

Algorithms

Algorithm 1: Physically Present Date (PPD)

Objective:

In order to create more granular death dates and to establish dates of hospitalization and ICU stays, we create physically present dates (PPD). This algorithm creates PPDs: accurate and available dates for a patient in which clinical events on that day suggest the patient was alive.

Method:

The PPD can only be identified from the *procedure* table, the *observation* table, or the *med administrations* table.

1. Procedure

- a) Use any of the following:
 - i. Any ICD9 or ICD10 procedure record
 - ii. Any HCPCS procedure record in which the HCPCS code starts with J
 1. These are typically injections
 - iii. Any CPT4 procedure record in which the CPT4 code starts with anything **other than 8, 7, or 93**
 1. The 8-codes are lab tests for drug content, genetic tests, metabolic panels, CBCs. The billing of these codes may cause date issues (e.g. after patient death)
 2. The 7-codes are for imaging tests; delays can exist between the order date and the evaluation date
 3. The 93-codes are EKG tests; billing can be weeks after the actual test

2. Observation

- a) Use any observations where the observation type is HR, PULSE, RESP, or TEMP
- b) Then, restrict to only use those with an observation result greater than 0, to ensure that the event is fully captured.

3. Med Administrations

- a) Any records from this table will suffice.

Algorithm 2: Date of Death

Objective:

In this database, the death date is only available at a year-month level, so we used the PPDs to identify a more granular death date for use as an outcome in the study.

Terminology:

Term	Definition
Last Physically Present Date (LPPD)	The last accurate and available date for a patient in which clinical events on that day suggest the patient was alive.
Adjusted Death Date (ADD)	The death date estimated using this algorithm, which provides a specific date in lieu of the year-month date from the database.

Method:

- 1. Find the last PPDs (LPPD)**
 - a. Using the PPD algorithm, identify the LPPDs for all patients with a death event
 - b. Once the last LPPD is identified, if it predates the cohort index date, set the LPPD to the cohort index date.
- 2. Determine the adjusted death date (ADD)**
 - a. If the LPPD is before Optum's death year-month date, use the first date of the death month.
 - i. For example: if LPPD is February 5, 2020 and the Optum death date is March 2020, use March 1, 2020.
 - b. If the LPPD is during Optum's death year-month date, use the LPPD.
 - i. For example: if LPPD is March 15, 2020 and the Optum death date is March 2020, use March 15, 2020.
 - c. If the LPPD is after Optum's death year-month date, use the last date of Optum's death year-month date.
 - i. For example: if LPPD is April 5, 2020 and the Optum death date is March 2020, use March 31, 2020.
- 3. Remove patients from the cohort if ADD is implausible**
 - a. If the ADD occurs prior to cohort index, remove the patient from the cohort
 - i. There may be a re-used patient id, in that a patient died in the past, but then a new patient has been given the same patient id

Algorithm 3: Hospitalization and Emergency Department Identification

Objective:

As the database does not provide research-quality visit start and end dates, we utilized PPDs to construct inpatient visit dates.

Terminology:

Term	Definition
Hospital encounter	Any record in the encounter table that has either: <ul style="list-style-type: none"> • Interaction type of “Inpatient,” “Observation patient,” or “Emergency patient” • An encounter id linked to any occurrence of an inpatient CPT code and/or emergency department CPT code, with interaction type NULL, “OTHER PATIENT TYPE”, or “UNKNOWN PATIENT TYPE”
Encounter stay (ES)	A hospitalization constructed based off of encounter records and clinical events.
Physically Present Date (PPD)	Accurate and available dates for a patient in which clinical events on that day suggest the patient was alive.
Encounter stay duration (ESD)	The number of days between the last PPD and the first PPD of an encounter stay. This can be computed using last PPD – first PPD.

Code List:

Criterion Name	Code Type	Code
Inpatient	CPT	99217
Inpatient	CPT	99218
Inpatient	CPT	99219
Inpatient	CPT	99220
Inpatient	CPT	99221
Inpatient	CPT	99222
Inpatient	CPT	99223
Inpatient	CPT	99224
Inpatient	CPT	99225
Inpatient	CPT	99226
Inpatient	CPT	99231
Inpatient	CPT	99232
Inpatient	CPT	99233
Inpatient	CPT	99234
Inpatient	CPT	99235
Inpatient	CPT	99236
Inpatient	CPT	99238
Inpatient	CPT	99239
Inpatient	CPT	99251
Inpatient	CPT	99252
Inpatient	CPT	99253

Inpatient	CPT	99254
Inpatient	CPT	99255
Inpatient	CPT	99291
Inpatient	CPT	99292
Inpatient	CPT	99356
Inpatient	CPT	99357
Inpatient	CPT	94002
Inpatient	CPT	94003
Inpatient	CPT	99460
Inpatient	CPT	99462
Inpatient	CPT	99463
Inpatient	CPT	99464
Inpatient	CPT	99465
Inpatient	CPT	99466
Inpatient	CPT	99467
Inpatient	CPT	99468
Inpatient	CPT	99469
Inpatient	CPT	99471
Inpatient	CPT	99472
Inpatient	CPT	99475
Inpatient	CPT	99476
Inpatient	CPT	99477
Inpatient	CPT	99478
Inpatient	CPT	99479
Inpatient	CPT	99480
Inpatient	CPT	99481
Inpatient	CPT	99482
Emergency Department	CPT	99281
Emergency Department	CPT	99282
Emergency Department	CPT	99283
Emergency Department	CPT	99284
Emergency Department	CPT	99285
Emergency Department	CPT	99288

Method:

1. **Using hospital encounters, find matching PPD**
 - a. For all hospital encounters, find PPD records with the same encounter id
2. **Add Hospitalization CPTs to eligible PPDs**
 - a. Find Inpatient and Emergency Department CPT codes (in the code list table) with no encounter id and include these as eligible PPDs
3. **Find encounter stays (ES)**
 - a. For each patient, find strings of consecutive PPDs to form encounter stays.

- b. These stays are not based on encounter id, but rather, they all just need to be for the same patient.
 - c. The ES start date is the first PPD.
 - d. The ES end date is the last PPD.
- 4. Restrict encounter stays based on encounter stay duration (ESD) and care setting**
- a. If multiple care settings are present in the encounter stay but ESD is 0, this is not a hospitalization and should be discarded.
 - b. If only the ED setting is recorded for all encounters in the ES, and the ESD is 0 or 1, this is a stand-alone ED visit rather than a hospitalization.
 - c. This logic is illustrated in the table below.
- 5. Bridge hospitalizations with 1 day between**
- a. To handle scenarios in which patients have 1 gap day between 2 hospitalizations, bridge the 2 hospitalizations together
 - i. The hospitalization start date will then be the start of the first hospitalization and the end date will be the end of the second hospitalization.

Scenario	Multiple settings	ED setting only
Last PPD – first PPD = 0 and no death occurred	ED if ED present; otherwise discard	Stand-alone ED visit
Last PPD – first PPD = 0 and death occurs	Hospitalization	Stand-alone ED visit with death occurring ED
Last PPD – first PPD = 1	Hospitalization	Stand-alone ED visit
Last PPD – first PPD ≥ 2	Hospitalization	Hospitalization

Algorithm 4: ICU Stays**Objective:**

As the database does not provide research-quality ICU dates, we utilized ICU codes and hospital discharge codes to create ICU stays.

Terminology:

Term	Definition
Continuous Stay	A string of consecutive dates in which the patient has an ICU code
Bridging	Due to missing data, what appears to be 2 distinct ICU stays may actually be one continuous ICU stay in reality. Bridging means to make one continuous ICU stay, such that it begins at the start of the first ICU stay and ends at the end of the second ICU stay.
Intervening Discharge Code	A discharge code that occurs during the period from the first ICU stay's end date up to and including the day before the second ICU stay's start date.
Bridge Candidate	A set of continuous stays that are proximal that could be bridged.
Within n days	The gap between two dates (A and B) should be such that $A \leq B + n$.

Code List:

Criterion Name	Code Type	Code
Hospital Discharge	CPT	99217
Hospital Discharge	CPT	99238
Hospital Discharge	CPT	99239
ICU	BETOS	M2C
ICU	CPT	99291
ICU	CPT	99292
ICU	CPT	99468
ICU	CPT	99469
ICU	CPT	99471
ICU	CPT	99472
ICU	CPT	99475
ICU	CPT	99476
ICU	CPT	99477
ICU	CPT	99478
ICU	CPT	99479
ICU	CPT	99480
ICU	CPT	99481
ICU	CPT	99482
ICU	REV	0200
ICU	REV	0201
ICU	REV	0202

ICU	REV	0203
ICU	REV	0204
ICU	REV	0207
ICU	REV	0208
ICU	REV	0209
ICU	REV	0212
ICU	REV	0233
ICU	CPT	94002
ICU	CPT	94003

1. Find Continuous Stays

- a) Using the ICU codes below, identify continuous ICU stays (consecutive days of ICU care).
- b) The start of the continuous stay will be the first date of the continuous string of dates.
- c) The end of the continuous stay will be the last date of the continuous string of dates.

2. Find Bridge Candidates

- a) For each candidate continuous stay, determine if there are any proximal continuous stays that are within 3 days of the candidate. These are bridge candidates.

3. Determine if any intervening discharge codes exist

- a) If there is a discharge code (see code list table above) that is intervening, then do not bridge. Use the existing dates for the continuous stays.

4. Bridge continuous stays if eligible

- a) Assign the start of the bridged continuous stay to be the first date of the continuous string.
- b) Assign the end of the bridged continuous stay to be the last date of the continuous string.

5. Remove 0-night stays unless they happen on date of death