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Surveying perceptions of the early impacts of an integrated electronic medical record across a hospital and healthcare service

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Abstract.

Objective. This study provides insights into the reported early impacts of the digital transformation of a large Australian hospital and healthcare service (HHS) by surveying staff perceptions of an integrated electronic medical record (ieMR).

Methods. The information systems success model was used as a tool to evaluate perceptions of system quality, information quality, individual benefits and expected organisational benefits of the ieMR soon after its introduction at the HHS. A questionnaire was distributed to staff in all five hospitals in the HHS immediately after implementation. Overall staff perceptions were examined, in addition to how perceptions differed by site and profession.

Results. Overall, staff held mildly positive early perceptions of system quality, information quality, individual benefits and expected organisational benefits. These views were largely consistent across sites. In terms of professions, allied health held more positive perceptions, followed by administrative and nursing professionals. Medical professionals held negative perceptions, but were neutral regarding their future expectations.

Conclusion. On average, staff viewed the ieMR mildly positively immediately after implementation (despite significant changes to work practices), but differences exist across professional groups.

What is known about the topic? Hospitals globally are in the midst of a digital transformation. Yet, reported impacts are mixed and there have been few studies of the effects of comprehensive electronic medical record (EMR) implementations.

What does this paper add? This paper evaluates a comprehensive EMR immediately after go-live. We found positive early perceptions of system quality, information quality, individual benefits and expected organisational benefits. We also found that perceptions of medical professionals were largely negative, but they were neutral in terms of their future expectations.

What are the implications for practitioners? Health services may be unsure of the effect of implementing a comprehensive EMR because of conflicting reports in the literature, some touting major benefits, others stressing major costs. Our results paint a middle-ground picture immediately after implementation. Staff perceptions are mildly positive on average, which is reassuring given the results were obtained during the early disruptive period after implementation.

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Introduction

To help address rapidly escalating health care demands, hospitals around the world are investing significantly in eHealth systems, including electronic medical records (EMRs), computerised provider order entry (CPOE), ePrescribing and clinical decision support systems (CDSS). Although these systems offer great potential, their impacts have often been inconclusive,[1] which is due, in part, to the comprehensiveness of functionality implemented.[2] For example, in the US 80% of hospitals have implemented eHealth technologies, but fewer than half implemented a comprehensive range of functionalities.[3] Insights into the evaluation of comprehensive eHealth adoption is much needed but scarce.[2]

Although few comprehensive EMRs have been implemented in European and US hospitals,[2] the Queensland Government in Australia invested over A$1 billion to implement a new integrated electronic medical record (ieMR) for the state (consisting of CPOE, ePrescribing and CDSS functionality).[4] This initiative resulted in Australia's first 'digital' hospital and health service (HHS), with all five of the hospitals in the HHS using a single database instance (i.e. data is accessible and editable across all sites implementing the system) of the ieMR. The implementation of such a comprehensive ieMR introduces great complexity, with broad implications for benefits and risks.[5] As such, formative evaluations are important to learn how to improve the system, guide future implementation efforts and inform other hospital decision makers of the likely impacts of such an initiative.[2] Accordingly, the aim of this study was to evaluate the new ieMR implemented in all hospitals in the HHS.

This study addressed the following question: what are the reported impacts as perceived by users of a comprehensive ieMR system during the 'stabilisation period' (immediately after go-live)? To answer this question, the information systems (IS) success model[6–8] was used as an evaluation tool to identify whether staff who use the ieMR hold positive or negative perceptions of the system. We further explored whether differences existed between sites and among professions.

Methods

To learn staff perceptions, staff in each of the hospitals in the HHS were surveyed, asking them for their perceptions of the ieMR and its impacts approximately 6 weeks after the go-live.[9] This complements a qualitative, interview-based study we conducted separately.[10] The study received ethics approval from the Metro South HHS (approval no. HREC/14/QPAH/636) and The University of Queensland (approval no. 2015000066).

We first discuss the case setting, followed by the evaluation framework and method of analysis.

Data collection site

The case study subject is a large Australian HHS, consisting of five hospitals with over 14 000 staff responsible for serving over 1 million people. Recognising rising health care demands, the HHS embarked on a digital transformation journey to provide digitally supported evidence-based practice and health system integration.[11] This involved implementing an EMR, CPOE, ePrescribing, CDSS and wireless device integration (referred to as the 'ieMR'). The objective of the ieMR is to facilitate the complete patient journey across all hospitals, units and professions in the HHS.

The largest hospital in the HHS, a tertiary–quaternary care hospital, was the exemplar (and first) site for the implementation,[12] which we refer to as the 'configuration site'. The configuration site implemented the ieMR in two phases. The first phase went live in November 2015 and focused on documentation and workflow functions; the second phase went live in March 2017, incorporating medication, anaesthetic, research and data analytic functions. Through ongoing use, defects and technical enhancements were identified and iteratively addressed. The refined ieMR was then sequentially rolled out to the other HHS hospitals, which we term 'implementation sites' (Site A, December 2017; Site B, January 2018; Site C, May 2018; and Site D, June 2018), using a single phased approach (i.e. all systems implemented at once within the one site). To compare results across sites, we focused on differences between the configuration site and the four implementation sites. Although it is instructive to make this comparison, we stress that the results need to be interpreted cautiously because the comparison involves three differences (differences in acuity, differences in level of configuration and differences in time period). This simply stems from the nature of the implementation approach.

Data collection framework and procedure

Many frameworks have been used to evaluate eHealth, including balanced scorecard,[13] fit framework,[14] economic evaluation framework[15] and the IS success model. We used the IS success model as the basis for our evaluation framework because it is recommended by practice,[6] well validated[16] and widely used in health informatics.[2,16–18]

The IS success model[6–8] suggests that the relative success or failure of a system depends on users' perceptions, whether positive or negative, across dimensions related to quality, behaviour and outcomes.[19] The model asserts that the quality of the ieMR (e.g. system, information and service) influences how it is used (e.g. intention to use, extent of use), which influences the satisfaction and benefits obtained (e.g. quality of care, access and productivity).[6–8] As recommended by Gable *et al.*,[20] to evaluate the impacts of the ieMR we examined the dimensions of system quality and information quality, and the outcome dimensions of individual impact and organisational impact. Because the evaluation was performed immediately after go-live (in the so-called 'stabilisation phase'), we assessed organisational impact by asking staff for their perceptions of expected organisational benefits.

Both confirmatory and exploratory approaches were used to evaluate the data. By 'confirmatory', we mean that we sought to test (i.e. refute or confirm) whether the IS success model could serve as a useful lens for understanding the perceptions of staff in the HHS. That is, we tested whether the pattern of perceptions held by staff matched the pattern expected by the IS success model (e.g. as reflected in the set of hypotheses shown in Fig. 1). By 'exploratory', we mean that we were interested in discovering potential differences in staff perceptions without any guiding hypothesis. That is, as Fig. 1 shows, we sought to identify whether different sites (i.e. configuration vs implementation) and professions (i.e. administrative personnel, allied health professionals, medical professionals and nursing professionals)

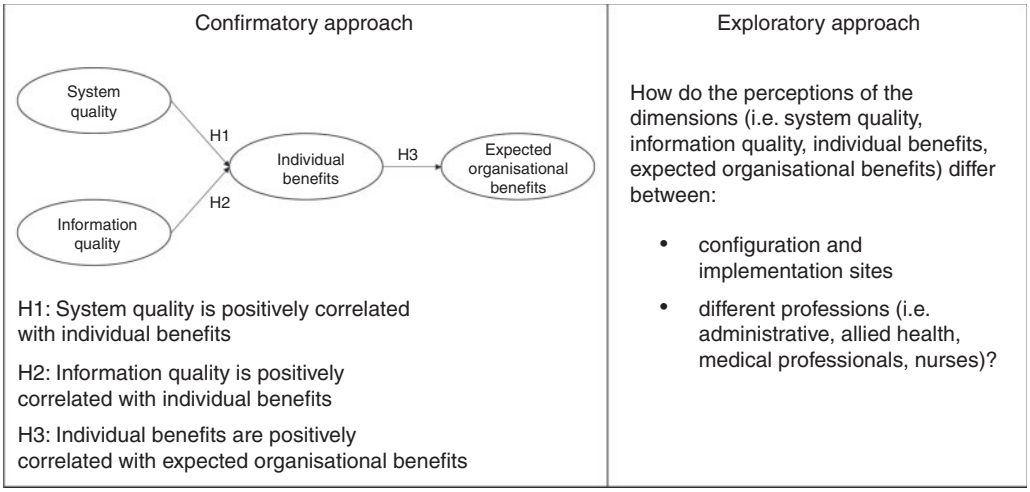

Fig. 1. Evaluation framework.

perceived the quality and impacts of the ieMR differently. These exploratory comparisons were performed because: (1) there may be differences across sites due to the level of patient acuity handled by the site or the level of configuration or maturity of the system by the time it went live at that site; and (2) because different professional groups interact with the system in different ways and the system may serve or affect different professional groups to different degrees.

A survey instrument was developed to measure the dimensions in the evaluation framework. Each dimension was assessed with multiple items measured on a seven-point Likert scale ranging from strongly disagree to strongly agree, as listed in Appendix 1. The survey was distributed to all staff who use the ieMR (doctors, nurses, allied health clinicians and administrative and executive-level staff) approximately 4 weeks after go-live. To maximise participation, both physical and electronic surveys were distributed.[21] The release of the survey at each site was preceded by a message from the hospital executive to all staff supporting the research. Multiple reminders to complete the survey were also sent. To encourage participation, a small monetary incentive was used[21] via a donation to the hospital's research foundation for each survey completed.

Method of analysis

Before analysing the results of questionnaire data, the data must be checked for reliability and validity.[22] Reliability is checked by determining whether each respondent answers the multiple questions on each variable consistently.[23] If they are inconsistent, this indicates that there may be problems with the measurement items (e.g. the questions may have been misinterpreted). Validity refers to whether the responses for each variable reflect the actual nature of each variable being examined.[24] For example, if variables such as information quality and system quality truly differ in their underlying meaning, then this should be reflected in the pattern of within and between correlations among responses to the questions measuring those variables. Standard tests were conducted (as outlined in Appendix 1) for reliability and validity, and the results showed no evidence of problems with either criterion.

Analyses were performed in IBM SPSS version 25 (IBM Corp., Armonk, NY, USA)[24] and MPlus version 8.2 (Muthén & Muthén, Los Angeles, CA, USA).[25,26] To determine whether favourable or unfavourable perceptions were held by staff who use the ieMR at the HHS, one-sample *t*-tests were performed, which compare the mean of each dimension in the evaluation framework (system quality, information quality, individual benefits, expected organisational benefits) to the midpoint of the Likert scale (i.e. the midpoint on a seven-point Likert scale is 4). Values above the midpoint, when statistically significant ($P < 0.05$), indicate that positive perceptions are held by respondents on the dimension. Values less than the midpoint, when statistically significant, indicate a negative perception. When the comparison is not significant ($P > 0.05$), the users appear to be neutral with regard to the dimension.

The same procedure was then followed to explore whether different perspectives were evident between sites (i.e. configuration site and implementation sites) and between professions (i.e. administrative, allied health, medical and nursing professionals). We then conducted an independent-samples *t*-test to determine whether differences in mean values of system quality, information quality, individual benefits and expected organisational benefits were apparent between sites and between professions.

Results

In total, the questionnaire was distributed to 17 668 HHS staff, of which 559 were undeliverable (via email), yielding a sample size of 17 109. In total, the responses to 916 questionnaires could be used in the analysis, a response rate of 5.2%. For questionnaires that were only partially completed, we used expectation maximisation to replace missing values,[27] except for instances where the participant had >50% missing data, in which case list-wise deletion was used.[23]

Although the response rate was low, the demographics of the respondents (see Table 1) are largely consistent with the HHS's staff demographics. For example, there were significantly more female than male employees, and more nurses than other professional groups. The mean age and years of experience

Table 1. Respondent demographics

We focused on administrative, allied health, medical and nursing staff because these were the largest cohort of respondents and, as informed from our qualitative investigation,[10] the professionals to be most affected by the integrated electronic medical record (ieMR). The 'Other' category represents professionals in health informatics, medical imaging, pathology, pharmacy, radiology and in operational and organisational roles. Respondents who did not disclose their profession were also categorised into 'Other'. We excluded them from the comparison of professional differences because the sample size is too low for a meaningful comparison to be performed. HHS, hospital and healthcare service

	Configuration site		Implementation sites		HHS[A] (total; $n = 916$)
	Respondents ($n = 381$)	Sample	Respondents ($n = 535$)	Sample	
Sex					
Male	61 (16.0%)	25%	78 (14.6%)	23%	139 (15.2%)
Female	319 (83.7%)	75%	455 (85.0%)	77%	774 (84.5%)
Mean age (years)	40.5	41.7	43.6	43.9	42.3
Mean experience (years)	8.8	9.8	7.4	8.6	8.0
Profession					
Administrative	43 (11.3%)	14%	51 (9.5%)	12%	94 (10.3%)
Allied health	41 (10.8%)	13%	71 (13.3%)	9%	112 (12.2%)
Medical	49 (12.9%)	12%	43 (8.0%)	13%	92 (10.0%)
Nurses	231 (60.6%)	48%	329 (61.5%)	54%	560 (61.1%)
Other	17 (4.4%)	12%	41 (7.7%)	12%	52 (5.7%)

[A]Due to missing demographic data, the total of a given demographic may not equate to the number of participants at the respective site.

Table 2. Analysis of mean values for the dimensions of the evaluation framework

Bolded mean values indicate a positive perception of the respective dimension

	System quality	Information quality	Individual benefits	Expected organisational benefits
No. respondents	916	916	916	916
Mean	**4.59**	**4.38**	**4.17**	**5.37**
s.d.	1.54	1.59	1.75	1.52
t_{915}	11.5	7.20	2.80	27.13
P-value	<0.001	<0.001	<0.01	<0.001

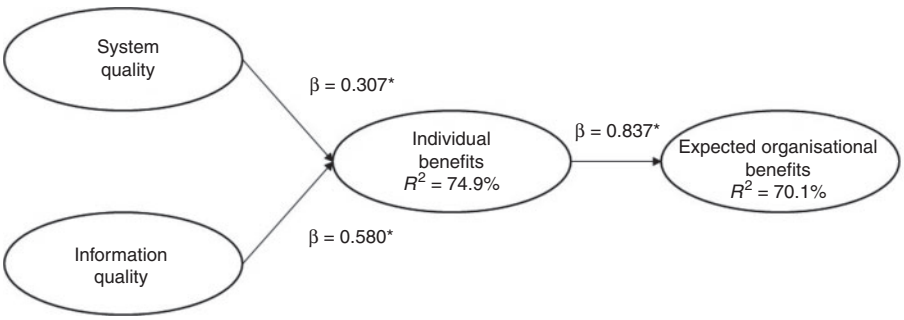

Fig. 2. Analysis of the evaluation framework. *$P < 0.001$.

were also consistent. In short, the demographics do not indicate the presence of response bias, but we cannot rule it out. Therefore, the results must be treated cautiously.[28]

The following sections provide the results of the overall analysis of the HHS and the exploratory analysis of site and professional differences.

Overall analysis of HHS results

The results of the one-sample *t*-test (Table 2) indicate that, overall, positive perceptions were held for each dimension of the evaluation framework at the HHS. That is, on average, users of the ieMR felt somewhat positive about each dimension of the framework: the quality of the system and the information it provides, how it affects them and their future expectations for the hospital. However, the positive sentiment is only slight, not much greater than the midpoint of 4.0.

To determine whether the perceptions of staff matched the pattern expected by the IS success model (i.e. as hypothesized above; Fig. 1), we performed structural equation modelling. As illustrated in Fig. 2 and detailed in Appendix 2, reasonable fit was established and all hypotheses were supported. System quality ($\beta = 0.307$, $P < 0.001$) and information quality

Table 3. Evaluation of the integrated electronic medical record (ieMR): site-level differences

Bolded mean values indicate a positive perception of the respective dimension; unbolded mean values indicate a neutral perception of the respective dimension. ConfS, configuration site where the ieMR was implemented in two phases; ImplS, implementation sites where the ieMR was sequentially rolled out in a single phase

	System quality		Information quality		Individual benefits		Expected organisational benefits	
	ConfS	ImplS	ConfS	ImplS	ConfS	ImplS	ConfS	ImplS
No. respondents	381	535	381	535	381	535	381	535
Mean	**4.31**	**4.79**	**4.30**	**4.43**	**4.24**	4.11	**5.25**	**5.44**
s.d.	1.56	1.51	1.58	1.59	1.74	1.76	1.57	1.48
t_{914}	−4.56		−1.26		1.10		−1.88	
P-value	<0.001		0.207		0.271		0.062	

Table 4. Professional's perceptions of the dimensions in the evaluation framework

Bolded mean values indicate a positive perception of the respective dimension; unbolded mean values indicate a neutral perception of the respective dimension; italicised mean values indicate a negative perception of the respective dimension

	Administrative staff	Allied Health professionals	Medical professionals	Nursing professionals
No. respondents	94	112	92	560
System quality				
Mean	**4.89**	**5.42**	*3.44*	**4.58**
s.d.	1.46	0.99	1.78	1.50
Information quality				
Mean	**4.87**	**5.15**	*3.12*	**4.39**
s.d.	1.47	1.63	1.68	1.58
Individual benefits				
Mean	**4.53**	**5.19**	*3.13*	4.08
s.d.	1.63	1.23	1.68	1.78
Expected organisational benefits				
Mean	**5.63**	**6.22**	4.30	**5.31**
s.d.	1.25	0.66	1.81	1.54

($\beta = 0.580, P < 0.001$) were positively correlated with individual benefits, which were positively correlated with expected organisational benefits ($\beta = 0.837, P < 0.001$). Therefore, the IS success model appears to provide a reasonable lens for understanding staff perceptions at the HHS.

Exploration of site- and professional-level differences

Recognising the underlying premise of the evaluation framework used in this study, which acknowledges that different users may have different perspectives of systems, we explored whether consistent or divergent perspectives exist at the HHS.

For the site differences, as evident in Table 3, overall both the configuration site and implementation sites held mildly positive perceptions of all dimensions of the evaluation framework, except for individual benefits, where the implementation sites held a neutral view. The implementation sites also perceived system quality more favourably than the configuration site. Consistent views were held for the remainder of the dimensions.

For the professional differences overall, divergent views were apparent (Tables 4, 5). Administrative personnel and allied health professionals perceived all dimensions in the framework favourably. Nurses viewed system quality and information quality favourably, held neutral perspectives of individual benefits, but were optimistic in terms of the future benefits of the system. Conversely, medical professionals held negative perspectives of system quality, information quality and individual benefits, and were neutral in their perceptions of future organisational benefits. We found differences in perceptions of the evaluation factors within professional groups due to age. After visual inspection of the within-profession age group column chart analysis of the evaluation factors, it was observed that there may be a difference between how those <45 and ≥45 years of age viewed the system. An independent *t*-test was performed to test the analysis. For the following professional groups and evaluation factors, those aged ≥45 years viewed the respective dimension less favourably than those <45 years of age: (1) administrative personnel's ratings of information quality and individual impact; (2) allied health professionals' ratings of user expectations; (3) nursing professionals' ratings of individual impact; and (4) medical professionals' ratings of all evaluation factors.

Across all dimensions, allied health held the most favourable perceptions of the ieMR, followed by administrative personnel (except for information quality, where administrative and allied health professionals held equally favourable views), nursing and medical professionals.

Discussion

This study evaluated the implementation of a comprehensive ieMR system across an entire HHS.

Table 5. Professional-level differences

Admin, administrative personnel; Allied, allied health personnel; ↑, denotes the professional group with the greater score per comparison for each impact dimension

Comparison	System quality			Information quality			Individual benefit			Expected organisational benefit		
	t-test results		Outcome	*t*-test result		Outcome	*t*-test result		Outcome	*t*-test result		Outcome
	t	*P*-value		*t*	*P*-value		*t*	*P*-value		*t*	*P*-value	
Admin vs Allied	−3.010	0.003	Allied ↑	−1.587	0.115	Admin = Allied	−3.207	0.002	Allied ↑	−4.103	<0.001	Allied ↑
Admin vs Medical	6.083	<0.001	Admin ↑	7.513	<0.001	Admin ↑	5.775	<0.001	Admin ↑	5.820	<0.001	Admin ↑
Admin vs Nursing	1.839	0.066	Admin = Nursing	2.748	0.006	Admin ↑	2.247	0.025	Admin ↑	2.229	0.027	Admin ↑
Allied vs Medical	9.549	<0.001	Allied ↑	10.098	<0.001	Allied ↑	9.789	<0.001	Allied ↑	9.605	<0.001	Allied ↑
Allied vs Nursing	7.436	<0.001	Allied ↑	6.454	<0.001	Allied ↑	7.910	<0.001	Allied ↑	10.059	<0.001	Allied ↑
Medical vs Nursing	−5.845	<0.001	Nursing ↑	−6.741	<0.001	Nursing ↑	−4.852	<0.001	Nursing ↑	−5.021	<0.001	Nursing ↑

The results for the HHS indicated that, on average, the users of the ieMR view the system, the information contained in the system and individual benefits and future expectation of benefits from the ieMR favourably. A deeper exploration of the dimensions revealed that these perceptions were not equally shared across sites or professions.

The mean comparison between the configuration site and implementation sites identified that system quality was viewed more favourably at the implementation sites. The enhanced system quality may simply be a result of different respondents involved at each site. However, the differences may also be due to the nature of the patients and the nature of the roll-out. For example, the configuration site has more complex patients than the implementation sites. This heightened complexity may place greater demands on the system, with the staff that use the system potentially having greater requirements. As a result, the system may not meet all the needs of the configuration hospital. Another potential rationale for improved system quality may be due to the system first going live at the configuration site. Although technical issues were still experienced at the implementation sites, the quantity and severity of the issues may have lessened to those reported at the configuration site immediately after go-live. This is likely because system defects had been identified, catalogued and resolved, in part, by the configuration site before the system was implemented at the implementation sites. Despite improved system quality, the perception of individual benefits was neutral (neither favourable nor unfavourable) at the implementation sites (Table 3). Future research needs to further investigate what site-level differences contribute to varying perceptions of the evaluation dimensions when the same database instance of a comprehensive EMR is implemented.

The mean comparisons identified that different professions held significantly different views of the ieMR. Allied health professionals had the most favourable perception of the ieMR and medical professionals had the most negative. The findings indicate that all professional groups aside from medical professionals had a somewhat positive view of system quality and information quality, whereas medical professionals held a negative view. This suggests that medical professionals may have different requirements of the system and different information needs that are not being adequately met by the system. Due to system quality and information quality affecting individual impacts (Fig. 2), improvements to these dimensions are necessary to improve how the system affects medical professionals. However, this is just one potential rationale for the differences in perceptions; the differences may be due to different professional cultures having different attitudes towards systems. Future research should further investigate why medical professionals hold a more negative perception, what strategies can be enacted to improve the systems for medical professionals and how to improve the engagement of medical professionals during the implementation and in the early stages after go-live.

Our analysis also provides initial insights into differences within professions based on age. For example, administrative, nursing and medical professionals' perceptions of individual benefits decreased when their age was >45 years. However, due to the small sample size, care needs to be taken when interpreting these results. Future research should seek to examine why these differences occur (e.g. technology affinity,[29] heightened system requirements through career progression).

As outlined previously, the present quantitative analysis of staff perceptions of the early impacts of ieMRs is part of a larger mixed-methods project that involves surveys, interviews and focus groups. The findings of this study are largely consistent with our qualitative findings in terms of overall perceptions, site-level differences and professional differences.[10] These findings are also consistent with and support assertions in systematic reviews of EMRs,[1] suggesting that the mixed results often reported with EMRs become more positive when they are integrated with auxiliary technologies.

To provide evidence of generalisability, following the same methodology we analysed sites other than the HHS. For brevity, we omit the details of this analysis. The findings of the additional analysis demonstrated the usefulness of the evaluation framework across these settings, with all relationships statistically significant. In addition, it was once again observed that allied health viewed the system the most favourably, followed by administrative personnel, nursing professionals and medical professionals.

Limitations

The quantitative approach used in this study enabled the evaluation of the ieMR implemented across the HHS. Surveys can be criticised for lacking richness (e.g. compared with qualitative studies).[30] We have published qualitative insights of this

transformation elsewhere.[10] However, beyond such perceptual studies, more research is needed that can triangulate these subjective perceptions with objective performance data.

Another limitation of this study is the low response rate. We were unable to find studies showing a consistent link between user perceptions and response rate (e.g. are respondents generally more positive or more negative?). Therefore, we do not know whether the low response rate biased our results. Moreover, according to Hulland *et al.*,[28] 'low response rates are not necessarily a problem…unless…the responding sample is systematically different from the sample that did not respond.' We cannot know whether the pattern of responses would have differed greatly if a higher percentage of staff responded. What we can report is that the demographics of our respondents, such as sex, age, experience and the proportion of staff in each professional group, are largely consistent with both the demographics of staff employed at the HHS and with the demographics of prior corporate surveys (a well-supported 'culture' survey) at the HHS that have achieved response rates >50% (based on data provided to us by the HHS). Yet, we cannot say whether the results reflect the perceptions of all staff. Because this study is embedded in one HHS, and the survey was conducted at one time (shortly after go-live), the generalisability of the study is also limited to similar hospitals and health services immediately following the implementation of a comprehensive EMR.

Conclusion

This study quantitatively evaluated the reported impacts of a comprehensive ieMR used by all medical professionals, nurses, allied health, administrative and executive-level staff across all hospitals in the HHS. Overall, mildly positive perceptions of the integrated system were held. This was a remarkably positive finding, given the sample was taken during the disruptive period immediately after implementation. During this time, workflows are still being changed and roles are evolving, forcing significant discretionary effort onto staff, creating stress and potential disillusionment.[31] Despite positive perceptions, the descriptive statistics highlight further improvements to the EMR are necessary, and there is a potential for greater benefits to emerge. As such, future research needs to examine how to improve these systems over time. Our findings provide confidence to decision makers that positive perceptions in the quality and impacts of a comprehensive EMR can be obtained during system stabilisation.

Competing interests

None declared.

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Appendix 1. Measurement, reliability and validity of the dimensions in the evaluation framework

The Appendix details the measurement items used to measure each dimension, as well as the reliability assessments performed. Our tests for measurement validity and reliability revealed no problems (see Table A1). Convergent validity was established because all items except Individual Benefit item 3 (IB3) (which we removed) had indicator reliability greater than the required threshold of 0.708.[23] We also removed System Quality item 3 (SQ3) and Information Quality item 2 (IQ2) because their indicator reliabilities differed to that of other items belonging to their respective constructs, which suggests that they may be reflecting a different underlying meaning. All constructs demonstrated adequate internal consistency reliability (composite reliability >0.70).[23] No multicollinearity issues were detected (variance inflation factors <10),[22] thus providing evidence of discriminant validity.

Table A1. Evaluation framework dimensions' survey items, and reliability assessment

ieMR, integrated electronic medical record; SQ, system quality; IQ, information quality; IB, individual benefits; EOB, expected organisational benefits

Dimension	Definition	Item[20]	Indicator reliability	Composite reliability
System quality	Perception of the quality of the ieMR from a technical perspective	SQ1. The ieMR is functionally fit for purpose	0.873	0.790
		SQ2. The ieMR is reliable	0.824	
		SQ3[A]. The ieMR is fast	0.750	
		SQ4. The ieMR meets my requirements	0.914	
Information quality	Perception of the quality of the information provided by the ieMR	IQ1. The ieMR provides output that is exactly what is needed	0.896	0.765
		IQ2[A]. Information needed from the ieMR is always available	0.754	
		IQ3. Information from the ieMR is presented in a form that is readily usable	0.909	
		IQ4. Information presented in the ieMR is easy to understand	0.894	
Individual benefits	Perception of how the ieMR personally affects individuals	IB1. The ieMR enhances my effectiveness in my job	0.950	0.797
		IB2. The ieMR increases my productivity	0.906	
		IB3[A]. The ieMR has transformed my work	0.541	
		IB4. The ieMR increases the reliability/ safety of my actions	0.887	
Expected organisational benefits	Perception of how the ieMR will impact the hospital in the future	EOB1. In six months' time, the ieMR will be benefitting patient care/safety	0.953	0.887
		EOB2. In 6 months time, the ieMR will be benefitting efficiency of care	0.949	
		EOB3. In 6 months time, the ieMR will be benefitting staff like me	0.923	
		EOB4. In 6 months time, the ieMR will be benefitting the hospital	0.943	

[A]Removed from analysis before performing composite reliability tests.

Appendix 2. Examining relationships in the evaluation framework for the hospital and healthcare service (HHS)

As indicated in Table A2 the model demonstrated reasonable fit, the absolute fit index of the standardised root mean squared residual and the incremental fit indices of the comparative fit index and the Tucker Lewis index met their required thresholds. The root mean square error of approximation and χ^2 test of model fit did not meet the required threshold, but this is expected given the large sample size.[23] In accordance with Hair,[23] reasonable fit is established when one incremental and one absolute index meet the required threshold, which is evident in this study.

Table A2. Analysis of the structural equation model

H1–H3, Hypotheses 1–3; RMSEA, root mean square error of approximation; CFI, comparative fit index; TLI, Tucker Lewis index; SRMR, standardised root mean squared residual

	Overall results
No. respondents	916
System quality ® individual benefits (H1)	$\beta = 0.307$, $P < 0.001$
Information quality ® individual benefits (H2)	$\beta = 0.580$, $P < 0.001$
Individual benefits ® expected organisational benefits (H3)	$\beta = 0.837$, $P < 0.001$
R^2 individual benefits	$R^2 = 0.749$, $P < 0.001$
R^2 expected organisational benefits	$R^2 = 0.701$, $P < 0.001$
χ^2	$\chi^2 = 437.882$, d.f. = 61, $P < 0.001$
RMSEA	0.082
CFI	0.974
TLI	0.967
SRMR	0.037