Type 1 and type 2 Diabetes Mellitus Phenotype Algorithm
Pseudo Code

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1. Introduction:

This document describes the Stanford University algorithm to extract individuals with diabetes and the type of diabetes from electronic health records (EHRs). There are two main tasks of this phenotype development: 1) to extract patients with diabetes (gestational diabetes is excluded), and 2) to discriminate between type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). Instead of identifying all diabetes cases, we aim to reduce the number of false positives in our diabetes cohort. The prior is crucial for public health surveillance, yet we aim to achieve the later for clinical research use.

2. Algorithm Description:

Individuals with diabetes were identified by having diagnosis codes combined with either having abnormal laboratory results or being prescribed with diabetes-related medications. We then modified the Klompas (2013) algorithm[1] by including additional ICD-10 diagnosis codes to classify T1DM vs. T2DM. Structured data required from EHRs include:

- Diagnosis code (ICD-9 and ICD-10)
- Prescribed medication (RxNorm)
- Laboratory test results (LOINC)

2.1. Diabetes Cohort Selection

Individuals with diabetes were identified using the following criteria. Diagnosis and medication codes are available in the Appendix.

- ICD-9 and/or ICD-10 codes for type 1 and/or type 2 diabetes *AND* ***ANY*** of the following criteria

  - With abnormal lab
    - Random glucose > 200 mg/dl
    - Fasting glucose ≥ 125 mg/dl
    - Hemoglobin A1c ≥ 6.5%

  - Being prescribed with diabetes-related medication
    - Insulin
    - glucagon
    - glucagon-like peptide-1 (GLP-1) receptor agonists
    - biguanides
    - sulfonylurea
    - thiazolidinediones
    - meglitinides
    - biguanides
    - α -glucose inhibitor
    - DPP-4 inhibitors
    - SGLT2 inhibitors
    - Cycloset

2.2. Classification algorithm for T1DM and T2DM

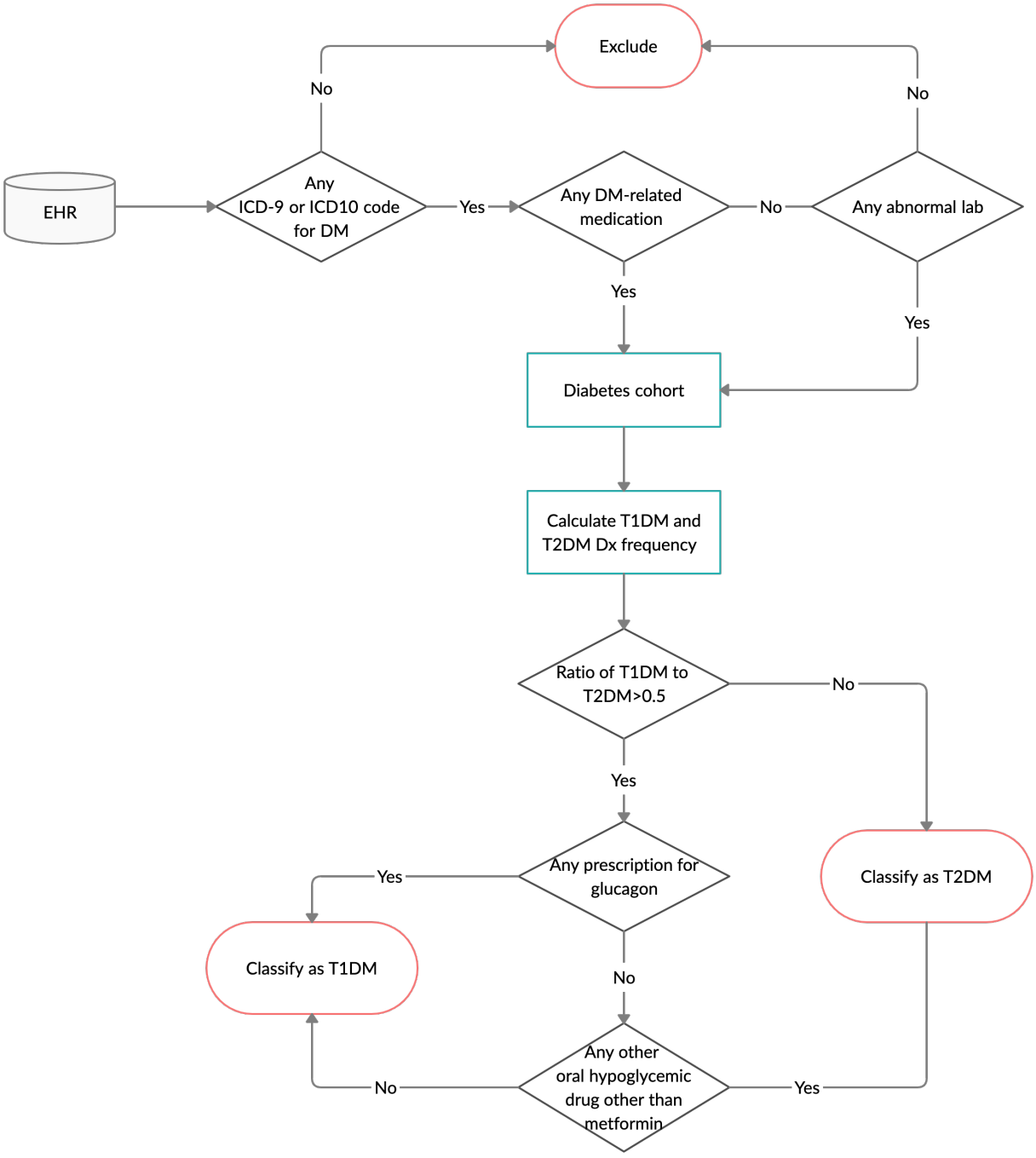
- Based on the Klompas (2013) algorithm, a patient will be classified as T1DM if ***ANY*** of the following present:

  - Ratio of T1DM to T2DM codes > 0.5 and prescription for glucagon
  - Ratio of T1DM to T2DM codes > 0.5 and no record of an oral hypoglycemic other than metformin

- A patient who did not meet the criteria for T1DM were presumptively classified as T2DM.

Flow Diagram

This is a schematic representation of the phenotype definition logic described above.



Appendix of Diagnosis and Medications

Diagnosis code for diabetes

- ICD-9 code: 250.x
- ICD-10 code: E10.x, E11.x

RxNorm/RXCUI codes for diabetes-related medications

Generic Name	RxNorm CUI
Oral hypoglycemic medications	
Biguanides	
Metformin	6809
Sulfonylureas	
Glipizide	4821
Glyburide	4815
Gliclazide	4816
Glimepiride	25789
Thiazolidinediones	
Rosiglitazone	84108
Pioglitazone	33738
Meglitinides	
Repaglinide	73044
Nateglinide	274332
α-Glucosidase inhibitors	
Acarbose	16681
Miglitol	30009
DPP-4 inhibitors	
Sitagliptin	593411
Saxagliptin	857974
Vildagliptin	596554
Linagliptin	1100699
Alogliptin	1368001
SGLT2 inhibitors	
Dapagliflozin	1488564
Canagliflozin	1373458
GLP-1 receptor agonists	
Exenatide	60548
Lixisenatide	1440051

Liraglutide	475968
Semaglutide	1991302
Dulaglutide	1551291
Cycloset	
Bromocriptine	1760
Glucagon	4832
Insulin	139825
	274783
	314684
	352385
	400008
	51428
	5856
	86009

LOINC codes for diabetes laboratory test

Laboratory test	LOINC code
Random glucose	2339-0
	2345-7
Fasting glucose	1558-6
Hemoglobin A1c	4548-4
	17856-6
	4549-2
	17855-8

Reference

1. Klompas M, Eggleston E, McVetta J, Lazarus R, Li L, Platt R. Automated detection and classification of type 1 versus type 2 diabetes using electronic health record data. *Diabetes Care*. 2013 Apr 1;36(4):914-21.