Estimating Aspirin Overuse for Primary Prevention of Atherosclerotic Cardiovascular Disease (from a Nationwide Healthcare System)

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The American College of Cardiology and American Heart Association recently published guidelines narrowing the indications for low-dose aspirin use. The suitability of the electronic health record (EHR) to identify patients for low-dose aspirin deprescribing is unknown. To apply the 3 low-dose aspirin guidelines to EHR data, the guidelines were deconstructed into components from their narrative text and assigned computer-interpretable definitions based on electronic data interchange standards. These definitions were used to search EHR data to identify patients for aspirin deprescribing. To verify EHR records for low-dose aspirin, we then compared the records with a survey of patients' self-reported use of low-dose aspirin. Of the 3 aspirin guidelines, only 1 had a definition suitable for EHR implementation. The other 2 contained difficult-to-implement phrases (e.g., "higher ASCVD risk", "increased bleeding risk"). An EHR search with the single implementable guideline identified 86,555 people for possible aspirin deprescribing (2% of 5,598,604). Only 676 of 1,135 (60%) patients who self-reported taking low-dose aspirin had an active EHR record for low-dose aspirin at that time. Limitations exist when using EHR data to identify patients for possible low-dose aspirin deprescribing such as incomplete EHR capture of and the interpretation of non-specific terminology when translating guidelines into an electronic equivalent. In conclusion, data show many people unnecessarily take low-dose aspirin. Published by Elsevier Inc. (Am J Cardiol 2020;137:25−30)

Although many people take low-dose aspirin to prevent atherosclerotic cardiovascular disease (ASCVD),[1] it is also associated with harm.[2−5] In recognition of recent findings that found greater risk of internal hemorrhage than previously demonstrated,[2−4,6,7] the American College of Cardiology and American Heart Association (ACC/AHA) narrowed their aspirin use recommendations for primary prevention of ASCVD (henceforth "guidelines").[5] Although 96% of hospitals have an electronic health record (EHR),[8] the practicality of using electronic data to identify people who should no longer take low-dose aspirin is unknown. Our goal was to investigate the suitability of the EHR to identify patients for deprescribing aspirin based on the updated guidelines. This required translating the guidelines into a computer-readable database query, estimating the number of patients affected by these guideline changes, and quantifying the accuracy of low-dose aspirin capture in the EHR compared with self-reports.

Methods

The Veterans Healthcare Administration (VHA, also called Veterans Affairs or VA) Corporate Data Warehouse (CDW) database was used to determine low-dose aspirin origination and the extent of EHR data capture. The VHA is an integrated network of 130 healthcare systems across the United States and Philippines sharing a common EHR. VHA EHR data are aggregated in the CDW from each healthcare system's Veterans Health Information Systems and Technology Architecture (VistA) and Computerized Patient Record System (CPRS) instances.[9−11] This study was approved by the VA Institutional Review Board.

Aspirin use guideline #1 states: Low-dose aspirin (75 to 100 mg orally daily) might be considered for the primary prevention of ASCVD among select adults 40 to 70 years of age who are at higher ASCVD risk but not at increased risk of bleeding. Guideline #2 states: Low-dose aspirin (75 to 100 mg orally daily) should not be administered on a routine basis for the primary prevention of ASCVD in adults >70 years of age. Guideline #3 states: Low-dose aspirin (75 to 100 mg orally daily) should not be administered for the primary prevention of ASCVD in adults of any age who are at increased risk of bleeding.[5]

Each guideline was dissected into components and assigned definitions. Components of the guidelines involved medications, diagnosis and procedure codes, and concepts of risk. Data standards incorporated into the Centers for Medicare and Medicaid Services (CMS) and the Unified Medical Language System (UMLS), maintained by

the US Department of Health and Human Services and the National Library of Medicine (NLM), were prioritized when available. Even if a definition from CMS or UMLS data standards existed, further translation was needed into EHR-readable terms either because the EHR lacked the data standard or the implementation of the data standard was a quality concern.

We identified aspirin in our database with a search for medication descriptions with a word fragment of either "aspirin," "ASA," or "Acetylsali" (case insensitive). We manually annotated this list to include only aspirin with a specified dose between 75 and 100 mg. Medications returned by the search which was not low-dose aspirin included Asafetida, Casanthranol, Dasabuvir, Dasatinib, Kerasal, Rasagiline, Neutrasal, and Sulfasalazine. Searching for low-dose aspirin prescriptions required a manual review of medication names because our EHR lacked an implementation of RxNORM, a data standard for medications produced by the NLM,[12] and aspirin formulations reported by patients had nonstandard names.

ASCVD was defined based on existing quality measure specifications from CMS,[13] which were used to identify corresponding International Statistical Classification of Diseases and Related Health Problems (ICD) and Current Procedural Terminology (CPT) codes within value sets from the Value Set Authority Center (VSAC, located at https://vsac.nlm.nih.gov). VSAC value sets were used to define ASCVD since they contain ICD-9, ICD-10, and CPT codes, and are currently used to support system interoperability and health information exchange. The CMS definition of ASCVD (acute coronary syndromes, history of myocardial infarction, stable or unstable angina pectoris, coronary or other arterial revascularization, stroke or transient ischemic attack, and peripheral arterial disease of atherosclerotic origin), when mapped to VSAC value sets, included a total of 153 ICD-9 codes, 745 ICD-10 codes, and 83 CPT codes (Appendix Table).

The concept of risk has additional explanations in the guidelines. For the term "higher ASCVD risk" in guideline #1, the guideline supportive text recognizes that older trials demonstrated an increased benefit-risk ratio at a 10-year ASCVD risk score ≥10%, but more recent data led to removal of a specific calculated risk threshold.[2−4,14] Instead, the guidelines recommend consideration of overall ASCVD risk including family history of premature myocardial infarction (MI), inability to achieve targets for blood pressure, lipids or glucose, significant elevations in coronary artery calcium scores, and patient and clinician preferences.[5] It was therefore not possible to translate "higher ASCVD risk" into a computable definition.

Similarly, the phrase "increased bleeding risk" in guidelines #1 and #3, also has additional explanation in the guidelines. The supportive text states that an increased risk of bleeding includes a nonexhaustive list of conditions such as a previous history of gastrointestinal bleeding or peptic ulcer disease or bleeding at other sites, age >70 years, thrombocytopenia, coagulopathy, chronic kidney disease, and concurrent use of other medications that increase bleeding risk such as nonsteroidal anti-inflammatory drugs, steroids, direct oral anticoagulants, and warfarin.[5] Without

further specifics, the term could not be translated into a computable definition.

Guideline definitions were applied to data in the VA CDW. We limited the population to patients actively engaged with primary care, meaning at least 1 VA Primary Care encounter in 2019. Aspirin use was determined by EHR evidence of daily low-dose aspirin at any time during 2019. Database query results were validated with manual chart review using the VA Compensation and Pension Record Interchange system until consistent concordance was reached (42 patients).

We omitted terms without a computer-readable definition ("higher ASCVD risk" and "increased bleeding risk") from the implementation of guidelines #1 and #3. In these cases, we calculated upper bounds for the number of patients who met partial criteria. The exception is guideline #2, which could be fully calculated.

To understand the extent of EHR capture of aspirin, data from a national electronic survey of self-reported low-dose aspirin use, conducted by the Council on Aspirin for Health and Prevention,[15] was analyzed in the CDW for US Veteran participants. Survey data include responses since 2012 and capture the source of aspirin, which includes VA prescribed, patient obtained (e.g., purchased over the counter or non-VA prescribed), or both. We limited comparative analysis of survey results to patients with EHR documentation of low-dose aspirin dosed at least once per week but without diagnosis codes for ASCVD (Appendix Table). The time period searched for an active aspirin medication was from 1 year before 1 month after survey completion. A manual chart review was performed on a random subset of survey participants until consistent concordance was reached (55 people). The Figure 1 shows major steps of the processes used to conduct our investigation.

Results

The records of nearly 5.6 million patients actively engaged in VA Primary Care in 2019 were queried for evidence of low-dose aspirin use for the primary prevention of ASCVD (Table 1). Patients taking low-dose aspirin for primary prevention of ASCVD tended to be older (50 to 79 years of age: 83% aspirin vs 63% non-aspirin) and male (94% aspirin vs 91% non-aspirin) compared with other patients. Patients without ASCVD and on low-dose aspirin comprised 5% (266,812/5,598,604) of the total population. The data reveal that most low-dose aspirin captured in our review was prescribed by the VA health system compared with the obtained from a non-VA prescriber or purchased over the counter (Table 2).

For guideline #1, there are 2,927,345 patients (52%, 2,927,345/5,598,604) aged 40 to 70 and actively receiving Primary Care. Of these patients, 174,868 (6%, 174,868/2,927,345 or 3%, 174,868/5,598,604 of the total study population) took low-dose aspirin for primary prevention of ASCVD. This represents an upper limit on the number of affected persons since the number of patients at a lower ASCVD risk or at increased risk of bleeding could not be identified in a database search.
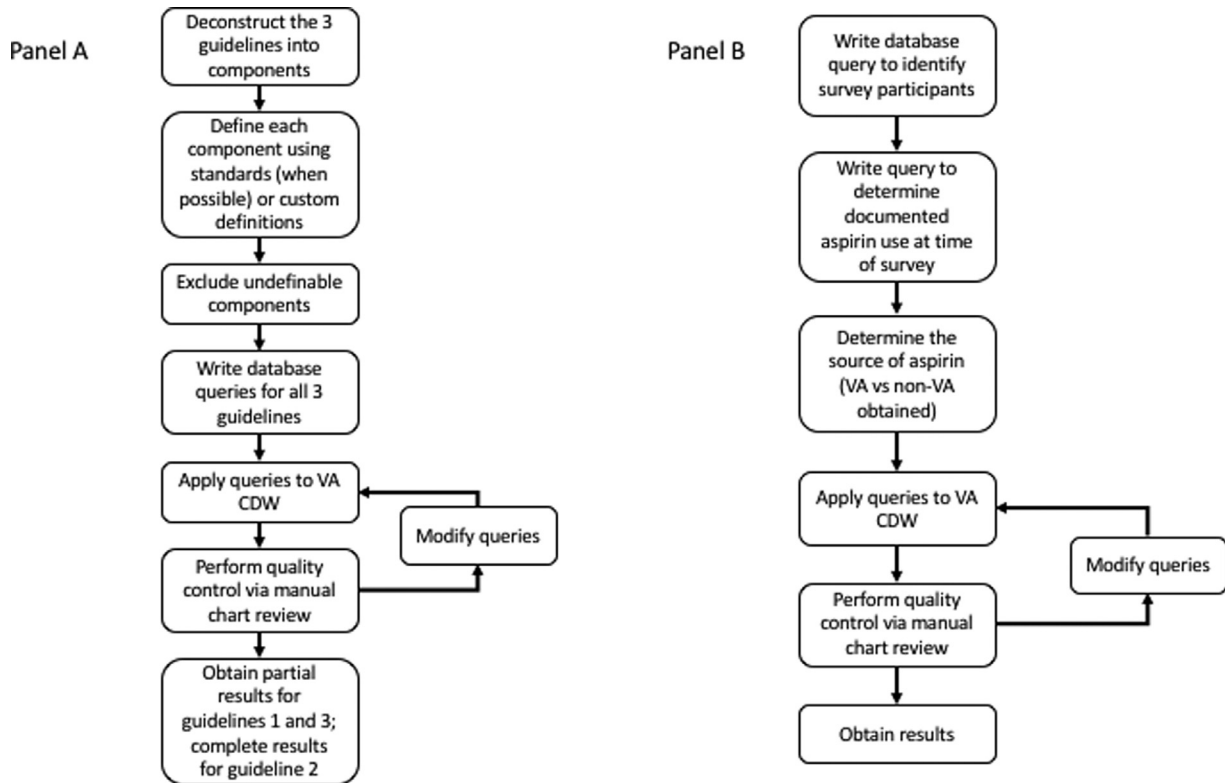
Panel A

Deconstruct the 3 guidelines into components

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Define each component using standards (when possible) or custom definitions

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Exclude undefinable components

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Write database queries for all 3 guidelines

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Apply queries to VA CDW ← Modify queries

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Perform quality control via manual chart review → Modify queries

↓

Obtain partial results for guidelines 1 and 3; complete results for guideline 2

Panel B

Write database query to identify survey participants

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Write query to determine documented aspirin use at time of survey

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Determine the source of aspirin (VA vs non-VA obtained)

↓

Apply queries to VA CDW ← Modify queries

↓

Perform quality control via manual chart review → Modify queries

↓

Obtain results

Figure 1. *(Panel A)* Flow chart of the steps for low-dose aspirin data analysis. *(Panel B)* Flow chart of the steps for determination of EHR capture of low-dose aspirin.

Table 1

Aspirin use for the primary prevention of atherosclerotic cardiovascular disease (ASCVD) with a primary care visit in 2019

Characteristic	Aspirin without ASCVD	Aspirin After ASCVD	Not on Aspirin	Total, n (%)
Group totals	266,812 (100%)	426,820 (100%)	4,904,972 (100%)	5,598,604 (100%)
Men	250,858 (94%)	412,809 (97%)	4,427,290 (90%)	5,090,957 (91%)
Women	15,954 (6%)	14,011 (3%)	477,677 (10%)	507,642 (9%)
Other/Unknown	0 (0%)	0 (0%)	5 (0%)	5 (0%)
Age range (years)				
<18	0 (0%)	0 (0%)	17 (0%)	17 (0%)
18 - 29	707 (0%)	130 (0%)	223,173 (5%)	224,010 (4%)
30 - 39	4,682 (2%)	1,686 (0%)	545,720 (11%)	552,088 (10%)
40 - 49	17,061 (6%)	9,577 (2%)	527,429 (11%)	554,067 (10%)
50 - 59	53,895 (20%)	45,704 (11%)	731,270 (15%)	830,869 (15%)
60 - 69	89,027 (33%)	139,318 (33%)	1,071,544 (22%)	1,299,889 (23%)
70 - 79	77,970 (29%)	167,435 (39%)	1,223,944 (25%)	1,469,349 (26%)
80 - 89	18,886 (7%)	50,474 (12%)	468,575 (10%)	537,935 (10%)
90+	4,584 (2%)	12,496 (3%)	113,296 (2%)	130,376 (2%)
Unknown	0 (0%)	0 (0%)	4 (0%)	4 (0%)
White	172,494 (65%)	304,807 (71%)	3,551,783 (72%)	4,029,084 (72%)
Black	67,133 (25%)	87,576 (21%)	840,608 (17%)	995,317 (18%)
Asian	3,967 (2%)	3,539 (1%)	62,034 (1%)	69,540 (1%)
Native Hawaiian or Other Pacific Islander	3,592 (1%)	4,774 (1%)	53,465 (1%)	61,831 (1%)
American Indian or Alaska Native	2,995 (1%)	4,488 (1%)	54,212 (1%)	61,695 (1%)
Other race	16,631 (6%)	21,636 (5%)	342,870 (7%)	381,137 (7%)
Non-Hispanic	237,715 (89%)	386,958 (91%)	4,359,721 (89%)	4,984,394 (89%)
Hispanic	19,205 (7%)	26,162 (6%)	328,100 (7%)	373,467 (7%)
Other ethnicity	9,892 (4%)	13,700 (3%)	217,151 (4%)	240,743 (4%)

Table 2
Low-dose aspirin by origin of medication. Categories are not mutually exclusiv

VA prescribed	Non-VA obtained	Both VA prescribed and Non-VA obtained
195,063/266,812 (73%)	76,725/266,812 (29%)	4,976/266,812 (2%)

VA = Veterans Affairs.
N = 266,812.

For guideline #2, there are 1,895,140 people (34%,1,895,140/5,598,604) >70 years old. Of those, 86,555 people (5%, 86,555/1,895,140 or 2%, 86,555/5,598,604 of the total study population) take low-dose aspirin for primary prevention of ASCVD.

For guideline #3, there are 5,598,583 patients ≥18 years old. Of those, 266,812 (5%, 266,812/5,598,583) take low-dose aspirin for primary prevention of ASCVD. This represents an upper limit on the number of affected persons since the number of patients who are at increased risk of bleeding could not be identified in a database search.

Results of 1,135 US Veterans since 2012 from the survey conducted by the Council on Aspirin for Health and Prevention aspirin use show that 40% of self-reported aspirin use is not captured in the EHR for 1 year before 1 month after survey completion (Table 3).

Discussion

Many patients in a nationwide integrated health system are prescribed or take low-dose aspirin unnecessarily. Data show that between 2% and 5% (86,555/5,598,604 to 266,812/5,598,604) of patients in our study take low-dose aspirin outside of the guidelines and qualify for the definition of medication overuse as defined by the Institute of Medicine.[16] The percentage of patients with low-dose aspirin use is especially high in people aged 50 to 79 (83%, 220,892/266,812). The true numbers are likely even higher by as much as 40% given the incomplete capture of aspirin use in the EHR.

Of the 3 updated guidelines for low-dose aspirin in the primary prevention of ASCVD, only guideline #2 (relating to people age >70) could be implemented as an electronic search. In patients age >70, a considerable number take aspirin outside the ACC/AHA recommendation (5%, 86,555/1,895,140). Guidelines 1 and 3 referenced "increased bleeding risk" and/or "higher ASCVD risk" without providing an

explicit definition, resulting in partial evaluation and reporting of their upper-limit numbers only.

The methodical process we took to apply existing definitions to the narrative guidelines demonstrates the difficulty of translating terms to an electronic format. To illustrate this, the guideline supportive text for both "higher ASCVD risk" and "increased risk of bleeding" provides a partial list of qualifying scenarios[5] but lacks specific criteria to create computable definitions. For example, "strong family history of premature MI" does not specify the number or relation of family members or the age cutoff for premature MI. Likewise, thrombocytopenia does not specify a platelet number cutoff or percentage below baseline. Given the difficulty in defining "higher ASCVD risk" and "increased bleeding risk" as currently explained, it is not possible to incorporate the criteria for data analysis in any EHR system.

Our study demonstrates the ambiguity of the guidelines for aspirin use for primary prevention of ASCVD. In their current form, the guidelines are difficult to define and apply at a population level. Although we used definitions and terms from CMS and NLM, we recognize that the values chosen may differ in other locations based on local practice patterns or individual physician preferences.

There is an increasing use of database queries to ensure adherence to guidelines and meet audit criteria.[17] Therefore, future guidelines and quality improvement initiatives would be better served by criteria formalization that can be easily applied to EHR data, especially with the widespread use of EHRs around the US and pay-for-performance reimbursement models.[18,19] Guideline translation methods such as the Guideline Elements Model (GEM) can enable developers to create high-quality guidelines.[20] EHR note templates incorporating clinical guidelines and formats that track adherence to guidelines can be helpful in the identification and documentation of eligible patients and may also facilitate shared decision-making.[21] Identifying patients appropriate for aspirin deprescribing may be a unique opportunity to reduce unnecessary bleeding episodes.

In addition, polypharmacy, defined by the use of many drugs at the same time (usually 5 or more) is common in older adults.[22] Polypharmacy has been associated with adverse drug events, which is the most common reason for deprescribing.[23] Low-dose aspirin for primary prevention of ASCVD is now another example of this well-established principle. Several studies have

Table 3
Self-reported low-dose aspirin use and EHR data capture

Aspirin captured as healthcare system medication	Aspirin captured as home medication	Aspirin captured as home and healthcare system medication	Aspirin not captured in EHR
650/1,135 (57%)	17/1,135 (2%)	9/1,135 (1%)	459/1,135 (40%)

EHR = electronic health record.
N = 1,135.

shown that cardiovascular medications account for a majority of polypharmacy.[22] Deprescribing medications is a complex process involving patient, prescriber, and system factors.[24] It has been recognized that deprescribing in the geriatric population is essential for best practices[25] but requires improved processes to effectively accomplish.[23] Our study advances these aims by providing a patient identification method that can be applied at other healthcare systems in the United States to initiate a process for targeted intervention.

Our study population included only US Veterans, which is not representative of the entire US adult population. We were unable to obtain exact numbers for 2 of 3 guidelines since we could not completely define "higher ASCVD risk" and "increased risk of bleeding." Based on validation of self-reported aspirin use survey results, the database in its current form does not capture low-dose aspirin use in its entirety, which leads to underreporting of aspirin use from a database-only source. Accurate application of aspirin guidelines along with subsequent interventions are limited until electronic capture of over the counter aspirin use is reliably achieved.

In summary, low-dose aspirin use in the US Veteran population age >70 is common and places them at increased risk of major bleeding events. Issues such as the inadequate database capture of low-dose aspirin, difficult to define terms, and the partial application of guidelines to EHR data impair a comprehensive patient evaluation for the updated ACC/AHA low-dose aspirin guidelines.

Author Contributions

SYO and RGH contributed to conceptualization, data curation, formal analysis, methodology, software, validation, original draft writing, and review and editing. PC, AB, and AJ contributed to writing - review and editing.

Declarations

Ethics Approval: This study was approved by the Veteran's Affairs (VA) Institutional Review Board (IRB).

Consent to Participate: Consent waiver was granted by the VA IRB due to the nature of this study.

Consent for Publication: This study has not been published previously nor is it under consideration with any other journals. All authors consent to publication of this study.

Availability of Data: Subject to VA policies.

Code Availability: Available upon request.

Disclosures

The authors have no conflicts of interest to disclose

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Appendix

Table
Atherosclerotic cardiovascular disease (ASCVD) definition based on value set authority center (VSAC) value sets

Value set name	Object identifier (OID)
Acute coronary syndromes	2.16.840.1.113883.3.3157.2000.10
Acute or evolving MI	2.16.840.1.113883.3.666.5.3022
Atherosclerosis and peripheral arterial disease	2.16.840.1.113762.1.4.1047.21
CABG, PCI procedure	2.16.840.1.113762.1.4.1138.566
CABG surgeries	2.16.840.1.113883.3.666.5.694
Cardiac surgery	2.16.840.1.113883.3.526.3.371
Cerebrovascular disease, stroke, TIA	2.16.840.1.113762.1.4.1047.44
Coronary artery disease No MI	2.16.840.1.113883.3.526.3.369
Ischemic heart disease or coronary occlusion, rupture, or thrombosis	2.16.840.1.113762.1.4.1047.46
Myocardial infarction	2.16.840.1.113883.3.526.3.403
Stable and unstable angina pectoris	2.16.840.1.113762.1.4.1047.47

CABG = coronary artery bypass grafting; MI = myocardial infarction; PCI = percutaneous coronary intervention; TIA = transient ischemic attack.

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