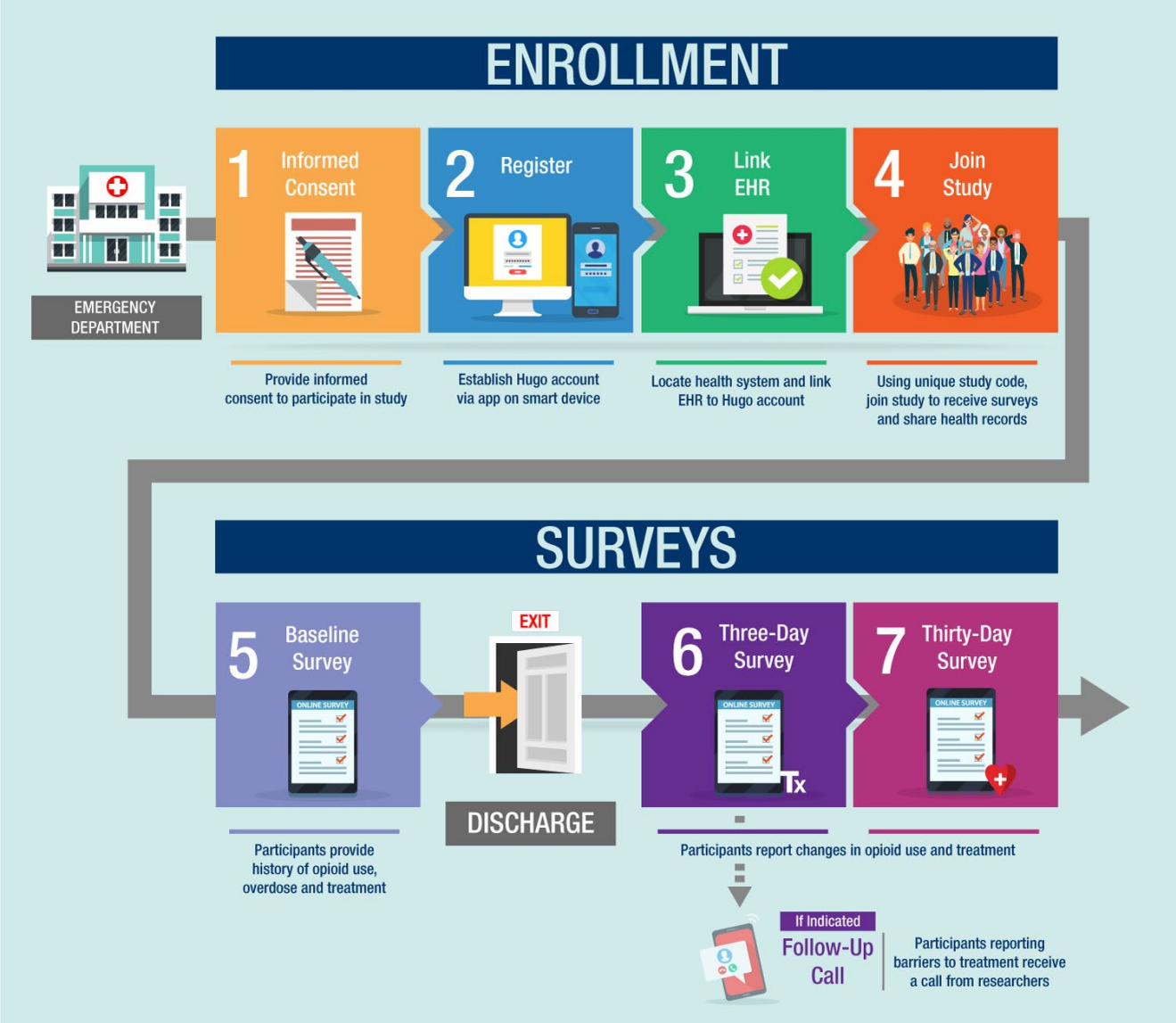
To facilitate harmonized measurement of OUD in ED EHRs, this study conducted validity and feasibility testing of OUD-related data components within the American College of Emergency Physicians' (ACEP) Clinical Emergency Data Registry (CEDR). ACEP CEDR is the premier emergency medicine data registry qualified by the Centers for Medicare and Medicaid Services (CMS) as a Quality Payment Program reporting tool for emergency medicine clinicians and health systems, which collected data from over 26 million ED visits occurring at over 800 EDs across the U.S. in 2019. Four sites participated in the study chosen from diverse geographic and EHR vendors including Epic, Medhost, Cerner, T-Systems, and Meditech. Four assessments were conducted, including automated extraction of data meeting criteria for an opioid-related emergency care visit, manual chart review, feasibility scorecards, and qualitative interviews with the data extractors and manual chart reviewers. The study was approved by the Yale University Institutional Review Board.

Validity testing demonstrated correct or partially correct data >90% of the time for most data elements across the four sites. Factors affecting validity included: lack of standardization, data incorrectness, problems with text normalization, and lack of a clearly defined delimiter to separate ED versus hospital care. Feasibility testing for sites demonstrated overall moderate-high assessments, but highlighted some variability within data sections, low-moderate feasibility of date components and social components, significant EHR platform variation, and inconsistency of the use or ability to extract common national data standards (ex. LOINC, ICD10 codes). Therefore, while some broad areas pertinent to OUD CDEs have clearly represented value sets and correspondence within a large emergency medicine registry, more specific/focused CDEs are not represented. The future development of quality measures, surveillance programs or research tools for OUD in the ED setting is selectively feasible but would be further enhanced by the structuring of EHR data for OUD specification and better methods to characterize ED care within the EHR.

Task findings were initially submitted to NIDA as an OUD data dictionary and formal report on OUD CDEs and CEDR outcomes. These findings were then adapted for a journal manuscript, which is currently in progress. Publications for the project will be posted on the NIDA CTN Dissemination Library when available.

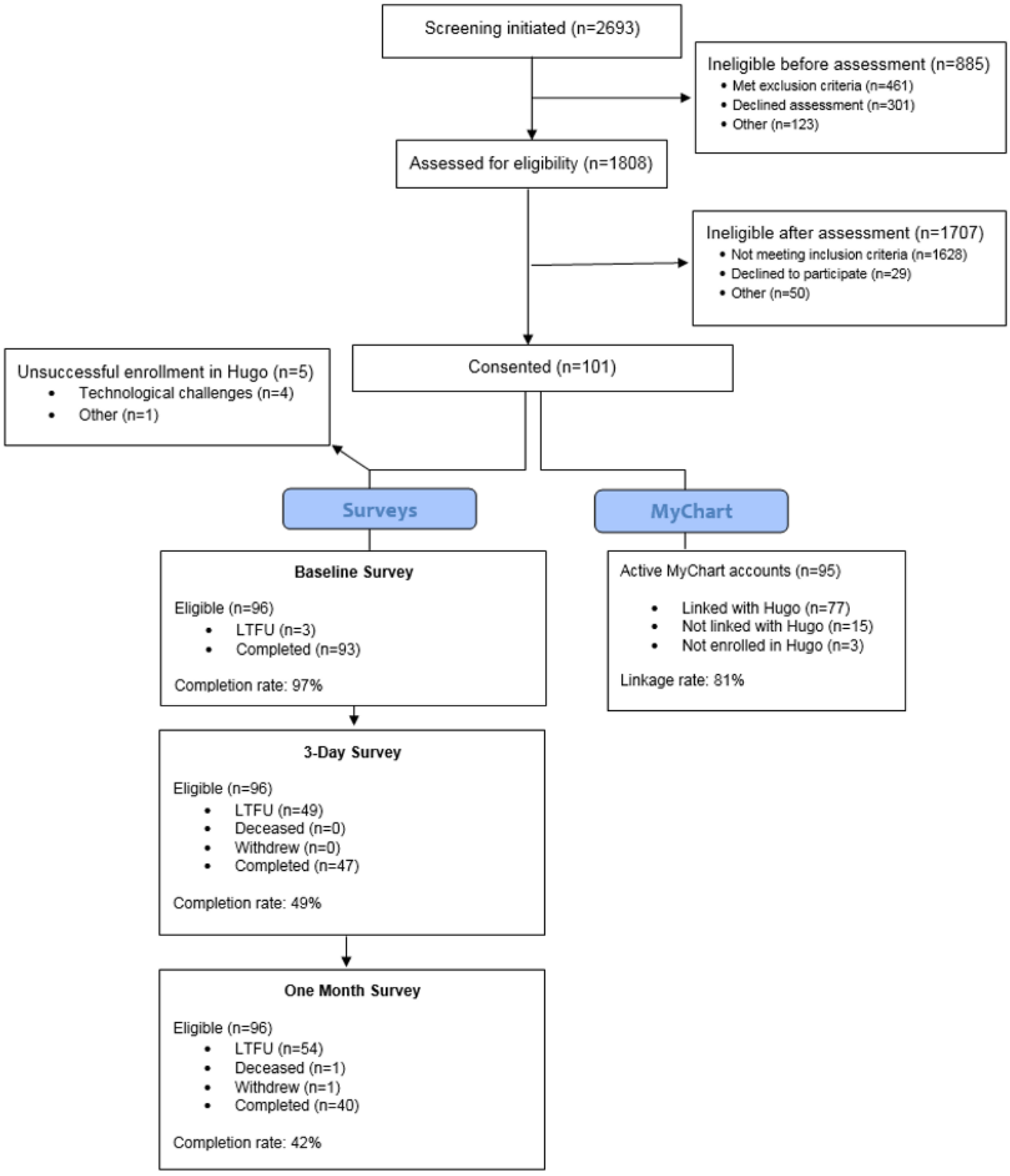
5.3 Deployment of Electronic PROs

To explore feasibility of electronic PRO collection, a pilot study was conducted among ED patients with non-medical opioid use or opioid overdose who endorsed willingness and ability to complete electronic surveys after discharge from a tertiary, urban academic ED. Participants were enrolled in a mobile health (mHealth) platform called Hugo Health, shared EHR with researchers, and completed electronic surveys of PROs at baseline, three- and thirty-days post discharge from the hospital. The study was approved by the Yale University Institutional Review Board. Below is a figure of study flow.



Among 1,808 patients assessed for eligibility between June-December 2019, 101 of 130 (78%) eligible adult patients consented to participate. Ninety-six (95%) of 101 patients completed registration in the

mHealth platform and 77/96 (80%) were successful in sharing their electronic health data. Completion rates for the baseline, three-day and thirty-day surveys were 97% (93/96), 47% (45/96) and 40% (36/91). A consort diagram of screening, enrollment and completion rates are included below.



It's important to note that while the three-day and thirty-day response rates are low, they are not entirely inconsistent with other ED and hospital-based follow-up surveys. There is a wide range of response rates for survey studies, many of which are impacted by the frequency of call attempts to participants. This study included only four attempts by either phone call and/or text in order to match usual ED clinical follow-up policies, which is well-suited to generalizing the use of this approach outside of research settings. However, four calls are fewer than the number of follow-up attempts that would be needed to maximize follow-up for strict research trials.

Implementation challenges included short engagement window during ED visit, limited access to smartphones/computers, insufficient device storage to download the mHealth app, forgotten emails and passwords, multi-step verification processes for account set up, and complaints about hospital care, most of which were effectively addressed by study personnel. A complete analysis of PROs is included in the manuscripts in progress below but in short, most PROs items did not differ by self-reported treatment status at 30 days. However, a significant decline in the mean overdose risk behavior item sum score (8.81+/-6.51 vs 5.71+/-6.14; p=0.05) and quantity of opioids used (1.15+/-1.19 vs. 0.61+/-0.86; p=0.016) was observed between the three- and thirty-day surveys. Nearly half (19/39) of participants reported treatment referrals and 31% (13/42) of 3-day surveys triggered a telephone call based on barriers to obtaining OUD treatment.

Based on study findings, ED patients with OUD were willing to share electronic health information and PROs, although implementation challenges were common and about half of participants were lost-to-follow-up after hospital discharge at 30 days. Efforts to streamline communication and remove barriers to engagement are needed to improve the collection of PROs and pathways of care in patients with OUD outside of traditional healthcare settings. However, successful electronic collection of PRO data and sharing of EHR data from study participants following ED discharge with minimal staff burden demonstrates the feasibility of patient-centered outcomes measurement and the opportunity for ED follow-up to bridge potential lapses in linkage to OUD care.

Task findings have been shared in the implementation guide, which is available online in the NIDA CTN Dissemination Library, and will be published in the two relevant manuscripts in progress.

5.4 Ad Hoc COVID-19 Analysis

In addition to the deliverables prescribed at the beginning of this project, data and findings from Task 2 were used to conduct an ad hoc analysis of ED utilization and outcomes for substance use disorders

(SUDs) and mental health conditions during COVID-19. The objective was to describe trends in ED visitation and ED deaths for SUDs since January 2019 and through November 2020 of the current COVID-19 pandemic. The dataset included an ACEP CEDR sample of 170 community EDs across 35 states, with SUD, OUD, mental health and Alcohol Use Disorders (AUDs) defined by ICD-10 Value Sets vetted in Task 2. Using LOWESS visit trend curves and Poisson regression models to report incident rate ratios (IRR) comparing 2020 to 2019, we found that overall ED visits declined in the early pandemic period and then only moderately returned to pre-pandemic levels by November (IRR: 0.77, 95%CI: 0.76-0.78). ED visit counts for SUD demonstrated similar, however, more muted but sustained declines in ED visitation. Compared to 2019, monthly ED utilization for all SUD, AUD and OUD all declined to 77% (95%CI: 75%-77%), 70% (95%CI: 69%-72%) and 73% (95%CI: 69-78%) of 2019 visit counts in April 2020. While visits for AUD remained below 2020 monthly comparisons through September 2020, ED utilization for OUD returned to 2019 levels by July. In comparison, ED utilization for non-alcohol and non-opioid substances have declined more precipitously in the early pandemic period and have remained lower as well in subsequent months. Furthermore, we did not observe any regional differences in overall ED visitation trends despite substantial differences in COVID-19 burden.

Based on findings, we conclude that unlike overall ED visitation, which has been shown to have substantially declined and then returned to modestly lower counts during the COVID-19 pandemic, declines in ED utilization for SUD were more muted and rebounded to prior baselines earlier than even emergency conditions, such as acute MI and stroke. As health systems continue to prepare for rising COVID-19 patient volumes and overburdened hospitals, the essential role of the hospital-based ED in providing 24/7/365 access to care for people with SUDs and mental health conditions must not be overlooked. The sustained persistence of ED visits supports the notion that the ED continues to be the de-facto safety net for care for populations in crisis and is the last stronghold for patients without other access to interventions and linkage to treatment.

Complete findings from this ad hoc analysis will be published in the relevant manuscript in progress, listed below.

6. Lessons Learned

This work generated insights into the conduct of patient-oriented research, as well as opportunities for integrating research with clinical workflows. In Task 1, much was learned about not only the fragmented nature of CDEs captured in the study, but also the fragmented nature of data systems. Specifically, our

work revealed the need to use a comprehensive list of data systems or databases for searches of potential data elements as current workstreams result in each database carrying distinct data elements with little overlap.

In Task 2, much was learned about the lack of standard EHR data warehouses. For example, the lack of distinct data delimiting between ED and inpatient hospital or even ambulatory diagnoses in many EHRs will present a major challenge to any future research or implementation efforts dependent on valid diagnostic coding.

Finally, Task 3 findings highlighted the unique tradeoffs in moving from traditional in-person or telephone research methods to electronic platforms. While the staffing resource needs and burden of direct communication are removed by virtual platforms, the complicated enrollment and participant engagement process in the absence of in-person contact generates new research challenges. Furthermore, virtual engagement of patients precludes many other clinical interventions that are traditionally more easily integrated into in-person research, which raises the need for future mHealth research initiatives with specifically designed clinical integration to ensure long-term use.

7. Publications and Presentations

The Yale team presented project information at several venues during the project period, as outlined below. One article has also been published in a peer-reviewed journal and four additional articles are in progress.

7.1 Oral presentations

- **NIDA CTN 0081 Steering Committee Meeting**, October 29, 2018.
  Presentation titles: "Task 1: Identifying Common Data Elements" by Arjun Venkatesh, MD, MBA. "Task 2: Integrating Common Data Elements into the American College of Emergency Physicians' Clinical Emergency Data Registry" by Andrew Taylor, MD, MHS. "Task 3: Exploring Patient-Reported Outcomes" by Kathryn Hawk, MD, MHS.
- **ASPE Meeting:** "Addressing the Opioid Epidemic: Harnessing the Power of Data for Patient-Centered Research", November 17, 2018.
  Presentation title: "Project CODE-PRO: Capturing Opioid Use Disorder Electronically and Patient Reported Outcomes" by Arjun Venkatesh, MD, MBA.

- **NIDA CTN Data Science Workshop***,* September 18, 2019.

  Presentation title: "Natural Language Processing: State of the Art Methods for Addiction Science" by Andrew Taylor, MD, MHS.
- **American Medical Informatics Association (AMIA) Annual Symposium,** Nov 13, 2020.

  Presentation title: "Harnessing the Potential of Electronic Health Records for Patient-Centered Outcomes Research" by Andrew Taylor, MD, MHS.
- **Academy Health Annual Research Meeting**, June 14-17, 2021.

  Presentation title: "Harnessing the Potential of Electronic Health Records for Patient-Centered Outcomes Research" by Andrew Taylor, MD, MHS.

7.2 Journal Publications

- Venkatesh A, Malicki C, Hawk K, D'Onofrio G, Kinsman J, Taylor A. Assessing the readiness of digital data infrastructure for opioid use disorder research. Addict Sci Clin Pract 15, 24. 2020 Jul 10. https://ascpjournal.biomedcentral.com/articles/10.1186/s13722-020-00198-3

7.3 Manuscripts in Progress

- Task 2: Taylor A, Kinsman J, Hawk K, D'Onofrio G, Malicki C, Malcolm B, Goyal P, Venkatesh A. "Development and Testing of Data Infrastructure within ACEP's Clinical Emergency Data Registry (CEDR) for Opioid Related Research"
- Task 2: Venkatesh A, Janke A, Kinsman J, Rothenberg C, Goyal P, Malicki C, D'Onofrio G, Taylor A, Hawk K. "Emergency Department Utilization and Outcomes for Substance Use Disorders and Mental Health Conditions During COVID-19"
- Task 3: Hawk K, Malicki C, Kinsman J, D'Onofrio G, Taylor A, Venkatesh A. "Feasibility and Acceptability of Electronic Administration of Patient Reported Outcomes using mHealth Platform in Emergency Department Patients with Non-Medical Opioid Use"
- Task 3: Hawk K, Malicki C, Kinsman J, D'Onofrio G, Taylor A, Venkatesh A. "Capturing Opioid Use Disorder Electronically and Patient Reported Outcomes: Results from the CODE-PRO Study"

7.4 Shared Documents and Project Data

- The Compendium from Task 1 and Implementation Guide from Task 3 are currently available in the NIDA CTN Dissemination Library.
- The protocol and limited de-identified dataset from the pilot study conducted in Task 3 will be available at the NIDA Data Share Website.

8. Future Considerations

Several future opportunities to build upon this work exist. First, Task 2 demonstrates that several types of electronic data elements related to OUD, namely diagnostic codes and medications, are captured fairly well in the CEDR. Findings support potential efforts to develop quality measures designed to promote increased treatment and better outcomes for patients with OUD in the ED setting. Second, Task 2 of this project has generated early interest and demonstrated feasibility to develop process measures of naloxone dispensation upon ED discharge for overdose as well as a process measure of buprenorphine administration for patients with OUD or withdrawal. In addition, the observational analysis of ED visits for SUD conducted on an ad-hoc basis demonstrated the potential surveillance value of ACEP CEDR as an epidemiologic research tool. Future work should seek to leverage the largest national database of ED visits to conduct other real time assessments, as well as trigger warning signs of a worsening pandemic. Finally, Task 3, which was designed as a pilot feasibility analysis, is very well-suited to future work by demonstrating that several PRO surveys not previously captured electronically are feasible for electronic capture through mHealth applications. However, the moderate dropout rate and challenges faced with some survey questions demonstrate that substantial work is required to build PRO assessment tools that are less burdensome and more clinically valuable to participants.

9. Summary

This project completed multiple tasks designed to improve interoperability and linkages between EHRs, research networks and registries for research relevant to the opioid epidemic. With three separate but complementary tasks, this project identified OUD CDEs relevant to the ED setting, demonstrated the integration of relevant CDEs into ACEP CEDR test sites, and explored the feasibility of electronic collection of PROs in an ED setting. An ad hoc analysis that utilized Task 2 data was also used to explore ED utilization and outcomes for SUDs and mental health conditions during COVID-19. The end products and findings of study tasks are available online through the NIDA CTN Dissemination Library and NIDA

Data Share Website, as well as through current and future publications. Through dissemination, the project provides researchers with tools and datasets to enhance data collection, analysis and innovation related to OUD. Study tasks have helped develop the initial framework for improved OUD surveillance and digitization of healthcare delivery, which can be harnessed to improve healthcare quality for patients with OUD.