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Original Paper

The Effect of Electronic Medical Records on Nurses' Job Satisfaction: A Multi-Year Analysis

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Abstract

To measure nurses' rankings of their electronic medical records (EMRs) on their job satisfaction over time, a retrospective analysis of a set of cross sectional data from a survey conducted by the United States' California Registered Nursing Board in 2008, 2010, 2012, 2014, and 2016. Approximately 4,500 nurses ranked the usefulness of their EMRs in each of the five years.

The EMR rankings increased steadily between 2008 and 2016 but the changes are small and the rates of change are very slow, suggesting that the problems with EMRs have been difficult to solve. The results show EMRs have a large impact: a one category increase in EMR rankings increased job satisfaction by as much as or slightly more than one-third for hospital and non-hospital nurses.

The size of the effects and their persistence over eight years imply a substantial loss from poorly designed EMRs, and one which could have been avoided had EMR designs more closely matched nurses' day to day work. The reductions in job satisfaction and potential effects on burnout are losses to be added to the more widely measured losses in productivity and negative effects of EMRs on patient-provider relationships.

Keywords

informatics/information technology, urban health policy, work environment/working conditions, care delivery system, nurse-patient relationships

1. Introduction

The history of electronic medical records demonstrates the error of changing work environments without adequately compensating for the impact of the changes on the end users. Electronic Medical Records (EMRs) might, in concept, have simply been substitutes for paper records but they substantially changed the working environments of nurses and other health care professionals. The introduction of EMRs complicated nurses' workloads, interfered with patient communication, increased work-arounds, reduced productivity, and increased patient complications (Taylor & Bice, 2019; Bristol et al., 2018; Topaz et al., 2017; Walker-Czyz, 2016; Ratwani et al., 2015; Gardner & Sparnon, 2014; Furukawa et al., 2010; DesRoches et al., 2008).

Nurses' difficulties with EMRs have lessened over time as nurses adapted to EMR use and newly graduated nurses benefited from training in the use of EMRs during their schooling. Some of the changes over time can be glimpsed from repeated surveys of nurses.

The Black Book Market Research Organization conducts an ongoing national, proprietary survey of U.S. hospital nurses (Kent, 2018). The 2014 survey reported widespread dissatisfaction with EMRs that, at worst, caused some nurses to leave hospitals for other jobs (Millard, 2014). The 2018 results, however, show improvement. Disruptions in productivity from EMR use were cited by 69% of nurses in 2018 compared to 84% in 2016 (Black Book Complimentary Results, 2018). The percent of nurses reporting that EMRs interfered with workflow fell to 44% from 85% and obstacles to patient-provider relationships were cited by 80% compared to 90% 2016 (Black Book Complimentary Results, 2018).

Despite the signs of improvement and several years of experience with EMRs, change has been slow and significant problems remain. One would expect, therefore, that EMRs might have reduced nurses' job satisfaction over several years. High levels of job satisfaction are a key defense against the problems of attrition and burnout that beset the nursing profession (Kovner et al., 2014; Gilmartin, 2013; Irvine & Evans, 1995), but there is relatively little information on the effects of EMRs on job satisfaction (Lu et al., 2019 Shin et al., 2021; Moy et al., 2021).

One exception is a study of 371 Advanced Practice Registered Nurses, that found that EMR users were more than twice as likely to burnout as non-users (Harris et al., 2018). The Harris et al. results suggest that although EMRs are but one element in nurses' work flow, they have a large effect on burnout and job satisfaction.

This article adds information on how EMRs affected nurses' job satisfaction over time, using data from five bi-annual surveys (2008, 2010, 2012, 2014, 2016) of California nurses. The data include the recession years of 2008-2009. The recession officially ended in June 2009, but unemployment rates remained high well into 2014: average annual unemployment rates in California increased from 7.3% in 2008, to 12.2% in 2010; dropped to 10.4% in 2012; fell to 7.5% in 2014 and to 5.3% in 2016 (US Bureau of Labor Statistics, 2020).

Shortages of Registered Nurses (RNs) in the hospital industry persist when economic activity is high and disappear during recessions (Brewer, 1996; Long, Goldfarb, & Goldfarb, 2008; Staiger,

Auerbach, & Buerhaus, 2012; Wood, 2011). The shortages are eliminated by shifts from part-time to full-time work, delayed retirements, and re-entry into the nursing labor force by nurses who previously left nursing (Sparkman, 2020; Johnson et al., 2016; Staiger et al., 2012; Buerhaus & Auerbach, 2011; Wood, 2011 Buerhaus, Auerbach, & Staiger, 2009; Long et al., 2008).

During recessions, newly graduated nurses have difficulty finding jobs so the recession nursing workforce is somewhat older than during non-recessionary periods (Johnson et al., 2016). Older nurses in 2008-2009, however, were unlikely to have received formal training in the use of EMRs and nurses returning from non-nursing employments likely required some retraining in EMR use. Our measures of the effects of EMRs on job satisfaction may, therefore, be influenced by the recession/recovery changes in the nursing workforce. Potential differences among the years are partially controlled by the inclusion of sociodemographic characteristics in the multivariate models that we estimate.

2. Method

In 2008, the California State Board of Registered Nursing (CBRN), in cooperation with the University of California, San Francisco, added questions about EMR use to their survey of registered nurses. Surveys are mailed, every other year, to approximately 10,000 RNs with active licenses. The survey methods and results are described elsewhere (Septz, Chu, Levin, Muench, & Keane, 2015; Spetz, Chu, Jura, & Miller, 2017).

We conducted a retrospective analysis of CBRN data for the years 2008, 2010, 2012, 2014 and 2016. Approximately 4,500 EMR users with non-missing values are included in each year (Spetz et al., 2016).

Nurses' ranked the usefulness of EMRs on a four-part ordinal scale: *4 (all systems work well), 3 (systems generally helpful but have some flaws), 2 (systems have problems that affect my work),* and *1 (systems interfere with my work*).

Nurses' ranking of EMR usefulness is included as one variable in a model of the determinants of job satisfaction. Job satisfaction is measured on a 5-part ordinal scale: *5=very satisfied; 4=satisfied; 3=neither satisfied nor dissatisfied; 2=dissatisfied; 1=very dissatisfied.* Control variables include real hourly wage; annual hours in principal job; female (1,0); children at home (1,0); age (in years); years in primary nursing position; commute (miles); Black (1,0); Hispanic (1,0); Non-Hispanic White (1,0) (the principal omitted ethnicity is Filipino).

We use multivariate ordinal logistic functions to estimate the job satisfaction model. The job satisfaction variable has five values (above) but only the transition from the most dissatisfied outcomes or into the most satisfied outcomes, is unambiguously defined (Greene, 1990, p. 704). Our results focus on transitions into the most satisfied category. The effect of EMR ratings on job satisfaction is estimated as the change in job satisfaction with a unit change in nurses' rankings of the usefulness of

EMRs. We also test whether the impact of EMRs on job satisfaction differs between hospital and non-hospital settings.

3. Results

Hospital nurses' rankings of EMR usability increased from 2008-2016 (Tables 1a). The largest improvement occurred in the *all systems work well* category (18% in 2016 vs 10% in 2008) and in reductions in the two lowest categories.

Table 1a. Descriptive Statistics by Year: Hospital Nurses--Means

	2008	2010	2012	2014	2016
No EMR (fraction)	0.028	0.023	0.019	0.0004	0.0
EMR Satisfaction:					
All Systems Work Well(fraction)	0.100	0.135	0.140	0.169	0.1792
Systems Generally Helpful But Some Flaws	0.608	0.628	0.595	0.570	0.5988
Systems' Problems Affect My Work	0.214	0.185	0.207	0.195	0.1633
Systems Interfere With My Work	0.079	0.052	0.058	0.066	0.0585
Mean Rank EMR Satisfaction	2.728	2.846	2.817	2.841	2.899
Real hourly wage ($)	51.68	48.52	52.74	56.26	57.80
Annual Hours in Principal Job	1708	1823	1809	1803	1809
Female (fraction)	0.840	0.879	0.862	0.866	0.851
One or More Children (fraction)	0.490	0.503	0.503	0.518	0.512
Age (years)	46.103	46.00	45.32	46.70	46.63
Years in Current job (tenure)	9.694	16.31	16.36	16.21	15.99
Commute (miles)	19.25	22.15	20.79	19.65	18.48
Black (fraction)	0.032	0.039	0.039	0.043	0.038
Hispanic (fraction)	0.057	0.064	0.055	0.060	0.080
Non-Hispanic White (fraction)	0.603	0.588	0.590	0.568	0.553
Job Satisfaction:					
Very Satisfied (fraction)	0.337	0.373	0.370	0.334	0.3248
Satisfied (fraction)	0.509	0.494	0.486	0.521	0.5551

Neither Satisfied nor Dissatisfied (fract.)	0.083	0.068	0.080	0.081	0.0644
Dissatisfied (fraction)	0.060	0.057	0.052	0.052	0.0487
Very Dissatisfied (fraction)	0.010	0.009	0.012	0.012	0.0068
Mean Rank Job Satisfaction (1-5)	4.103	4.166	4.150	4.112	4.1422
Number of observations (those using EMRs)	2616	3080	2612	2363	1947

The means for No EMR are for the full sample of hospital nurses; the means for all other variables are for those hospital nurses who work with EMRs.

The most striking feature of the trend in rankings, however, is the very slow rate of improvement. Remembering that EMRs were in place for approximately 97% of hospital nurses in 2008, the additional eight years of experience only increased the mean ranking of EMR usability from 2.7 to 2.9. In words, the rank is *systems problems affect my work*, closely approaching *systems generally helpful but with some flaws*. The mean level of job satisfaction increased from 4.10 in 2008 to 4.14 in 2016, varying slightly among the individual years. Most of the change occurred in shifts from the *dissatisfied* and *very dissatisfied* categories to the *satisfied* group.

The trends for non-hospital nurses are similar but more muted (Table 1b). EMR use increased from approximately 89% in 2008 to effectively 100% in 2016 with some variation in the intervening years. There is little change over time in the lowest ranked groups (*systems interfere with my work*) or in (*the systems generally helpful…* etc. rank=3). There is, however, a consistent trend, reducing the importance of (*systems problems affect my work*) and increasing the percentage of nurses ranking EMRs as *all systems work well*. Once again, rankings have improved very slowly over time with the mean ranking increasing slightly from 2.85 in 2008 to 2.96 in 2016. The very slow pace of improvement implies that the problems with EMRs have been difficult to solve, suggesting that the problems are found in the design of the EMRs.

The trends in job satisfaction among non-hospital nurses are mixed, with small but consistent increases in *satisfied* and small but consistent decreases in *dissatisfied*. Trends in the other levels of satisfaction are not consistent over time. The mean rank for job satisfaction reflects the inconsistencies, exhibiting both increases and decreases in different years. These results reflect the fact that EMR use is not the sole determinant of job satisfaction.

The interpretation of the descriptive data must recognize that the survey data are not drawn from a panel. Instead, each sample year is a different draw from a population of nurses whose composition changes over time. Thus, differences in rankings among the years are affected in unknown ways by differences in the nurses who responded to the survey.

Table 1b. Descriptive Statistics by Year: Non-Hospital Nurses--Means

	2008	2010	2012	2014	2016
No EMR (fraction)	0.111	0.136	0.089	0.001	.001
EMR Satisfaction:					
All Systems Work Well(fraction)	0.151	0.208	0.195	0.179	0.222
Systems Generally Helpful But Some Flaws	0.592	0.572	0.555	0.590	0.559
Systems' Problems Affect My Work	0.210	0.182	0.204	0.188	0.177
Systems Interfere With My Work	0.045	0.038	0.046	0.043	0.042
Mean Rank EMR Satisfaction	2.85	2.949	2.900	2.91	2.961
Real hourly wage ($)	48.84	44.50	46.43	50.00	51.85
Annual Hours in Principal Job	1730	1844	1844	1792	1833
Female (fraction)	0.884	0.895	0.902	0.895	0.874
One or More Children (fraction)	0.382	0.394	0.395	0.392	0.387
Age (years)	54.53	54.11	53.58	54.50	55.75
Years in Current job (tenure)	8.623	21.54	21.61	21.576	21.21
Commute (miles)	16.027	16.68	24.05	21.42	18.26
Black (fraction)	0.036	0.039	0.047	0.040	0.047
Hispanic (fraction)	0.041	0.055	0.041	0.048	0.055
Non-Hispanic White (fraction)	0.699	0.653	0.674	0.660	0.631
Job Satisfaction:					
Very Satisfied (fraction)	0.399	0.414	0.402	0.371	0.371
Satisfied (fraction)	0.424	0.439	0.449	0.467	0.482
Neither Satisfied nor Dissatisfied (fract.)	0.075	0.073	0.070	0.093	0.081
Dissatisfied (fraction)	0.077	0.060	0.065	0.054	0.052
Very Dissatisfied (fraction)	0.024	0.014	0.014	0.015	0.014
Mean Rank Job Satisfaction (1-5)	4.10	4.180	4.161	4.125	4.144
	1423	1564	1484	1247	951

The means for No EMR are for the full sample of non-hospital nurses; the means for all other variables are for those non-hospital nurses who work with EMRs.

Hospital nurses are younger and have shorter job tenures than non-hospital nurses. Although the absolute values differ, both groups have much shorter job tenures in 2008 than in subsequent years. Among hospital nurses, job tenure is 9.7 years in (2008) and between 16 and 16.4 years in subsequent years. Job tenure for non-hospital nurses is 8.6 years in 2008 versus 21.2 to 21.6 years in subsequent years. These results are consistent with a temporary influx of nurses back to nursing during the economic recession and their departures as economic conditions improved.

We estimate multivariate models that control for the differences in nurses' characteristics in different years and allow for interactions among the various influences on job satisfaction. These estimated effects of nurses' EMR ratings on job satisfaction are described in Tables 2a & 2b. Intercepts corresponding to the different levels of satisfaction "ÉMR Satisfaction" are statistically significant. The marginal effects calculated in Tables 2a & 2b (given in the "[ ]" brackets under the logistic point estimators) represent the percentage point change in the most satisfied category of job satisfaction given a unit increase in the EMR rating. An increase in hospital nurses' rating of EMR usability from 3, *systems generally helpful but have flaws*, to a rating of 4, *all systems work well* increases the likelihood of nurses being *very satisfied* by 11.3 percentage points in 2008 (Table 2a). Since approximately 33.7 percent of EMR users were *very satisfied* in 2008 (Table 1a), the likelihood of nurses being *very satisfied* would increase to 45 percent (33.7+11.3). In 2010 and 2012, being *very satisfied* would increase from approximately 37% to more than 51% and from approximately 33% to slightly more than 47% in 2014 and 2016.

Table 2a. Ordinal Logistic Model of Highest Job-Satisfaction—Hospital Nurses Who Use EMRs [marginal effect]

	2008	2010	2012	2014	2016
EMR Satisfaction	.523***	0.633***	0.672***	0.653***	0.711***
	[0.113]	[.140]	[.149]	[.137]	[.148]
real hourly wage	0.003**	0.015***	0.005**	0.005**	0.001
annual hours	.0001	0.0003***	0.0002**	0.0001*	0.0001
female	0.195*	0.255**	0.056	0.037	0.099
child	0.144*	0.237***	0.187**	0.043	0.305***
age	-0.006	-0.005	0.003	-0.006	-0.002
current tenure (yrs)	0.023***	0.006	0.003	0.009*	0.007
commute miles	0.001	-0.0003	-0.0001	-0.002***	0.002
black	-0.127	-0.314	-0.270	-0.445**	-0.176
Hispanic	0.502***	0.184	0.318	0.248	0.314*
Non-Hispanic white	0.379***	0.371***	0.231**	0.136	0.250**
Sample size	2267	2204	2143	2113	1728

Note. all models include only those nurses with an EMR system (and hence, an EMR rating). Significance levels: ***-significant at 1 percent level, **-significance at 5 percent level, *-significance at 10 percent level. "[ ]" marginal response as discussed in text: change in in the likelihood of going to the highest level of job satisfaction (from 4 to 5) for a unit increase in EMR functionality.

Table 2b. Ordinal Logistic Model of Highest Job-Satisfaction—Non-Hospital Nurses Who Use EMRs

[marginal effect]

	2008	2010	2012	2014	2016
EMR Satisfaction	0.561***	0.529***	0.658****	0.676***	0.749***
	[.128]	[.121]	[.149]	[.147]	[.159]
real hourly wage	0.005**	0.005	0.001	0.008***	0.004**
annual hours	-.00004	.0001	0.0001	0.0002**	0.0004***
female	-0.263	0.122	0.042	-0.025	-0.013
child	0.015	0.126	0.037	0.176	0.112
age	0.006	0.004	0.001	0.013*	-0.007
current tenure (yrs)	0.016**	0.013*	0.012*	0.003	0.024***
commute miles	-0.002	-0.003**	-0.0002	0.002	0.003
black	0.2232	0.005	-0.457*	-0.299	0.230
Hispanic	0.306	0.037	0.415	0.489**	-0.062
Non-Hispanic white	0.560***	0.419***	0.208	0.351**	-0.028
Sample size	1203	1086	1170	1087	785

Note. all models include only those nurses with an EMR system (and hence, an EMR rating). Significance levels: ***-significant at 1 percent level, **-significance at 5 percent level, *-significance at 10 percent level. "[ ]" marginal response as discussed in text: change in in the likelihood of going to the highest level of job satisfaction (from 4 to 5) for a unit increase in EMR functionality.

Non-hospital nurses are generally more satisfied with their jobs than hospital nurses but increased EMR rankings would substantially increase their levels of satisfaction as well (Table 1b & Table 2b). The percentage of nurses in the *very satisfied* group would increase from 40% to 53% in 2008. The increase in 2010 would be from 41% to 44% and from 40% to 55% in 2012. In 2014 and 2016, the percentage of nurses in *very satisfied* would increase from 37% to 52%.

The results show that EMRs have a substantial impact on job satisfaction despite being just one part of a nurse's daily routine.

The results offer the advantage of tracing the relationship between EMR use and job satisfaction over several years. The samples are large but limited to the State of California which differs from many

other States in many respects including mandated nurse to bed ratios in hospitals. Inferences from the data must be conditioned on these limits.

4. Conclusion

The nurses' evaluations of EMRs over the eight years covered by the survey trace the pattern of adaptation to the changes in nurses' work environment that were induced by the introduction of EMRs. The EMR rankings increased steadily between 2008 and 2016 but the changes are small and the rates of change are very slow suggesting that the problems with EMRs have been difficult to solve. Recent national surveys for 2018 confirm the persistence of significant problems faced by nurses using EMRs. What then, during this long and as yet incomplete period of adaptation, has been the effect on the job satisfaction of nurses?

The results show that EMRs have a large impact on nurses' job satisfaction even though EMRs are but one element in the nursing workplace. A one category increase in EMR rankings would have increased job satisfaction by as much as or slightly more than one-third for hospital and non-hospital nurses, varying among the years. Variations in the composition of the sample prohibit summarizing the potential losses in job satisfaction but the size of the effects and their persistence over eight years imply a substantial loss and one which could have been avoided had EMR designs more closely matched nurses' day to day work. There is evidence that the losses in job satisfaction from EMR use induced burnout and there is a voluminous literature on losses of productivity and other problems related to EMRs. The example is EMRs but the lesson is more general. Introducing new technologies into healthcare without careful consideration of how the changes affect the workplace environment guarantees a long, costly and inefficient process of adaptation.

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