The Office of the National Coordinator for Health Information Technology

Synthea™ Module Companion Guide

PRESCRIBING OPIOIDS FOR CHRONIC PAIN AND TREATMENT OF OPIOID USE DISORDER

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Prepared by Clinovations Government + Health for the Office of the National Coordinator for Health Information Technology and approved for public release

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Introduction

Synthea™ is an open-source, synthetic patient generator, created by MITRE, that models the medical history of synthetic patients. Clinical disease modules are created using a combination of clinical care protocols and publicly available disease incidence and prevalence statistics. Synthea uses these modules to generate individual synthetic patient records, simulating the progression and treatment of disease from birth to death. Synthea Module Companion Guides serve to orient users to a specific Synthea module. The intended audience includes those who are reviewing a module under development and/or are interested in utilizing the module to generate synthetic patient data.

This document summarizes the scope and intent of the Prescribing Opioids for Chronic Pain and Treatment of Opioid Use Disorder (OUD) module. It provides details of the module states and contains a full list of references and data sources used to develop the module.

Module Description

Table 1: Prescribing Opioids for Chronic Pain and Treatment of OUD Module Metadata contains a list of metadata attributes that help describe the module, including but not limited to module steward, module developer, date of last update, and other descriptive information.

Table 1: Prescribing Opioids for Chronic Pain and Treatment of OUD Module Metadata

Metadata	Description
Title	Prescribing Opioids for Chronic Pain and Treament of Opioid Use Disorder
Module File Name	prescribing_opioids_for_chronic_pain_and_treatment_of_oud.json
Version Number	1.0
Last Updated	November 1, 2020
Module Steward	Office of the National Coordinator for Health Information Technology (ONC)
Module Developer	Clinovations Government + Health
Description	This module models the prescribing of opioids for chronic pain and treatment of opioid use disorder (OUD) for patients age >= 18. It is based on the Centers for Disease Control (CDC) Guideline for Prescribing Opioids for Chronic Pain. This CDC guideline provides recommendations for the prescribing of opioid pain medication by primary care clinicians for chronic pain (i.e., pain conditions that typically last >3 months or past the time of normal tissue healing) in outpatient settings outside of active cancer treatment, palliative care, and end-of-life care. The applicable year of this module is set to 2014 and after. This module does not address the transition from acute pain to chronic pain. The Treatment of OUD component of this module is modeled based on the American Society of Addiction Medicine (ASAM) National Practice Guideline for the Use of Medications in the Treatment of Addiction Involving Opioid Use.
Disclaimer	Synthea™ is an open-source synthetic patient generator, created by MITRE, that models the medical history of synthetic patients. This module is developed using the Synthea Module Builder and is limited to the capabilities of Synthea and the Synthea Module Builder. This Synthea module is not a clinical guideline, does not establish a standard of medical care, and has not been tested for all potential applications. THIS MODULE IS PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND.
Related Module(s)	The Opioid Addiction (opioid_addiction.json) module applies to the period prior to 2014.
Reference(s)	CDC Guideline for Prescribing Opioids for Chronic Pain — United States, 2016. (1) The ASAM National Practice Guideline for the Use of Medications in the Treatment of Addiction Involving Opioid Use, June 1, 2015. (2)

Module Diagram

A Synthea™ module diagram within the Synthea Module Builder is often large and complex to view, as it includes both clinical states and control states. It may be challenging for users to understand and navigate the module within Synthea, especially those who are new to the process. The purpose of the following Visio diagrams is to provide a high-level, simplified view of the module contents and flow so users understand the scope and main components of the module before diving into details.

Figure 1: Prescribing Opioids for Chronic Pain Visio Diagram

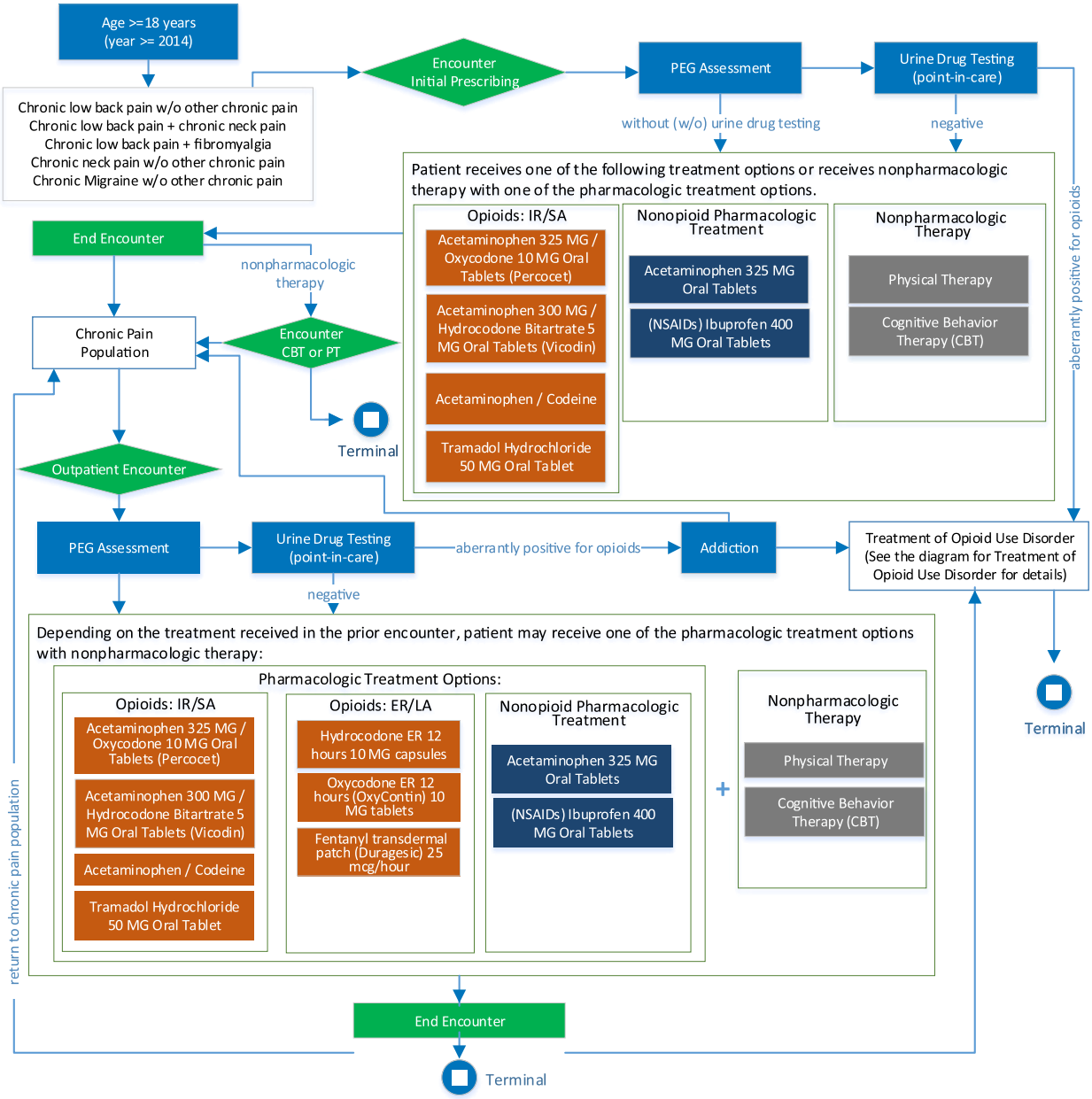
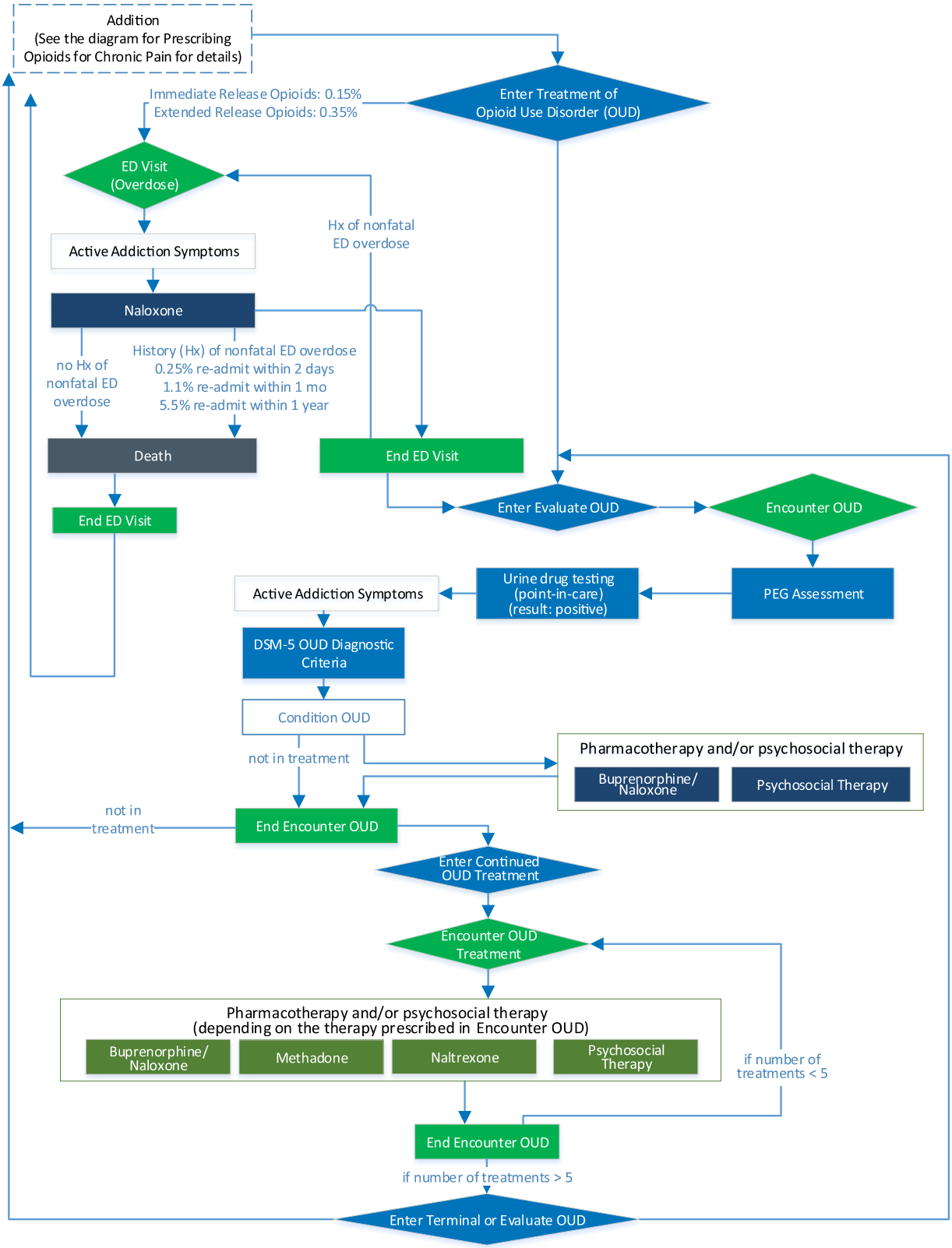


Figure 2: Treatment of Opioid Use Disorder Visio Diagram



Module States

Table 2: Prescribing Opioids for Chronic Pain and Treatment of OUD Module States provides details about each clinical and control state modeled within the module. State Names are modeled in the Prescribing Opioids for Chronic Pain and Treatment OUD module. The Type column indicates the Synthea state type used to define the state. State Remarks provides detailed documentation for each state, including notes, references, and data sources used to define probabilities. The Terminology column identifies the standard codes used to model the clinical states.

Table 2: Prescribing Opioids for Chronic Pain and Treatment of OUD Module States

State Name	Type	State Remarks	Terminology
Initial	Initial	Initial state of a module required by Synthea™.	n/a
Age_and_Module_Effective_Time_Guard	Guard	This Guard state ensures the module applies to patients age >= 18 years and is applicable to year 2014 and after.	n/a
General_Adult_Population	Delay	The Delay is set to 1 month. Module will not continue to the next stage until 1 month is passed.	n/a
Condition_Chronic_Low_Back_Pain	Condition Onset	Probability set to 9% of adult population having chronic low back pain without other chronic pain. Taking the average of 19.6% and 28.1% from both references cited below of adult population to have chronic low back pain. Further distributed as 9% for chronic low back pain without other chronic pain, 12% for chronic low back pain with chronic neck pain, and 3% for chronic low back pain with fibromyalgia. Assign to Attribute: chronic_low_back_pain_only Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain Reference: (3) Chronic low back pain prevalence was 4.2% in individuals aged 24 – 39 years old and 19.6% in those aged 20 – 59. Of nine studies with individuals aged 18 and above, six reported chronic low back pain between 3.9% and 10.2% and three reported prevalence between 13.1% and 20.3%. In the Brazilian older population, chronic low back pain prevalence was 25.4%. Reference: (4) Age-adjusted rate of U.S. adults reporting pain in the last 3 months, 2009. Low back pain, 28.1%.	System: SNOMED-CT Code: 278860009 Display: Chronic low back pain (finding)

State Name	Type	State Remarks	Terminology
Condition_Chronic_Neck_Pain	Condition Onset	Probability set to 3% of adult population having chronic neck pain without other chronic pain. Assign to Attribute: chronic_neck_pain_only Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain Reference: (4) Age-adjusted rate of U.S. adults reporting pain in the last 3 months, 2009. Neck pain, 15.1%.	System: SNOMED-CT Code: 1121000119107 Display: Chronic neck pain (finding)
Condition_Chronic_Neck_Pain_3	Condition Onset	Probability set to 12% of adult population having chronic neck pain with chronic low back pain (the Condition_Chronic_Low_Back_Pain_3 state). Assign to Attribute: chronic_neck_and_low_back_pain Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain	System: SNOMED-CT Code: 1121000119107 Display: Chronic neck pain (finding)
Condition_Chronic_Low_Back_Pain_3	Condition Onset	Probability set to 12% of adult population having chronic neck pain with chronic low back pain. Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain	System: SNOMED-CT Code: 1121000119107 Display: Chronic neck pain (finding)
Condition_Fibromyalgia	Condition Onset	Probability set to 3% (based on the estimate in the reference below) of adult population having fibromyalgia and chronic low back pain (the Condition_Chronic_Low_Pain_3 state). Assign to Attribute: chronic_low_back_pain_with_fibromyalgia Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain Reference: (5) Fibromyalgia affects an estimated 2% – 4% of the U.S. population or as many as 6 – 12 million people.	System: SNOMED-CT Code: 203082005 Display: Fibromyalgia (disorder)
Condition_Migraine	Condition Onset	Probability set to 1% of adult population having migraine. Assign to Attribute: migraine_only Diagnosed at Initial_Prescribing_Encounter_for_Chronic_Pain Reference: (6) In the US population, the prevalence of chronic migraine was nearly 1%.	System: SNOMED-CT Code: 427419006 Display: Transformed migraine (disorder)
Initial_Prescribing_Encounter_for_Chronic_Pain	Encounter	This is the initial prescribing encounter in the module for patient with chronic pain.	System: SNOMED-CT Code: 185347001 Display: Encounter for problem (procedure)

State Name	Type	State Remarks	Terminology
PEG_Assessment_Score_1	Multi Observation	Assessing pain and function using Pain, Enjoyment of life, General activity (PEG) scale as recommended in the CDC guideline. Set the pain score to a range of 1 to 10 for each question. Note that the lowest is set to 1 instead of 0. Q1: What number from 0 – 10 best describes your pain in the past week? 0 = "no pain," 10 = "worst you can imagine." Q2: What number from 0 – 10 describes how, during the past week, pain has interfered with your enjoyment of life? 0 = "not at all," 10 = "complete interference." Q3: What number from 0 – 10 describes how, during the past week, pain has interfered with your general activity? 0 = "not at all," 10 = "complete interference." The PEG scale score is the mean of the three individual item scores. Mean score is not modeled due to limitation of Synthea. Reference: (7)	System: LOINC Code: 91148-7 Display: Pain intensity, Enjoyment of life, General activity (PEG) 3 item pain scale System: LOINC Code: 75893-8 Display: What number best describes your pain on average in the past week? System: LOINC Code: 91145-3 Display: What number best describes how, during the past week, pain has interfered with your enjoyment of life? System: LOINC Code: 91146-1 Display: What number best describes how, during the past week, pain has interfered with your general activity?
Without_Urine_Drug_ Testing	Simple	Set probability to 20% for patient with chronic pain not receiving drug testing at the intial prescribing encounter.	n/a
Enter_Urine_Durg_Testing	Simple	Set probability to 80% for patient with chronic pain receiving drug testing at the intial prescribing encounter.	n/a
Urine_Drug_ Aberrant_Positive_1	Observation	Set probability of aberrancies observed in Urine Drug Testing (UDT) results based on age group. Age 18 – 44: 9.3%, Age 45 – 64: 5.0%, Age 65+: 3.9%. Reference: (15) Aberrancies observed in UDT results for non-prescribed opioid by age group: Age 20 – 44: 9.3%, Age 45 – 64: 5.0%, Age 65+: 3.9%. By opioid type: short-acting only: 5.2%, long-acting only: 5.6%, long-acting plus short-acting: 5.3%.	System: LOINC Code: 65750-2 Display: Drugs of abuse 5 panel - Urine by Screen method System: SNOMED-CT Code: 10828004 Display: Positive (qualifier value)

State Name	Type	State Remarks	Terminology
Urine_Drug_Testing_ Negative_1	Observation	Set probability of negative UDT results based on age group. Age 18 – 44: 90.7%, Age 45 – 64: 95%, Age 65+: 96.1%. Set probability to 60% for patient testing negative receiving nonpharmacologic treatment only or with pharmacologic treatment. Set probability to 60% for patient testing negative receiving nonopioid pharmacologic treatment. Set the probability to 20% for patient testing negative receiving Immediate Release/Short Acting opioid pain medication. Reference: (15)	System: LOINC Code: 65750-2 Display: Drugs of abuse 5 panel - Urine by Screen method System: SNOMED-CT Code: 260385009 Display: Negative (qualifier value)
Nonpharmacologic_ Treatment_ Careplan_1	CarePlan Start	Set probability to approximately 27% for patient with chronic pain receiving nonpharmacologic treatment (alternative treatment, such as physical therapy) only. (Probability determined based on 44% of the 60% of patients with chronic pain receiving nonpharmacologic treatment only or with pharmacologic treatment, either with UDT or UDT not given.) No available prevalence data was identified. Therefore, the remaining percentage is the probability for receiving nonpharmacologic treatment after setting the probabilities of 37% and 36% for patient receivng nonopioid pain medication and opioid medication, respectively. An alternative treatment, such as physical therapy, is a separate encounter, so patient on this path will go directly to the end of current encounter. Assign to Attribute: 'therapy_referral'	System: SNOMED-CT Code: 276239002 Display: Therapy (regime/therapy) System: SNOMED-CT Code: 91251008 Display: Physical therapy procedure (regime/therapy) System: SNOMED-CT Code: 228557008 Display: Cognitive and behavior therapy
Enter_Nonopioid_ Pharmacologic_ Treatment_1	Simple	Set probability to approximately 37% for patient with chronic pain being prescribed nonopioid pain medication during visit. This includes patient receiving nonopioid pain medication only (20%) and patient receiving both nonopioid pain medication and nonpharmacologic treatment (29% of the 60% of patients with negative UDT receiving nonpharmacologic treatment only or with pharmacologic treatment). Two common nonopioid pain medications, acetaminophen and ibuprofen, are used in this module. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID). Set probability to 50% for being prescribed acetaminophen and 50% for being prescribed ibuprofen. Reference: (8) In 2014, among patients with chronic pain, 16% filled only an opioid prescription, 17% filled only a nonopioid prescription, and 28% filled both a nonopioid and an opioid prescription.	n/a

State Name	Type	State Remarks	Terminology
Rx_Ibuprofen_1	Medication Order	No prevalence data is available to determine distribution probability of patient being prescribed acetaminophen or ibuprofen for chronic pain. Set probability to 50%, so patient has 50% chance of getting ibuprofen. Assign to Attribute: 'nonopioid_prescription_1' Reference: (9) Usual Adult Dose for Pain Oral: 200 to 400 mg orally every 4 to 6 hours as needed Maximum dose: 3200 mg/day (prescription strength); 1200 mg/day (over-the-counter)	System: RxNorm Code: 206905 Display: Ibuprofen 400 MG Oral Tablet [Ibu] System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
Rx_Acetaminophen_1	Medication Order	No prevalence data is available to determine distribution probability of patient being prescribed acetaminophen or ibuprofen. Set probability to 50%, so patient has 50% chance of getting acetaminophen. Assign to Attribute: 'nonopioid_prescription_1'Reference: (10) Usual Adult Dose for Pain Oral: Immediate-release: 325 mg to 1 g orally every 4 to 6 hours Minimum Dosing Interval: every 4 hours Maximum Single Dose: 1000 mg Maximum Dose: 4 g per 24 hours	System: RxNorm Code: 209387 Display: Acetaminophen 325 MG Oral Tablet [Tylenol] System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
Enter_IR/SA_Opioid_ Directed_ Use_1	Simple	Set total probability to 36% (a rough estimate based on data from the reference) for patient with chronic pain being prescribed Immediate Release/Short Action (IR/SA) opioid pain medication rather than nonopioid pain medication or nonpharmacologic treatment. Patient will not be prescribed with Extended Release/Long-Acting (ER/LA) opioid pain medication in the initial prescribing encounter in this module. The 36% includes 20% of patients testing UDT negative to receive IR/SA opioid pain medication only) and the remaining approximately 16% receiving both IR/SA opioid pain medication and anonpharmacologic treatment (27% of the 60%). Commonly prescribed IR/SA opioid pain medications hydrocodone, oxycodone, tramadol, and codeine are used in this module. Reference: (7) In 2014, among patients with chronic pain, 16% filled only an opioid prescription, 17% filled only a nonopioid prescription, and 28% filled both a nonopioid and an opioid prescription.	n/a

State Name	Type	State Remarks	Terminology
Rx_Vicodin_1	Medication Order	Set the probability to 55.25% for patient with chronic pain being prescribed Vicodin when IR/SA opioid pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (hydrocodone: 53%+2.25%). Assign to Attribute: 'IR_opioid_Rx_1' Reference: (11) An estimated 205 million prescriptions were written for eight opioids nationwide in 2008. Of these, hydrocodone prescriptions accounted for 53%, oxycodone prescriptions 21%, followed by tramadol, propoxyphene and codeine (10%, 9%, and 7%, respectively). (Note that propoxyphene was removed from the US market by FDA, so data was excluded from this module.) Reference: (12) VICODIN ® 5 mg/300 mg. The usual adult dosage is one or two tablets every four to six hours as needed for pain. Total daily dosage should not exceed 8 tablets.	System: RxNorm Code: 856987 Display: Acetaminophen 300 MG / Hydrocodone Bitartrate 5 MG Oral Tablet System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
Rx_Percocet_1	Medication Order	Set probability to 23.25% for patient with chronic pain being prescribed Percocet when IR/SA opioids pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (oxycodone: 21%+2.25%). Assign to Attribute: 'IR_opioid_Rx_1' Reference: (11) Reference: (13) From 2013 to 2015, the proportion of Medicare Part D enrollees who received a hydrocodone prescription in a year decreased from 21.9% to 18.3%. Reference: (14) PERCOCET 10 mg/325 mg Usual Adult Dosage: 1 tablet every 6 hours as needed for pain Maximal Dosage: 6 Tablets Reference: (15)	System: RxNorm Code: 1049625 Display: Acetaminophen 325 MG / Oxycodone Hydrochloride 10 MG Oral Tablet [Percocet] System: SNOMED-CT Code: 307468000 Display: Every six hours (qualifier value)

State Name	Type	State Remarks	Terminology
Rx_Tramadol_1	Medication Order	Set probability to 12.25% for patient with chronic pain being prescribed Tramadol when IR/SA opioid pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (tramadol: 10% + 2.25%). Dosage: 1 tablet every 6 hours as needed Assign to Attribute: 'IR_opioid_Rx_1'Reference: (11)	System: RxNorm Code: 835603 Display: tramadol hydrochloride 50 MG Oral Tablet System: SNOMED-CT Code: 307468000 Display: Every six hours (qualifier value)
Rx_Codeine_1	Medication Order	Set probability to 9.25% for patient with chronic pain being prescribed Tramadol when IR/SA opioids pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (codeine: 7% + 2.25%). Dosage: 1 tablet every 4 hours as needed Assign to Attribute: 'IR_opioid_Rx_1' Reference: (11)	System: RxNorm Code: 993770 Display: Acetaminophen 300 MG / Codeine Phosphate 15 MG Oral Tablet System: SNOMED-CT Code: 225756002 Display: Every four hours (qualifier value)
End_Initial_Chronic_Pain_ Encounter	Encounter End	End current encounter (Initial_Prescribing_Encounter_for_Chronic Pain). If patient receives referral for Cognitive and Behavior Therapy (CBT) or physical therapy (PT) (Attribute 'therapy_referral' is not nil), then patient either continues with CBT or PT. No prevalence data is available to determine distribution probability. To favor physical therapy, 80% is assigned to PT and 20% is assigned to CBT. If patient does not receive referral for either CBT or PT (Attribute 'therapy_referral' is nil), then continue with option of prescribing opioid or nonopioid pain medication (state: On_Opioid_Or_Nonopioid).	n/a
Enter_CBT_Therapy_1	Delay	Set Delay to 3 days to simulate patient receiving CBT sessions approximately twice a week.	n/a
CBT_Therapy_Counter_1	Counter	Set counter to increments of 1; the counter is then used to repeat CBT session 8 times (Attribute: 'number_of_CBT' < 8).	n/a
CBT_Encounter_1	Encounter	Encounter for CBT. There is no SNOMED code specific to a CBT-related encounter.	System: SNOMED-CT Code: 308335008 Display: Patient encounter procedure (procedure)

State Name	Type	State Remarks	Terminology
CBT_Pain_Observation	Observation	Set patient reported pain score with a value range from 1 to10.	System: LOINC Code: 38208-5 Display: Pain severity – Reported
Cognitive Behavior Therapy (CBT)_1	Procedure	CBT with duration of 30 – 60 minutes per session.	System: SNOMED-CT Code: 228557008 Display: Cognitive and behavioral therapy (regime/therapy)
End_CBT_Therapy_ Encounter_1	Encounter End	End current encounter for CBT. If counter value < 8 (Attribute: 'number_of_CBT' <8), then counter repeats CBT. If counter value =8 (8 CBT sessions are completed), tthen end the Nonpharmacologic_Treatment_Careplan_1.	n/a
End_Nonpharmacologic_ Treatment_Careplan_2	CarePlan End	End the Nonpharmacologic_Treatment_Careplan_1. Patient is either well and ends the module (goes to Terminal) or patient continues path of chronic pain population for further treatment. No prevalence data is available to determine distribution probability. Assigned 80% to Terminal and 20% for chronic_pain_population.	n/a
Enter_Physical_Therapy_1	Delay	Set Delay to 3 days to simulate patient receiving PT approximately twice a week.	n/a
Physical_Therapy_Counter _1	Counter	Set counter increments of 1; counter is then used to repeats PT session 10 times (Attribute: 'number_of_PT' <10).	n/a
Physical_Therapy_ Encounter_1	Encounter	Encounter for PT. There is no SNOMED code specific for PT-related encounter.	System: SNOMED-CT Code: 308335008 Display: Patient encounter procedure (procedure)
Physical_Therapy_1	Procedure	PT with duration of 45 – 60 minutes per session.	System: SNOMED-CT Code: 229064008 Display: Movement therapy (regime/therapy)
PT_Pain_Observation	Observation	Patient-reported pain score with value range from 1 to 10.	System: LOINC Code: 38208-5 Display: Pain severity – Reported

State Name	Type	State Remarks	Terminology
End_Physical_Therapy_ Encounter_1	Encounter End	End current encounter for PT. If counter value < 10 (Attribute: 'number_of_PT' < 10), then repeat PT. If counter value =10 (10 PT sessions completed), then end Nonpharmacologic_Treatment_Careplan_1.	n/a
End_Nonpharmacologic_ Treatment_Careplan_1	CarePlan End	End Nonpharmacologic_Treatment_Careplan_1. Patient is either well and ends module (goes to Terminal) or patient enters path of chronic pain population for further treatment. No prevelance data is available to determine distribution probability. Set patient to have 80% chance of becoming well and going to Terminal and 20% chance of entering path of chronic_pain_population for further treatment.	n/a
On_Opioid_Or_Nonopioid_ 1	Delay	Set the Delay to 1 week to end the prescription.	n/a
On_Nonopioid_ Prescription_1	Simple	No available prevalence data. If patient was prescribed nonopioid pain medication (nonopioid_prescription is not nil). Set the probability to 50% for patient to receive further treatment for chronic pain; and set the probability to 50% for patient not needing follow up treatment, module ends (goes to Terminal).	n/a
On_IR_Opioid_Prescription _1	Simple	Set the probability to 10% for the module to continue to Addiction state. Reference: (16) Rates of addiction ranged from a minimum of 7.8% for the mean weighted by Winsorized sample size to a maximum of 11.7% for the unweighted mean. Calculation of 95% CI indicated an overall range across all methods of mean calculation of 12.9% to 37.5% for misuse and 3.2% to 17.3% for addiction.Reference: (17) A 2015 systematic review of studies of adults prescribed oral opioids for chronic pain estimates the prevalence of opioid misuse (defined in the study as "opioid use contrary to the directed or prescribed pattern of use, regardless of the presence or absence of harm or adverse effects") in the U.S. as 21.7% – 29.3% and the prevalence of addiction (defined as continued use despite harm) to be 7.8% – 11.7%.	n/a

State Name	Type	State Remarks	Terminology
Chronic_Pain_Population	Delay	Delay is set to 1 month. If Attribute 'chronic_low_back_pain_only' is not nil, then goes to the Condition_Chronic_Low_Back_Pain_2 state. If Attribute 'chronic_neck_pain_only' is not nil, then goes to the Condition_Chronic_Neck_Pain_2 state. If Attribute 'migraine_only', then goes to the Condition_Migraine_2 state. If Attribute 'chronic_neck_and_low_back_pain' is not nil, then goes to the Condition_Chronic_Neck_Pain_2 state and the Condition_Chronic_Low_Back_Pain_2 state. If Attribute 'chronic_low_back_pain_with_fibromyalgia' is not nil, then goes to the Condition_Fibromyalgia_2 state and the Condition_Chronic_Low_Back_Pain_2 state.	n/a
Condition_Chronic_Low_Back_Pain_2	Condition Onset	If patient had chronic low back pain in initial prescribing encounter (Attribute 'chronic_low_back_pain' is not nil), then condition onset is set to chronic low back pain for follow-up encounter.	System: SNOMED-CT Code: 278860009 Display: Chronic low back pain (finding)
Condition_Chronic_Neck_Pain_2	Condition Onset	If patient had chronic low neck pain in initial encounter (Attribute 'chronic_neck_pain' is not nil), then condition onset is set to chronic neck pain for the follow up encounter.	System: SNOMED-CT Code: 1121000119107 Display: Chronic neck pain (finding)
Condition_Fibromyalgia_2	Condition Onset	If patient had fibromyalgia in initial encounter (Attribute 'fibromyalgia' is not nil), then condition onset is set to fibromyalgia for follow up encounter.	System: SNOMED-CT Code: 203082005 Display: Fibromyalgia (disorder)
Condition_Migraine_2	Condition Onset	If the patient had migraine ininitial encounter (Attribute 'migraine' is not nil), then condition onset is set to migraine for follow up encounter.	System: SNOMED-CT Code: 427419006 Display: Transformed migraine (disorder)
Follow_Up_Encounter_for_Chronic_Pain	Encounter	Follow up encounter for chronic pain. No data available to determine how often providers order UDT. For patient follow up encounter for chronic pain, set probability to 50% for takingUDT (go to state: Enter_Urine_Drug_Testing_2) and 50% for not taking no UDT (go to state: PEG_Assessment_Score_2). Reference: (1) When prescribing opioids for chronic pain, clinicians should use UDT before starting opioid therapy and consider UDT at least annually to assess for prescribed medications as well as other controlled prescription drugs and illicit drugs.	System: SNOMED-CT Code: 390906007 Display: Follow-up encounter (procedure)

State Name	Type	State Remarks	Terminology
Enter_Urine_Drug_Testing_2	Simple	Patient either has negative UDT result or result that is aberrantly positive for opioids; probability is set conditionally based on age group.	n/a
Urine_Drug_Aberrant_Positive_2	Observation	Set probability of aberrancies observed in UDT results based on age group. Age 18 – 44: 9.3%, Age 45 – 64: 5.0%, Age 65+: 3.9%. The module continues to PEG_Assessment_Score_3, misuse, and then Enter_Treatment_Opioid_Use_Disorder states. Reference: (15)	System: LOINC Code: 65750-2 Display: Drugs of abuse 5 panel - Urine by Screen method System: SNOMED-CT Code: 10828004 Display: Positive (qualifier value)
Urine_Drug_Testing_Negative_2	Observation	Set probability of negative UDT results based on age group. Age 18 – 44: 90.7%, Age 45 – 64: 95%, Age 65+: 96.1%. Reference: (15)	System: LOINC Code: 65750-2 Display: Drugs of abuse 5 panel - Urine by Screen method System: SNOMED-CT Code: 260385009 Display: Negative (qualifier value)

State Name	Type	State Remarks	Terminology
PEG_Assessment_Score_2	Multi Observation	Assessing pain and function using PEG scale as recommended in the CDC guideline. Set pain score range from 1-10. No prevalence data available to set distribution probability. Distribution probabilities are assigned based on the following assumptions: If patient received CBT or PT in previous encounters (Attribute 'therapy_referral' is not nil), then 10% probability of receiving CBT or PT as treatment again, 20% probability of receiving nonopioid pain medication (acetaminophen or ibuprofen), and 70% probability of being prescribed IR/SA opioid pain medication. Patient will not be prescribed ER/LA opioid. If patient was prescribed IR/SA opioid (Attribute 'IR_opioid_prescription_1' is not nil) in previous encounter, then 20% probability of being prescribed IR/SA opioid pain medication again and 80% probability of being prescribed ER/LA opioid pain medication. If patient was prescribed nonopioid pain medication in the previous encounter (Attribute 'non_opioid_prescription_2' is not nil), then 20% probability of being prescribed nonopioid medication and 80% probability of being prescribed IR/SA opioid pain medication.No ER/SA opioid pain medication will be prescribed. Reference: (7)	System: LOINC Code: 91148-7 Display: Pain intensity, Enjoyment of life, General activity (PEG) 3 item pain scale System: LOINC Code: 75893-8 Display: What number best describes your pain on average in the past week? System: LOINC Code: 91145-3 Display: What number best describes how, during the past week, pain has interfered with your enjoyment of life? System: LOINC Code: 91146-1 Display: What number best describes how, during the past week, pain has interfered with your general activity?
Nonpharmacologic_ Treatment_Careplan_2	CarePlan Start	Patient given nonpharmacologic treatment (alternative treatment, such as PT) instead of prescribing opioid or non-opioid pain medications. The module continues toto End_Follow_Up_Encounter_for_Chronic_Pain state and then Terminal.	System: SNOMED-CT Code: 276239002 Display: Therapy (regime/therapy) System: SNOMED-CT Code: 91251008 Display: Physical therapy procedure (regime/therapy) System: SNOMED-CT Code: 228557008 Display: Cognitive and behavior therapy

State Name	Type	State Remarks	Terminology
Enter_IR/SA_Opioid_ Directed_Use_2	Simple	Set probability to 36% (a rough estimate based on data from the reference) for patient with chronic pain being prescribed IR/SA opioid pain medication rather than nonopioid pain medication or nonpharmacologic. Commonly prescribed IR/SA opioid pain medications hydrocodone, oxycodone, tramadol, and codeine are used in this module. Reference: (7)	n/a
Rx_Vicodin_2	Medication Order	Set probability to 55.25% for patient with chronic pain being prescribed Vicodin when IR/SA opioid pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (hydrocodone: 53%+2.25%). Assign to Attribute: 'IR_opioid_Rx_2' Reference: (11) Reference: (12)	System: RxNorm Code: 856987 Display: Acetaminophen 300 MG / Hydrocodone Bitartrate 5 MG Oral Tablet System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
Rx_Percocet_2	Medication Order	Set probability to 23.25% for patient with chronic pain being prescribed Percocet when IR/SA opioids pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (oxycodone: 21%+2.25%). Assign to Attribute: 'IR_opioid_Rx_2' Reference: (11) Reference: (13) Reference: (14) Reference: (15)	System: RxNorm Code: 1049625 Display: Acetaminophen 325 MG / Oxycodone Hydrochloride 10 MG Oral Tablet [Percocet] System: SNOMED-CT Code: 307468000 Display: Every six hours (qualifier value)
Rx_Tramadol_2	Medication Order	Set probability to 12.25% for patient with chronic pain being prescribed Tramadol when IR/SA opioids pain medication was the choice. Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (tramadol: 10% + 2.25%). Assign to Attribute: 'IR_opioid_Rx_2' Reference: (11)	System: RxNorm Code: 1049625 Display: Acetaminophen 325 MG / Oxycodone Hydrochloride 10 MG Oral Tablet [Percocet] System: SNOMED-CT Code: 307468000 Display: Every six hours (qualifier value)

State Name	Type	State Remarks	Terminology
Rx_Codeine_2	Medication Order	Set probability to 9.25% for patient with chronic pain being prescribed Codeine when IR/SA opioids pain medication was the choice Because propoxyphene was removed from the US market by the FDA, propoxyphene data was excluded from the module and the 9% of patients receiving propoxyphene was evenly distributed between the remaining 4 IR/SA opioids included in the module (codeine: 7% + 2.25%). Assign to Attribute: 'IR_opioid_Rx_2' Reference: (11)	System: RxNorm Code: 993770 Display: Acetaminophen 300 MG / Codeine Phosphate 15 MG Oral Tablet System: SNOMED-CT Code: 225756002 Display: Every four hours (qualifier value)
Enter_ER/LA_Opioid_ Directed_Use	Simple	No available prevalence data for distribution. Set probability to 30% for patient beingprescribed Oxycontin, 40% for Duragesic, and 30% for 12HR Hydrocodone.	n/a
Rx_Oxycontin	Medication Order	This is the medication order for opioid pain medication Oxycontin. Assign to Attribute: 'ER_opioid_Rx'	System: RxNorm Code: 1049504 Display: Abuse-Deterrent 12 HR Oxycodone Hydrochloride 10 MG Extended Release Oral Tablet [Oxycontin]
Rx_Duragesic	Medication Order	This is the medication order for opioid pain medication Duragesic. Assign to Attribute: 'ER_opioid_Rx'	System: RxNorm Code: 245134 Display: 72 HR Fentanyl 0.025 MG/HR Transdermal System System: SNOMED-CT Code: 396143001 Display: Every seventy two hours as needed (qualifier value)
Rx_12HR_Hydrocodone	Medication Order	This is the medication order for opioid pain medication extended release 12 hr. Hydrocodone. Assign to Attribute: 'ER_opioid_Rx'	System: RxNorm Code: 1860491 Display: 12 HR Hydrocodone Bitartrate 10 MG Extended Release Oral Capsule System: SNOMED-CT Code: 1831000175103 Display: Every 12 hours as needed (qualifier value)

State Name	Type	State Remarks	Terminology
Enter_Nonopioid_ Pharmacologic_ Treatment_2	Simple	Patient prescribed nonopioid pain medications. No prevalence data available to determine distribution probability. Two common nonopioid medications, acetaminophen and ibuprofen, are used in this module. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID). Set probability to 50% for patient being prescribed acetaminophen and ibuprofen, respectively.	n/a
Rx_Ibuprofen_2	Medication Order	No prevalence data is available to determine distribution probability of patient being prescribed acetaminophen or ibuprofen for chronic pain. Set probability to 50% so patient has 50% chance of getting ibuprofen. Assign to Attribute: 'nonopioid_Rx_2' Reference: (9)	System: RxNorm Code: 206905 Display: Ibuprofen 400 MG Oral Tablet [Ibu] System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
Rx_Acetaminophen_2	Medication Order	No prevalence data is available to determine distribution probability of patient being prescribed acetaminophen or ibuprofen. Set probability to 50%, so patient has 50% chance of getting acetaminophen. Assign to Attribute: 'nonopioid_Rx_2' Reference: (10)	System: RxNorm Code: 209387 Display: Acetaminophen 325 MG Oral Tablet [Tylenol] System: SNOMED-CT Code: 225757006 Display: Every four to six hours (qualifier value)
End_Follow_Up_Encounter _for_ Chronic_Pain	Encounter End	End current follow up encounter	n/a
On_Opioid_Or_Nonopioid_ 2	Delay	Set Delay to 30 days, then end prescription.	n/a
On_ER_Opioid_ Prescription	Simple	If Attribute 'ER_opioid_Rx is not nil, then based on the reference, probability is set to 12% for patient to continue on to Addiction state, and probability is set to 60% for patient returning back to chronic pain population under directed use and 11% for continuing on to Terminal state. Reference: (16) Rates of addiction ranged from a minimum of 7.8% for the mean weighted by Winsorized sample size to a maximum of 11.7% for the unweighted mean. Calculation of 95% CI indicated an overall range across all methods of mean calculation of 12.9% to 37.5% for misuse and 3.2% to 17.3% for addiction.	n/a

State Name	Type	State Remarks	Terminology
On_IR_Opioid_Prescription_2	Simple	If Attribute 'IR_opioid_Rx_2' is not nil, thenbased on the reference, probability is set to 10% for patient to continue on to Addiction state, and probability is set to 50% for patient returning back to chronic pain population under directed use and 40% for continuing on to Terminal state. Reference: (16)	n/a
On_Nonopioid_ Prescription_2	Simple	If Attribute 'nonopioid_Rx_2' is not nil, then set probability to 50% for module to continue on to Terminal state and 50% probability of returning to Chronic_Pain_Population state for continued treatment. No prevalence data available	n/a
PEG_Assessment_Score_3	Multi Observation	Assessing pain and function using PEG scale as recommended in the CDC guideline. Set pain score in a range of 1-10. The module continues on to Addiction state.	System: LOINC Code: 91148-7 Display: Pain intensity, Enjoyment of life, General activity (PEG) 3 item pain scale System: LOINC Code: 75893-8 Display: What number best describes your pain on average in the past week? System: LOINC Code: 91145-3 Display: What number best describes how, during the past week, pain has interfered with your enjoyment of life? System: LOINC Code: 91146-1 Display: What number best describes how, during the past week, pain has interfered with your general activity?
Addiction	Delay	Set Delay to 0-60 days. Set probability to 10% to go to Start_Treatment_Opioid_Use_Disorder state and 90% to return to Chronic_Pain_Population state. (18)	n/a

State Name	Type	State Remarks	Terminology
Start_Treatment_Opioid_ Use_Disorder	Simple	This simple state branches out to Evaluate_Opioid_Use_Disorder and Enter_Overdose. If patient was prescribed IR opioid pain medication (IR_opioid_Rx_1 is not nil or IR_opioid_Rx_2 is not nil). Probability is set to 0.15% to Enter_Overose (have an ED Visit due to overdose). If patient was prescribed ER opioids pain medication (ER_opioid_Rx is not nil). Probability is set to 0.35% to Enter_Overose. Reference:(19)	n/a
Enter_Overdose	Simple	This is a simple transition state.	n/a
Opioid_Addiction_ Symptom_1	Symptom	Addiction symptom: Anxiety	n/a
Opioid_Addiction_ Symptom_2	Symptom	Addiction symptom: Confusion	n/a
Opioid_Addiction_ Symptom_3	Symptom	Addiction symptom: Cognitive Difficulties	n/a
Opioid_Addiction_ Symptom_4	Symptom	Addiction symptom: Nausea/Vomiting	n/a
Opioid_Addiction_ Symptom_5	Symptom	Addiction symptom: Constipation	n/a
Opioid_Addiction_ Symptom_6	Symptom	Addiction symptom: Reduced Sex Drive	n/a
Opioid_Addiction_ Symptom_7	Symptom	Addiction symptom: Slurred Speech	n/a
Opioid_Addiction_ Symptom_8	Symptom	Addiction symptom: Shallow Breathing	n/a
Opioid_Addiction_ Symptom_9	Symptom	Addiction symptom: Mood Swing	n/a
Opioid_Addiction_ Symptom_10	Symptom	Addiction symptom: Sensitivity to Pain	n/a
Opioid_Addiction_ Symptom_11	Symptom	Addiction symptom: Yawning	n/a
Opioid_Addiction_ Symptom_12	Symptom	Addiction symptom: Sweating	n/a

State Name	Type	State Remarks	Terminology
Condition_Drug_Overdose	Condition Onset	This is a ConditionOnset state for drug overdose. Targeted encounter for this state is ED_Visit state.	System: SNOMED-CT Code: 55680006 Display: Drug overdose (disorder)
ED_Visit	Encounter	This is an encounter state for emergency department (ED) Visit.	System: SNOMED-CT Code: 50849002 Display: Patient encounter procedure (procedure)
Naloxone	Medication Order	Patient receives Naloxone for treatment of overdose. Medication is administered.	System: RxNorm Code: 1191222 Display: naloxone hydrochloride 0.4 MG/ML Injectable Solution
Death	Death	Patient died of overdose. If patient has no history of nonfatal ED overdose (history_nonfatal_ED_overdose is not nil), then overdose death rate is 0.02%. If patient has history of nonfatal ED overdose and was re-admitted within two days (readmit_2_days is not nil), then overdose death rate is 0.25%. If patient has history of nonfatal ED overdose and was re-admitted within one month (readmit_1_month is not nil), then overdose death rate is 1.1%. If patient has history of nonfatal ED overdose and was re-admitted within one year (readmit_1_year is not nil), then overdose death rate is 5.5%. Reference: (20)	System: SNOMED-CT Code: 55680006 Display: Drug overdose (disorder)
End_ED_Visit_Disposition_Death	Encounter End	This ends the current encounter (ED_Visit) and goes to Terminal.	System: NUBC Code: 41 Display: Expired in a medical facility, such as a hospital, SNF, ICF or freestanding hospice
End_ED_Visit	Encounter End	This ends the current encounter (ED_Visit).	n/a

State Name	Type	State Remarks	Terminology
Set_Attribute_Hx_Nonfatal_ ED_ Overdose	SetAttribute	This state is used to set the attribute “history_nonfatal_ED_overdose”. Value is set to true. Set probability to 25% for patients to be readmitted. Set probability to 75% to Enter_OUD_Treatment_1. Note that the reference is for 90-day readmission. Use estimated probability of 25% for readmission within a year. Reference: (21)	n/a
No_OUD_Treatment	Simple	This simple state is a distributed transition type. Set re-admit rate to 4.6% for patient being readmitted within 2 days of discharge from a nonfatal ED visit. Set re-admit rate to 20.5% for patient being readmitted within one month of discharge from a nonfatal ED visit. Set re-admit rate to 74.9% for patient being readmitted within one year of discharge from a nonfatal ED visit. Reference: (20)	n/a
Delay_Within_2_Days	Delay	Delay is set to 0 – 2 days.	n/a
Set_Attribute_Readmit_1	SetAttribute	This state is used to set the attribute “readmit_2_days” to true. From this state, patient returns to the Enter_Overdose state and continues on to the Condition_Drug_Overdose state and the ED_Visit state, where the attribute would then be used to control death rate in the Death state.	n/a
Delay_Within_1_Month	Delay	Delay is set to 3 – 30 days.	n/a
Set_Attribute_Readmit_3	SetAttribute	This state is used to set the attribute “readmit_1_month” to true. From this state, patient returns to the Enter_Overdose state and continues on to the Condition_Drug_Overdose state and the ED_Visit state, where the attribute would then be used to control death rate in the Death state.	n/a
Delay_Within_1_Year	Delay	Delay is set to 1 – 12 months.	n/a
Set_Attribute_Readmit_2	SetAttribute	This state is used to set the attribute “readmit_1_year” to true. From this state, patient returns to the Enter_Overdose state and continues on to the Condition_Drug_Overdose state and the ED_Visit state, where the attribute would then be used to control death rate in the Death state..	n/a
Enter_OUD_Treatment_1	Delay	Delay set to 1 week after ED discharge before starting the office visit for evaluating OUD.	n/a
Enter_Evaluate_Opioid_ Use_Disorder	Simple	This is a simple state that transitions the Encounter_OUD state.	n/a

State Name	Type	State Remarks	Terminology
Opioid_Addiction_ Symptom_2_1	Symptom	Adidction symptom: Anxiety	n/a
Opioid_Addiction_ Symptom_2_2	Symptom	Addiction symptom: Confusion	n/a
Opioid_Addiction_ Symptom_2_3	Symptom	Addiction symptom: Cognitive Difficulties	n/a
Opioid_Addiction_ Symptom_2_4	Symptom	Addiction symptom: Nausea/Vomiting	n/a
Opioid_Addiction_ Symptom_2_5	Symptom	Addiction symptom: Constipation	n/a
Opioid_Addiction_ Symptom_2_6	Symptom	Addiction symptom: Reduced Sex Drive	n/a
Opioid_Addiction_ Symptom_2_7	Symptom	Addiction symptom: Slurred Speech	n/a
Opioid_Addiction_ Symptom_2_8	Symptom	Addiction symptom: Shallow Breathing	n/a
Opioid_Addiction_ Symptom_2_9	Symptom	Addiction symptom: Mood Swing	n/a
Opioid_Addiction_ Symptom_2_10	Symptom	Addiction symptom: Sensitivity to Pain	n/a
Opioid_Addiction_ Symptom_2_11	Symptom	Addiction symptom: Yawning	n/a
Opioid_Addiction_ Symptom_2_12	Symptom	Addiction symptom: Sweating	n/a
Encounter_OUD	Encounter	This is an encounter (office visit) for Opioid Use Disorder.	System: SNOMED-CT Code: 50849002 Display: Patient encounter procedure (procedure)

State Name	Type	State Remarks	Terminology
PEG_Assessment_Score_4	Multi Observation	Patient is assessed for pain and function using the Pain, Enjoyment of Life and General Activity (PEG) scale. Set pain score in a range of 1-10.	System: LOINC Code: 91148-7 Display: Pain intensity, Enjoyment of life, General activity (PEG) 3 item pain scale System: LOINC Code: 75893-8 Display: What number best describes your pain on average in the past week? System: LOINC Code: 91145-3 Display: What number best describes how, during the past week, pain has interfered with your enjoyment of life? System: LOINC Code: 91146-1 Display: What number best describes how, during the past week, pain has interfered with your general activity?
Urine_Drug_ Aberrant_Positive	Observation	Patient is tested positive for urine drug testing (UDT).	System: LOINC Code: 65750-2 Display: Drugs of abuse 5 panel - Urine by Screen method System: SNOMED-CT Code: 10828004 Display: Positive (qualifier value)

State Name	Type	State Remarks	Terminology
DSM_5_OUD_Diagnostic_ Criteria	Multi Observation	Patient is evaluated for OUD using the DSM-5 Criteria for Diagnosis of Opioid Use Disorder. Score for each observation is set to 0 to 1. Reference: (22)	(Note that no LOINC codes are available for DSM-5 and placeholder codes are used. Synthea only allows LOINC as the code system for MultiObservation) System: LOINC Code: 99999-0 Display: DSM-5 Clinical Diagnostic Criteria for Opioid Use Disorder System: LOINC Code: 99999-1 Display: Opioids are often taken in larger amounts or over a longer period than was intended System: LOINC Code: 99999-2 Display: There is a persistent desire or unsuccessful efforts to cut down or control opioid use System: LOINC Code: 99999-3 Display: A great deal of time is spent in activities necessary to obtain the opioid, use the opioid, or recover from its effects System: LOINC Code: 99999-4 Display: Craving or a strong desire to use opioids

State Name	Type	State Remarks	Terminology
DSM_5_OUD_Diagnostic_ Criteria (continued)			System: LOINC Code: 99999-6 Display: Continued opioid use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of opioids System: LOINC Code: 99999-7 Display: Important social, occupational, or recreational activities are given up or reduced because of opioid use System: LOINC Code: 99999-8 Display: Recurrent opioid use in situations in which it is physically hazardous System: LOINC Code: 99999-9 Display: Continued use despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by opioids.

State Name	Type	State Remarks	Terminology
DSM_5_OUD_Diagnostic_ Criteria (continued)			System: LOINC Code: 99999-10 Display: Tolerance,as defined by either of the following: a) Need for markedly increased amounts of opioids to achieve intoxication or desired effect b) Markedly diminished effect with continued use of the same amount of opioid System: LOINC Code: 99999-11 Display: Withdrawal, as manifested by either of the following: a) Characteristic opioid withdrawal syndrome b) Same (or a closely related) substance is taken to relieve or avoid withdrawal symptoms
Condition_OUD	Condition Onset	Patient is diagnosed with OUD. No available prevalence data to determine distribution probability of the three treatment options: Buprenorphine and psychosocial therapy, Buprenorphine only, or psychosocial treatment only. Set probability to 60% for Buprenorphine combined with psychosocial therapy, 20% for Buprenorphine, 3% for Methadone combined with psychosocial therapy, 2% for Methoadone, 5% for psychosocial therapy only, and 10% for no treatment. Reference: (2)	System: SNOMED-CT Code: 5602001 Display: Opioid abuse (disorder)

State Name	Type	State Remarks	Terminology
OUD_Treatment_ Buprenorphine_ Psychosocial	CarePlan Start	Patient starts care plan to receive both Buprenorphine and psychosocial therapy for OUD treatment.	System: SNOMED-CT Code: 736271009 Display: Outpatient care plan (record artifact) System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy) System: SNOMED-CT Code: 792902005 Display: Drug addiction therapy using buprenorphine and naloxone (regime/therapy)
Psychosocial_Therapy_1	Procedure	Patient receives psychosocial therapy.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
Rx_Buprenorphine_2	Medication Order	Patient receives Buprenorphine for treatment of overdose. Assign to Attribute “on_buprenorphine”. (Patient receives both Buprenorphine and psychosocial therapy).	System: RxNorm Code: 351266 Display: buprenorphine 2 MG / naloxone 0.5 MG Sublingual Tablet
Set_Attribute_Treatment_ Pharmaco_ Psychosocial	SetAttribute	This state is used to set the attribute “pharmaco_and_psychosocial” with a value “true.”	n/a
OUD_Treatment_Buprenorphine	CarePlan Start	Patient starts care plan to receive Buprenorphine therapy only.	System: SNOMED-CT Code: 792902005 Display: Drug addiction therapy using buprenorphine and naloxone (regime/therapy)
Rx_Buprenorphine_1	Medication Order	Patient receives Buprenorphine for treatment of overdose. Assign to Attribute “on_buprenorphine”. (Patient receives Buprenorphine only).	System: RxNorm Code: 351266 Display: buprenorphine 2 MG / naloxone 0.5 MG Sublingual Tablet
Set_Attribute_Treatment_ Pharmaco_ Only	SetAttribute	This state is used to set the attribute “pharmaco” to a value “true.”	n/a

State Name	Type	State Remarks	Terminology
OUD_Treatment_ Psychosocial	CarePlan Start	Patient starts care plan to receive psychosocial therapy only.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
Psychosocial_Therapy_2	Procedure	Patient receives psychosocial therapy only.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
Set_Attribute_No_ Treatment	SetAttribute	This state is used to set the attribute “no_treatment” to a value “true.”	n/a
Rx_Methadone_1	Medication Order	Patient receives Methadone for treatment of overdose. Assign to Attribute “on_methadone”. (Patient receives Methadone only).	System: RxNorm Code: 864706 Display: methadone hydrochloride 10 MG Oral Tablet
Psychosocial_Therapy_5	Procedure	Patient receives psychosocial therapy.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
Rx_Methadone_2	Medication Order	Patient receives Methadone for treatment of overdose. Assign to Attribute “on_ methadone”. (Patient receives both Methadone and psychosocial therapy).	System: RxNorm Code: 864706 Display: methadone hydrochloride 10 MG Oral Tablet
End_Encounter_OUD	Encounter End	This state ends the current encounter Encounter_OUD. If the patient is not on OUD treatment (attribute “no_treatment” is not nil), they continue to the Terminal state and exit the submodule. The patient then returns back to the calling module, which is the Prescribing Opioids for Chronic Pain module. If the patient is on OUD treatment (attribute “no_treatment” is nil), they proceed to Enter_Continued_OUD_Treatment state.	n/a
Encounter_OUD_Treatment _Cont	Encounter	This is an encounter (office visit) to continue OUD treatment. Visit reason is Condition_OUD, Opioid abuse (disorder).	System: SNOMED-CT Code: 50849002 Display: Patient encounter procedure (procedure)

State Name	Type	State Remarks	Terminology
Enter_Treatment_Options	Simple	This is a simple state for setting up conditional transition logic based on the treatment option received in the Encounter_OUD state. If patient received one of the treatment options in the previous office visit, they will continue with the same treatment option in the follow-up visit for continuation of OUD treatment.	n/a
Buprenorphine_Or_ Methadone_Or_Naltrexone	Simple	If “pharmaco” is not nil, then patient will continue on with Buprenorphine or Methadone or Naltrexone.	n/a
Rx_Methadone_3	Medication Order	If “on_methadone” is not nil, then the patient receives Methadone only for treatment of OUD in the follow-up visit for continuation of OUD treatment.	System: RxNorm Code: 864706 Display: methadone hydrochloride 10 MG Oral Tablet
Rx_Buprenorphine_3	Medication Order	If “on_buprenorphine” is not nil, then the patient receives Buprenorphine only for treatment of OUD in the follow-up visit for continuation of OUD treatment.	System: RxNorm Code: 351266 Display: buprenorphine 2 MG / naloxone 0.5 MG Sublingual Tablet
Rx_Nalrexone_3	Medication Order	If “on_naltrexone” is not nil, then the patient receives Naltrexone only for treatment of OUD in the follow-up visit for continuation of OUD treatment.	System: RxNorm Code: 1483744 Display: Naltrexone hydrochloride 50 MG Oral Tablet
Psychosocial_Therapy_4	Procedure	Patient receives psychosocial therapy in the follow-up visit for continuation of OUD treatment.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
Rx_Buprenorphine_4	Medication Order	If “on_buprenorphine” is not nil, then the patient receives Buprenorphine for treatment of OUD in follow-up visit for continuation of OUD treatment. (Patient receives both Buprenorphine and psychosocial therapy).	System: RxNorm Code: 351266 Display: buprenorphine 2 MG / naloxone 0.5 MG Sublingual Tablet
Rx_Methadone_4	Medication Order	If “on_methadone” is not nil, then the patient receives Methadone for treatment of OUD in follow-up visit for continuation of OUD treatment. (Patient receives both Methadone and psychosocial therapy).	System: RxNorm Code: 864706 Display: methadone hydrochloride 10 MG Oral Tablet

State Name	Type	State Remarks	Terminology
Rx_Nalrexone_4	Medication Order	If “on_naltrexone” is not nil, then the patient receives naltrexone only for treatment of OUD in the follow-up visit for continuation of OUD treatment. (Patient receives both Naltrexone and psychosocial therapy).	System: RxNorm Code: 1483744 Display: Naltrexone hydrochloride 50 MG Oral Tablet
Psychosocial_Therapy_3	Procedure	Patient receives psychosocial therapy only in the follow up visit for continuation of OUD treatment.	System: SNOMED-CT Code: 408919008 Display: Psychosocial care (regime/therapy)
End_Encounter_OUD_ Treatment_Cont	Encounter End	This ends the current encounter, which is the Encounter_OUD_Treatment_Cont state.	n/a
Counter_Treatment_Visit	Counter	Set counter to increments of 1, the counter is then used to track 5 follow-up visits for continuation of OUD treatment (attribute: “num_oud_treatment_visit” < 5).	n/a
Enter_Next_Treatment_ Visit	Delay	Set delay to 1 month before next follow up visit for continuation of OUD treatment. After 5 visits (if attribute “num_oud_treatment_visit” > 5), patient goes to Enter_Evalaute_OUD_Or_Terminal state.	n/a
Enter_Evaluate_OUD_Or_ Terminal	Simple	No available prevalence data for distribution. Set probability to 50% for patient going to Terminal and return to the calling module (Prescribing Opioids for Chronic Pain); set probability to 50% for patient return to Enter_Evaluate Opioid_Use_Disorder state.	n/a

Module Parameters

Table 3: Prescribing Opioids for Chronic Pain and Treatment of OUD Module Parameters summarizes the probabilities used to construct distributed module states where branching occurs in the module flow. A value of 1.0 indicates 100% and 0 indicates 0%.

Table 3: Prescribing Opioids for Chronic Pain and Treatment of OUD Module Parameters

Parameter	Value	Notes and References
General adult population	1.0	Selected 4 common chronic pain conditions. Among the general adult population, 28%* has chronic pain. *(Note that * indicates the parameter value is referenced in Table 4: and is shown in the Prevalence Benchmark Defined in Module column.)*
A. Probability of chronic low back pain	0.24*	
1. Probability of chronic low back pain without other chronic pain	0.09	(3)
2. Probability of chronic low back pain with chronic fibromyalgia	0.03	
3. Probability of chronic low back pain with neck pain	0.12	(5)
B. Probability of chronic neck pain	0.15*	
1. Probability of chronic neck pain without other chronic pain	0.03	(4) (23)
2. Probability of chronic low back pain with neck pain	0.12	(5)
C. Probability of migraine without other chronic pain	0.01*	(6)
Probability of receiving urine drug testing at initial encounter	1.0	
1. UDT	0.80	Prevalence data not available.
2. UDT not given	0.20	Prevalence data not available.
Probability of aberrancies observed in UDT results	1.0	
1. Age 18-44	0.0930 (Aberrantly positive for opioids) 0.9070 (Negative)	(15)

Parameter	Value	Notes and References
2. Age 45-64	0.0500 (Aberrantly positive for opioids) 0.9500 (Negative)	(15)
3. Age 65 +	0.0390 (Aberrantly positive for opioids) 0.9610 (Negative)	(15)
Probability of treatment options at initial encounter	1.0	ER/LA opioid pain medications are not included. The module assumes patient will always be started with IR/SA opioid pain medication before ER/LA. Applied same probabilities for the negative UDT path and no UDT path.
1. Nonopioid pharmacologic treatment only	0.20	(7)
2. Nonopioid pharmacologic treatment with nonpharmacologic treatment	0.17	(8)
3. Pharmacologic treatment (IR/SA Opioid) only	0.20	(8)
4. Pharmacologic treatment (IR/SA Opioid) with nonpharmacologic treatment	0.16	(8)
5. Nonpharmacologic treatment only	0.27	Prevalence data not available.
Probability of specific IR/SA opioid pain medication prescribed from among 4 common IR/SA opioid pain medications	1.0	
1. Vicodin	0.5525	(11)
2. Percocet	0.2325	(11)
3. Tramadol	0.1225	(11)
4. Codeine	0.0925	(11)
Probability of specific nonopioid medications prescribed	1.0	
1. Acetaminophen	0.50	Prevalence data not available.
2. Ibuprofen	0.50	Prevalence data not available.
Probability of patient receiving UDT at follow up encounter	1.0	
1. UDT	0.50	Prevalence data not available.
2. UDT not given	0.50	Prevalence data not available.

Parameter	Value	Notes and References
Probability of treatment options at the follow up encounter if patient previously was prescribed nonopioid pain medication only or with nonpharmacologic treatment	1.0	
1. Nonopioid pharmacologic treatment	0.20	Prevalence data not available.
2. Pharmacologic treatment (IR/SA opioid)	0.80	Prevalence data not available.
Probability of treatment options at follow up encounter if patient previously prescribed IR/SA opioid pain medication only or with nonpharmacologic treatment	1.0	
1. Pharmacologic treatment (IR/SA opioid)	0.20	Prevalence data not available.
2. Pharmacologic treatment (ER/LA Opioid)	0.80	Prevalence data not available.
Probability of specific IR/SA opioid pain medication prescribed among 4 common IR/SA opioid pain medications if patient previously prescribed IR/SA opioid pain medication only or with nonpharmacologic treatment	1.0	n/a
1. Vicodin	0.5525	(11)
2. Percocet	0.2325	(11)
3. Tramadol	0.1225	(11)
4. Codeine	0.0925	(11)
Probability of patient receives specific ER/LA opioid pain medication if patient previously prescribed IR/SA opioid pain medication only or with nonpharmacologic treatment	1.0	n/a
1. 12 HR Hydrocodone Bitartrate 10 MG Extended Release Oral Capsule	0.30	Prevalence data not available.
2. Oxycontin	0.30	Prevalence data not available.
3. Duragesic	0.40	Prevalence data not available.

Parameter	Value	Notes and References
Probability of addiction after follow up encounter if patient previously prescribed IR/SA opioid pain medication	1.0	n/a
1. Addiction	0.10	(16)
2. Returns to chronic pain population and continues with additional follow up encounter	0.50	Prevalence data not available.
3. Terminal (exits the module)	0.40	Prevalence data not available.
Probability of addiction after follow up encounter if patient previously prescribed ER/LA opioid pain medication	1.0	n/a
1. Addiction	0.12	(16)
2. Returns to chronic pain population and continues with additional follow up encounter	0.60	Prevalence data not available.
3. Terminal (exits the module)	0.28	Prevalence data not available.
Probabilities after follow up encounter if patient previously prescribed non-opioid pain medication	1.0	n/a
1. Returns to chronic pain population and continues with additional follow up encounter	0.50	Prevalence data not available.
2. Terminal (exits the module)	0.50	Prevalence data not available.
Probabilities of patient from Addiction state entering treatment of OUD component of the module for potential overdose, OUD evaluation, and receiving treatment if diagnosed	1.0	n/a
1. Returns to chronic pain population and continues with additional follow up encounter	0.90	Prevalence data not available.
2. Enters the treatment of OUD component	0.10	Prevalence data not available.
Patients from Addiction state entering treatment of OUD component	1.0	n/a
1. Probability of ED Admission for overdose (if patient was on immediate release opioid pain medication)	0.0015 (ED Admission) 0.9985 (No ED Admission)	(19)

Parameter	Value	Notes and References
2. Probability of ED admission for overdose (if patient was on extended release opioid pain medication)	0.0035 (ED admission) 0.9965 (No ED Admission)	(19)
Probability of ED readmission after nonfatal overdose	1.0	n/a
1. Probability of readmission within 1 year	0.0025	(21) The reference has information for 90-day readmission, not for readmission within a year.
2. Probability of no readmission	0.9975	(21)
Probability of death for patient with no history of nonfatal ED overdose	1.0	
1. Death rate for overdose	0.0002	(20)
2. Probability of no overdose death	0.9998	(20)
Probability of readmission with history of nonfatal ED overdose	1.0	
1. Probability of readmission within 2 days of discharge from a nonfatal overdose ED visit	0.046	(20)
2. Probability of readmission within 1 month of discharge from a nonfatal overdose ED visit	0.205	(20)
3. Probability of readmission within 1 year of discharge from a nonfatal overdose ED visit	0.749	(20)
Probability of death for patient with history of nonfatal ED overdose	1.0	
1. Overdose death rate for readmitted within 2 days	0.0025 (Death) 0.9975 (No Death)	(20)
2. Overdose death rate for readmitted within 1 month	0.0110 (Death) 0.9890 (No Death)	(20)
3. Overdose death rate for readmitted within 1 year	0.0550 (Death) 0.9450 (No Death)	(20)
Probability of OUD treatment options	1.0	
1. Buprenorphine and psychosocial therapy	0.60	Prevalence data not available.
2. Buprenorphine	0.20	(24)

Parameter	Value	Notes and References
3. Methadone and psychosocial therapy	0.01	Prevalence data not available.
4. Methadone	0.01	Prevalence data not available.
5. Naltrexone and psychosocial therapy	0.02	Prevalence data not available.
6. Naltrexone	0.01	(24)
7. Psychosocial therapy	0.05	Prevalence data not available.
8. No treatment	0.10	Prevalence data not available.
Probabilities after patient completes OUD treatment (5 monthly follow-up office visits)	1.0	n/a
1. Patient returns for OUD evalutation	0.50	Prevalence data not available.
2. Terminal (exits the module)	0.50	Prevalence data not available.

Sample Synthetic Data Results

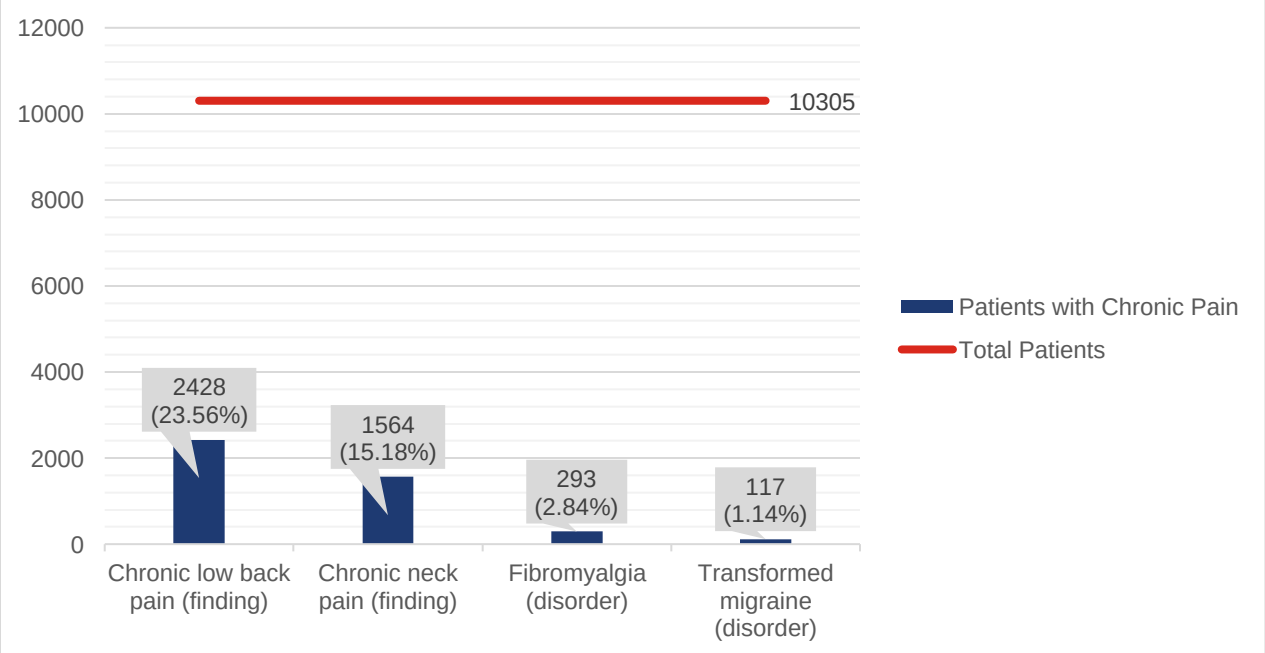
Sample Synthea generated data results for this module are included below (see Table 4). The sample results are also displayed as a chart in Figure 3. Analysis was performed using 10,305 patients generated in CSV output from Synthea. The synthetic prevalence rates matched the prevalence benchmark defined in the module. For example, 15.18% of patients have chronic neck back pain, which matches the 15% prevalence benchmark defined in the module for patients with chronic neck pain (12% with chronic neck pain and chronic low back pain, 3% with chronic neck pain).

Table 4: Patients with Chronic Pain Synthetic Prevalence

Chronic Pain Condition Type	Patients with Chronic Pain	Total Patients	Synthetic Prevalence	Benchmark Prevalence Defined in Module
Chronic low back pain (finding)	2428	10305	23.56%	24%*
Chronic neck pain (finding)	1564	10305	15.18%	15%*
Fibromyalgia (disorder)	293	10305	2.84%	3%*
Transformed migraine (disorder)	117	10305	1.14%	1%*
Chronic Pain Total	2859	10305	27.74%	28%*

* *See* Table 3: Prescribing Opioids for Chronic Pain and Treatment of OUD Module Parameters

Figure 3: Patients with Chronic Pain Synthetic Prevalence Graph



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