MINI-SENTINEL SYSTEMATIC EVALUATION OF HEALTH OUTCOME OF INTEREST DEFINITIONS FOR STUDIES USING ADMINISTRATIVE DATA

SUICIDE REPORT

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Suicide Report

I. EXECUTIVE SUMMARY

A. OVERVIEW OF PROJECT

The Food and Drug Administration (FDA) Mini-Sentinel contract is a pilot program that aims to conduct active surveillance to detect and refine safety signals that emerge for marketed medical products. To perform this active surveillance, it is necessary to develop and understand the validity of algorithms for identifying health outcomes of interest in administrative data. Thus, the goal of this project was to identify algorithms used to detect selected health outcomes of interest using administrative data sources and describe the performance characteristics of these algorithms as reported by the studies in which they were used. This report summarizes the process and findings of the suicide algorithm review.

B. SUMMARY OF FINDINGS

Little is known about the completeness of claims and the validity of claims based algorithms to identify completed suicide or medically injurious suicide attempts. Due to the paucity of research, no medical claims based algorithms are known to have well established and acceptable concordance with independent assessments of either suicide or suicide attempts. Specific recommendations regarding a preferred algorithm for the identification of suicide or suicide attempt from claims data cannot be made at this time.

Using claims to monitor suicide at a population level is vulnerable to two potentially important sources of under counting. Some completed suicides present to hospitals or emergency departments but are not properly coded while other completed suicides are never in the hospital. As a result, only a small proportion of suicides in death registries appear in hospital or emergency department billing records (one study: 14.3%, 70 of 491) (1). However, the limited available evidence suggests that the majority of in-hospital deaths coded as deliberate self-harm are confirmed as suicides in death registries (one study: 59.5%, 91 of 153) (2).

In terms of suicide attempts, a small study of outpatients (n=30) at one HMO who were starting treatment for depression confirmed intentional self-harm in medical records of all study patients who had received an outpatient code for deliberate self-harm (PPV=100%) (3). The extent to which these findings can be safely generalized to other clinical populations is unknown.

C. RECOMMENDATION FOR ALGORITHMS AND SUGGESTION FOR FUTURE RESEARCH

As indicated above, a paucity of research prevents recommendation of a specific claims-based algorithm to identify either attempted suicide or suicide death in electronic health data files. Concern over the completeness of coding casts uncertainty over claims-based detection of suicide-related outcomes. The relevant codes are External Cause of Injury codes, commonly referred to as E codes. They were developed by the World Health Organization as supplementary codes for use with the International Classification of Diseases (ICD). E-codes offer a systematic way to classify diagnostic information that health care professionals enter into the medical or billing records. E codes provide information about the event during which the injury took place and the individuals who were injured. E-codes in the 950-959 range refer to injuries that are deliberate in intent (self-harm) and span a range of methods (see Appendix C).

An important preliminary step to address concerns over completeness of E-codes would involve establishing norms or benchmarks from covered populations of the rate and distribution of the relevant codes (E950-959) by age, sex, and treatment setting to serve as reference points. These values, which would be derived from populations with required E-coding, could be used to identify health care systems with acceptable levels of E-code completeness. A second important preliminary research task involves development and testing of standardized procedures for validating E-codes from external data sources such as medical records. A key issue in this regard involves distinguishing intentional self-harm with suicidal and non-suicidal intent. Beyond these preliminary research tasks, substantive assessments are needed of the positive predictive value of algorithms to identify suicide attempts and suicide deaths. Work is also needed to assess variation in the validity of the algorithms across treatment setting and coding detail as well as variation related to basic demographic and clinical characteristics of the patient populations.

II. PROJECT OBJECTIVES

The primary objective of this project was to identify studies that have validated algorithms used to identify various health outcomes of interest (HOIs) using administrative data from the United States or Canada, and to summarize the results of those validation studies. The current report focuses on suicide and suicide attempts as outcomes of interest. No research was found on suicide ideation.

III. BACKGROUND

The Food and Drug Administration (FDA) Mini-Sentinel contract is a pilot program that aims to conduct active surveillance to detect and refine safety signals that emerge for marketed medical products. In order to perform this work, the program needed to identify algorithms used to detect various health outcomes of interest using administrative data sources and identify the performance characteristics of these algorithms as measured in the studies in which they were used. The data sources of interest were limited to those from the United States or Canada to increase their relevance to the Mini-Sentinel data sources, which are all from the United States. The Mini-Sentinel Protocol Core developed a preliminary list of approximately 140 potential health outcomes of interest, based on several criteria. These criteria included: A) previous validation studies had been identified in a textbook chapter reviewing the validity of drug and diagnosis data used in pharmacoepidemiologic studies (4), B) a list of designated medical events from a proposed FDA rule on the safety reporting requirements for human drug and biological products (5), C) the Observational Medical Outcomes Partnership (OMOP) had commissioned reports on algorithms used to identify the health outcome using administrative data (6).

From the original list of 140 HOIs, the Protocol Core worked with FDA to select 20 for which reviews of algorithms would be completed. HOIs for which OMOP had already commissioned reports were purposefully excluded in order to avoid duplication of effort.

Suicide was one of the 20 HOIs selected for review. This report describes the review process and findings for the suicide definition algorithms.

IV. METHODS

A. SEARCH STRATEGY

The general search strategy was developed based on prior work by OMOP and its contractors, and modified slightly for these reports. Originally, OMOP contracted with two organizations to perform reviews of 10 HOIs. Because the search strategies used by each organization resulted in very different sets of articles, OMOP investigators reviewed the PubMed indexing of the articles deemed useful in final reports and developed a strategy that would identify the majority of these citations while maintaining efficiency in the number of abstracts that would need to be reviewed. Mini-Sentinel investigators made minor changes to this strategy that would result in the identification of more citations, and confirmed empirically that the majority of relevant articles from one set of OMOP reports (angioedema) (7, 8) would be identified using this approach. The base search strategy was then combined with PubMed terms representing the HOIs. Medical subject heading (MeSH) terms were generally preferred as HOI search terms due to their likely specificity. Text word searches were sometimes used, particularly when the MeSH search resulted in a small number of citations for review. The workgroup also searched the database of the Iowa Drug Information Service (IDIS) using a similar search strategy to identify other relevant articles that were not found in the PubMed search. For a limited number of outcomes where very few citations were identified from PubMed and IDIS searches, Embase searches were conducted. Search results were restricted to articles published on or after January 1, 1990.

University of Iowa investigators compiled the search results from different databases and eliminated duplicate results using a citation manager program. The results were then output into two sets of files, one containing the abstracts for review and the other for documenting abstract review results.

The search strategy and results for suicide are detailed in the Results section. The PubMed search was conducted on May 8, 2010, and the IDIS searches on June 12, 2010.

B. ABSTRACT REVIEW

1. Abstract Review Methods

Each abstract was reviewed independently by two investigators to determine whether the full-text article should be reviewed. Exclusion criteria were documented sequentially (i.e. if exclusion criterion 1 was met then the other criteria were not documented). If the reviewers disagreed on whether the full-text should be reviewed, then it was selected for review. Inter-rater agreement on whether to include or exclude an abstract was calculated using a Cohen's kappa statistic. The goal was to review any administrative database study that used data from the United States or Canada and studied the HOI, as validation components of studies are not necessarily included in the abstract and other relevant citations might be identified from the references of such studies.

2. Abstract Exclusion Criteria

1. Did not study the suicide, suicide attempt, or suicide ideation.

2. Not an administrative database study. Eligible sources included insurance claims databases as well as other secondary databases that identify health outcomes using billing codes.

3. Data source not from the United States or Canada.

C. FULL-TEXT REVIEW

1. Full-Text Review Methods

Full-text articles were reviewed independently by two investigators, with a goal of identifying validation studies described in the article itself or from the reference section of the article. Citations from the article's references were selected for full-text review if they were cited as a source for the suicide or suicide attempt algorithm, or were otherwise deemed likely to be relevant. Full-text review exclusion criteria were applied sequentially. If there was disagreement on whether a study should be included, the two reviewers attempted to reach consensus on inclusion by discussion. If the reviewers could not agree, a third investigator was consulted to make the final the decision.

2. Full-Text Exclusion Criteria

1. Poorly described identification algorithm that would be difficult to operationalize.

2. No validation of outcome definition or reporting of validity statistics.

D. MINI-SENTINEL INVESTIGATOR SURVEY

Mini-Sentinel investigators were surveyed to request information on any published or unpublished studies that validated an algorithm to identify an HOI in administrative data. Studies that would not be excluded by one of the aforementioned criteria were included in the final report.

E. EVIDENCE TABLE CREATION

A single investigator abstracted each study for the final evidence table. The data included in the table were confirmed by a second investigator for accuracy.

F. CLINICIAN OR TOPIC-EXPERT CONSULTATION

A clinician or topic-expert was consulted to review the results of the evidence table and discuss how they compare and contrast to diagnostic methods currently used in clinical practice. This included whether certain diagnostic codes used in clinical practice were missing from the algorithms, and the appropriateness of the validation definitions compared to diagnostic criteria currently used in clinical practice. A summary of this consultation was included in the results.

V. RESULTS

A. SEARCH STRATEGY AND RESULTS

The following summarizes the search results obtained from PubMed and IDIS searches. The PubMed search identified 484 citations (Table 1), and the two IDIS searches identified 39 unique citations (Table 2). The total number of unique citations from the combined searches was 508. An additional PubMed

search was conducted at a later date to amend the original search strategy with names of relevant databases that were not included in the original search. This search identified 19 citations (Table 3).

Table 1. PubMed Search Strategy and Results: Performed on 05/08/10

Results = 484

Search	Query	Results
#1	Search ("Suicide"[Mesh] OR "Suicide, Attempted"[Mesh]) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	22431
#2	suicidal ideation Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	2444
#3	suicidality Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	1710
#4	suicidal behavior Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	6731
#5	Search #1 or #2 or #3 or #4 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	23961
#6	("Pharmaceutical preparations/adverse effects"[Mesh] OR "Pharmaceutical preparations/contraindications"[Mesh] OR "Pharmaceutical preparations/poisoning"[Mesh] OR "Pharmaceutical preparations/therapeutic use"[Mesh] OR "Pharmaceutical preparations/toxicity"[Mesh] OR "Pharmaceutical preparations/therapy"[Mesh] OR "Pharmaceutical preparations/analysis"[Mesh] OR "Chemical actions and uses/adverse effects"[Mesh] OR "Chemical actions and uses/contraindications"[Mesh] OR "Chemical actions and uses/poisoning"[Mesh] OR "Chemical actions and uses/therapeutic use"[Mesh] OR "Chemical actions and uses/toxicity"[Mesh] OR "Chemical actions and uses/therapy"[Mesh] OR "Chemical actions and uses/analysis"[Mesh] OR "Chemical actions and uses/epidemiology"[Mesh] OR "Drug toxicity"[Mesh] OR "Diseases Category/chemically induced"[Mesh] OR "Diseases Category/drug therapy"[Mesh] OR "Diseases Category/epidemiology"[Mesh] OR "Validation Studies"[pt] OR "Validation Studies as Topic"[Mesh] OR "Sensitivity and Specificity"[Mesh] OR "Predictive Value of Tests"[Mesh] OR "Reproducibility of Results"[Mesh] OR "Predictive Value"[tw]) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	1844889
#7	("Premier"[All] OR "Solucient"[All] OR "Cerner"[All] OR "Ingenix"[All] OR "LabRx"[All] OR "IHCIS"[All] OR "marketscan"[All] OR "market scan"[All] OR "Medstat"[All] OR "Thomson"[All] OR "pharmetrics"[All] OR "healthcore"[All] OR "united healthcare"[All] OR "UnitedHealthcare"[All] OR "UHC"[All] OR "GPRD"[All] OR "general practice research database"[All] OR "Research Database"[All] OR "Group Health"[All] OR "HCUP"[All] OR ("Healthcare Cost"[All] AND "Utilization Project"[All]) OR ("Health Care Cost"[All] AND "Utilization Project"[All]) OR "MEPS"[All] OR "Medical Expenditure Panel Survey"[All] OR "NAMCS"[All] OR "National Hospital Ambulatory Medical Care Survey"[All] OR "National Ambulatory Medical Care Survey"[All] OR "NHIS"[All] OR "National Health Interview Survey"[All] OR "Kaiser"[All] OR "HMO Research"[All] OR "Health Maintenance Organization"[All] OR "HMO"[All] OR "Cleveland Clinic"[All] OR "Lovelace"[All] OR "Department of Defense"[All] OR "Henry Ford"[All] OR ("Denmark"[All] AND "Epidemiology"[All]) OR "i3 Drug Safety"[All] OR "i3"[All] OR "Aetna"[All] OR "Humana"[All] OR "Wellpoint"[All] OR "IMS"[All] OR "Intercontinental Marketing Services"[All] OR "IMS	395147

	Health"[All] OR "Geisinger"[All] OR "GE Healthcare"[All] OR "MQIC"[All] OR "PHARMO"[All] OR "Institute for Drug Outcome Research"[All] OR "Pilgrim"[All] OR "Puget Sound"[All] OR "Regenstrief"[All] OR "Saskatchewan"[All] OR "Tayside"[All] OR "MEMO"[All] OR "Medicines Monitoring Unit"[All] OR "Veterans Affairs"[All] OR "Partners Healthcare"[All] OR "Mayo Clinic"[All] OR "Rochester Epidemiology"[All] OR "Indiana Health Information Exchange"[All] OR "Indiana Health"[All] OR "Intermountain"[All] OR THIN"[All] OR "The health improvement network"[All] OR "blue cross"[All] OR "health partners"[All] OR "health plan"[All] OR "health services"[All] OR "Nationwide Inpatient Sample"[All] OR "National Inpatient Sample"[All] OR "medicaid"[All] OR "medicare"[All] OR "MediPlus"[All] OR "Outcome Assessment"[All] OR "insurance database"[All] OR "insurance databases"[All] OR "Data Warehouse"[All] OR "ICD-9"[All] OR "international statistical classification"[All] OR "international classification of diseases"[All] OR "ICD-10"[All] OR "Database Management Systems"[Mesh] OR "Medical Records Systems, Computerized"[Mesh] OR "CPT"[All] OR "Current procedural terminology"[All] OR "drug surveillance"[All] OR ("claims"[tw] AND "administrative"[tw]) OR ("data"[tw] AND "administrative"[tw]) OR "Databases, Factual"[Mesh] OR "Databases as topic"[Mesh] OR "Medical Record Linkage"[Mesh] OR "ICD-9-CM"[All Fields] OR "ICD-10-CM"[All Fields] Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	
#8	("Clinical Trial"[pt] OR "Editorial"[pt] OR "Letter"[pt] OR "Meta-Analysis"[pt] OR "Randomized Controlled Trial"[pt] OR "Clinical Trial, Phase I"[pt] OR "Clinical Trial, Phase II"[pt] OR "Clinical Trial, Phase III"[pt] OR "Clinical Trial, Phase IV"[pt] OR "Comment"[pt] OR "Controlled Clinical Trial"[pt] OR "case reports"[pt] OR "Clinical Trials as Topic"[Mesh] OR "double-blind"[All] OR "placebo-controlled"[All] OR "pilot study"[All] OR "pilot projects"[Mesh] OR "Review"[pt] OR "Prospective Studies"[Mesh]) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	2701948
#9	Search #6 and #7 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	117951
#10	Search #9 not #8 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	71403
#11	Search #5 and #10 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	484

Table 2. IDIS Search Strategy and Results: Performed on 06/12/10

Results = 39 unique citations

Search 1: 25 Results

ADVANCED SEARCH

All Fields:

Suicide and ("Premier" OR "Solucient" OR "Cerner" OR "Ingenix" OR "LabRx" OR "IHCIS" OR "marketscan" OR "market scan" OR "Medstat" OR "Thomson" OR "pharmetrics" OR "healthcore" OR "united healthcare" OR "UnitedHealthcare" OR "UHC" OR "GPRD" OR "general practice research database" OR "Research Database" OR "Group Health" OR "HCUP" OR ("Healthcare Cost" AND "Utilization Project") OR ("Health Care Cost" AND "Utilization Project") OR "MEPS" OR "Medical Expenditure Panel Survey" OR "NAMCS" OR "National Hospital Ambulatory Medical Care Survey" OR "National Ambulatory Medical Care Survey" OR "NHIS" OR "National Health Interview Survey" OR "Kaiser" OR "HMO Research" OR "Health Maintenance Organization" OR "HMO" OR "Cleveland Clinic" OR "Lovelace" OR "Department of Defense" OR "Henry Ford" OR ("Denmark" AND "Epidemiology") OR "i3 Drug Safety" OR "i3" OR "Aetna" OR "Humana" OR "Wellpoint" OR "IMS" OR "Intercontinental Marketing Services" OR "IMS Health" OR "Geisinger" OR "GE Healthcare" OR "MQIC" OR "PHARMO" OR "Institute for Drug Outcome Research" OR "Pilgrim" OR "Puget Sound" OR "Regenstrief" OR "Saskatchewan" OR "Tayside" OR "MEMO" OR "Medicines Monitoring Unit" OR "Veterans Affairs" OR "Partners Healthcare" OR "Mayo Clinic" OR "Rochester Epidemiology" OR "Indiana Health Information Exchange" OR "Indiana Health" OR "Intermountain" OR "THIN" OR "The health improvement network" OR "blue cross" OR "health partners" OR "health plan" OR "health services" OR "Nationwide Inpatient Sample" OR "National Inpatient Sample" OR "medicaid" OR "medicare" OR "MediPlus" OR "Outcome Assessment" OR "insurance database" OR "insurance databases" OR "Data Warehouse" OR "ICD-9" OR "international statistical classification" OR "international classification of diseases" OR "ICD-10" OR "Database Management Systems" OR "Medical Records Systems, Computerized" OR "CPT" OR "Current procedural terminology" OR "drug surveillance" OR ("claims" AND "administrative") OR ("data" AND "administrative") OR "Databases, Factual" OR "Databases" OR "Medical Record Linkage" OR "ICD-9-CM" OR "ICD-10-CM")

AND NOT **Descriptor**:

"CASE REPORT ADULT 0" or "FDA APPROVAL PACKAGE 155" OR "FDA BLACK BOX WARNING 165" OR "PIVOTAL STUDY 162" OR "FDA ADVISORY COMMITTEE 164" or "CASE REPORT PEDIATRIC 1" or "CASE REPORT GERIATRIC 2" or "REVIEW ADULT 6" or "STUDY NON-CLINICAL 8" or "REVIEW PEDIATRIC 21" or "REVIEW GERIATRIC 23" or "STUDY RANDOMIZE ADULT 135" or "STUDY RANDOMIZE PEDIATRIC 136" or "STUDY RANDOMIZE GERIATRIC 137" or "CROSS-OVER 144" or "META-ANALYSIS 145" or "N-OF-ONE TRIAL 146" or "PRACTICE GUIDELINE 156" or "SYSTEMATIC REVIEW 161" or "ANNOTATED BIBLIOGRAPHY 167" or "PRIORITY CLIN PRACT GUIDE 168"

AND NOT **Author**:

 "(EDITORIAL)"

Years: 1990-2010

Records = 25

Search 2: 22 Results

ADVANCED SEARCH

All Fields:

"Premier" OR "Solucient" OR "Cerner" OR "Ingenix" OR "LabRx" OR "IHCIS" OR "marketscan" OR "market scan" OR "Medstat" OR "Thomson" OR "pharmetrics" OR "healthcore" OR "united healthcare" OR "UnitedHealthcare" OR "UHC" OR "GPRD" OR "general practice research database" OR "Research Database" OR "Group Health" OR "HCUP" OR ("Healthcare Cost" AND "Utilization Project") OR ("Health Care Cost" AND "Utilization Project") OR "MEPS" OR "Medical Expenditure Panel Survey" OR "NAMCS" OR "National Hospital Ambulatory Medical Care Survey" OR "National Ambulatory Medical Care Survey" OR "NHIS" OR "National Health Interview Survey" OR "Kaiser" OR "HMO Research" OR "Health Maintenance Organization" OR "HMO" OR "Cleveland Clinic" OR "Lovelace" OR "Department of Defense" OR "Henry Ford" OR ("Denmark" AND "Epidemiology") OR "i3 Drug Safety" OR "i3" OR "Aetna" OR "Humana" OR "Wellpoint" OR "IMS" OR "Intercontinental Marketing Services" OR "IMS Health" OR "Geisinger" OR "GE Healthcare" OR "MQIC" OR "PHARMO" OR "Institute for Drug Outcome Research" OR "Pilgrim" OR "Puget Sound" OR "Regenstrief" OR "Saskatchewan" OR "Tayside" OR "MEMO" OR "Medicines Monitoring Unit" OR "Veterans Affairs" OR "Partners Healthcare" OR "Mayo Clinic" OR "Rochester Epidemiology" OR "Indiana Health Information Exchange" OR "Indiana Health" OR "Intermountain" OR "THIN" OR "The health improvement network" OR "blue cross" OR "health partners" OR "health plan" OR "health services" OR "Nationwide Inpatient Sample" OR "National Inpatient Sample" OR "medicaid" OR "medicare" OR "MediPlus" OR "Outcome Assessment" OR "insurance database" OR "insurance databases" OR "Data Warehouse" OR "ICD-9" OR "international statistical classification" OR "international classification of diseases" OR "ICD-10" OR "Database Management Systems" OR "Medical Records Systems, Computerized" OR "CPT" OR "Current procedural terminology" OR "drug surveillance" OR ("claims" AND "administrative") OR ("data" AND "administrative") OR "Databases, Factual" OR "Databases" OR "Medical Record Linkage" OR "ICD-9-CM" OR "ICD-10-CM"

AND **Disease**:

E950. SUICIDE/OVERDOSE/POISONING

AND NOT **Descriptor**:

"CASE REPORT ADULT 0" or "FDA APPROVAL PACKAGE 155" OR "FDA BLACK BOX WARNING 165" OR "PIVOTAL STUDY 162" OR "FDA ADVISORY COMMITTEE 164" or "CASE REPORT PEDIATRIC 1" or "CASE REPORT GERIATRIC 2" or "REVIEW ADULT 6" or "STUDY NON-CLINICAL 8" or "REVIEW PEDIATRIC 21" or "REVIEW GERIATRIC 23" or "STUDY RANDOMIZE ADULT 135" or "STUDY RANDOMIZE PEDIATRIC 136" or "STUDY RANDOMIZE GERIATRIC 137" or "CROSS-OVER 144" or "META-ANALYSIS 145" or "N-OF-ONE TRIAL 146" or "PRACTICE GUIDELINE 156" or "SYSTEMATIC REVIEW 161" or "ANNOTATED BIBLIOGRAPHY 167" or "PRIORITY CLIN PRACT GUIDE 168"

Years: 1990-2010

Records = 22

Table 3. Search to Update the Original PubMed Search with Additional Database Names: Performed on 07/06/10

Results = 19

Search	Query	Results
#1	("Pharmaceutical preparations/adverse effects"[Mesh] OR "Pharmaceutical preparations/contraindications"[Mesh] OR "Pharmaceutical preparations/poisoning"[Mesh] OR "Pharmaceutical preparations/therapeutic use"[Mesh] OR "Pharmaceutical preparations/toxicity"[Mesh] OR "Pharmaceutical preparations/therapy"[Mesh] OR "Pharmaceutical preparations/analysis"[Mesh] OR "Chemical actions and uses/adverse effects"[Mesh] OR "Chemical actions and uses/contraindications"[Mesh] OR "Chemical actions and uses/poisoning"[Mesh] OR "Chemical actions and uses/therapeutic use"[Mesh] OR "Chemical actions and uses/toxicity"[Mesh] OR "Chemical actions and uses/therapy"[Mesh] OR "Chemical actions and uses/analysis"[Mesh] OR "Chemical actions and uses/epidemiology"[Mesh] OR "Drug toxicity"[Mesh] OR "Diseases Category/chemically induced"[Mesh] OR "Diseases Category/drug therapy"[Mesh] OR "Diseases Category/epidemiology"[Mesh] OR "Validation Studies"[pt] OR "Validation Studies as Topic"[Mesh] OR "Sensitivity and Specificity"[Mesh] OR "Predictive Value of Tests"[Mesh] OR "Reproducibility of Results"[Mesh] OR "Predictive Value"[tw]) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	1867752
#2	("Premier"[All] OR "Solucient"[All] OR "Cerner"[All] OR "Ingenix"[All] OR "LabRx"[All] OR "IHCIS"[All] OR "marketscan"[All] OR "market scan"[All] OR "Medstat"[All] OR "Thomson"[All] OR "pharmetrics"[All] OR "healthcore"[All] OR "united healthcare"[All] OR "UnitedHealthcare"[All] OR "UHC"[All] OR "GPRD"[All] OR "general practice research database"[All] OR "Research Database"[All] OR "Group Health"[All] OR "HCUP"[All] OR ("Healthcare Cost"[All] AND "Utilization Project"[All]) OR ("Health Care Cost"[All] AND "Utilization Project"[All]) OR "MEPS"[All] OR "Medical Expenditure Panel Survey"[All] OR "NAMCS"[All] OR "National Hospital Ambulatory Medical Care Survey"[All] OR "National Ambulatory Medical Care Survey"[All] OR "NHIS"[All] OR "National Health Interview Survey"[All] OR "Kaiser"[All] OR "HMO Research"[All] OR "Health Maintenance Organization"[All] OR "HMO"[All] OR "Cleveland Clinic"[All] OR "Lovelace"[All] OR "Department of Defense"[All] OR "Henry Ford"[All] OR ("Denmark"[All] AND "Epidemiology"[All]) OR "i3 Drug Safety"[All] OR "i3"[All] OR "Aetna"[All] OR "Humana"[All] OR "Wellpoint"[All] OR "IMS"[All] OR "Intercontinental Marketing Services"[All] OR "IMS Health"[All] OR "Geisinger"[All] OR "GE Healthcare"[All] OR "MQIC"[All] OR "PHARMO"[All] OR "Institute for Drug Outcome Research"[All] OR "Pilgrim"[All] OR "Puget Sound"[All] OR "Regenstrief"[All] OR "Saskatchewan"[All] OR "Tayside"[All] OR "MEMO"[All] OR "Medicines Monitoring Unit"[All] OR "Veterans Affairs"[All] OR "Partners Healthcare"[All] OR "Mayo Clinic"[All] OR "Rochester Epidemiology"[All] OR "Indiana Health Information Exchange"[All] OR "Indiana Health"[All] OR "Intermountain"[All] OR "THIN"[All] OR "The health improvement network"[All] OR "blue cross"[All] OR "health partners"[All] OR "health plan"[All] OR "health services"[All] OR "Nationwide Inpatient Sample"[All] OR "National Inpatient Sample"[All] OR "medicaid"[All] OR "medicare"[All] OR "MediPlus"[All] OR "Outcome Assessment"[All] OR "insurance database"[All] OR "insurance databases"[All] OR "Data Warehouse"[All] OR "ICD-9"[All] OR "international statistical classification"[All] OR "international classification of diseases"[All] OR "ICD-10"[All] OR "Database Management Systems"[Mesh] OR "Medical Records Systems, Computerized"[Mesh] OR "CPT"[All] OR "Current procedural terminology"[All] OR "drug surveillance"[All] OR ("claims"[tw] AND "administrative"[tw]) OR ("data"[tw] AND "administrative"[tw]) OR "Databases, Factual"[Mesh] OR "Databases as topic"[Mesh] OR "Medical Record Linkage"[Mesh] OR "ICD-9-CM"[All Fields] OR "ICD-10-CM"[All Fields] Limits: Humans, English, Publication Date from	399576

		1990/01/01 to 2011/01/01	
#3	("Clinical Trial"[pt] OR "Editorial"[pt] OR "Letter"[pt] OR "Meta-Analysis"[pt] OR "Randomized Controlled Trial"[pt] OR "Clinical Trial, Phase I"[pt] OR "Clinical Trial, Phase II"[pt] OR "Clinical Trial, Phase III"[pt] OR "Clinical Trial, Phase IV"[pt] OR "Comment"[pt] OR "Controlled Clinical Trial"[pt] OR "case reports"[pt] OR "Clinical Trials as Topic"[Mesh] OR "double-blind"[All] OR "placebo-controlled"[All] OR "pilot study"[All] OR "pilot projects"[Mesh] OR "Review"[pt] OR "Prospective Studies"[Mesh]) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	2729582
#4	#1 NOT #2 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	1748136
#5	#4 NOT #3 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	819148
#6	(TennCare [tiab]) OR (RAMQ [tiab]) OR (Cigna [tiab]) OR ((british columbia[tiab]) AND ((health[tiab]) OR (data[tiab]) OR (database[tiab]) OR (population[tiab]))) OR (CIHI [All Fields]) OR ((manitoba[tiab]) AND ((center for health policy[all fields]) OR (population[tiab]) OR (health insurance[tiab]))) OR ((ontario[tiab]) AND ((population[tiab]) OR (OHIP[tiab]) OR (registered persons database[tiab]) OR (health insurance [tiab]) OR (ICES[All Fields]) OR (Institute for Clinical Evaluative Sciences[All Fields]))) OR ((Alberta[tiab]) AND ((health[tiab]) OR (data[tiab]) OR (database[tiab]) OR (population[tiab]) OR (Alberta Health and Wellness[All Fields]))) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	5128
#7	#5 AND #6 Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	1579
#8	Search #7 AND (("Suicide"[Mesh] OR "Suicide, Attempted"[Mesh]) OR (suicidal ideation) OR (suicidality) OR (suicidal behavior)) Limits: Humans, English, Publication Date from 1990/01/01 to 2011/01/01	19

B. ABSTRACT REVIEWS

Of the 527 abstracts reviewed, 48 were selected for full-text review; 33 were excluded because they did not study suicide or suicide attempt, 248 were excluded because they were not administrative database studies, and 198 were excluded because the data source was not from the United States or Canada. Cohen's kappa for agreement between reviewers on inclusion vs exclusion of abstracts was 0.68.

C. FULL-TEXT REVIEWS

Of the 48 full-text articles reviewed, 5 were included in the final evidence tables; 6 were excluded because the suicide or suicide attempt identification algorithm was poorly defined, 35 were excluded because they included no validation of the outcome definition or reporting of validity statistics, and 2 were excluded because the data were not from the United States or Canada (not determined by abstract review). Based on reading of the full text articles, reviewers identified a further 18 citations for review. Of these, 0 were included in the final report; 3 were excluded because they did not study suicide or suicide attempt, 6 were excluded because they were not administrative database studies, 6 were excluded because the data source was not from the United States or Canada, and 2 were excluded because were the suicide algorithm was poorly defined, and 1 was excluded because it included no validation of the outcome definition or reporting of validity statistics.

D. MINI-SENTINEL INVESTIGATOR SURVEY

Mini-Sentinel investigators provided 0 published and 0 unpublished reports of validation studies that had been completed by their teams. [They also provided 2 published reports that they were familiar with but not directly involved in.]

E. EVIDENCE INCLUDED IN TABLE

Of the 5 studies included in the table, all 5 were identified from the initial search strategy, none were identified through references of articles that underwent full-text review, and none were provided by Mini-Sentinel Investigators.

F. SUMMARY AND DISCUSSION OF ALGORITHMS AND VALIDATION

Codes Used in Algorithms. All 5 publications listed in the evidence table used ICD-9 E-codes to identify patients with suicide attempts or completion (1-3, 9, 10). All but one of the studies (3) used the full range of ICD-9 E-codes (950-959) for intentional self-injury. The one exception excluded E959, self-inflicted injury with poorly specified mechanism/cause. See Appendix C for definitions of the suicide-related codes.

1. Validation Criteria and Method

Suicide Attempts. Two of the three studies in this report that focused on suicide attempts validated administrative coding data through abstraction of medical charts (3, 9, 10). Documentation of suicide attempts in the medical records was based on review of inpatient, outpatient, and emergency department notes. None of the studies specified criteria from medical records for determining suicide attempts. The fourth study involving suicide attempts assessed the construct validity of suicide attempt codes through prospective risk of completed suicide (9).

Completed Suicides. Both studies in the report focusing on completed suicide validated administrative claims through death registry information (1, 2). One study used a statewide death registry (2) and one relied on an integrated violent death reporting system that included death certificates, coroner reports, and law enforcement reports (1).

2. Validation Algorithms

Suicide Attempts. Since each of the three studies of suicide attempts used different study methods, it is difficult to make comparisons across studies.

In a small study of 30 outpatients who received E-codes of deliberate self-harm (E950-958) during the course of a new episode of depression treatment, all 30 patients had medical records that were assessed to document intentional injury and suicidal intent (PPV=100%) (3).

A study of adult patients presenting for emergency care with a principal diagnosis of suspected drug overdose or poisoning, other than alcohol intoxication, focused on the validity of E-coding classification of intent (9). E-codes were partitioned in four groups by intent (intentional E950-959; accidental E800-869; assault E960-969, 979; undetermined E980-989). Intention was independently determined by

expert review of the medical record. The intent determinations of the record review agreed with the E-codes on intent in 171 of 533 patients (32.1%). Because separate data were not presented for each intention group, it is not possible to compare agreement of the intentional self-injury group.

A study of adults discharged with self-poisoning diagnoses from a Canadian teaching hospital specializing in trauma (n=181) reported that a substantially lower percentage of patients received E-codes of intentional self-injury (E950-959) (36.5%) than were determined to be intentional self-injuries by expert record review (59.5%) (2). Because information was not presented on the intersection of the two ratings, it is not possible to determine operating characteristics of the E-codes from this analysis.

One prospective study, which was not included in the table for not including sufficient validity information, followed a consecutive sample of outpatients age 6 years and older who presented to a university-affiliated emergency department (11). The investigators compared the rate of completed suicide among patients initially receiving emergency department codes for intentional self-injury (E950-959) to those with other diagnoses. The results indicate that suicide death rates are significantly higher for discharges with self-injury E-codes (345.5 per 100,000 patient years) than other diagnoses (30.9 per 100,000 patient years) (Adjusted Hazard Ratio: 10.45, 95% CI: 7.78-14.04) (11). By comparison, the word "overdose" in the chief complaint or diagnosis field of emergency department records had roughly one-half as strong an association with suicide death (AHR:5.24, 95% CI:3.93-7.00) (11).

Completed Suicides. The two studies of suicide death also employed different research methods rendering comparisons difficult. One archival analysis was limited to 202 inpatient deaths that were all determined as suicides either by hospital E-codes or a death registry (2). The investigators report that hospital E-coding had a PPV for death registry confirmed suicide of 59.5% (91 of 153). However, the kappa, a chance corrected measure of agreement, was 0.37, which is regarded as poor (12).

In the second study, the validity of suicide codes in a statewide hospital and emergency department billing records was assessed by comparing them with suicide deaths in an integrated violent death registry as a criterion standard (1). The registry included death certificates, coroner reports, and law enforcement reports. Of the 491 suicide deaths in the violent death registry, 70 appeared in the billing records (sensitivity: 14.3%). The extent to which deaths registered as suicide occurred in the field and were not brought to medical facilities or miscoding occurred within facilities could not be determined from this study. These uncertainties may have a significant impact, inasmuch as most people who complete suicide are not receiving mental health care at the time of their death (13). A majority of the individuals who completed suicide in this study (57.4%, 282 of 491) received at least some inpatient or emergency care during the year prior to their death (1).

Selected Patient Populations. The studies were highly heterogeneous with respect to treatment setting (e.g., outpatients (3), inpatients (2), and emergency department patients (9)), geography (e.g. South Carolina (1) and urban Canada (10), and self-injury status (e.g., completed suicides (1) to non-lethal self-poisoning (10).

Age of Study Population. All of the studies included adults. Two studies had lower patient age limits, which were 16 (10), and 17 years (1), respectively. Two of the studies did not specify an age range for eligibility (1, 3) and one study included patients without regard to age (9). None of the studies focused specifically on adolescents, a group at high risk for medically injurious suicide attempts (14).

One study compared rates of E-code and clinician assessed intentional self-poisoning among discharges from an urban teaching hospital by patient age. In the two oldest age groups (55-64 years and 65+ years), self-poisoning was identified far more commonly by clinician assessment of medical records than by E-codes. The reverse was true among patients age 16-24 years and 35-44 years (10).

Patient Sex. In this same study, estimates of self-poisoning based on clinician assessment of medical records were 67.1% higher in males and 58.7% higher in females than rates based on E-codes (10). None of the other studies provided information relevant to validation stratified by patient sex.

Time Period of Data Collection. The 5 reviewed studies were published between 1993 and 2007. The earliest data were based on care delivered in 1979 (2) and the most recent data were derived from 2005 (3).

Principal vs Secondary Diagnosis. None of the studies were limited to patients with E-codes that were in the principal or primary position and therefore most likely responsible for the service utilization. In addition, none of the studies included analyses that were limited to E-codes in the principal position. Two studies indicated that E-codes were considered in any diagnostic field (9, 10) and one study did not indicate the position of the E-codes (3).

Hospitalization Diagnosis vs Outpatient Encounter. The studies included in this report examined suicide outcomes on the basis of hospitalization (1, 2, 10), outpatient visits (3) or emergency encounters (1). None of the studies separately assessed or compared the validation of suicide outcomes from different treatment settings.

G. SUMMARY OF EXCLUDED POPULATIONS AND DIAGNOSES

One of the studies was limited to outpatients who were initiating new treatment episodes for depression (3). One study selected patients with poisoning (10), thereby excluding patients with other means of self-harm that do not include self-poisoning. These selection criteria may have affected the validation measures. Determining intent of injury may be more straightforward in poisoning than in some other methods of self-injury. In one study that compared agreement on intent of injury of computerized hospital discharge data with expert review of medical records, the kappa for intent was greater for poisoning (kappa=0.72) than falls (kappa=0.40) (15).

As indicated in section F above, the design of the studies resulted in substantial differences in excluded populations. The two studies that involved death certificate validation, for example, drew on general community source populations without regard to health care seeking behavior (1, 2). By contrast, the two studies of suicide attempt outcomes were limited to patients receiving medical services (3, 9). Such structural design differences likely affect the observed validation measures, especially estimates of positive predictive value which relate directly to the prevalence of underlying condition. For example, it would be expected that a self-injury E code would have a much higher PPV for confirmed suicide attempt within a population of patients receiving treatment for bipolar disorder, depression, or schizophrenia, which are all high risk conditions, than in a much lower risk general population sample.

None of the studies were based on nationally representative data. In terms of geography, two studies were derived from single state reporting systems (1, 2), and the others were based on one (3, 10) or two

(9) large health care facilities or systems. Because the completeness of E-codes likely varies across treatment settings, it is difficult to generalize from the available studies.

H. EVIDENCE TABLE

Table 4. Positive Predictive Values by Algorithm

Citation	Study Population and Time Period	Description of Outcome Studied	Algorithm	Validation/Adjudication Procedure and Operational Definition	Validation Statistics
Blanc et al., 1993	Emergency department patients to 2 urban hospitals with principal diagnosis of suspected drug overdose or poisoning, except alcohol intoxication; 10/1989-12/1990; N=533; 65.5% male; median age=32 years; 24.6% admitted to hospital	Intention of overdose (unintentional, suicide/intentional, assault by poisoning, or undetermined intent) determined by medical record review	E-codes classified into one of four intention categories: unintentional (E800-869, E880-E929), intentional (E950-959), assault (E960-969, 979) or undetermined (E980-989)	Percentage of E-codes and medical record review determinations that agree by intention category	32.1% (171 of 533) agreement by intention category
Rhodes et al., 2002	Discharges in 1998-1999 (age ≥16 years) with self-poisoning E codes (969-989) from urban Canadian trauma hospital; N=181; mean age: 49.4 years; 56.4% males.	Proportion of discharges determined intentional self-poisoning by three experts blind to administrative (E-code) diagnosis	Discharge E-codes for deliberate self-harm (E950–E959) as distinct from unintentional (E800-E869, E880-E929) or undetermined (E980–E989) intent.	Percentage of self-poisoning determined by discharge diagnosis to be intentional compared to consensus of 3 experts' determinations based on latent class analysis.	36.5% intentional self-poisoning by medical record 59.5% intentional self-poisoning by expert review.
Shevchenko et al., 1995	Discharges from 35 Connecticut acute care hospitals; 1979-1993; N= 202 suicides across hospital and mortality databases, Age and gender distribution not	Suicide as cause of death in Connecticut Death Registry	Hospital stay ending in death with a discharge diagnosis of E950-E959 from uniform hospital discharge data sets (UHDDS)	Calculation of sensitivity and PPV with suicide in death registry as criterion standard	Sens=65.0% (91 of 140) PPV=59.5% (91 of 153)

	available.			
Simon et al., 2007	HMO outpatients starting antidepressants for depression; 1996-2005; N=109,256 patients; N=131,788 episodes; 68.7% female; Mean age: 42.6 years; No antidepressant prescription I80 days before index script and ≥1 outpatient depression visit (296.2, 296.3, 311, 300.4) within 30 days of index script.	Review of outpatient notes, emergency room notes, and inpatient discharge summaries for documentation of intentional injury.	1. An ICD-9 code for intentional self-harm (E950-958) in 90 days before or 180 days after initial antidepressant prescription or psychotherapy visit related to a depression code. 2. A self-harm code of undetermined intent (E980-E987) during the same period.	Positive predictive value for medical record verified intentional self-harm (PPV_{1SH}) and suicidal intent (PPV_{1INT}) among patients with intentional self-harm codes and undetermined intent self-harm codes (PPV_{2SH} PPV_{2INT}).	PPV_{1SH}=100% (30 of 30) PPV_{1INT}=100% (30 of 30) PPV_{2SH}=80% (24 of 30) PPV_{1INT}=70% (21 of 30)
Weis et al., 2006	Suicides in the South Carolina Violent Death Reporting System; 2004; N=491; 80.9% male; Age range: 17-84 years, 4.1% ≤ 17 years; 87.4% white race.	Suicide as cause of death determined by death certificates, coroner reports, and law enforcement reports	1. Emergency or inpatient visits on date of confirmed suicide 2. Suicide-related claims (E-codes: 950-959) from statewide hospital and emergency department billing records during year.	Proportion of confirmed suicides that have hospital or emergency department visit within 1 day of death ($Sens_1$) and proportion that have such claims for suicide-related events during year ($Sens_2$)	$Sens_1$= 13.8% (68 of 491) $Sens_2$= 14.3% (70 of 491)

I. TOPIC-EXPERT CONSULTATION

A paucity of evidence exists to evaluate the validity of E-codes to identify suicide attempts and suicide death. Without further empirical research, it is not possible to determine the positive predictive value or sensitivity of E950-959 as indicators of suicide attempts or suicide death. Insufficient data currently exist to make specific recommendations regarding a preferred algorithm and caution should be exercised in interpreting clinical and pharmacological epidemiological research that relies on these codes as measures of suicide-related outcomes. Because of the scarcity of research in this area, the effects of variation in treatment setting, local coding practices, patient populations, and reporting requirements on the completeness and accuracy of E-codes remain largely unknown.

In future research in this area, it will be important to establish a reliable criterion standard against which to evaluate E-codes. In the study of suicide death, death certificates appear to be a reasonably valid means of determining cause of death. In one study of injury-related deaths, suicide as a recorded cause of death demonstrated perfect specificity (100%) and high sensitivity (90%) with a criterion standard of independent expert review of hospital, law enforcement, autopsy, and medical examiner records (n=54) (16).

Little is known about the validity of criterion standards that have been used to evaluate self-injury E-codes. Researchers have relied on review of medical records (3, 9, 10). However, the procedures for reviewing and adjudicating cases have not been well defined or standardized. While medical record reviewers in some studies were masked to the E-code status of cases (9, 10), this was not uniformly true (3). Perhaps more importantly, no research has been conducted on the concordance between medical record reviews and more extensive probes such as those that have been used in psychological autopsy studies of suicides to identify risk factors for suicide, (17, 18), but might be adapted to assess suicidal intent. Progress has been recently made in the development of a scale to assess suicidal behavior as an adverse event in clinical trials (19), and models developed to characterize non-suicidal self-injury as a distinct behavioral construct (20). It is possible that some of these approaches to measurement will prove relevant to research on the validation of self-injury E-codes.

The importance of developing criterion standards is underscored by the nature of the E-codes 950-959. These codes designate self-inflicted injury. However, not all self-inflicted injuries are clinically considered as suicidal behavior. Punching a wall in anger, for example, may result in self-injury of the hand that leads to the appropriate use of an E-code (E956) as well as an N-code (833, open wound of fingers), but because there was no intent to die, the injury would not clinically be considered a suicide attempt. Epidemiological research indicates that self-harm events that are associated with high potential lethality also tend to have high suicidal intent and suicidal risk (21). These include especially E-codes related to firearms (E955.0-955.4) and suffocation (E953.0-953.9), but not to the more common low lethality self-injuries such as cutting or piercing (E956) or even methods associated with moderate risk of lethality such as intentional poisoning (E950.0-952.9). At the same time, there is evidence to suggest that some emergency department presentations of cutting/piercing or poisoning that are given E-codes of undetermined intent actually represent deliberate self-harm (22). Developing criteria standards to measure suicidal intent poses a central challenge to research on the validation of E950-959 codes.

Another important limitation of the available literature concerns the potential for incompleteness of E-codes. E-coding is mandatory in only approximately one-half of the states. In states where it is required, completeness often surpasses 90% (23) and exceeds rates in without mandates or regulations for E code submission on injury records (24). Similarly high rates of completion have been reported from Canadian administrative databases. In Medicare and private insurance claims databases, however, low rates of E-code completeness are common. This may be because the billing programs used by some hospitals remove E-codes because they do not factor directly in hospital billing and payment. One report indicated that 28% of injury hospitalizations in a Medicare Provider Analysis and Review data set included an E-code (25). The relatively low sensitivity of death record confirmed suicides coded as suicide E-codes in one of the reviewed studies may partially reflect incomplete E-coding in the hospitals within the study region (11). More generally, incompleteness poses interpretive challenges to findings regarding concordance between recorded E-codes and any criterion standard, since many sources of

incompleteness may be correlated with factors likely to affect concordance (e.g. ambiguity regarding intent).

One recent promising development to address the problem of unpopulated E-codes is the advent of an algorithm to estimate intentional self-harm events from ubiquitous N-codes. The algorithm was developed using a split half design and two large inpatient administrative data sets that are well populated with E-codes (US Nationwide Inpatient Sample, British Columbia Ministry of Health Inpatient Data). In this work, E-codes for deliberate self-harm (E950-E958) served as the criterion standard. The preferred algorithm required a diagnosis of selected psychiatric disorders in combination with a diagnosis of poisoning, asphyxiation, or an open wound to the upper extremity (26). In the US database, the algorithm achieved a sensitivity of 74%, a specificity of 98%, and a positive predictive value of 73%. This algorithm provides a means of examining deliberate self-harm in data sets with incomplete E-coding, though its performance has not been tested with outpatient claims.

In recent years, there has been an increased interest in potential applications of text mining strategies of electronic medical record notes for identifying cases for clinical research or pharmacovigilance (27). For example, software tools have been developed that reliably identify a diagnosis of diabetes mellitus documented in physician notes of the electronic medical record (28). If similar tools were developed to identify suicidal behaviors, it would provide a powerful means of case identification.

Perhaps the most encouraging finding in the review derives from a small claims based study of outpatients who were initiating new episodes of treatment for depression (3). One of the investigators, an academic psychiatrist, reviewed medical records from 30 outpatients who had received E-codes for deliberate self-harm. The medical records of each of the 30 patients clearly documented intentional injury and suicidal intent. The study was set in a large mixed-model prepaid health plan that serves employer based and private paying members as well as members covered through capitation contracts with Medicare and Medicaid. This study suggests that within this health setting, E-codes can be used to identify suicide attempts among individuals treated for depression.

VI. SUMMARY AND CONCLUSIONS

A. RECOMMENDATIONS FOR ALGORITHMS

Insufficient data currently exist to make specific recommendations regarding a preferred algorithm for the identification of suicide or suicide attempt from claims data. In addition, no means currently exist for identifying suicidal ideation from commonly available electronic health data. The scant available research suggests that the performance of E-codes 950-959 to identify suicide related outcomes may be highly dependent on local coding practices and requirements.

B. SUGGESTIONS FOR FUTURE RESEARCH BASED ON EVIDENCE GAPS

Because of the possibility that some medications may increase the risk of suicidal behavior (29- 31), the availability of well validated algorithms to identify suicide attempts from electronic health data would likely prove of substantial value to the post-marketing evaluation of drug safety. Empirical research in this area is currently in an early stage of development.

Research priorities include:

1. Development of expected norms of rates and distributions of E-codes by age, sex, and treatment setting. Such norms could be used to identify health care systems with acceptable levels of E-code completeness. A second means of assessing completeness involves evaluating the proportion of patients with an injury principal diagnosis that have an external cause of injury code.

2. Development of standardized procedures for validating E-codes from external sources that include but that are not necessarily limited to medical records.

3. Assessment of the positive predictive value of algorithms to identify suicide attempts and suicide deaths. Research on the validity of algorithms might assess variation in validity by treatment setting (inpatient, emergency department, outpatient), position (principal or primary, secondary), and specific code (e.g., cutting vs ingestion).

4. Because the predictors and lethality of suicide attempts vary markedly by age and gender (14), assessment is needed of potential variation in the positive predictive value of E-code algorithms by patient age and gender.

5. Research focused on developing software programs capable of reliably identifying suicidal behaviors from the analysis of the text of physician notes in electronic medical records.

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VIII. APPENDICES

A. APPENDIX A: ABSTRACTS OF STUDIES INCLUDED IN EVIDENCE TABLE

Blanc PD, Jones MR, Olson KR. Surveillance of poisoning and drug overdose through hospital discharge coding, poison control center reporting, and the drug abuse warning network. *Am J Emerg Med*. 1993; 11: 14-19.

There is no gold standard for determining poisoning incidence. We wished to compare four measures of poisoning incidence: International Classification of Diseases 9th Revision (ICD-9) principal (N-code) and supplemental external cause of injury (E-code) designations, poison control center (PCC) reporting, and detection by the Drug Abuse Warning Network (DAWN). We studied a case series at two urban hospitals. We assigned ICD-9 N-code and E-code classifications, determining whether these matched with medical records. We ascertained PCC and DAWN system reporting. A total of 724 subjects met entry criteria; 533 were studied (74%). We matched poisoning N-codes for 278 patients (52%), E-code by cause in 306 patients (57%), and E-code by intent in 171 patients (32%). A total of 383 patients (72%) received any poisoning N-code or any E-code. We found that PCC and DAWN reporting occurred for 123 of all patients (23%) and 399 of 487 eligible patients (82%), respectively. In multiple logistic regression, factors of age, hospital admission, suicidal intent, principal poisoning or overdose type, and mixed drug overdose were statistically significant predictors of case match or report varying by surveillance measure. Our findings indicate that common surveillance measures of poisoning and drug overdose may systematically undercount morbidity.

Crandall C, Fullerton-Gleason L, Aguero R, LaValley J. Subsequent suicide mortality among emergency department patients seen for suicidal behavior. *Acad Emerg Med*. 2006; 13: 435-442.

OBJECTIVES: To determine whether suicide mortality rates for a cohort of patients seen and subsequently discharged from the ED for a suicide-related complaint were higher than for ED comparison groups. METHODS: This was a nonconcurrent cohort study set at a university-affiliated urban ED and Level 1 trauma center. All ED patients 10 years and older, with at least one ED visit between February 1994 and November 2004, were eligible. ED visit characteristics defined the cohort exposure. Patients with visits for suicide attempt or ideation, self-harm, or overdose (exposed) were compared with patients without these visits (unexposed). Exposure classification was determined from billing diagnoses, E-codes (E950-E959), and free-text searching of the ED tracking system data for suicide, overdose, and spelling variants. Emergency department patient data were probabilistically linked to state mortality records. The principal outcome was suicide death. Suicide mortality rates were calculated by using person-year (py) analyses. Relative rates (RR) and 95% confidence intervals (95% CIs) were calculated from Cox proportional hazards models. RESULTS: Among the 218,304 patients, the average follow-up was 6.0 years; there were 408 suicide deaths (incidence rate [IR]: 31.2 per 100,000 py). Males (IR: 48.3) had a higher rate than females (IR: 13.5; RR: 3.6; 95% CI = 2.8 to 4.6). A single ED visit for overdose (RR: 5.7; 95% CI = 4.5 to 7.4), suicidal ideation (RR: 6.7; 95% CI = 5.0 to 9.1), or self-harm (RR: 5.8; 95% CI = 5.1 to 10.6) was strongly associated with increased suicide risk, relative to other patients. CONCLUSIONS: The suicide rate among these ED patients is higher than population-based estimates. Rates among patients with suicidal ideation, overdose, or self-harm are especially high, supporting policies that mandate psychiatric interventions in all cases.

Rhodes AE, Links PS, Streiner DL, Dawe I, Cass D, Janes S. Do hospital E-codes consistently capture suicidal behaviour? *Chronic Dis Can*. 2002; 23: 139-145.

Hospital separation data are used to study suicidal behaviour; however, there is little information about the appropriateness of these data for research and planning activities. The study purpose is to examine how consistently hospital separation E-code data reflect suicidal behaviours. Expert clinicians reviewed medical records of individuals who had a separation for self-poisoning to determine whether the self-poisoning was deliberate. Agreement among clinicians was evaluated and latent class analysis performed to derive a summary estimate of the prevalence of deliberate self-poisoning. This estimate was then compared to the prevalence of deliberate self-poisoning based on the external cause of injury (E-codes). Clinicians estimated the prevalence to be 63% higher than the E-code based prevalence. Much larger discrepancies were apparent among older age groups, those whose care was primarily medical in nature and those with a longer length of hospital stay. In acute care settings, self-poisonings among the elderly may not receive adequate attention and/or documentation. Estimating the prevalence of admissions for suicidal behaviour using hospital separation data is of questionable validity, particularly among older age groups.

Shevchenko IP, Lynch JT, Mattie AS, Reed-Fourquet LL. Verification of information in a large medical database using linkages with external databases. *Stat Med*. 1995; 14: 511-530.

Efforts to utilize Uniform Hospital Discharge Data Sets (UHDDS) for epidemiological studies have been hampered by the limitations of those databases. The purpose of this paper is to illustrate that linking to external databases can provide the verification necessary to overcome many of those limitations. This method has dramatically altered study design at the Connecticut Hospital Research and Education Foundation and has provided an efficient method for specifying data collection weaknesses within the resident databases.

Simon GE, Savarino J. Suicide attempts among patients starting depression treatment with medications or psychotherapy. *Am J Psychiatry*. 2007; 164: 1029-1034.

OBJECTIVE: This study compared the time patterns of suicide attempts among outpatients starting depression treatment with medication or psychotherapy. METHOD: Outpatient claims from a prepaid health plan were used to identify new episodes of depression treatment beginning with an antidepressant prescription in primary care (N=70,368), an antidepressant prescription from a psychiatrist (N=7,297), or an initial psychotherapy visit (N=54,123). Outpatient and inpatient claims were used to identify suicide attempts or possible suicide attempts during the 90 days before and 180 days after the start of treatment. RESULTS: Overall incidence of suicide attempt was highest among patients receiving antidepressant prescriptions from psychiatrists (1,124 per 100,000), lower among those starting psychotherapy (778 per 100,000), and lowest among those receiving antidepressant prescriptions in primary care (301 per 100,000). The pattern of attempts over time was the same in all three groups: highest in the month before starting treatment, next highest in the month after starting treatment, and declining thereafter. Results were unchanged after eliminating patients receiving overlapping treatment with medication and psychotherapy. Overall incidence of suicide attempt was higher in adolescents and young adults, but the time pattern was the same across all three treatments. CONCLUSIONS: The pattern of suicide attempts before and after starting antidepressant treatment is not specific to medication. Differences between treatments and changes over time probably reflect referral patterns and the expected improvement in suicidal ideation after the start of treatment.

Weis MA, Bradberry C, Carter LP, Ferguson J, Kozareva D. An exploration of human services system contacts prior to suicide in South Carolina: An expansion of the South Carolina violent death reporting system. *Inj Prev*. 2006; 12 Suppl 2: ii17-ii21.

OBJECTIVE: To link South Carolina Violent Death Reporting System (SCVDRS) data with state government human services databases, enabling expanded analysis of suicide in South Carolina and providing a model for other jurisdictions. DESIGN: The SCVDRS database compiles data from vital statistics, coroner reports, and law enforcement incident and supplemental reports. The Office of Research and Statistics, South Carolina Budget and Control Board (ORS) created a "Data Warehouse", to which a variety of state agencies and healthcare providers submit data on a regular basis. A unique identifier was used to link SCVDRS data to the Data Warehouse so that data may be analyzed on aggregate and case-specific levels. Year 2004 suicide data from SCVDRS were linked to South Carolina Uniform Billing codes from hospital in-patient and emergency room billing records, State Department of Mental Health service records, and criminal justice databases. RESULTS: SCVDRS year 2004 suicide data are augmented by hospitalization and emergency room visit data and diagnoses; State Department of Mental Health service provision; and criminal involvement. Of the 491 suicides occurring in 2004, 282 linked with hospitalization and emergency room data, 196 linked with criminal history databases, and 91 had previous contact with the State Department of Mental Health. CONCLUSIONS: Linking SCVDRS data to additional human services databases enables greater examination of factors surrounding suicide. Results show the positive benefits of partnerships created through SCVDRS, illustrate how SCVDRS and human service databases may augment each other, and suggest practitioners should explore implementation of prevention programs in specific settings.

B. APPENDIX B: LIST OF CITATIONS SELECTED FOR FULL-TEXT REVIEW BUT NOT INCLUDED, BY REASONS FOR EXCLUSION

1. Full Text Exclusions –#1: Poor Algorithm (6)

Anderson BA, Howard MO, Walker RD, Suchinsky RT. Characteristics of substance-abusing veterans attempting suicide: A national study. *Psychol Rep*. 1995; 77: 1231-1242.

Breslau N, Davis GC, Andreski P. Migraine, psychiatric disorders, and suicide attempts: An epidemiologic study of young adults. *Psychiatry Res*. 1991; 37: 11-23.

Derby LE, Jick H, Dean AD. Antidepressant drugs and suicide. *J Clin Psychopharmacol*. 1992; 12: 235-240.

Klein SR, Kanno IJ, Gilmore DA, Wilson SE. The socioeconomic impact of assault injuries on an urban trauma center. *Am Surg*. 1991; 57: 793-797.

Sapien RE, Fullerton L, Olson LM, Broxterman KJ, Sklar DP. Disturbing trends: The epidemiology of pediatric emergency medical services use. *Acad Emerg Med*. 1999; 6: 232-238.

Smith SM. Colwell LS Jr. Sniezek JE. An evaluation of external cause-of-injury codes using hospital records from the Indian Health Service, 1985. *American Journal of Public Health.* 1990 Mar; 80(3): 279-81.

2. Full Text Exclusions - #2: No Validation Standard (34)

Becker M, Brown L, Ochshorn E, Diamond R. Risk for suicide among Medicaid beneficiaries. *Suicide Life Threat Behav*. 2009; 39: 172-181.

Bland RC, Newman SC, Dyck RJ. The epidemiology of parasuicide in Edmonton. *Can J Psychiatry*. 1994 Oct; 39(8): 391-6.

Bunn T L, Yu L, Spiller H A, Singleton M. Surveillance of methadone-related poisonings in Kentucky using multiple data sources. *Pharmacoepidemiol Drug Saf*. 2010; 19: 124-131.

Collins JC, McFarland BH. Divalproex, lithium and suicide among Medicaid patients with bipolar disorder. *J Affect Disord*. 2008; 107: 23-28.

Crandall M, Luchette F, Esposito TJ, West M, Shapiro M, Bulger E. Attempted suicide and the elderly trauma patient: Risk factors and outcomes. *J Trauma*. 2007; 62: 1021-7.

Crown W H, Finkelstein S, Berndt E R, Ling D, et al. The impact of treatment-resistant depression on health care utilization and costs. *J Clin Psychiatry*. 2002; 63: 963-971.

Jick SS, Kremers HM, V. Isotretinoin use and risk of depression, psychotic symptoms, suicide, and attempted suicide. *Arch Dermatol*. 2000; 136: 1231-1236.

Johnson MS, Moore M, Mitchell P, Owen P, Pilby J. Serious and fatal firearm injuries among children and adolescents in Alaska: 1991-1997. *Alaska Med*. 2000; 42: 3-10, 27.

Gibbons R D, Hur K, Brown C H, Mann JJ. Relationship between antiepileptic drugs and suicide attempts in patients with bipolar disorder. *Arch Gen Psychiatry*. 2009; 66: 1354-1360.

Gibbons RD, Brown CH, Hur K, Marcus SM, Bhaumik DK, Mann JJ. Relationship between antidepressants and suicide attempts: An analysis of the Veterans Health Administration data sets. *Am J Psychiatry*. 2007; 164: 1044-1049.

Goodwin F K, Fireman B, Simon G E, Hunkeler E M, et al. Suicide risk in bipolar disorder during treatment with lithium and divalproex (ref art 503822). *JAMA*. 2003; 290: 1467-1473

Ilgen MA, Downing K, Zivin K, et al. Exploratory data mining analysis identifying subgroups of patients with depression who are at high risk for suicide. *J Clin Psychiatry*. 2009; 70: 1495-1500.

Juurlink DN, Mamdani MM, Kopp A, Redelmeier DA. The risk of suicide with selective serotonin reuptake inhibitors in the elderly. *Am J Psychiatry*. 2006 May; 163(5): 813-21.

Katz LY, Kozyrskyj AL, Prior HJ, Enns MW, Cox BJ, Sareen J. Effect of regulatory warnings on antidepressant prescription rates, use of health services and outcomes among children, adolescents and young adults. *CMAJ*. 2008; 178: 1005-1011.

Koroukian SM, Beaird H, Duldner JE, Diaz M. Analysis of injury- and violence-related fatalities in the Ohio Medicaid population: Identifying opportunities for prevention. *J Trauma*. 2007; 62: 989-995.

Miller BJ, Paschall CB,3rd, Svendsen DP. Mortality and medical comorbidity among patients with serious mental illness. *Psychiatr Serv*. 2006; 57: 1482-1487.

Miller M, Mogun H, Azrael D, Hempstead K, Solomon DH. Cancer and the risk of suicide in older Americans. *J Clin Oncol*. 2008; 26: 4720-4724.

Myers RP, Li B, Fong A, Shaheen AA, Quan H. Hospitalizations for acetaminophen overdose: A Canadian population-based study from 1995 to 2004. *BMC Public Health*. 2007; 7: 143.

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Neutel CI, Patten SB. Risk of suicide attempts after benzodiazepine and/or antidepressant use. *Ann Epidemiol*. 1997; 7: 568-574.

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Patorno E, Bohn RL, Wahl PM, et al. Anticonvulsant medications and the risk of suicide, attempted suicide, or violent death. *JAMA*. 2010; 303: 1401-1409.

Pfeiffer PN, Ganoczy D, Ilgen M, Zivin K, Valenstein M. Comorbid anxiety as a suicide risk factor among depressed veterans. *Depress Anxiety*. 2009; 26: 752-757.

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Ray WA, Hall K, Meador KG. Racial differences in antidepressant treatment preceding suicide in a Medicaid population. *Psychiatr Serv*. 2007; 58: 1317-1323.

Rhodes A, Bethell J, Jaakkimainen RL, et al. The impact of rural residence on medically serious medicinal self-poisonings. *Gen Hosp Psychiatry*. 2008; 30: 552-560.

Sernyak MJ, Desai R, Stolar M, Rosenheck R. Impact of clozapine on completed suicide. *Am J Psychiatry*. 2001; 158: 931-937.

Shi L, Thiebaud P, McCombs JS. The impact of unrecognized bipolar disorders for patients treated for depression with antidepressants in the fee-for-services California Medicaid (Medi-Cal) program. *J Affect Disord*. 2004; 82: 373-383.

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Valenstein M, Kim HM, Ganoczy D, et al. Higher-risk periods for suicide among VA patients receiving depression treatment: Prioritizing suicide prevention efforts. *J Affect Disord*. 2009; 112: 50-58.

Valuck RJ, Libby AM, Sills MR, Giese AA, Allen RR. Antidepressant treatment and risk of suicide attempt by adolescents with major depressive disorder: A propensity-adjusted retrospective cohort study. *CNS Drugs*. 2004; 18: 1119-1132.

Valuck RJ, Orton HD, Libby AM. Antidepressant discontinuation and risk of suicide attempt: A retrospective, nested case-control study. *J Clin Psychiatry*. 2009; 70: 1069-1077.

Ward A, Ishak K, Proskorovsky I, Caro J. Compliance with refilling prescriptions for atypical antipsychotic agents and its association with the risks for hospitalization, suicide, and death in patients with schizophrenia in Quebec and Saskatchewan: A retrospective database study. *Clin Ther*. 2006; 28: 1912-1921.

3. **Full Text Exclusions - #3: Other (2)**

Aizenberg D, Olmer A, Barak Y. Suicide attempts amongst elderly bipolar patients. *J Affect Disord*. 2006; 91: 91-94.

Gaertner I, Gilot C, Heidrich P, Gaertner HJ. A case control study on psychopharmacotherapy before suicide committed by 61 psychiatric inpatients. *Pharmacopsychiatry*. 2002; 35: 37-43.

C. APPENDIX C: LIST AND DEFINITIONS OF ICD-9 E-CODE GROUPINGS FOR PRESENTING INJURY MORTALITY AND MORBIDITY DATA

	Manner				
	Self-inflicted	**Unintentional**	**Assault**	**Undetermined**	**Other**
Cut/pierce	E956	E920	E966	E986	E974
Drowning/ submersion	E954	E830, E832, E910	E964	E984	
Fall	E957	E880-E886, E888	E968.1	E987	
Fire/burn	E958.1,.2,.7	E890.0-E899, E924	E961, E968.0,.3, E979.3	E988.1,.2,.7	
Firearm	E955.0-.4	E922.0-.3,.8, .9	E965.0-4, E979.4	E985.0-.4	E970
Machinery		E919			
Motor vehicle traffic	E958.5	E810-E819	E968.5	E988.5	
Other transport related	E958.6	E800-E807, E820-E825 E826.1,.9, E827-E829, E831, E833-845		E988.6	
Natural/environmental	E958.3	E900.0-E909, E928.0-.2		E988.3	
Overexertion		E927.0-.4,.8-.9			
Poisoning	E950.0-E952.9	E850.0-E869.9	E962.0-.9, E979.6,.7	E980.0-E982.9	E972
Struck by, against		E916-E917.9	E960.0; E968.2		E973, E975
Suffocation	E953	E911-E913.9	E963	E983	
Other specified	E955.5,.6,.7,.9 E958.0,.4 E958.8, E959	E846-E848, E914-E915, E918, E921, E922.4,.5, E923, E925-E926, E928(.3-.6),	E960.1, E965.5-.9 E967.0-.9, E968.4,.6, .7 E979 (.0-	E985.5,.6,.7 E988.0,.4 E988.8, E989	E971, E978, E990-E994, E996 E997.0-.2 E977, E995, E997.8,

		E929.0-.5 E928.8, E929.8	.2,.5,.8,.9) E968.8, E969, E999.1		E998, E999.0
Unspecified	E958.9	E887, E928.9, E929.9	E968.9	E988.9	E976, E997.9
All injury	E950-E959	E800-E869, E880-E929	E960-E969, E979, E999.1	E980-E989	E970-E978, E990-E999.0