# Deriving International Classification of Diseases, 9th and 10th revision, codes for identifying and following up patients with diabetic lower extremity ulcers

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## ABSTRACT

**Objective:** Administrative claims data offer a rich data source for clinical research. However, its application to the study of diabetic lower extremity ulceration is lacking. Our objective was to create a widely applicable framework by which investigators might derive and refine the International Classification of Diseases, 9th and 10th revision (ICD-9 and ICD-10, respectively) codes for use in identifying diabetic, lower extremity ulceration.

**Methods:** We created a seven-step process to derive and refine the ICD-9 and ICD-10 coding lists to identify diabetic lower extremity ulcers. This process begins by defining the research question and the initial identification of a list of ICD-9 and ICD-10 codes to define the exposures or outcomes of interest. These codes are then applied to claims data, and the rates of clinical events are examined for consistency with prior research and changes across the ICD-9 to ICD-10 transition. The ICD-9 and ICD-10 codes are then cross referenced with each other to further refine the lists.

**Results:** Using this method, we started with 8 ICD-9 and 43 ICD-10 codes used to identify lower extremity ulcers in patients with known diabetes and peripheral arterial disease and examined the association of ulceration with lower extremity amputation. After refinement, we had 45 ICD-9 codes and 304 ICD-10 codes. We then grouped the codes into eight clinical exposure groups and examined the rates of amputation as a rudimentary test of validity. We found that the rate of lower extremity amputation correlated with the severity of lower extremity ulceration.

**Conclusions:** We identified 45 ICD-9 and 304 ICD-10 ulcer codes, which identified patients at risk of amputation from diabetes and peripheral artery disease. Although further validation at the medical record level is required, these codes can be used for claims-based risk stratification for long-term outcomes assessment in the treatment of patients at risk of limb loss. (J Vasc Surg Cases Innov Tech 2022;8:877-884.)

**Keywords:** Administrative claims research; Diabetic; International Classification of Diseases; Ulcer

The use of administrative claims for clinical research has led to advances across a number of disciplines and specialties.[1-6] Despite the common use of administrative claims data for clinical research, one area that has remained challenging to explore with these methods is diabetic ulcers of the lower extremities.[7]

Given the significant amputation risk, decrement in quality of life, and economic burden in excess of $1 billion annually and increasing, it would be prudent to have a method of identifying patients with diabetic lower extremity ulcers within administrative claims data.[8,9] With a reliable set of codes to capture patients with diabetic lower extremity ulcers, investigators could better study diabetic ulcers at both regional and national levels. Furthermore, additional or improved methods to identify those at greatest risk

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The present study was supported in part by an American Heart Association Strategically Focused Research Network Award (grant 18SFRN3390008; primary investigator, M.P.B.). All statements, including the findings and conclusions, are solely those of the authors and do not necessarily represent the views of the American Heart Association, its board of governors, or the methodology committee.

Author conflict of interest: none.

Additional material for this article may be found online at www.jvscit.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287



https://doi.org/10.1016/j.jvscit.2022.10.003

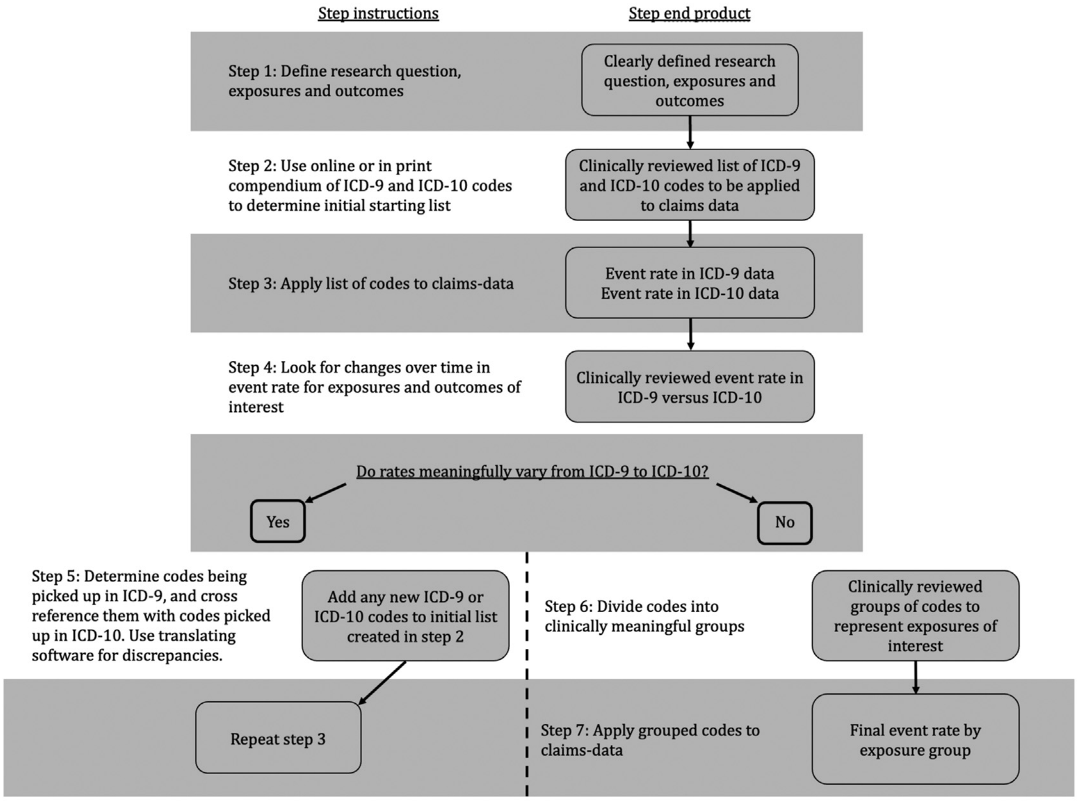



**Fig 1.** General outline of our seven-step method for derivation and refinement of International Classification of Diseases, 9th and 10th revision (ICD-9 and ICD-10, respectively) billing codes.

of amputation could facilitate the development of more targeted interventions.

To the best of our knowledge, no reported studies have definitively established a widely applicable set of International Classification of Diseases, 9th and 10th revision (ICD-9 and ICD-10, respectively), codes to identify patients with diabetic lower extremity ulcers.[9] Previous efforts have involved abbreviated code lists, data derived from electronic medical records (EMR) from a single healthcare system, or codes predating the implementation of ICD-10.[7,9,10] Furthermore, no studies have examined the associations between the presence of these codes and patients' long-term amputation risk.

Therefore, in the present study we sought to establish a list of ICD-9 and ICD-10 codes used to describe diabetic lower extremity ulcers in administrative claims data and examined the associations between the presence of these codes and the amputation risks over time.

## METHODS

**Methodologic overview.** We have previously described a framework whereby investigators could derive lists of ICD-9 and ICD-10 codes to use in outcome identification in claims-based analyses.[11] The framework follows an iterative process requiring the following:

- A research question with an exposure and outcome
- A compendium of ICD-9 and ICD-10 codes
- A claims-based data source in which to apply the codes
- One, or ideally two, clinical reviewers

We then applied our seven-step process (Fig 1) to our research group's investigation into lower extremity amputation rates in patients with diabetes mellitus (DM) and peripheral arterial disease (PAD). The institutional review board approved the application of this process to a database containing Medicare claims data.

**Step 1: defining the research question, exposures, and outcomes.** The beginning of any clinical investigation, including a claims-based analysis, should be a research question with a concrete exposure and outcome.[12] For claims-based analyses, this is especially important because the ICD-9, clinical modification, contains ~14,000 diagnosis codes and the ICD-10, clinical modification nearly 70,000 diagnosis codes.[13] Without a clear definition of the question and outcomes under examination, it will be impossible to define a set of codes to use in the analyses. The research question and set of exposures and outcomes must be determined from the types of codes available. The exposures of interest might need to be refined according to the ICD-9 and ICD-10 coding descriptions found in step 2.

**Step 2: identifying the initial list of billing codes to be used.** An initial list of billing codes should be compiled and left broad to capture all likely exposures of interest. The code chapters and families can then be identified from either online or in-print compendiums of the ICD-9 and ICD-10 codes.[13,14] Thus, to find a list of codes identifying patients with a diagnosis of myocardial infarction, we would begin by identifying the relevant ICD chapter and drill down to the more detailed diagnosis codes of interest. Many subcodes and more specific codes of interest can thus be identified. At this step, clinical review is necessary to identify which codes will be the most relevant to the exposure of interest. In addition, changes to the ICD codes are made annually; thus, one must ensure the use of the most recent compendiums.

**Step 3: application of codes to claims data.** Once a set of codes has been derived and categorized into groups for analysis, these codes are applied to the data to identify the clinical events. The event rates are then closely examined for several items. First, the event rates for the expected outcomes should be consistent with the known pathology and clinical disease course. Thus, we would expect patients with gangrene of the limb to have a higher rate of lower extremity amputation than those with cellulitis. Event rates that are counterintuitive will often result from an error made during code derivation or grouping. Second, the event rates should be compared between those identified from the ICD-9 data and ICD-10 data. A substantial change at the transition between the two coding editions often indicates that codes could have been missed in the initial derivation of either the ICD-9 or ICD-10 codes. This would require an iterative revision of the codes used for outcome identification. A clinical review at both these points is important to ensure the validity of the outcomes.

Also, instances could occur in which multiple diagnosis codes of interest will be present in a claim file. The handling of this situation will vary depending on the study question. In our example, in cases in which a MedPAR claim had had multiple ulcer diagnosis codes, the codes were flagged first by order. If a patient had had 12 diagnosis codes, the codes were searched sequentially until an ulcer code was found. The search did not subsequently continue through the rest of the codes in that claim. This differed when searching the carrier line files. If a single claim had had multiple codes, the one with the highest payment amount was chosen. Finally, if we had both carrier (part b) and MedPAR claims for the same claim, we selected the code from the MedPAR inpatient records.

**Steps 4 and 5: iterative revision of codes used for analysis.** The groups of codes applied to claims data should then be examined to determine which ICD-9 and ICD-10 codes were found most often in the analysis. This will allow investigators to determine which codes will be the most useful for identifying the exposure or outcome of interest. If a step-off between event rates at the transition between ICD-9 and ICD-10 is found, the codes should be examined further. The descriptions of the codes can then be compared between ICD-9 and ICD-10. Codes commonly found in ICD-9 can then be translated into ICD-10, and vice versa, to identify codes that might have been missed in the initial derivation. This can be performed using the general equivalence mapping system or other system.[15] The translated code descriptions can then be reviewed and added as appropriate. Once the list of codes has been revised, it should be reapplied to the claims data. The results should again be critically reviewed, and revisions made as necessary. The revisions will be complete when the event rates appear clinically appropriate based on prior studies, and the transition between ICD-9 and ICD-10 does not show a substantial step-up or step-off in events.

**Steps 6 and 7: placing codes into groups and applying them to claims data.** Code chapters and families contain many similar, nuanced codes that are unlikely to be meaningfully different in exposure groups. Thus, for investigators seeking to examine mortality after stroke, a clinically meaningful difference might not be present between I63.031 ("cerebral infarction due to thrombosis of right carotid artery") and I63.131 ("cerebral infarction due to embolism of right carotid artery"). Although the codes can be abbreviated or collapsed into groups for ease of use (eg, using I63.xx to represent all cerebral infarction codes within that family), we have found it best to list each code individually. This serves two purposes. First, it allows the person doing the statistical analysis to be as specific as possible about the codes being used and identified in the data. Second, it is more favorable for clinical review when each code can be reviewed side by side with its associated description. Finally, once the codes have been grouped into the exposures of interest, they can be applied to the claims data for outcomes analysis. The analytic plan for the application of codes to the claims data should also consider the possibility of multiple ulcer code diagnoses appearing in a single claim. How to best manage this scenario will vary with the study question; however, some options include using the first diagnosis code to appear, the most severe diagnosis code, or the code associated with the highest Medicare payment.

## RESULTS

We have detailed the steps and outcomes of the described method as applied to our sample research question.

**Step 1.** We aimed to describe the association between different types of lower extremity ulcers and the rate of

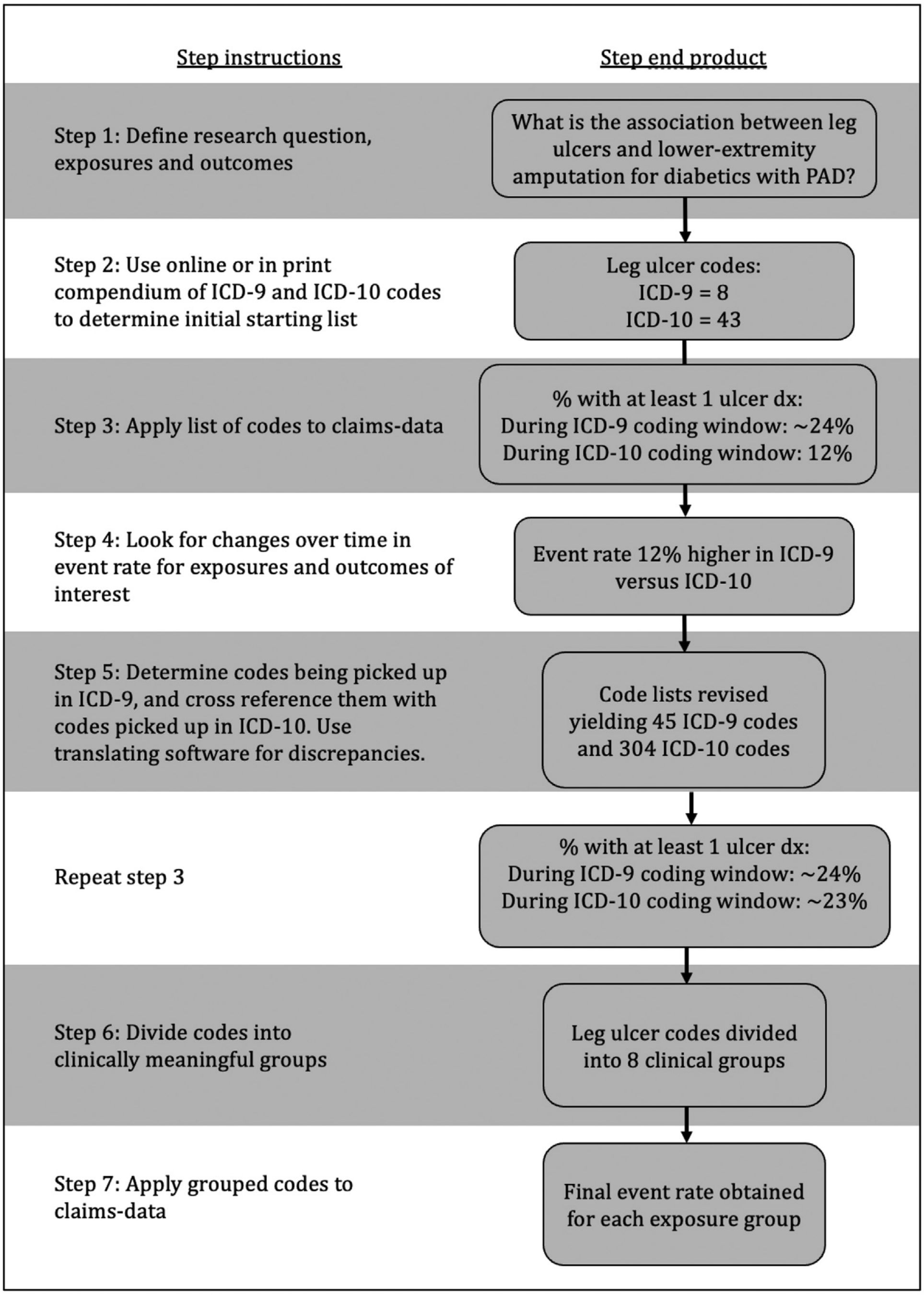
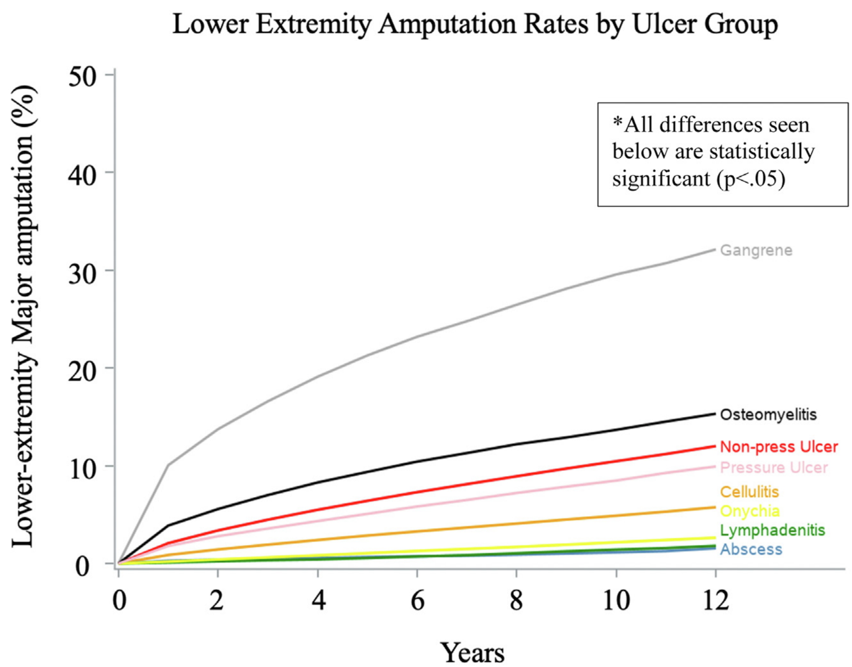



**Fig 2.** Results of seven-step method for deriving codes to identify patients with lower extremity ulceration. *ICD-9,* International Classification of Diseases, 9th revision; *ICD-10,* International Classification of Diseases, 10th revision.

lower extremity amputation in Medicare beneficiaries with a diagnosis of DM and PAD (Fig 2). We defined this cohort using the ICD-9 and ICD-10 codes for DM and PAD that have been used in contemporary studies to capture similar cohorts.[16-18] These codes were applied to 100% of Medicare claims (using MedPAR and carrier files) for 2003 through 2016, yielding a total of 10,505,853 unique encounters (the file was restricted to unique individuals to allow us to follow patients over time). We defined the first date on which a diagnosis code of DM was identified as time zero in our Kaplan-Meier analysis of lower extremity amputation.

**Step 2.** The clinician review using the Centers for Medicare and Medicaid Services website compendium of ICD-9 and ICD-10 codes and the publicly available




| Ulcer Group | 0 yrs | 2.5 yrs | 5 yrs | 7.5 yrs | 10 yrs | 12.5 yrs |
|---|---|---|---|---|---|---|
| Gangrene | 105,669 | 53,455 | 30,687 | 16,709 | 6,684 | 1,762 |
| Osteomyelitis | 94,050 | 63,463 | 40,252 | 23,706 | 9,797 | 2,643 |
| Non-pressure Ulcer | 1,362,559 | 966,358 | 610,748 | 353,977 | 142,296 | 35,393 |
| Pressure Ulcer | 187,161 | 112,193 | 62,467 | 31,593 | 11,122 | 2,272 |
| Cellulitis | 1,549,504 | 1,219,641 | 830,692 | 508,888 | 210,005 | 52,849 |
| Onychia | 486,436 | 425,213 | 309,517 | 199,094 | 85,879 | 22,108 |
| Lymphadenitis | 11,880 | 10,246 | 7,634 | 4,974 | 2,099 | 549 |
| Abscess | 62,668 | 40,591 | 24,508 | 14,769 | 5,778 | 1,390 |

**Fig 3.** Kaplan-Meier rates of lower extremity amputation stratified by lower extremity ulceration severity.

icd9data.com and icd10data.com databases yielded 8 ICD-9 and 43 ICD-10 codes for lower extremity ulceration (Appendix).

**Step 3.** After applying our initial list of ICD-9 and ICD-10 ulcer codes to our DM and PAD cohort, we identified 3,859,927 patients with lower extremity ulcers. We then examined the rates of lower extremity amputation between the ICD-9 and ICD-10 periods. This revealed a step-off of ~12% in amputations between the ICD-9 (~24%) and ICD-10 (~12%) codes, indicating that codes could be missing from our initial lists of codes.

**Steps 4 and 5.** The iterative clinician review and online code translating systems revealed codes that were missing a counterpart between the ICD-9 and ICD-10 lists. We found that one of the most common codes found in ICD-9 was 682 ("other cellulitis or abscess"); however, no similar code was found in our list of ICD-10 codes. The online translating systems yielded several codes that were reviewed by two clinical reviewers to determine the appropriateness for addition to our list. After revision, the final lists of codes included 45 ICD-9 codes and 304 ICD-10 codes (Appendix). After reapplying the updated code lists, the lower extremity amputation rates were more consistent across the ICD-9 to ICD-10 transition at ~24% and ~23%, respectively.

**Steps 6 and 7.** With our final list of codes for lower extremity ulceration, we created eight categories based on work by other investigators: cellulitis, cutaneous abscess, gangrene, lymphadenitis, nonpressure ulcers, onychia of toe, osteomyelitis, and pressure ulcer.[10+] Applying these eight groups to the claims data demonstrated a stepwise increase in the rate of major amputation with each increase in the severity of the lower extremity ulcer ($P < .0001$; Fig 3). The codes included in each group are presented in the Appendix.

## DISCUSSION

In the present report, we have outlined our approach for creating and refining a list of ICD-9 and ICD-10 codes to use in claims-based research. Using this approach, we identified 45 ICD-9 codes and 304 ICD-10 codes to

**Table.** Comparison of methods for identifying patients with diabetic lower extremity ulcers

| Investigator | Includes ICD-9 | Includes ICD-10 | Robust code list | Generalizable[a] |
|---|---|---|---|---|
| Sohn et al[9] | Yes | No | No (2 ICD codes in total) | No[b] |
| Cahn et al[7] | No | No | No (4 diagnosis codes in total) | No |
| Present method | Yes | Yes | Yes (349 ICD codes in total) | Yes |

*ICD-9,* International Classification of Diseases, 9th revision; *ICD-10,* International Classification of Diseases, 10th revision.
[a]Applicable across time and at any institution.
[b]Although the use of ICD codes is conceptually generalizable, the method by Sohn et al[9] is not inclusive of ICD-10 codes and does not include a method for generating an up-to-date list for future investigators.

capture patients with lower extremity ulceration. We found that the rates were similar across the transition from ICD-9 to ICD-10. These findings are consistent with the reported results of patients with foot infections, and we believe they reflect the true rate of amputation in diabetic patients with PAD who develop a foot ulcer.[19]

When organized into groups according to ulcer severity, these codes appeared to discriminate a large cohort of patients into differential risks of amputation. We found a stepwise increase in the rate of lower extremity amputation for each increase in the severity of the lower extremity ulceration category (Fig 3). This pattern of increasing amputation risk is also consistent with reported studies on amputation risk factors.[20,21]

We believe our method offers a more comprehensive and generalizable approach to identifying patients with lower extremity ulceration (Table). Previous methods in the literature, such as that reported by Sohn et al,[9] offer simplicity by requiring only two ICD-9 codes. However, our work has revealed that hundreds of codes were needed to fully capture diabetic lower extremity ulcers.[9] Some of this was obviously due to the transition to ICD-10 since the time of previous reports; however, that only strengthens the argument for a new, more comprehensive method. Other investigators such as Cahn et al[7] have used diagnosis codes derived from EMRs. Inherent in the use of diagnosis codes specific to a given EMR is the lack of generalizability to other centers using different EMRs or datasets such as that of Medicare claims. Overall, to the best of our knowledge, no complete list of administrative codes for identifying patients with diabetic lower extremity ulcers was evident in the literature.

Our study offers investigators a new, potentially valuable, long-term mechanism for identifying and following up patients with diabetic lower extremity ulcers in large data sets. In contrast to other reported methods, our method is very generalizable because it uses ICD codes for the identification of patients. Furthermore, using the steps we have outlined, future investigators will be equipped to adapt to future iterations of ICD compendiums.

Our study had several limitations. First, claims-based data use billing events as a surrogate for clinical event identification. Without a comprehensive review of the medical records or patient interview, we could not be certain that a given patient actually had had the condition or outcome of interest. Such an investigation lies ahead for our group's validation efforts and is a process that will be facilitated by the steps outlined in our report. Considering this limitation and the importance of validating these methods, ongoing efforts are underway to validate coding algorithms through a medical record review in a multi-institutional study. Second, the clinical severity of each coding group could vary. However, it appears plausible that patients with more severe degrees of ulceration would experience greater amputation rates. Moving forward, we hope to validate our method using external data for which the findings can be compared with the patients' medical records for validation.

## CONCLUSIONS

Using the described steps, we identified 45 ICD-9 and 304 ICD-10 codes to identify patients with lower extremity ulcers within claims-based datasets. Additionally, these codes appeared capable of stratifying patients into differential risks of amputation. Although additional validation using a medical record review remains to be accomplished, we believe these codes can be used for claims-based risk stratification for long-term outcomes assessment in the treatment of patients at risk of limb loss.

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Submitted Jul 19, 2022; accepted Oct 3, 2022.

*Additional material for this article may be found online at www.jvscit.org.*

## APPENDIX

### Initial and final ICD-9 and ICD-10 codes for lower extremity ulcer identification

Initial International Classification of Diseases, 9th revision (ICD-9), codes for lower extremity ulcers: 681, 682.5, 682.6x, 682.7, 682.8, 682.9, 683xx, 707xx

Final ICD-9 codes for lower extremity ulcers: 6806, 6807, 68110, 68111, 6826, 6827, 683, 68600, 68601, 6868, 6869, 70706, 70707, 70710,70711, 70712, 70713, 70714, 70715, 70719, 0400, 7854, 44024, 44023, 73005, 73006, 73007, 73015, 73016, 73017, 73025, 73026, 73027, 73035, 73036, 73037, 73075, 73076, 73077, 73085, 73086, 73087, 73095, 73096, 73097

Initial International Classification of Diseases, 10th revision (ICD-10), codes for lower extremity ulcers: Z86.31, L97.101-106, L97.108-109, L97.111-116, L97.119, L97.121-126, L97.128-129, L97.201-206, L97.208-209, L97.211-216, L97.218-219, L97.221-226, L97.228-229, L97.301-306, L97.308-309, L97.311-316, L97.318-319, L97.321-326, L97.328-329, L97.401-406, L97.408, L97.411-416, L97.418-419, L97.421-426, L97.428-429, L97.501-506, L97.508-509, L97.511-516, L97.518-519, L97.521-526, L97.528-529, L97.801-806, L97.808-809, L97.811-816, L97.818-819, L97.821-826, L97.828-829, L97.901-906, L97.908-909, L97.911-916, L97.918-919, L97.921-926, L97.928-929

Final ICD-10 codes for lower extremity ulcers: L97101, L97102, L97103, L97104, L97105, L97106, L97108, L97109, L97111, L97112, L97113, L97114, L97115, L97116, L97119, L97121, L97122, L97123, L97124, L97125, L97126, L97128, L97129, L97201, L97202, L97203, L97204, L97205, L97206, L97208, L97209, L97211, L97212, L97213, L97214, L97215, L97216, L97218, L97219, L97221, L97222, L97223, L97224, L97225, L97226, L97228, L97229, L97301, L97302, L97303, L97304, L97305, L97306, L97308, L97309, L97311, L97312, L97313, L97314, L97315, L97316, L97318, L97319, L97321, L97322, L97323, L97324, L97325, L97326, L97328, L97329, L97401, L97402, L97403, L97404, L97405, L97406, L97408, L97411, L97412, L97413, L97414, L97415, L97416, L97418, L97419, L97421, L97422, L97423, L97424, L97425, L97426, L97428, L97429, L97501, L97502, L97503, L97504, L97505, L97506, L97508, L97509, L97511, L97512, L97513, L97514, L97515, L97516, L97518, L97519, L97521, L97522, L97523, L97524, L97525, L97526, L97528, L97529, L97801, L97802, L97803, L97804, L97805, L97806, L97808, L97809, L97811, L97812, L97813, L97814, L97815, L97816, L97818, L97819, L97821, L97822, L97823, L97824, L97825, L97826, L97828, L97829, L97901, L97902, L97903, L97904, L97905, L97906, L97908, L97909, L97911, L97912, L97913, L97914, L97915, L97916, L97918, L97919, L97921, L97922, L97923, L97924, L97925, L97926, L97928, L97929, L89500, L89501, L89502, L89503, L89504, L89509, L89510, L89511, L89512, L89513, L89514, L89519, L89520, L89521, L89522, L89523, L89524, L89529, L89600, L89601, L89602, L89603, L89604, L89609, L89610, L89611, L89612, L89613, L89614, L89619, L89620, L89621, L89622, L89623, L89624, L89629, L02415, L02416, L02425, L02426, L02435, L02436, L02611, L02612, L02619, L02621, L02622, L02629, L02631, L02632, L02639, L03031, L03032, L03039, L03041, L03042, L03049, L03115, L03116, L03125, L03126, L043, L080, L081, L0881, L0882, L0889, L089, A480, I96, I70269, I7025, E1152, E11621, M86051, M86052, M86059, M86061, M86062, M86069, M86071, M86072, M86079, M86159, M86161, M86162, M86169, M86171, M86172, M86179, M86251, M86252, M86259, M86261, M86262, M86269, M86271, M86272, M86279, M86351, M86352, M86359, M86361, M86362, M86369, M86371, M86372, M86379, M86451, M86452, M86459, M86461, M86462, M86469, M86471, M86472, M86479, M86551, M86552, M86559, M86561, M86562, M86569, M86571, M86572, M86579, M86651, M86652, M86659, M86661, M86662, M86669, M86671, M86672, M86679, M868X5, M868X6, M868X7