Validation of the V49.86 Code for Do-Not-Resuscitate Status in Hospitalized Patients at a Single Academic Medical Center

To the Editor:

Within medicine, there is a growing focus on understanding the care that is provided at the end of life (1). Although the ability to capture preferences for life-sustaining treatments in routinely collected healthcare data is limited, one existing option is the *International Classification of Diseases, Ninth Revision* (ICD-9), code V49.86, signifying "do-not-resuscitate status." This code may potentially be used to examine the care of patients with do-not-resuscitate (DNR) status (2, 3); to examine trends, patterns, and variation in end-of-life decision making (4); or potentially to adjust for patient preferences when examining the quality of care (5). However, performance characteristics for this code are unknown. Therefore, we performed a single-center validation study to determine the sensitivity and specificity of the V49.86 code for identifying whether hospitalized patients had a DNR status at any time during their hospitalization. We hypothesized that the code would be specific but not sensitive for the presence of DNR status.

Methods

This study was approved by the Columbia University Medical Center (CUMC) Institutional Review Board (IRB-AAAP2112 New York, NY). Written informed consent was waived. Data for this study were extracted from the CUMC Clinical Data Warehouse, a repository of electronic medical records for all hospitalizations at CUMC. We included all adult admissions (age ⩾18 yr) from August 1, 2013, through August 31, 2015, including repeat hospitalizations. We collected demographic and clinical variables, including age, sex, race, whether patients were admitted to an intensive care unit (ICU), discharge destination, and all diagnoses received during the hospitalization. Although our unit of analysis was a hospitalization, we use the term *patients* in this letter to refer to hospitalizations. At CUMC, specific note templates are routinely used to document DNR status within the electronic medical record, whereby completion of the note automatically generates a DNR order in the patient's chart. (DNR orders also may be entered separately.) We identified *1*) whether a patient had DNR status documented either by a DNR note and/or by a DNR order and *2*) whether a patient had a V49.86 code (Figure 1). Because timing of DNR orders identified with the V49.86 code may be unclear, we also determined when DNR notes and orders were placed in relation to the admission date. The reference standard for this study was the presence of a DNR note and/or a DNR order in the Clinical Data Warehouse database. To validate our reference standard, we reviewed 50 charts labeled as having documented DNR status and looked for the physical presence of a DNR note or order, as well as 50 charts labeled as not having documented DNR status to confirm absence of a note or order. We specified *a priori* that the reference standard would be considered adequate if the DNR note had a positive predictive value (PPV) and negative predictive value (NPV) greater than 90%. For the V49.86 code, all diagnosis fields were searched for the presence of the code, and any use was counted.

We calculated sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratios, and the area under the receiver operating characteristic curve for the V49.86 code. We also calculated these characteristics for several predefined subgroups to determine if the performance of the code differed, including *1*) patients who did and those who did not die during hospitalization, *2*) patients who were and those who were not admitted to the ICU, *3*) patients stratified by Charlson comorbidity index, *4*) patients with metastatic cancer, and *5*) patients with conditions for which in-hospital mortality is reported as a measure of the quality of care (pneumonia, heart failure, acute myocardial infarction [AMI], chronic obstructive pulmonary disease [COPD], and stroke). Database management and analyses were performed using SAS 9.4 (SAS Institute) and Stata 13.1 (StataCorp) software.

Results

During the study period, there were 100,910 hospitalizations at CUMC of 68,657 different patients, of whom 7,369 (7.3%) had documented DNR status and 5,428 (5.4%) had a diagnosis code of V49.86. DNR status was documented within 24 hours of admission in approximately half (54.7%; $n = 4{,}027$) of patients with a DNR order and approximately half of patients with a V49.86 code billed (54.0%; $n = 2{,}931$). Compared with the overall cohort, patients who had documented DNR status or a diagnosis code of V49.86 were more likely to be older; to have a higher number of comorbidities; to have a diagnosis of cancer, pneumonia, AMI, COPD, or stroke; to be discharged to hospice or a skilled nursing facility; or to have died during hospitalization (Table 1).

The reference standard had a PPV of 100% and NPV of 100% when compared with gold standard manual chart review. The V49.86 code had high specificity (99.7% [99.6–99.7]) and moderate sensitivity (69.2% [53.3–80.5]) for identifying patients with DNR status, as well as a high PPV (94.0% [93.3–94.6]), NPV (97.6% [97.5–97.7]), and area under the receiver operating characteristic curve (0.84 [0.84–0.85]). Specificity was slightly lower for patients who died during hospitalization (93.7% [90.7–96.0]), whereas sensitivity was lower for patients without comorbidities (58.6% [55.9–61.2]). Sensitivity was modestly improved for patients with certain conditions (pneumonia, 75.7% [71.3–79.8]; AMI, 74.7% [70.1–78.9]; stroke, 74.2% [69.2–78.8]), whereas specificity was maintained (Table 2).

Discussion

In a single academic medical center, we found that the ICD-9 code V49.86 was highly specific and moderately sensitive in identifying hospitalized patients with a DNR status. The V49.86 code performed similarly to or better than other ICD-9 diagnosis codes, which generally have had high specificity but low sensitivity for identifying patients with a given condition (6–10). Performance of the code was stable across various subgroups of patients, with small variation in sensitivity for patients with certain conditions. Despite its relative accuracy, the code did not discriminate the timing of DNR status, which may limit its utility because early DNR status is more likely to reflect preexisting preferences for treatment, whereas DNR status occurring later in hospitalization may reflect patient preferences, clinical decline, and/or the quality of

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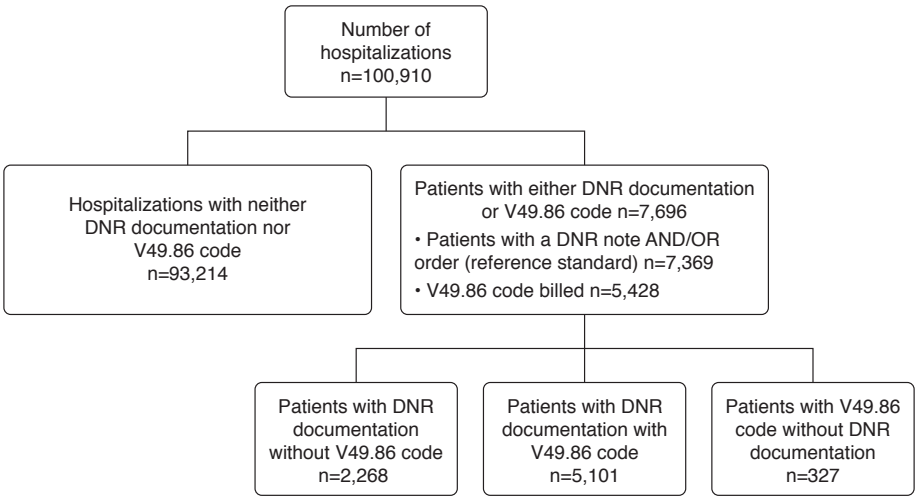

Figure 1. Flowchart demonstrating the number of hospital admissions with documented do-not-resuscitate (DNR) status and with the International Classification of Diseases, Ninth Revision, V49.86 code billed.

Table 1. Characteristics of patients at Columbia University Medical Center, August 2013–August 2015

	Total *n* (%) (*N* = 100,910)	DNR Note/Order Present *n* (%) (*N* = 7,369)	ICD-9 V49.86 Code Present *n* (%) (*N* = 5,428)
Age, yr			
18–64	61,828 (61.3)	1,222 (18.9)	960 (17.7)
65–74	17,267 (17.1)	1,176 (18.2)	917 (16.9)
75–84	13,390 (13.3)	1,669 (25.8)	1,422 (26.2)
⩾85	8,424 (8.4)	2,409 (37.2)	2,129 (39.2)
Sex			
Female	58,578 (58.1)	3,840 (59.3)	3,261 (60.1)
Male	42,332 (42.0)	2,636 (40.7)	2,167 (39.9)
Race			
White	38,442 (38.1)	2,400 (37.1)	2,022 (37.3)
Black	12,241 (12.1)	737 (11.4)	608 (11.2)
Asian	2,778 (2.8)	122 (1.9)	100 (1.8)
Other/declined	47,449 (47.0)	3,217 (49.7)	2,698 (49.7)
Charlson comorbidity index			
0	48,567 (48.1)	1,237 (19.1)	894 (16.5)
1–2	29,177 (28.9)	2,126 (32.8)	1,843 (34.0)
⩾3	23,166 (23.0)	3,113 (48.1)	2,691 (49.6)
Metastatic cancer	10,830 (10.7)	1,421 (21.9)	1,188 (21.9)
Pneumonia	1,771 (1.8)	363 (20.5)	326 (18.4)
Heart failure	15,784 (15.6)	2,193 (13.9)	1,950 (12.4)
Acute myocardial infarction	2,410 (2.4)	348 (14.4)	308 (12.8)
Chronic obstructive pulmonary disease	1,196 (1.2)	153 (12.8)	119 (10.0)
Stroke	1,921 (1.9)	305 (15.9)	265 (13.8)
Admitted to intensive care	14,142 (14.0)	2,084 (14.7)	1,573 (11.1)
Discharge destination			
Home	61,050 (60.5)	629 (9.7)	524 (9.7)
Home with health services	21,779 (21.6)	1,505 (23.2)	1,338 (24.7)
Skilled nursing facility	9,203 (9.1)	1,508 (23.3)	1,298 (23.9)
Hospice	850 (0.8)	620 (9.6)	576 (10.6)
Other facility	861 (0.9)	199 (3.1)	165 (3.0)
Rehabilitation facility	2,704 (2.7)	87 (1.3)	77 (1.4)
Other	1,969 (2.0)	22 (0.3)	18 (0.3)
Died in hospital	2,453 (2.4)	1,905 (29.4)	1,431 (26.4)

Definition of abbreviations: DNR = do not resuscitate; ICD-9 = *International Classification of Diseases, Ninth Revision*.

Table 2. Performance characteristics of the *International Classification of Diseases, Ninth Revision*, V49.86 code for do-not-resuscitate status

	Sensitivity (%)	Specificity (%)	AUC	PPV (%)	NPV (%)	LR+	LR−
All patients	69.2 (68.2–70.3)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	94.0 (93.3–94.6)	97.6 (97.5–97.7)	198.0 (177.5–220.9)	0.31 (0.30–0.32)
Died in hospital	67.4 (65.4–69.4)	93.7 (90.7–96.0)	0.81 (0.79–0.82)	98.4 (97.6–99.0)	33.5 (30.6–36.5)	10.7 (7.2–15.9))	0.35 (0.32–0.37)
Survived hospitalization	69.9 (68.7–71.2)	99.7 (99.6–99.7)	0.85 (0.84–0.85)	92.4 (91.5–93.2)	98.3 (98.2–98.4)	214.3 (191.3–240.1)	0.30 (0.29–0.31)
Admitted to ICU							
Yes	65.5 (63.5–67.5)	99.5 (99.4–99.6)	0.83 (0.82–0.83)	96.3 (95.2–97.1)	93.7 (93.2–94.1)	131.4 (101.7–169.7)	0.35 (0.33–0.37)
No	70.9 (69.6–72.2)	99.7 (99.6–99.7)	0.85 (0.85–0.86)	93.0 (92.2–93.8)	98.2 (98.1–98.3)	216.2 (191.6–244.0)	0.29 (0.28–0.30)
Charlson comorbidity index, %							
0	58.6 (55.9–61.2)	99.8 (99.8–99.9)	0.79 (0.78–0.80)	91.7 (89.7–93.4)	98.8 (98.7–98.9)	373.3 (296.1–470.8)	0.41 (0.39–0.44)
1–2	70.7 (68.9–72.5)	99.6 (99.5–99.6)	0.85 (0.84–0.86)	93.7 (92.5–94.8)	97.4 (97.2–97.6)	163.1 (135.8–195.9)	0.29 (0.28–0.31)
⩾3	72.4 (70.9–73.9)	99.3 (99.2–99.4)	0.86 (0.85–0.87)	94.9 (94.0–95.7)	95.2 (94.9–95.5)	103.8 (87.7–122.8)	0.28 (0.26–0.29)
Metastatic cancer							
Yes	71.5 (69.2–73.7)	99.4 (99.3–99.6)	0.85 (0.84–0.87)	95.7 (94.4–96.8)	95.3 (94.8–95.7)	129.5 (98.3–170.5)	0.29 (0.27–0.31)
No	68.6 (67.4–69.8)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	93.5 (92.7–94.2)	97.9 (97.8–98.0)	209.6 (186.0–236.1)	0.32 (0.30–0.33)
Pneumonia							
Yes	75.7 (71.3–79.8)	99.0 (98.3–99.4)	0.87 (0.85–0.89)	95.7 (92.9–97.6)	93.1 (91.6–94.3)	73.5 (43.5–124.1)	0.25 (0.21–0.29)
No	68.8 (67.7–69.9)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	93.9 (93.2–94.5)	97.7 (97.6–97.8)	202.7 (181.3–226.7)	0.31 (0.30–0.32)
Heart failure							
Yes	72.5 (70.7–74.2)	99.1 (99.0–99.3)	0.86 (0.85–0.87)	94.2 (93.0–95.2)	95.0 (94.6–95.3)	84.2 (70.0–101.3)	0.28 (0.26–0.30)
No	67.5 (66.2–68.8)	99.7 (99.7–99.8)	0.84 (0.83–0.84)	93.9 (93.0–94.6)	98.1 (98.0–98.2)	254.6 (222.3–291.5)	0.33 (0.31–0.34)
Acute myocardial infarction							
Yes	74.7 (70.1–78.9)	99.2 (98.7–99.5)	0.87 (0.85–0.89)	94.8 (91.7–97.0)	95.3 (94.3–96.2)	94.2 (57.7–154.1)	0.26 (0.22–0.30)
No	68.9 (67.8–70.0)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	93.9 (93.2–94.6)	97.7 (97.6–97.8)	202.8 (181.3–226.9)	0.31 (0.30–0.32)
COPD							
Yes	67.1 (59.4–74.1)	99.5 (98.9–99.8)	0.83 (0.80–0.87)	95.8 (90.5–98.6)	94.8 (93.3–96.0)	137.6 (57.0–332.0)	0.33 (0.27–0.41)
No	69.3 (68.2–70.3)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	93.9 (93.3–94.6)	97.7 (97.6–97.8)	199.0 (178.3–222.2)	0.31 (0.30–0.32)
Stroke							
Yes	74.2 (69.2–78.8)	99.2 (98.7–99.6)	0.87 (0.84–0.89)	95.5 (92.2–97.6)	94.7 (93.5–95.7)	97.7 (55.4–172.2)	0.26 (0.22–0.31)
No	69.0 (67.9–70.1)	99.7 (99.6–99.7)	0.84 (0.84–0.85)	93.9 (93.2–94.5)	97.7 (97.6–97.8)	201.4 (180.2–225.1)	0.31 (0.30–0.32)

Definition of abbreviations: AUC = area under the receiver operating characteristic curve; COPD = chronic obstructive pulmonary disease; ICU = intensive care unit; LR = likelihood ratio; NPV = negative predictive value; PPV = positive predictive value.

care delivered. Our study does have limitations because our findings arise from a single center. Also, we did not evaluate the equivalent ICD-10 code (Z66 "Do-not-resuscitate") that is now largely used, though prior studies have demonstrated a similar performance between equivalent ICD-9 and ICD-10 codes (11–13). Given the observed performance characteristics, we recommend that the V49.86 code be used for studies designed to capture the general epidemiology of patients with DNR status (e.g., evaluating secular trends and variation in DNR orders). However, given that administrative data cannot reliably determine timing of DNR status within a hospitalization, this code should not be used for risk adjustment within a hospitalization, though prior DNR may be used for risk adjustment in longitudinal studies.

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Interpretation of Spirometry in Saskatchewan First Nations Adults

To the Editor:

The Canadian First Nations and Inuit communities bear a large burden of respiratory disease, with increased rates of smoking, respiratory infections, asthma, chronic obstructive lung disease, and hospitalizations (1). Identification of respiratory disease and classification has relied on spirometric reference values from white individuals, or in the case of the Global Lung Initiative (GLI) dataset, "other" (2), because there are no published reference values for Canadian First Nations individuals. Several studies have suggested that spirometric values for Canadian Inuit populations may be different from those for white populations (3–7), but these observations are not consistent (7–10). This study investigated whether lung function measured in Plains Cree adults differed from that expected in white adults. Part of the data reported in this letter was presented at the 2014 American Thoracic Society International Conference in abstract form (11).

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Author Contributions: M.E.F. and B.L.G.: design; data acquisition, analysis, and interpretation; drafting/revising the manuscript; and approving the final manuscript; S.S.: data analysis and interpretation, drafting/revising the manuscript, and approving the final manuscript; L.W.: data acquisition as well as critical review and approval of the final manuscript; and L.I.: design, data acquisition, and critical review and approval of the final manuscript.

Methods

We conducted a voluntary survey of Saskatchewan Plains Cree adults aged 18 years and older. Exclusion criteria were physician diagnosis of lung disease, current respiratory infection, dialysis, congestive heart failure, and inability to perform spirometry. Those reporting respiratory diseases were included if there was no spirometric evidence of obstruction or restriction and no current symptoms.

Spirometry was performed using an Easy on-PC spirometer (ndd Medical Technologies, Inc.) following American Thoracic Society/European Respiratory Society guidelines (12). Forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and flow–volume graphs were reviewed and graded separately (13) by two readers (M.E.F. and B.L.G.) to exclude unusable results. *z*-Scores were calculated using the 2012 GLI spirometric reference equations for white individuals (2).