

Discordance between Emergency Department Electronic Health Records and Patient Self-Reported Data

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Abstract. Electronic Health Records (EHRs) have many clinical, financial, and logistical benefits, yet the extent of their accuracy is unknown. We compared patient self-reported data at emergency department (ED) presentations with the corresponding EHR, focusing on key demographics, physical characteristics, and social history. Emphasis was placed on understanding whether major life stressors were noted on patients' charts and how that could impact quality of care. Life stressors are defined as life-altering and emotionally demanding or traumatic events. We enrolled a convenience sample of 357 ambulatory, English speaking, adult patients at the Vanderbilt University Medical Center Emergency Department (VUMC ED), an urban, academic, tertiary care ED with an annual census estimate of 70,000 patients per year. We compared the EHR with self-reported data from bedside patient interviews, including information on demographics (age, sex, race, ethnicity), physical characteristics (height, weight), and life history (smoking, life stressors). Between EHR and patient-reports, sex and age matched in 99%, and race/ethnicity matched in 90%. Race was more discordant when the patient self-identified as multiple races. Weight, height, and smoking were similar between patient interviews and EHR. Of 281 self-reported life stressors, only 75 were recorded in the EHR. Although most demographic and clinical data were concordant, life stressors were frequently absent from the EHR which suggests a discrepancy in data collection and maintenance.

I. Introduction

The Electronic Health Record (EHR) has become the standard for collecting and storing patient information. It often leads to increased patient safety, reduced healthcare costs, and better access to clinical information, not only for patient care, but also for research and healthcare planning (Chaudhry et al., 2006; Valikodath et al., 2017). Emergency department (ED)-based studies suggest EHR implementation reduces short-term readmissions, outpatient referrals, and redundant imaging (Ben-Assuli et al., 2013; Cienki et al., 2013; Lammers et al., 2014), as well as improves the quality, confidence, and efficiency of ED clinical decision-making (Ben-Assuli et al., 2015).

Unfortunately, none of these functions or benefits of the EHR are available if inaccuracies exist within the patient charts. Previous studies have found varying levels of discordance between patient-reported symptoms and those noted on corresponding EHRs (Barbara et al., 2012; Chen et al., 2012; Echaiz et al., 2015; Fromme et al., 2004; Fanous et al., 2012; DeVon et al., 2004; Pakhomov et al., 2008; Strömngren et al., 2001; Xu et al., 2004). Previous studies suggest inconsistencies between the EHR and patient self-reports are often traced back to patient care transitions, including ED admission, department transfers, and discharge (Cornish et al., 2005; Monte et al., 2015). Furthermore, once the inaccuracies exist, they may be linked to decreased quality of care, and they allow for the perpetuation of incorrect information

throughout the patient's stay and into future encounters (Cornish et al., 2005; Monte et al., 2015; Valikodath et al., 2017).

While previous studies have examined EHR discordance in patients' medical histories, medication lists, and physical characteristics such as height and weight, there has been limited investigation of consistency levels between the EHR and other patient self-reported characteristics, such as demographics, personal history, or lifestyle. We have observed that while patient self-reported social history is commonly considered during clinical decision making, grant proposals, and medical research, it is not typically detailed in the EHR. Any background information obtained about a patient, including their medical history, social history, or life stressors, has the potential to reveal causes or precursors of illness and injury. Therefore, inclusion of this information could possibly be helpful in improving clinical decision making and health outcomes. In this study, we aimed to better understand the level of accuracy and completeness present in the EHR in the Vanderbilt University Medical Center Emergency Department (VUMC ED). We examined the degree of consistency between patients' electronic charts with their self-reported data, which we acquired through in-person patient interviews. Specifically, we were interested in information such as demographics (age, sex, race, ethnicity), physical characteristics (height, weight), medical history, social history, and life stressors. Life stressors were defined as events that are life-altering and emotionally demanding or traumatic, such as a change in partner status, a death of a family member, job stress, or a major motor vehicle collision. We hypothesized that there would be a lack of information in the EHR about patients' social history and life stressors, but that there would be consistency in the patients' demographics, physical characteristics, and medical history.

II. Methods

A. Study Design and Setting

We enrolled a convenience sample of ED patients at the Vanderbilt University Medical Center Emergency Department, which is an adult, urban, academic, tertiary care, Level I Trauma Center serving a 100-mile radius (70,000 visits annually). The local

institutional review board approved the study.

B. Selection of Participants

Ambulatory, English speaking, adult patients presenting to the ED with any illness or injury were eligible. Patients were enrolled over a six-month period (September 2016 - February 2017), according to the availability of undergraduate research assistants and research staff. StarPanel, a proprietary electronic health record database, was used to identify eligible patients. All patients were given informed consent, or an option of surrogate consent.

C. Method of Measurement

Research assistants approached pre-screened patients at any point after triage, depending on researcher availability. They administered a survey at the bedside utilizing thirteen demographic and eight social history questions. Questions were a mix of free-response, yes/no, and multiple choice. For demographics and physical characteristics, we collected data on gender, self-identified race, ethnicity, height, and weight. Additionally, social history was measured based on smoking habits, partner status, habituation status, primary mode of transportation, employment status, dietary habits, and the occurrence of life stressors. Life stressors were collected from both the EHR and the patient interviews. The list of events deemed life stressors was created based on the Social Readjustment Rating Scale (Holmes & Rahe, 1967), a measure of the impact of a wide range of common stressors. It included a change in employment status or job stress, change in substance use/abuse, change in living arrangements, death of a friend or close family member, caregiver stress, change in partner status, change in health status, familial stress, financial problems, car wreck, or other undefined stressful events. Caregiver stress was defined as a patient self-reporting a major stressful event in their life as a result of a family member or other significant person's medical condition. Change in health status included patients self-reporting their own medical diagnoses being the source of their stress (cancer, diabetes, heart failure, major medical procedure, etc.). After interviewing each patient, research assistants utilized a REDCap (Research Electronic

Data Capture) database, a secure, web-based application, to record and maintain responses (Harris et al., 2009). The entire Vanderbilt EHR for a patient was utilized, including all past clinic visits and hospitalizations.

D. Data Analysis

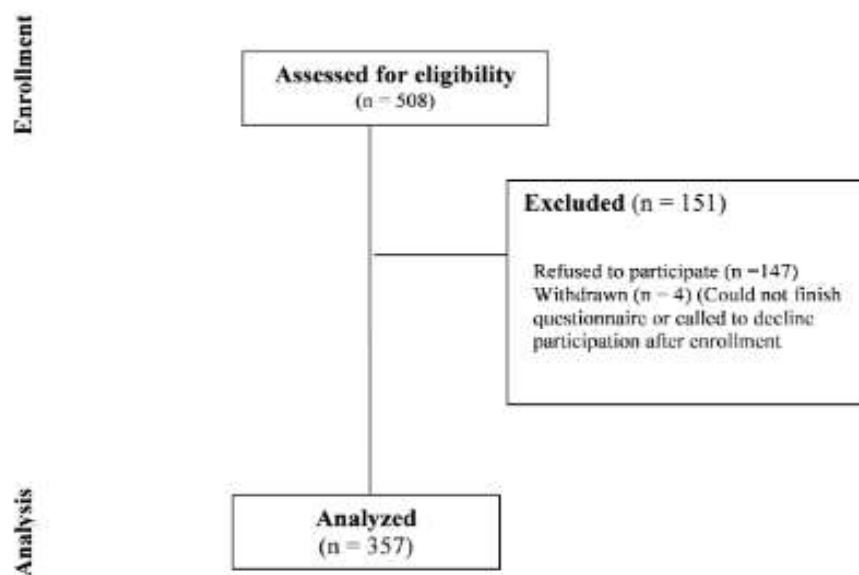
Data was analyzed using R Studio. Demographic and clinical characteristics of consented patients were described using median (Interquartile Range [IQR]) or percent (frequency), as appropriate. A priori selected variables were compared between what the subject reported at the index ED visit and what was recorded in the EHR. These variables included: 1) key demographics, such as age, sex, race, ethnicity; 2) physical characteristics, such as height and weight; 3) smoking status; and 4) life stressors. Missing values were considered missing, and no imputation was performed. Depending on the nature of the variable (continuous or categorical), agreement was assessed using Cohen kappa statistics or Bland-Altman plots. The statistical approach was developed by our departmental biostatistician in consultation with the investigators prior to study start.

jects for eligibility and approached them for enrollment. We excluded 151 subjects for either not meeting inclusion criteria, refusing to participate, or withdrawal due to their inability to finish the questionnaire or calling to remove self-reported data from the study. Of the 4 withdrawn patients, 3 did not finish the questionnaire and 1 declined participation after enrollment. Thus, a total of 357 subjects' self-reported interview information was utilized for analysis purposes. A consort diagram represents the flow of total patients who were approached for a study to the number included for analysis (Figure 1).

Points more than two standard deviations from the mean difference and patterns observed in the points in our Bland-Altman plots (Figure 2) suggest some consistent bias across the board. The plot for the number of life stressors appears to have a fan shape, suggesting that as the mean number of events increased, the difference in the measured number of events between the patient self-reported data and the EHR record increased, with values skewing negative. The data reflects an underreporting of life stressors in the EHR when compared to the self-reported instances in interviews.

Table 2 displays a measurement of the agree-

Figure 1: Consort Diagram detailing enrollment (eligibility and exclusion) and analysis



III. Results

Over the course of this study, we assessed 508 sub-

ject between categorical variables with the kappa statistic. Agreement in many of the variables is poor, especially related to life stressors. The number of data points was lower for the number of life stressors

Table 1: Descriptive statistics on demographic data from both interview and EHR sources.				
Variable	N	Interview	N	EHR
	(interview)	data	(EHR)	data
Age at index ED visit (yrs)	357	48 (35, 62)	357	48 (35, 62)
Sex at index ED visit	356		357	
Female		62% (221)		63% (225)
Male		38% (135)		37% (131)
Both		0% (0)		0% (1)
Race at index ED visit	355		357	
Caucasian		70% (247)		76% (271)
African American		18% (65)		21% (74)
Asian		0% (1)		1% (2)
American Indian-Alaskan		1% (2)		0% (0)
Other		1% (3)		0% (0)
Multiple races		10% (37)		3% (9)
Unknown		0% (0)		0% (1)
Ethnicity at index ED visit	351		357	
Hispanic		4% (13)		1% (3)
Non-hispanic		95% (334)		97% (347)
Unknown		1% (4)		2% (7)
Height at index ED visit	355	66 (63, 70)	288	667 (63, 70)
Weight at index ED visit	352	184 (150, 230)	345	185 (150, 222)
Smoking history at index ED visit	315		354	
Current		19% (60)		20% (70)

Recent		3% (8)		0% (0)
Former		18% (57)		18% (62)
Never		60% (190)		61% (216)
Insufficient EHR		0% (0)		2% (6)
Number of life stressors	357	1 (0, 1)	357	0 (0, 0)
Change in employment	357		357	
No		91% (326)		97% (348)
Yes		9% (31)		3% (9)
Variable	N	Interview	N	EHR
	(interview)	data	(EHR)	data
Change in substance abuse	357		357	
No		99% (352)		99% (353)
Yes		1% (5)		1% (4)
Moved	357		357	
No		85% (302)		99% (355)
Yes		15% (55)		1% (2)
Death of a loved one	357		357	
No		91% (326)		99% (354)
Yes		9% (31)		1% (3)
Change in partner status	357		357	
No		96% (343)		98% (350)
Yes		4% (14)		2% (7)
Change in functional status	357		357	

No	96% (344)	99% (352)
Yes	4% (13)	1% (5)
Surgery	357	357
No	86% (306)	92% (327)
Yes	14% (51)	8% (30)
Money issues	357	357
No	94% (334)	97% (348)
Yes	6% (23)	3% (9)
Other stressful event	357	357
No	84% (299)	98% (351)
Yes	16% (58)	2% (6)

Overall values for each life stress event: employment change = 40; substance abuse change = 8; partner status change = 20; death of loved one = 33; functional status change = 18; surgery = 62; money issues = 30; other life stressor = 63; and moved = 56. Total number of life stressors recorded during the interview = 281; total number of life stressors recorded in the EHR = 75.

as not every participant surveyed had a stressor to report. However, the EHR did not reliably represent this information except with regards to surgical procedures. In general, the life stressors with less relevance to the medical chart, such as social or lifestyle changes, were recorded less reliably in the EHR. Meanwhile, information that could be perceived as more relevant to the medical chart, including sex, height, weight, smoking history, etc., were recorded more reliably in the EHR.

Data in Table 1 indicated excellent consistency between the patient-reported interview and the EHR for demographic information (age, sex, ethnicity), physical characteristics (height, weight), and smoking history. Sex and age matched for 99% of patients in the sample. On the contrary, race and life stressors were substantially different between patient and EHR-reported information. Race/ethnicity was concordant in 90% of patients in the sample. While the majority of the proportions of the reported races were similar between the interview and EHR, the

proportion of multiple races reported varies. In the patient-reported data, 10% (37) of interviewees identified with multiple races, and only 3% (9) of interviewees' EHR data indicated more than one race. A discrepancy in reported life stressors also occurred, where 281 total life stressors were recorded in patient interviews and only 75 were recorded in the EHR. These life stressors were attributed to a total of 159 patients, and 198 patients reported that they did not experience any life stressor events. Finally, only 30 out of 51 self-reported occurrences of surgery within the past six months were recorded in the EHR.

IV. Limitations

This study contains several limitations. The single site of enrollment is a large, urban, Level I Trauma Center and may not be reflective of other EDs or health care settings. The sample size was somewhat small. A convenience sample of only ambulatory and English-speaking patients were enrolled. The inclusion

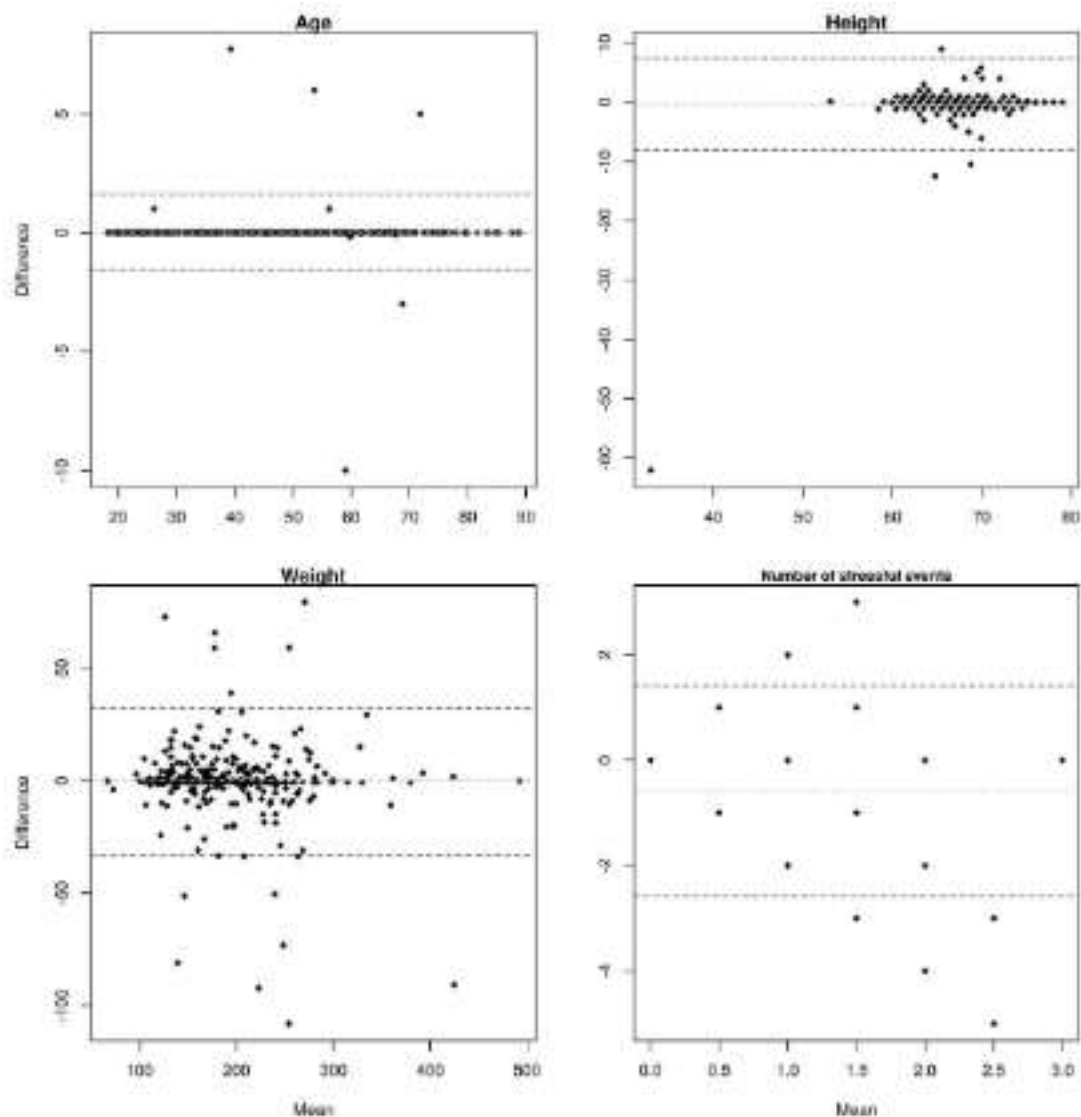


Figure 2: Bland-Altman Plot illustrating agreement between interview and EHR data for continuous variables

of non-English-speaking patients or those with more serious conditions may have led to different results, and therefore this is a source of bias in our study. For instance, the inclusion of trauma patients may have increased the amount of life stressors recorded, as details of the traumatic event are usually collected by pre-hospital or triage professionals, but this also may have decreased the amount of demographic information or physical characteristics if they are not considered necessary in an emergent situation. The entire 43-item SRRS was not utilized due to constraints of obtaining in acutely ill or injured patients, thus comparison with other studies is not possible. The stressors were chosen by investigator consensus informed by those thought most associated with an emergency department visit. VUMC transitioned to EPIC as our EHR in 2018, after study completion.

Our results were obtained in a proprietary EHR, thus comparison within EPIC to other institutions is not within the scope of this study. Furthermore, Nashville may not be representative of other sites with perhaps greater diversity in race, ethnicity, sexual orientation, or other characteristics. The length of an individual patient's EHR depends upon numerous factors such as time spent within our care system, medical conditions, age, number of providers, and perhaps the strength of each provider's relationship with the patient. We did not control for these factors. We accepted the patients' self-report of medical procedures as fact: validity checks were not within the scope of this study. The clinical research form (CRF) in the study was left blank on several questions, and researchers did not specifically note the reasons for missing fields during survey administration; it could

Table 2: Cohen's kappa statistics with 95% confidence intervals to assess agreement between the interview and EHR data.

Categorical variable	Kappa	95% CI
Sex	0.958	(0.927, 0.989)
Smoking history	0.638	(0.562, 0.714)
Surgery	0.406	(0.263, 0.550)
Substance abuse change	0.212	(-0.152, 0.577)
Ethnicity	0.126	(-0.064, 0.316)
Money issues	0.092	(-0.071, 0.255)
Partner status change	0.071	(-0.107, 0.249)
Death of a loved one	0.044	(-0.087, 0.175)
Moved	0.025	(-0.081, 0.130)
Other	0.001	(-0.097, 0.098)
Functional status change	-0.021	(-0.069, 0.028)
Employment change	-0.041	(-0.103, 0.021)

have been because the question was never asked by researchers or because the participants declined to answer.

V. Discussion

Our results suggest that in the VUMC ED, selected demographics (age, sex, and ethnicity), history (smoking), and physical characteristics (weight, and height) were accurately recorded in the EHR. This was in support of our original hypothesis. This result also coincides with existing literature in other fields and patient populations. For example, a study that compared patients' self-reports of influenza symptoms with information in their primary care medical records found higher levels of accuracy and detail in the report of symptoms in the medical records (Barbara et al., 2012). However, patients who

self-reported as multiple races or ethnicities often had significant discordance which might be attributed to various causes, including provider prioritization of primary race during care, or patient conformity to social norms during reporting. Employees at registration might even assume the race of individuals without personal inquiry. Though the implications of this specific discordance in multi-racial identity have yet to be established, it suggests that there is information being lost at some point during a patient's medical care.

Our analysis also suggested that the EHR often fails to encapsulate many major life stressors. Surgery/major procedure and substance abuse change in the previous six months were the two life stressor categories the EHR recorded the most accurately. However, even in these fields, the kappa statistics were 0.406 and 0.212 respectively, referring to the

EHR missing 40% (21) and 20% (1). This high discordance with surgery or major procedures in the six months prior to presentation is especially concerning as an individual's surgical history is often extremely pertinent to the medical advice given and medications prescribed in the ED. This is because certain procedures can make treatments contraindicated or more needed than otherwise. For instance, studies have shown that medical and lifestyle histories are important factors for HIV treatment success (Kabue et al., 2007). Thus, a physician being unaware of a medical procedure such as surgery could have avoidable negative implications later.

In general, the more medically relevant an event or piece of information, the more reliably it is recorded in the EHR. Life stressors, including employment or marital status, financial issues, and relocations, were less reliably recorded. In fact, other than surgery and substance abuse change, no patient-reported life stressor was recorded with more than 50% frequency in the corresponding EHRs. It is important to note that 198 out of 357 patients in the study reported zero life stressors to interviewers. This means that all 281 life stressors were attributed to 159 patients. For patients who had experienced multiple major life stressors, events beyond the first may have been excluded from the list by providers or patients, thus providing a possible explanation for the discordance in life stressor reporting. This may indicate increased time required to discover and document such information. If ED health care providers could accurately record the presence of such an event in the EHR, there may be opportunities to affect clinical care. For instance, case studies have shown the value in incorporating social determinants of health into patient records (Gottlieb et al., 2015). So, knowledge about such factors could further impact decisions made in the emergency department, which could then have implications in patients' lives for years to come.

However, there are implications of this study that we have yet to fully understand, especially in terms of direct medical outcomes. Recent studies have established a link between high stress levels and immune system suppression, levels of insulin need, psychiatric illness, broncho-constriction in asthmatics, and tumor development (Salleh, 2008). So, it would be worthwhile to see how and which specific

nonmedical life stressors, such as an employment change, could affect medical outcomes or physician decision making. This would reveal which life stressors' discordance would need to be addressed first and provide a foundation to begin discussion around implementing change. Considering that not all stressors are created equally, the SRRS used for life stressors could be a valuable starting point for such future directions. For instance, we could investigate whether technological restructuring in terms of the prompts given to medical staff when filling out an EHR could improve accurate life stressor reporting. Another direction would be to consider whether a more accurate EHR could improve ED care times by assisting in the efficiency of diagnoses and treatment plans, especially since physicians have become reliant on EHR information in order to be more confident in their decision-making (Ben-Assouli et al., 2015). Furthermore, the presence of any discordance in the first place raises questions regarding EHR data quality and whether there is an issue with data transmission during patient admission, transfer, or handoff. We believe that it is of utmost importance to determine why this discordance is present in the EHR as a measure of whether there is a major flaw in the process by which we currently collect data in the ED. This information would have the potential to show what clinical changes would be most worthwhile to consider in order to improve the agreement of EHR and patient reported characteristics.

Finally, it is worthwhile to note that VUMC has transitioned from using StarPanel as their EHR software to using EPIC. EPIC is a widely used EHR system in hospitals around the country, which could contribute to increased detail and agreement in patient charts. This is particularly important because the VUMC ED admits patients from a multitude of cities and states, so the transfer of medical records from other medical encounters could help reduce discordance in the reports of life stressors and patient history.

VI. Conclusion

The numerous benefits of electronic health records warrant review of their accuracy and representation of patient information. Although the EHR is reli-

able with patient self-report for most demographic and clinical data, discordance occurs in several areas informing clinical care decisions and disposition.

VII. Acknowledgement and Disclaimer

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