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Agreement Between Electronic Medical Record-based and Self-Administered Pain Numeric Rating Scale: Clinical and Research Implications

Joseph L. Goulet, PhD, MS^{1,2}, Cynthia Brandt, MD^{1,3}, Stephen Crystal, PhD⁴, David A. Fiellin, MD⁵, Cynthia Gibert, MD⁶, Adam J. Gordon, MD, MPH⁷, Robert D. Kerns, PhD^{1,8}, Stephen Maisto, PhD⁹, and Amy C. Justice, MD, PhD^{1,10}

¹VA Connecticut Healthcare System, West Haven, CT, USA

²Department of Psychiatry, Yale University School of Medicine, New Haven, CT, USA

³Department of Anesthesiology, Yale University School of Medicine, New Haven, CT, USA

⁴Center for Health Services Research on Pharmacotherapy, Chronic Disease Management and Outcomes, Institute for Health, Rutgers University, New Brunswick, NJ

⁵Department of Internal Medicine, Yale University School of Medicine, New Haven, CT, USA

⁶VA Medical Center and George Washington University Medical Center, Washington, DC

⁷VA Pittsburgh Healthcare System and University of Pittsburgh Center for Research on Health Care, Pittsburgh, PA, USA

⁸Departments of Psychiatry, Neurology, and Psychology, Yale University School of Medicine, New Haven, CT, USA

⁹VA Syracuse and Department of Psychology Syracuse University, Syracuse NY

¹⁰School of Medicine and Public Health, Yale University School of Medicine, New Haven, CT, USA

Abstract

Background—Pain screening may improve the quality of care by identifying patients in need of further assessment and management. Many healthcare systems use the numeric rating scale (NRS) for pain screening, and record the score in the patients' electronic medical record (EMR).

Objective—Determine level of agreement between EMR and patient survey NRS, and whether discrepancies vary by demographic and clinical characteristics.

Methods—We linked survey data from a sample of Veterans receiving care in eight Veterans Affairs (VA) medical facilities, to EMR data including an NRS collected on the day of the survey

Corresponding Author: Joseph L. Goulet, PhD, MS, VA Connecticut Healthcare System, 950 Campbell Avenue, Building 35a Room 2-207, West Haven, CT 06516, Tel: (203) 932-5711 ext 5325.

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in order to compare responses to the NRS question from these two sources. We assessed correlation, agreement on clinical cut-points (e.g. severe), and, using the survey as the gold standard, whether patient characteristics were associated with a discrepancy on moderate-severe pain.

Results—A total of 1,643 participants had a survey and EMR NRS score on the same day. The correlation was 0.56 (95% CI 0.52/0.59), but the mean EMR score was significantly lower than the survey score (1.72 vs. 2.79; $p<0.0001$). Agreement was moderate ($\kappa=0.35$). Characteristics associated with a increased odds of a discrepancy included: diabetes (adjusted odds ratio (AOR)=1.48), post traumatic stress disorder (AOR=1.59), major depressive disorder (AOR=1.81), other race vs. white (AOR=2.29), and facility in which care was received.

Conclusions—The underestimation of pain using EMR data, especially clinically actionable levels of pain, has important clinical and research implications. Improving the quality of pain care may require better screening.

Keywords

Veterans; pain measurement; electronic medical records

Introduction

Pain is one of the most common reasons for seeking medical care.(1) Pain screening may improve the quality of care by identifying patients in need of further assessment and management.(2) (3) One widely used screening instrument is the numeric rating scale (NRS) on which patients indicate their pain intensity on a scale of 0 ("no pain") to 10 ("worst pain").(4) The NRS is short, easy to administer, correlates with other measures of pain intensity, and is used in many large healthcare systems, including the Department of Veterans Affairs (VA). (5–7)

Routine pain screening has been VA policy since 2003.(8) In the VA, patients are screened when vital signs are taken, and the NRS score is recorded in the electronic medical record (EMR).(9) Because it is a national, integrated system of care serving a diverse population of over 8 million patients in 152 medical centers and 1400+ community based outpatient clinics,(10) the VA's EMR-based NRS is a valuable resource because it can be readily analyzed, and, by merging with patient and facility characteristics, variation in pain reporting, course, treatment, temporal trends, and outcomes may be detected. (11) While EMR-based NRS data is abundant, it has only recently been used in research. For example, two recent studies using such data found variation in pain reporting by gender. (12, 13)

Several studies of EMR-based pain NRS have found underestimation compared with direct patient self-report. In one, one-third of patients reporting pain-related functional interference on the Brief Pain Inventory had an NRS of 0 (i.e., no pain) recorded.(14) Another study reported that a nurse-recorded NRS correlated only 'modestly' with a researcher-recorded NRS ($r=0.63$) and that 51% of patients reported that nurse-recorded pain was rated qualitatively (e.g. 'how is your pain today?'), a practice associated with lower scores in the EMR.(15) However, it is unknown whether such discrepancies are associated with patient characteristics and potentially pain-related comorbid conditions including depression (16), substance use disorders (17), post-traumatic stress disorder (PTSD),(18) HIV (19–21), and diabetes (22).

We compared a patient survey based NRS to an EMR-based NRS collected on the same day during an outpatient visit. We examined the agreement, and, using the survey NRS as the

gold standard, determined whether discrepancies between the two were associated with demographic and clinical characteristics, including the facility in which care was received.

Methods

Participants

Data are from wave three of the Veterans Aging Cohort Study (VACS), an ongoing, prospective cohort study of HIV-infected patients and an age-, race-, and site matched comparison group of HIV uninfected patients receiving care in eight VA medical centers. (23) (24) HIV-infected participants were recruited from Infectious Diseases (ID) clinics, and comparators from General Medicine (GM) clinics. All participants gave written informed consent. More information is provided at www.vacohort.org.

Survey Information

All participants completed a self-administered paper survey, there were no proxy surveys. As recommended by VA clinical practice guidelines, a survey item asked the participant “On a scale of 0 to 10, where 0 means no pain and 10 means the worst possible pain, what is your current pain level?” Participants provided their age, sex, race/ethnicity, and height and weight (used to calculate body mass index (BMI)). Those reporting Asian (n=4), Pacific Islander (n=4), Native American (n=15), or multiple races (n=34) were categorized as ‘other’.

Administrative Data

We used VA administrative data to identify participants with an ID or GM outpatient visit (i.e., stop codes 301, 323, or 310) on the survey day, verified by a blood pressure reading on that day. We then searched the EMR for an NRS score on that day. If there were more than one, we retained the highest. Participants may have completed the survey either before or after their clinic visit, typically in the clinic waiting area. Diagnoses were based on *International Classification of Diseases, Ninth Revision* (ICD-9) codes from VA Patient Treatment Files.(25) Only chronic conditions noted in the prior year and up to 6 months after the survey were retained, as they were likely to be active at the time of the survey. We chose conditions based on their high prevalence and potential relation to pain. Because opioid abuse may cause healthcare providers to “avoid full assessment of the pain complaint”(26) (page 859, Ch 58 ‘Pain in HIV disease’), we determined whether the participant received any opioid medication in the year prior to the survey date.

Analysis

Because pain severity categories (e.g. severe) have clinical applications, we categorized both scores into four levels: 0, no pain; 1 to 3, mild; 4 to 6, moderate; and 7 or greater, severe. (27) Since prior studies have demonstrated that EMR based NRS under-estimate direct patient reports of pain, we used the survey NRS as the gold standard, and defined a discrepancy as the survey NRS being four or more (moderate to severe) but the EMR NRS being three or less (mild or no pain). This is consistent with VA’s pain initiative, which states “it is reasonable to expect that a pain score of 4 or higher would trigger a comprehensive pain assessment and prompt intervention.” (2, 28, 29)

We used Spearman rank-order to assess correlation, the signed rank test to determine the significance of the difference between the two NRS scores, and Kappa to evaluate agreement on the four categories, as well as on any pain, moderate pain, and severe pain. (30) We report sensitivity and specificity of the EMR NRS for identifying any, mild, moderate, and severe pain on the survey. We calculated odds ratios for each characteristic, comparing the odds for a discrepancy for those with the characteristic to those without. We

then used multivariable logistic regression to model the association of patient characteristics and facility with a discrepancy. In the results, facilities were assigned a letter to safeguard confidentiality. We used the Hosmer-Lemeshow test to assess model fit.(31) Analyses were performed using SAS 9.2 (SAS, Cary, NC)

Results

A total of 4,116 participants completed the survey, and 2,346 (57%) had a clinic visit on the survey day. Among those with a visit, 1,643 (70%) had an EMR NRS. Participants with a visit but without an EMR NRS had higher survey NRS scores compared to those with an EMR score (3.34 vs. 2.79, $p<0.001$). Participants seen in ID were more likely to have an EMR NRS compared to those in GM (80% vs. 47%, $p<0.001$). Women (40% vs. 71%), obese participants (62% vs. 72%), and those with alcohol use disorders (65% vs. 70%) were significantly less likely to have had an EMR NRS.

All 1,643 participants with an EMR NRS had a survey NRS. Socio-demographic and clinical features of the sample are presented in Table 1. Seventy percent of participants ($n=1,152$) had a zero in the EMR, while 41% ($n=674$) reported zero on the survey NRS (figure 1). The correlation between scores was 0.56 (95%CI 0.52/0.59), but the mean EMR was significantly lower than the survey NRS (1.72 vs. 2.79; $p<0.0001$).

Table 2 shows agreement between the four pain categories. The diagonal represents the number and percent of participants in the same category on both NRS (e.g. among participants having no pain on the EMR NRS, 54.2% reported no pain on the survey). Three hundred eighty four (23.4%) EMR NRS were categorized as moderate - severe pain (score of 4), while 613 (37.3%) survey NRS were. Overall agreement was 57.3% (942/1,643). Kappa was significant, but in the fair range ($k=0.35$, 95% CI 0.32/0.38).

Agreement on any pain was fair ($k=0.35$). The sensitivity, or proportion of participants with a survey NRS indicating any pain identified as such by the EMR, was low (0.46), but specificity was high (0.93). The positive predictive value, or proportion of participants identified by the EMR NRS as having any pain when the survey NRS indicated so, was high (0.90), but negative predictive value was poor (0.54). Agreement on mild pain was poor ($k=0.13$), but moderate pain was higher ($k=0.36$). For these categories, sensitivity was low, and specificity was high. Agreement on severe pain was good ($k=0.56$). Both positive and negative predictive values were moderate to high. (Table 3) Participants reporting other race (compared to white), with obesity, major depressive disorder, PTSD, drug use disorder, alcohol use disorders, diabetes, receiving opioids, receiving care in GM clinics, and those at facility B were more likely to report moderate-severe pain on the survey. Participants with PTSD had the highest prevalence of discrepancies (28.5%).(Table 4)

Seventeen percent ($n=284$) of participants had a discrepancy in which the survey NRS was four or more but the EMR was three or less. In unadjusted analyses, participants aged 50 and older, those reporting other race (compared to white), with MDD, PTSD, alcohol use disorder, diabetes, or an opioid were each significantly more likely to have a discrepancy. Participants at facilities A, B, D, and F were more likely to have a discrepancy compared to H, the facility with the least discrepancies (11.1%). In the regression results, other race, MDD, PTSD, diabetes, and facility remained associated with increased odds of a discrepancy. Similar results were found when requiring a discrepancy of 2 or more points, except that facility A was no longer different than H (data not shown).

Discussion

We compared a pain NRS score entered in the EMR of a large healthcare system to a survey NRS score collected on the same day. We found that patients with high survey scores were more likely to have a missing EMR score, suggesting that these patients may be screened in a non-standardized manner or that results are not entered in EMR numeric field. In particular, women, and those with obesity and alcohol disorders were less likely to have an EMR NRS. Despite a high correlation, the EMR NRS was significantly lower than the survey NRS, and discrepancies varied by patient characteristics and facility of care. Agreement on pain severity categories was moderate, and nearly half of participants who reported clinically actionable pain on the survey had a lower EMR score.

Because most screening in the VA is done by a health technician prior to the encounter, our findings are not consistent with “competing demands”, whereby patients with multiple conditions receive less attention for each problem due to clinicians’ time constraints. (32–34) Several studies reveal patient under-reporting pain by race, sex, diagnoses, and age (35–37). For example, Green reports that “patients with cancer often do not want to be labeled as complainers, do not want to distract their physicians from treating the cancer, or are afraid that pain means that their cancer is progressing.” In addition, Hispanic and African American patients reported concerns about pain treatment, in particular the potential for addiction. Our finding that patients with chronic conditions were more likely to have a discrepancy may be consistent with Green’s; however, we did not find similar results for race.

Despite the VA being an integrated system of care, with a commitment to pain screening, we found a two-fold difference in discrepancies by facility.(38, 39) This may reflect differences in clinical documentation at these facilities.(40) For example, blood pressure is routinely collected and recorded in the EMR prior to the physician visit. If the reading is high, the physician may reassess it, entering the new reading in the progress note rather than the blood pressure field.(41) Facilities with a high staff turnover may experience more under reporting if patients are less likely to report pain to strangers.(42) Pain underestimation is also related to clinic staff using non-standard screening methods.(15) Conversely, facilities with fewer discrepancies could have better pain screening practices as a result of staff and provider training, education, and monitoring, which are potentially transferable to poorer performing sites.

Our findings have implications for the use of EMR NRS pain scores for clinical care and research. First, the EMR NRS may substantially underestimate the level of pain and result in under-treatment of clinically actionable pain if the provider relies on them to conduct further pain assessment. Second, because discrepancies vary by patient characteristics, the rate of pain treatment relative to the level of pain reported may seem to vary by condition. Third, since pain under treatment may interfere with the treatment of other conditions, an important source of variation in outcomes may be unaccounted for. Fourth, because discrepancies vary by facility, statistically adjusting to reflect sources of variation is made more difficult.

Strengths of this study include data from a large integrated system of care with consistent information systems across facilities, surveys conducted on the visit day, data collection spanning a short duration reducing the potential for variation in screening policies and processes, and a large and diverse sample of patients. In addition, ours was a direct comparison of responses using the (hypothetically) same screening question in two different contexts.

Our study has several limitations. First, using the patients’ pain report as the “gold standard” has been questioned in cases of cognitive impairment.(43, 44) While we were unable to

assess the participants cognitive functioning, all were deemed eligible for participation by their providers. Second, there is no agreed upon standard for clinically important pain, we chose a score of four or more to be consistent with VA guidelines. Third, analysis was limited to patients seen in VA clinics most likely to administer a pain screen and thus we were unable to evaluate those seen in other clinics. Fourth, the VACS study focuses on patients with HIV and a matched comparison group. In our analysis, HIV status (and hence clinic) was not associated with a discrepancy, and we make no claims as to the prevalence of pain in these conditions, only the association between the two methods of pain reporting. Finally, our findings may be limited to primary care within the VA; thus, our results may not generalize to all care settings.

Our study reveals systematic under-reporting of pain in the EMR compared to patient survey reported pain, and that discrepancies vary by chronic conditions such as PTSD and diabetes, and facility of care. Since screening is useful only if it reflects the patient's true condition, such discrepancies may diminish the clinical utility of the EMR NRS, and may lead to under-treatment or erroneous conclusions as to the success of treatment. Improving pain care may require better screening measures, possibly including direct patient entry of pain ratings. While we did not examine the efficacy of patient data entry (e.g., computer kiosks) in this study, such methods could help to reduce sources of variability in screening results associated with facility and rater effects, and patient socially desirable responses when interacting with healthcare staff. Our center is currently conducting a study in which we will compare clinician-documented versus patient-reported approaches directly in a multi-site randomized controlled pain assessment trial, the Effective Screening for Pain (ESP) Study.

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Figure 1.
Number of VACS participants reporting pain scores, by source of NRS

TABLE 1

Socio-Demographic and Clinical Characteristics of the 1,643 VACS Participants with a Survey and EMR NRS Score on the Same Day

Characteristic	
Age, mean (SD)	52.78 (9.1)
Median	52.48
Age 50+, n (%)	1,020 (62.1%)
Female, n (%)	54 (3.3%)
Race/ethnicity, n (%)	
Black	1,066 (64.9%)
Hispanic	139 (8.5%)
Other	57 (3.5%)
White	381 (23.2%)
BMI 30+, n (%)	339 (20.6%)
General Medicine, n (%)	359 (21.9%)
MDD, n (%)	176 (10.7%)
PTSD, n (%)	144 (8.8%)
Drug use disorder, n (%)	290 (17.7%)
Alcohol use disorder, n (%)	210 (12.8%)
Diabetes, n (%)	340 (20.7%)
Opioid prescription, n (%)	599 (36.5%)
Facility, n (%)	
A	135 (8.2%)
B	213 (13.0%)
C	171 (10.4%)
D	236 (14.4%)
E	224 (13.6%)
F	240 (14.6%)
G	82 (5.0%)
H	342 (20.8%)

Abbreviations: BMI body mass index; MDD Major Depressive Disorder; PTSD Post-Traumatic Stress Disorder

TABLE 2

Agreement between categorized EMR NRS and survey NRS

EMR NRS	Survey NRS				Total
	No pain	Mild	Moderate	Severe	
No pain	625 (54.3%)	280	165	82	1,152
Mild	18	50 (47.6%)	22	15	105
Moderate	14	17	115 (64.3%)	33	179
Severe	17	9	29	152 (73.4%)	207
Total	674	356	331	282	1,643

TABLE 3

Kappa, sensitivity, and specificity of the EMR NRS for any, mild, moderate, or severe pain on the survey NRS

Measure	Kappa (95% CI)	Sensitivity	Specificity	PPV	NPV
Any	0.35 (0.31, 0.38)	0.45	0.93	0.90	0.54
Mild	0.13 (0.08, 0.18)	0.14	0.96	0.48	0.80
Moderate	0.36 (0.30, 0.42)	0.35	0.95	0.64	0.85
Severe	0.56 (0.50, 0.61)	0.54	0.96	0.73	0.91

Abbreviations: PPV = Positive Predictive Value; NPV = Negative Predictive Value

Socio-demographic and clinical characteristics of VACS participants with both an EMR and survey NRS score, and multivariable logistic regression model results of the association with an NRS discrepancy

TABLE 4

Characteristic	Survey NRS 4 n (%)	Discrepant n (%)	OR (95% CI)	AOR (95% CI)
Age				
50+	386 (37.8%)	88 (14.1%)	1.45 (1.10, 1.90) *	1.22 (0.91, 1.63)
<50	227 (36.4%)	196 (19.2%)		
Sex				
Male	592 (37.3%)	276 (17.4%)	1.21 (0.56, 2.59)	1.37 (0.61, 3.10)
Female	21 (38.9%)	8 (14.8%)		
Race/ethnicity				
Black	386 (36.2%)	185 (17.4%)	1.15 (0.83, 1.58)	1.14 (0.81, 1.61)
Hispanic	52 (37.4%)	21 (15.1%)	0.97 (0.57, 1.67)	0.78 (0.43, 1.40)
Other	32 (56.1%) *	19 (33.3%)	2.73 (1.47, 5.06) *	2.31 (1.21, 4.41) *
White	143 (37.5%)	59 (15.5%)		
BMI				
30+	156 (46.0%) *	67 (19.8%)	1.23 (0.91, 1.67)	0.94 (0.67, 1.32)
<30	457 (35.1%)	217 (16.6%)		
Clinic				
Infectious Disease	436 (34.0%) *	207 (16.1%)	0.70 (0.53, 0.94) *	0.84 (0.61, 1.18)
General Medicine	177 (49.3%)	77 (21.5%)		
MDD				
Yes	112 (63.6%) *	49 (27.8%)	2.02 (1.41, 2.89) *	1.81 (1.23, 2.67) *
No	501 (34.2%)	235 (16.0%)		
PTSD				
Yes	82 (56.9%) *	41 (28.5%)	2.06 (1.40, 3.03) *	1.59 (1.04, 2.44) *
No	531 (35.4%)	243 (16.2%)		
Drug use disorder				

Characteristic	Survey NRS n (%)	Discrepant n (%)	OR (95% CI)	AOR (95% CI)
Yes	128 (44.1%)*	54 (18.6%)	1.12 (0.80, 1.55)	0.78 (0.51, 1.18)
No	485 (35.9%)	230 (17.0%)		
Alcohol use disorder				
Yes	101 (48.1%)*	47 (22.4%)	1.46 (1.02, 2.07)*	1.32 (0.84, 2.08)
No	512 (35.7%)	237 (16.5%)		
Diabetes				
Yes	153 (45.0%)*	81 (23.8%)	1.69 (1.27, 2.27)*	1.48 (1.08, 2.04)*
No	460 (35.3%)	203 (15.6%)		
Opioid prescription				
Yes	306 (51.1%)*	119 (19.9%)	1.32 (1.02, 1.71)*	1.18 (0.90, 1.55)
No	307 (29.4%)	165 (15.8%)		
Facility				
A	52 (38.5%)	28 (20.7%)	2.09 (1.23, 3.58)*	2.09 (1.17, 3.73)*
B	100 (47.0%)*	46 (21.6%)	2.20 (1.38, 3.52)*	1.90 (1.16, 3.10)*
C	62 (36.3%)	25 (14.6%)	1.37 (0.80, 2.36)	1.15 (0.66, 2.02)
D	84 (35.6%)	48 (20.3%)	2.04 (1.29, 3.24)*	1.87 (1.15, 3.04)*
E	79 (35.3%)	31 (13.8%)	1.28 (0.77, 2.13)	1.10 (0.65, 1.88)
F	83 (34.6%)	58 (24.2%)	2.55 (1.63, 3.99)*	2.11 (1.32, 3.37)*
G	35 (42.7%)	10 (12.2%)	1.11 (0.53, 2.33)	0.93 (0.43, 2.00)
H	118 (34.5%)	38 (11.1%)		

* Statistically significant at p<0.05

Abbreviations: bivariate OR odds ratio for discrepancy; AOR adjusted odds ratio from regression model

The Hosmer-Lemeshow test's p-value (0.50) indicates good model fit of multivariable logistic regression model.