Insight Report

Evidence of the Effects of Healthcare IT on Healthcare Outcomes

Winter 2014

HIMSS *Europe*

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Introduction

About this Publication

This is our second report in an ongoing series of local investigations concerned with the visible, measurable effects of good practice in healthcare IT practices on healthcare outcomes. It follows HIMSS Analytics' recent report completed with Healthgrades (www.healthgrades.com) evaluating the connection between EMR capability and mortality rates in the USA (More information about this report is available at http://www.himssanalytics.org/about/NewsDetail.aspx?nid=82169).

As this series gains traction, we intend to publish additional reports for other countries, as well as providing regular updates on current publications.

Objectives and Scope

For this report as much as the series as a whole, the objective is to uncover quantifiable evidence supporting the claim that advanced IT capabilities facilitate efforts to realize desired health outcomes.

Disclaimer / Use of Data

The analysis presented in this report leverages two types of data; proprietary EMR capability data from HIMSS Analytics (referred to as the EMR Adoption Model or EMRAM[SM] database), and publicly available data from various United Kingdom ("UK") governmental institutions (e.g. the Department of Health, the Healthcare & Social Care Information Centre, the Office of National Statistics). A detailed account of references can be found at the end of this document.

With any analysis based on metrics not exclusively intended for this purpose, there is a general risk of misinterpretation and over-interpretation. Moreover, by its nature the data used is fundamentally impersonal, which negates any back-checking with its original source. The EMRAM data furthermore provides its own challenges; most prominent is a skew of the body of data towards better-equipped, better-documented trusts, who produce a greater amount of public domain information and who are more incentivised and more likely to participate in digital maturity scoring. Our notice of caution to the reader is a consequence of these circumstances.

The EMR Adoption Model

HIMSS Analytics' Electronic Medical Record Adoption Model (EMRAMSM) incorporates methodology and algorithms to automatically score the hospitals in the HIMSS Analytics database relative to their EMR capabilities.

Ranging from limited ancillary department systems through a paperless EMR environment, EMRAM scores provide peer comparisons for hospital organizations as they strategize their path to implementing a complete EMR and participation in an electronic health record (EHR).

Hospitals participating in HIMSS Analytics' annual survey are evaluated and stratified into 8 stages, each of which represents progression from the previous stage and indicates the level of healthcare IT maturity for the hospital.

Ranging from limited ancillary department systems (EMRAM Stage 0) through a paperless EMR environment (EMRAM Stage 7), EMRAM scores provide peer comparisons for hospital organizations as they strategize their path to implementing a complete EMR and participation in an electronic health record (EHR) **(HIMSS, 2014).**

Analysis Sample

The sample for this analysis consists of a cohort of 91 English National Health System ("NHS") trusts evaluated between 2013 and 2014. The demographic distribution was as follows (HSCIC, 2014):

Hospital Size by Number of Beds	Community Hospital	General Acute Hospital	Multi-Service Hospital	Specialist Hospital	Grand Total
LARGE	0	24	0	0	**24**
MEDIUM	0	15	4	2	**21**
SMALL	4	13	5	8	**30**
Grand Total	**4**	**52**	**9**	**10**	**75**

The cohort's distribution across the 8 EMRAM Stages was as follows:

0	1	2	3	4	5	6	7
8%	15%	16%	9%	**4%**	**48%**	**0%**	**0%**

EMRAM and Clinical Outcomes

There are many measures that can be considered indicative of health outcomes; even the most prominent ones are highly diverse and include metrics such as hospital readmission rates, times-to-treatment and cost of care to name but a few. However the following section focuses on perhaps one of the most basic of indicators of healthcare quality, Mortality.

Mortality

In the present context of healthcare quality, the terms "mortality", "mortality rate", "hospital mortality" all describe the result of measuring how many individuals die over a given timeframe (usually a year) under circumstances involving their healthcare providers; in this respect our analysis follows the previously published HIMSS Analytics/Healthgrades report.

The prevalent mortality measures used in this report come from the Healthcare & Social Care Information Centre ("HSCIC"). The HSCIC is U.K. governmental agency which publishes the Summary Hospital-level Mortality Indicator ("SHMI") for all U.K. hospitals. Over the years,

> **What is HSCIC?**
> HSCIC is an executive non-departmental public body, sponsored by the Department of Health ("DoH"). With offices across the UK, its 2,500 staff work closely with the DoH and its departments to provide on the one hand data and analysis for the public and healthcare commissioners and on the other hand systems and services for healthcare providers.

"mortality" and "mortality indices" have been the subject of continuous debate around validity, their meaning, and even their ethics. These are hardly populist debates; the bulk of this disaccord is concerned with questions of data collection methods, definitions of what constitutes a set of circumstances warranting inclusion (or demanding exclusion) and statistical/mathematical methods. Short of replicating the whole argument to this debate, we have summarised examples of the key differences between the method underpinning this report and alternative mortality indicators (Guidance, 2011):

SHMI	Alternatives
• Includes all observed deaths of patients whilst in hospital care and until 30 days after discharge	• Include all deaths of patients whilst in hospital care but not after discharge • Include all deaths of patients whilst in hospital care or after discharge less a national average of 20%
• Is based on Hospital Episode Statistics ("HES") which are generated by trained medical coders on the basis of patient records coupled with the Office for National Statistics ("ONS") mortality index generated from death certificates	• Based on individual hospitals' outcomes coding • Based on separate data collection • Evaluates clinically rich data from electronic patient records using discrete, structured data

Most importantly, we urge our readers to acknowledge the limitations inherent in any mortality index. Naturally, such indices are subject to variation from a large array of externalities; Events not attributable to healthcare quality, for example a particularly cold winter or an influenza outbreak can (and do) have an impact on mortality rates. It follows that the analysis of mortality indices must provide appropriate levels of abstraction in order to avoid conclusions born out of data irregularities from events outside of a hospital's control.

Furthermore, mortality indices cannot (and do not) truly distinguish between deaths that are avoidable and those that are not. For example, a hospital specialising in end-of-life care will retain a normal mortality rate because a higher quota of deaths is to be expected from such a facility; a hospital that just happens to care for an unusual number of end-of-life patients at a point in time will attract a higher mortality score.

Whichever (if any) school of thought you follow when it comes to mortality reporting, we would invite you to put the (valid) disagreements over mortality rate measurement aside for the purposes of our analysis. Because our report aggregates SHMI data either nationally or at least by EMRAM stage and never includes less than one years' worth of data, the findings presented are far less sensitive to the externalities experienced by mortality indices.

The Summary Hospital-level Mortality Indicator (SHMI)

The SHMI is, in short, the ratio between a) the actual number of patients who die following hospitalization at any individual trust and b) the number that would be expected to die at that trust on the basis of average country figures, given the characteristics of the patients treated there. It covers all deaths reported to occur either while the patient is hospitalized or within 30 days of discharge. The expected number of deaths is calculated from statistical models derived to estimate the risk of mortality based on the characteristics of the patients (including the condition the patient is in hospital for, other underlying conditions the patient suffers from, age, gender and method of admission to hospital).

The data are generated from mandatory trust submissions to HSCIC's Hospital Episode Statistics (HES) service, which are then linked with data from the Office for National Statistics death registrations to enable capturing of deaths which occur outside of hospital. (HSCIC, 2012)

Mortality by EMRAM Score

To establish the correlation between patient mortality and hospital IT maturity, we averaged the SHMI scores of the 91 UK NHS hospitals by their EMRAM Stage giving us a SHMI placement from 1-3 on the vertical axis and an EMRAM placement from 0-7 on the horizontal axis below. After adding average variance from SHMI target (purple line, on right-hand scale), the chart suggests indeed that Providers **with a higher EMRAM score tend to have a lower mortality rate.**
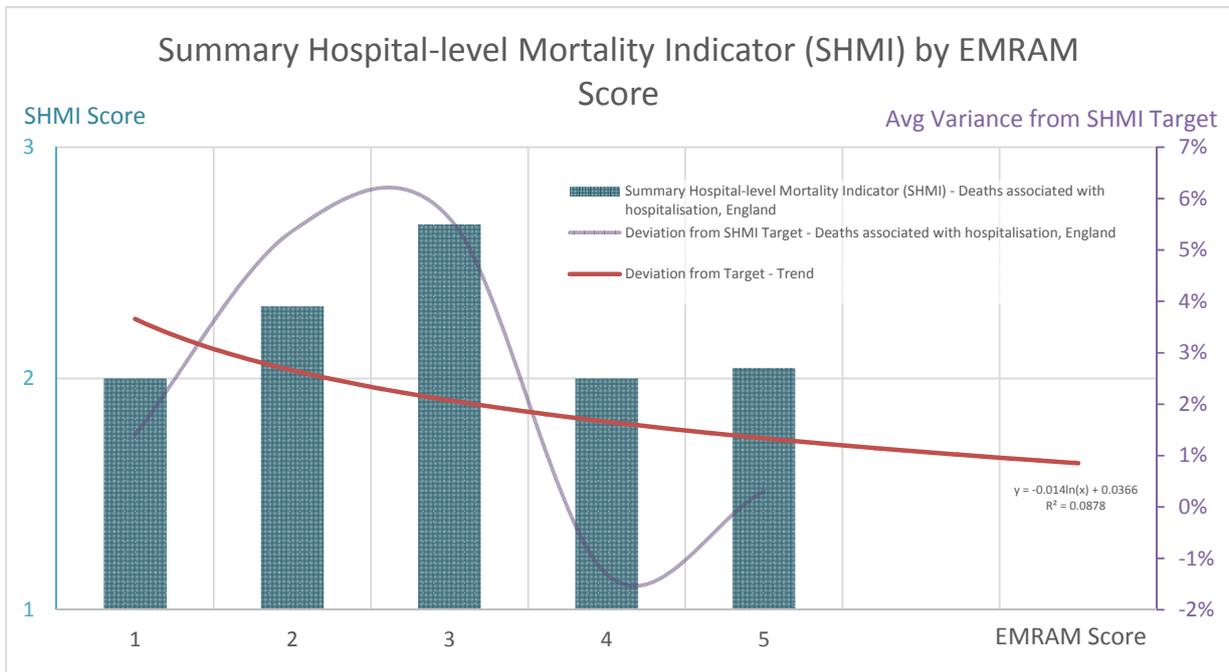
Figure 1: Mortality by EMRAM Score

It's worth noting that all of the hospitals in our EMRAM cohort are doing relatively well in terms of meeting their mortality targets; even the deviation from target is not particularly strong.

Considering the unavoidable sample bias within the EMRAM cohort discussed previously, which acts on this analysis in a way that makes differences smaller and harder to detect, we are especially confident in our conclusion.

The adjacent table reiterates our findings and displays them numerically (green = better / red = worse).

EMRAM Score ->	Summary Hospital-level Mortality Indicator (SHMI) - Deaths associated with hospitalisation, England	Summary Hospital-level Mortality Score - Deaths associated with hospitalisation, England	Deviation from SHMI Target - Deaths associated with hospitalisation, England
0			
1	2.00	0.97	0.01
2	2.31	0.95	0.05
3	2.67	0.81	0.06
4	2.00	1.01	-0.01
5	2.05	1.00	0.00

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EMRAM Scores by SHMI Index

When analyzing the provider's SHMI Index score by their HIMSS Analytics' EMRAM Score, a clear sense of the relationship between Healthcare IT and Healthcare Outcomes emerges. For the moment there is insufficient data available to make further discoveries about the exact rules that connect one to the other. What we can say is that the connection between the two metrics is not precise; for example, in the chart below there are spreads of SHMI scores (horizontal axis) in every EMRAM Score category (vertical axis). Nonetheless, we have been able to discover a broad relationship that supports the notion **that hospitals with a higher EMRAM Score tend to show less unexpected mortality.**
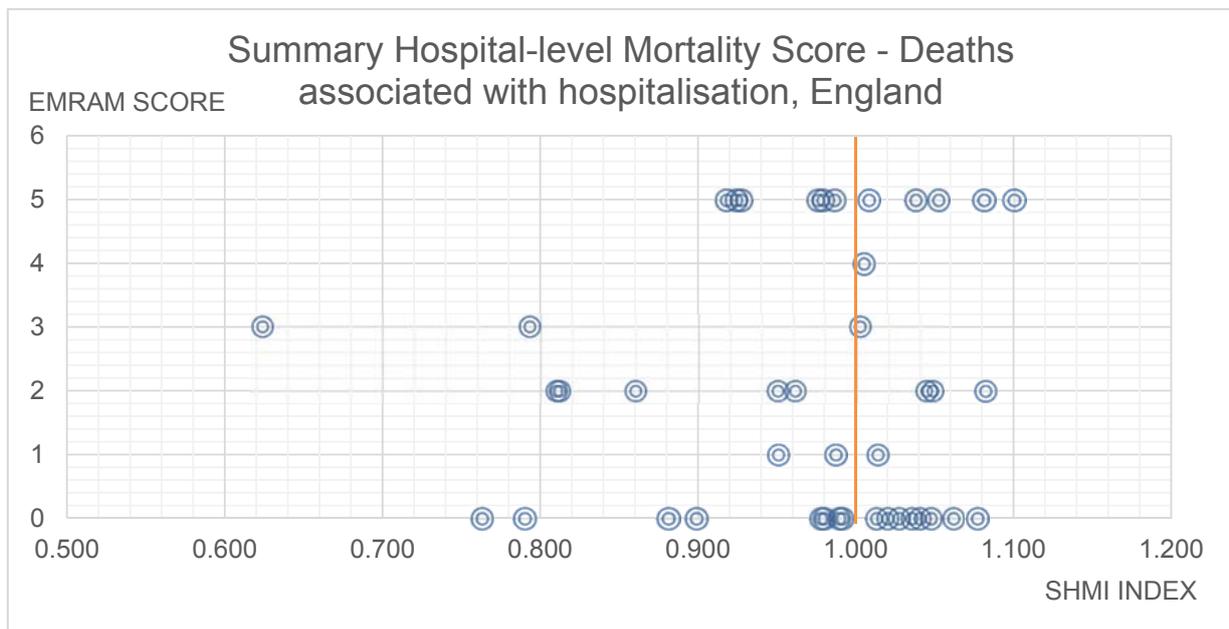
Figure 2: EMRAM Score vs SHMI Index

Interviews with CEO's and CIO's of healthcare providers confirm our conclusions; in fact, most of the individuals we talked to already suspected that a 'conditional' relationship between IT and Healthcare Quality exists:

"Of course. We don't do all this work and spend all of this money without reason!"

"It's visible in the detail in ways statistics can't show; get a good useful piece of IT to work, and staff become more effective, less stressed, more attentive, and consequentially better at their jobs. In a place where it takes everyone to make a difference, making anyone's job easier means making the outcome better"

Mortality by EMRAM Bisection

Looking at the same data by EMRAM Bisection allows us to show even more clearly the difference between relatively low-scoring and relatively high-scoring providers; This is significant in terms of answering our central question because providers with relatively high scores on the EMRAM model table are much better positioned in terms of their IT capabilities.

What's an "EMRAM Bisection"?
An EMRAM Bisection is a method of aggregating or grouping EMRAM data in order to show more clearly how those groups are affected by outside factors; in this example, the groups "Lower" and "Higher" are used to denote providers tending towards low (0-3) and high (4-7) EMRAM scores respectively.

What's more, from around stage 5 onwards, EMRAM assesses providers not only for the presence of IT systems, but also takes into consideration the efficiency of the processes and workflows in the hospital that help make the most of those systems, thus introducing an element of IT use pervasiveness into the score composition. The following chart shows mortality rates for each of relatively low and relatively high scoring providers respectively.
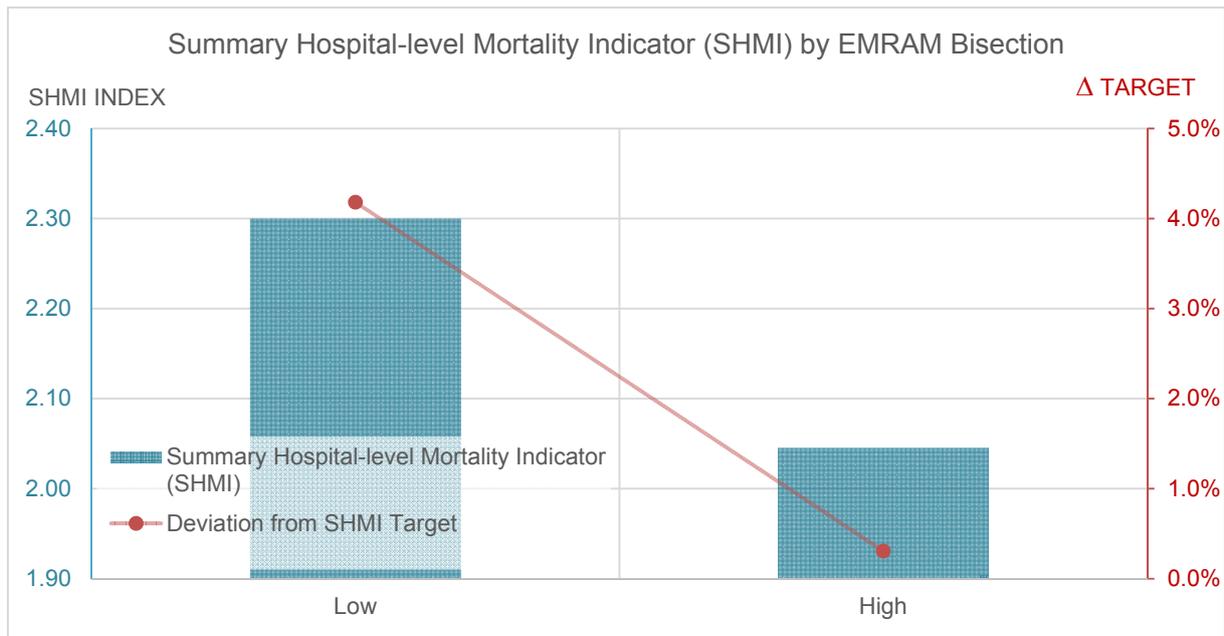
Figure 3: Mortality by EMRAM Trend

Based on our findings, we can say that providers tending to score high on the EMRAM model scale have stronger clinical information systems in place to support interventions designed to diminish deaths associated with hospitalisation than those with a lower EMRAM score. Since EMRAM only tracks IT – related subjects, it is fair to infer that **IT progress contributes to lower mortality.**

	Summary Hospital-level Mortality Indicator (SHMI) - Deaths associated with hospitalisation, England	Summary Hospital-level Mortality Score - Deaths associated with hospitalisation, England	Deviation from SHMI Target - Deaths associated with hospitalisation, England
Low	2.30	0.93	0.04
High	2.05	1.00	0.00

Table 2: Mortality by EMRAM Bisection

EMRAM and Hospital Processes / Efficiencies

Healthcare quality is a concept composed from a number of constituent factors; most importantly, it encompasses quality of care, but it also denotes efficiency. From a patient's viewpoint, efficient healthcare providers are quick to undertake whatever diagnostic or therapeutic measures are necessary and communicate clearly and precisely about treatments, scheduling and medical matters. From a clinician's viewpoint, efficiency entails, for example, waste-less workflows and intuitive systems; physicians in efficient hospitals encounter less obstacles and bottlenecks to providing quality care, as we have so often heard in conversations with hospital doctors and nurses. It is for these reasons that we include below a section on hospital processes and efficiencies as part of our assessment of the effect of good hospital IT on healthcare outcomes.

Imaging Operations

Rightfully, the NHS leadership has recognised imaging workflow capacity as a key component in efficient hospital operations (NHSIQ, 2013). Whilst in the past, the cost of imaging equipment seemed to incentivise long deployment timeframes over regular renewal of technology, the throughput requirements and space constraints commonplace today favour renewal over retention.

At a spend of £500m a year (Moore, 2014), replacing scanners or other imaging modalities with newer models or even adding new technologies to their radiological portfolio is far less difficult for many trusts than in the past thanks to modern financing options, such as Managed Equipment Services ("MES"), Leasing, Public-Private-Partnerships ("PPP") as well as new strategic options for procurement savings, such as the NHS Supply Chain service (BBH, 2014).

Imaging Test-to-Report times by EMRAM Score

The HSCIC tracks the average number of days it takes for a provider to facilitate an imaging test once one has been requested (request-to-test) and also the number of days taken to produce a report after the test has taken place (test-to-report).

Our query is whether IT progress bears any correlation to these metrics; however before we can attend to this question, we need to address a precursory question of scale: Arguably, it is far easier to achieve fast processing times if only very few tests are conducted; similarly, a workflow management tool of any kind, whether RIS, PACS or otherwise, would not be employed as effectively under such circumstances as it would be in a facility that processes a large number of tests.

As a means of adjusting for this factor, we have simply ranked all providers in our cohort for both 'quantity processed' and 'speed of processing' and combined them into a co-factor value. Whilst crude as a method, the outcome is instructive, as the following chart shows:
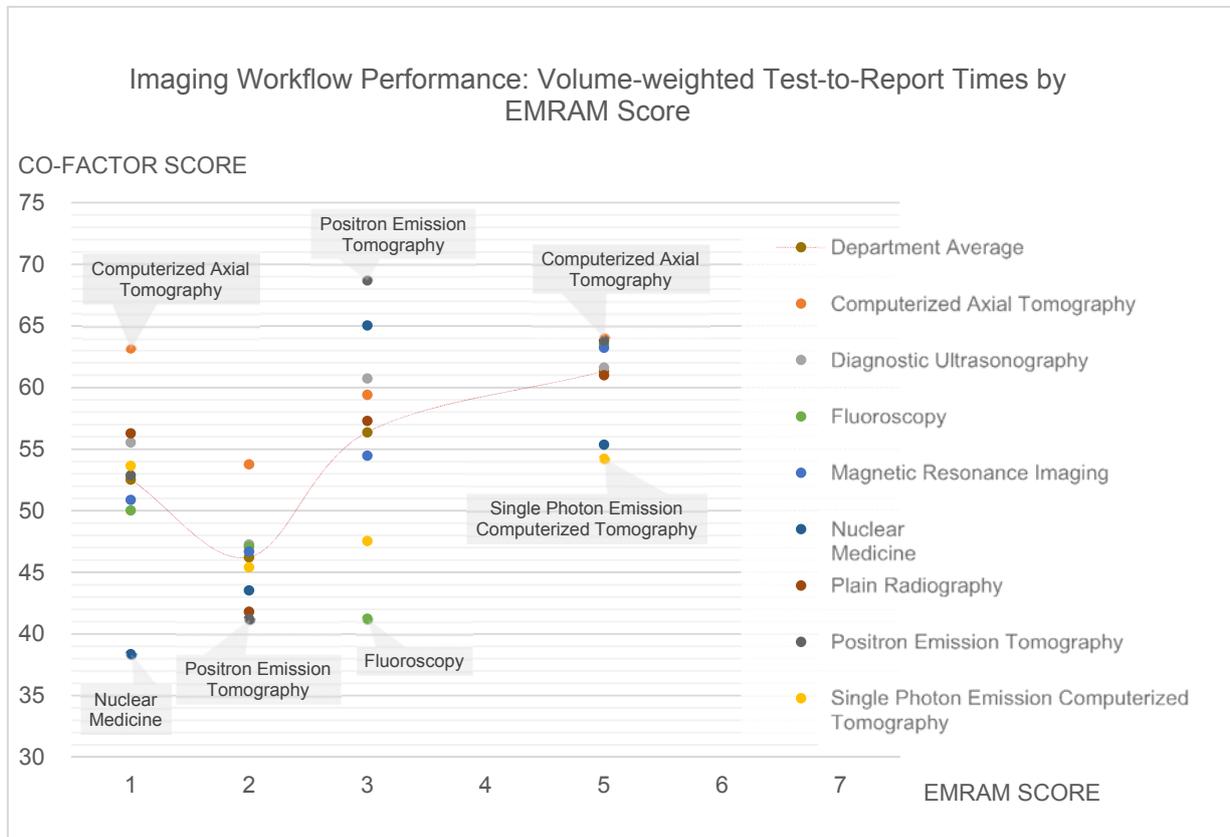

Figure 4: Volume-adjusted Imaging Workflow Performance by EMRAM Score

Clearly and sensibly, there is a positive correlation between EMR capabilities and imaging workflow performance wherever technology can streamline tasks and assist staff staying on top of workflow management: **Suitably digitised Imaging Departments appear to be more efficient.**

EMRAM and Patient Experience

Having made a short foray into elements of healthcare quality that can be seen from both patients' and physicians' viewpoints, we felt that it was important to also investigate some metrics that are exclusively attributed to patients.

Patient-Reported Experience by EMRAM Bisection

In addition to clinical benefits we wondered whether healthcare IT had an effect on how patients perceived the quality of their care; if well-organised could improve the work of clinicians then there should, we hypothesize, some indication of that from a patient's perspective. To do so, we correlated results from then NHS' annual patient survey, which attracts over 60,000 responses per year and is commissioned by the Care Quality Commission (CQC, 2014), with our EMRAM Bisections. The following charts show the result (scale from 0 (negative) to 100 (positive).
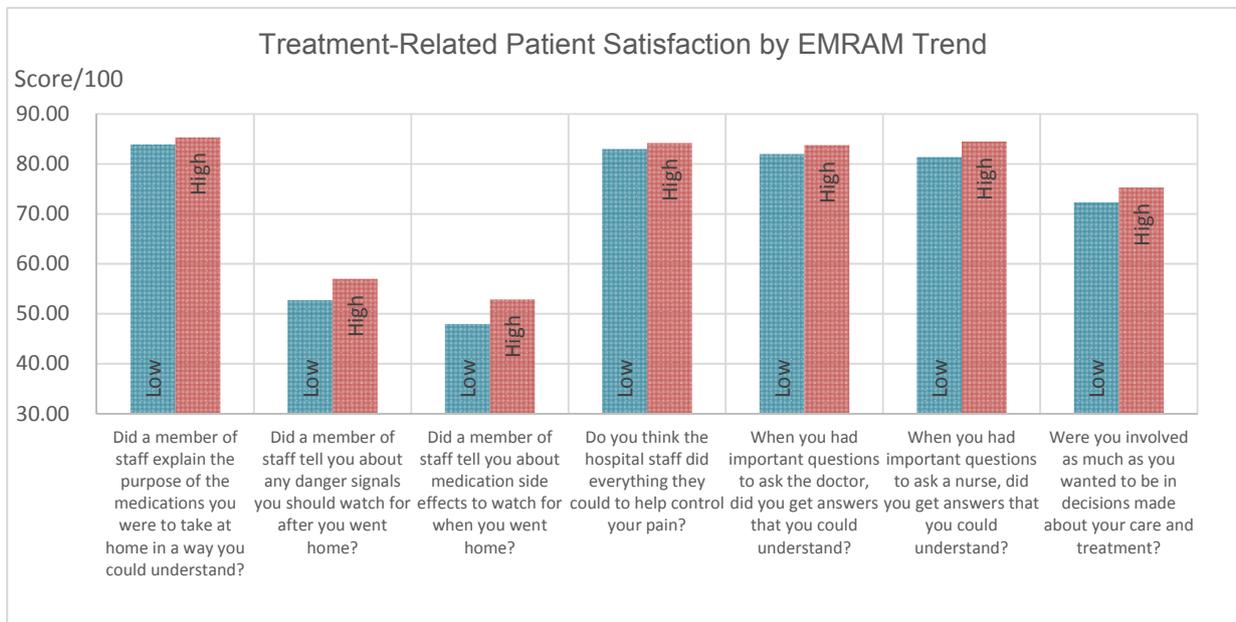
Figure 6: Treatment-related Patient Satisfaction by EMRAM Trend

Albeit only by a slight margin, providers tending towards a higher EMRAM score performed consistently better than their counterparts tending towards lower EMRAM scores for treatment-related patient satisfaction questions.

	Did a member of staff explain the purpose of the medications you were to take at home in a way you could understand?	Did a member of staff tell you about any danger signals you should watch for after you went home?	Did a member of staff tell you about medication side effects to watch for when you went home?	Do you think the hospital staff did everything they could to help control your pain?	When you had important questions to ask the doctor, did you get answers that you could understand?	When you had important questions to ask a nurse, did you get answers that you could understand?	Were you involved as much as you wanted to be in decisions made about your care and treatment?
Low	83.98	52.73	47.96	82.99	81.98	81.40	72.31
High	85.39	57.00	52.89	84.20	83.78	84.50	75.29

Table 3: Treatment-related Patient Satisfaction by EMRAM Trend

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Patient-Reported Experience by EMRAM Bisection (Cont'd.)

Similar lines of investigation into organisation and attitude-related patient satisfaction reports returned similar results:
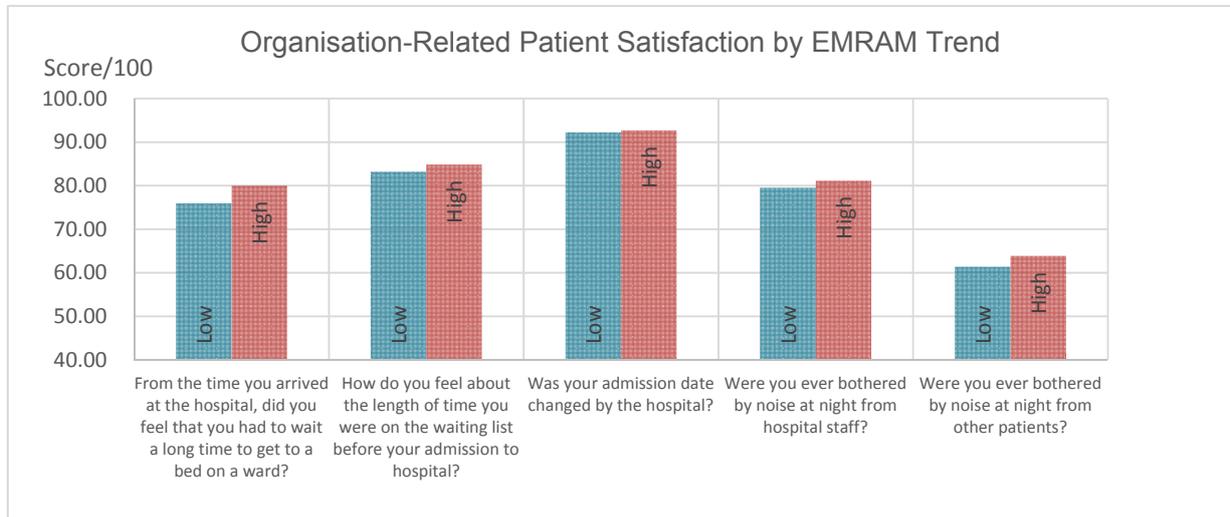

Figure 7: Organization-related Patient Satisfaction by EMRAM Trend
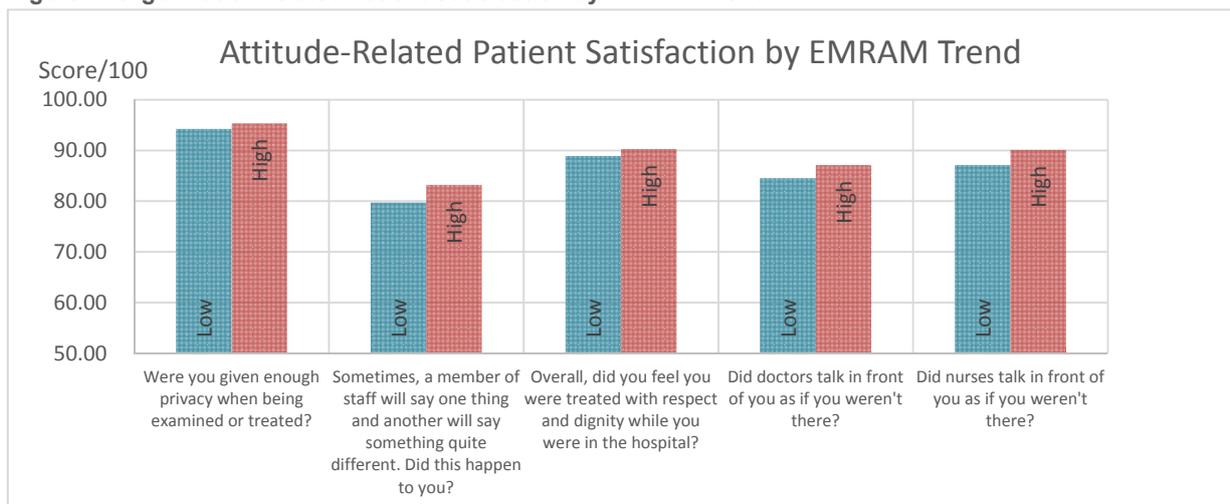
Figure 8: Attitude-related Patient Satisfaction by EMRAM Trend

	From the time you arrived at the hospital, did you feel that you had to wait a long time to get to a bed on a ward?	How do you feel about the length of time you were on the waiting list before your admission to hospital?	Was your admission date changed by the hospital?	Were you ever bothered by noise at night from hospital staff?	Were you ever bothered by noise at night from other patients?	Were you given enough privacy when being examined or treated?	Sometimes, a member of staff will say one thing and another will say something quite different. Did this happen to you?	Overall, did you feel you were treated with respect and dignity while you were in the hospital?	Did doctors talk in front of you as if you weren't there?	Did nurses talk in front of you as if you weren't there?
Low	75.95	83.23	92.27	79.57	61.40	94.28	79.72	88.93	84.55	87.15
High	80.03	84.88	92.73	81.15	63.90	95.36	83.22	90.27	87.16	90.13

Table 4: Organisation and Attitude-related Patient Satisfaction by EMRAM Trend

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Patient-Reported Experience by Presence of Business Intelligence Solution

Following on from our first hypothesis on patient–reported effects of healthcare IT on non-clinical healthcare quality, our second avenue of inquiry revolves around intentional or planned improvements to the patient experience. Although the NHS and its constituents have, over the years, introduced a number of initiatives designed to capture and act upon patient feedback, there are a myriad of ways in which providers have implemented these and their own, local schemes; separating the data at patient level from the data on unintentional effects is truly impossible.

What is "Business Intelligence Software"?

Business intelligence software packages collect data from continuous data sources available in an organization and (if necessary) transform that data into a useful format before displaying it to management, typically in form of dashboards, scorecards and graphs. Typically, BI Software has deep configuration or even scripting options in order to be able to accept as much data and deliver as many insights as possible.

However, one can argue that, from a certain organisational size and level of organisational complexity onwards, those local programmes and those local implementations of non-local programmes most consistently driven towards success are those based on the sorts of feedback loops for which many providers utilise business intelligence software. This method is not perfect and we urge the reader to understand the following analysis, which correlates patient-reported experience with the presence of business intelligence applications at the provider, with the caution and in the spirit of directionality with which it is intended:
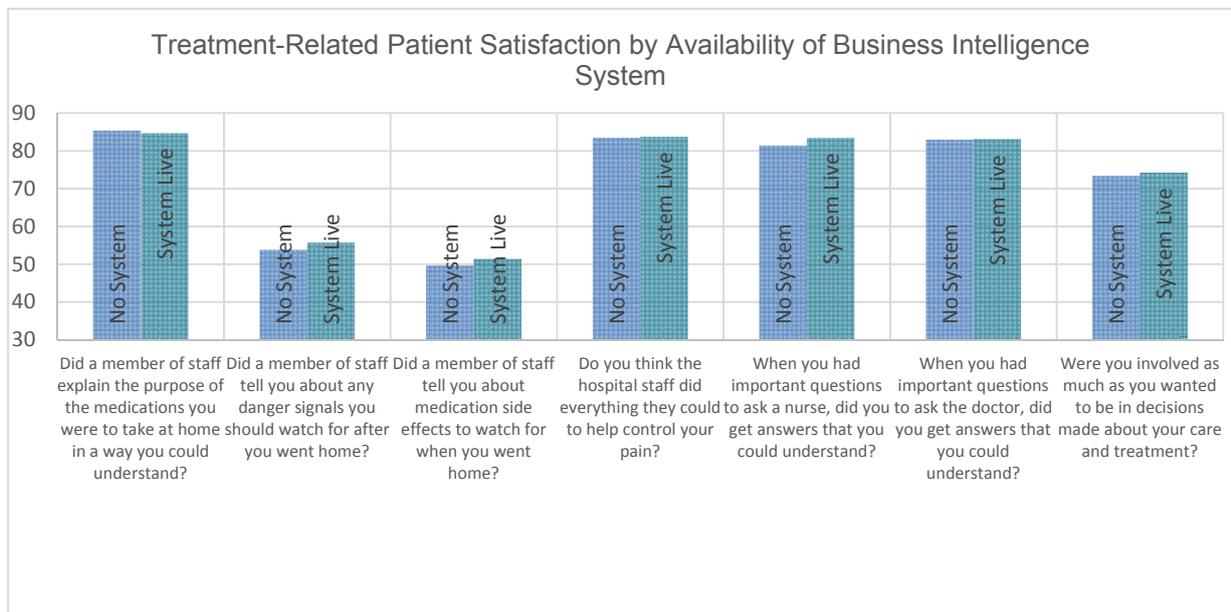
Figure 9: Treatment-Related Patient Satisfaction by Availability of Business Intelligence System

As the chart shows, an analysis of the data by presence of a business intelligence application reveals only very weak differences.

Patient-Reported Experience by Presence of Business Intelligence Solution (Cont'd.)

A similar outcome for organisation and attitude-related experiences shows a similar result:
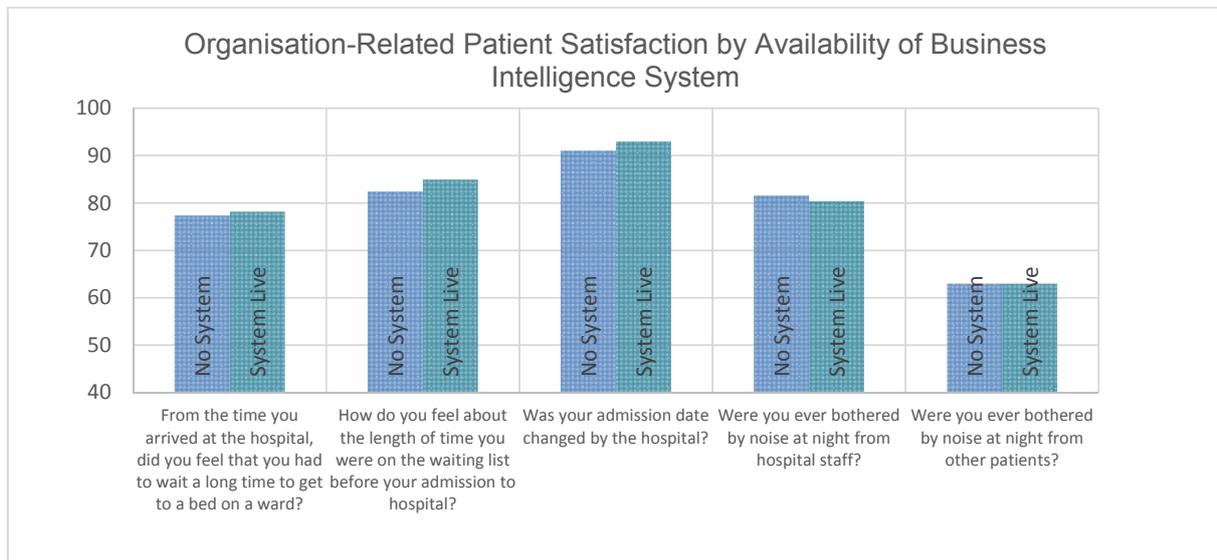
**Figure 10: Organisation-Related Patient Satisfaction by Availability of Business Intelligence System**
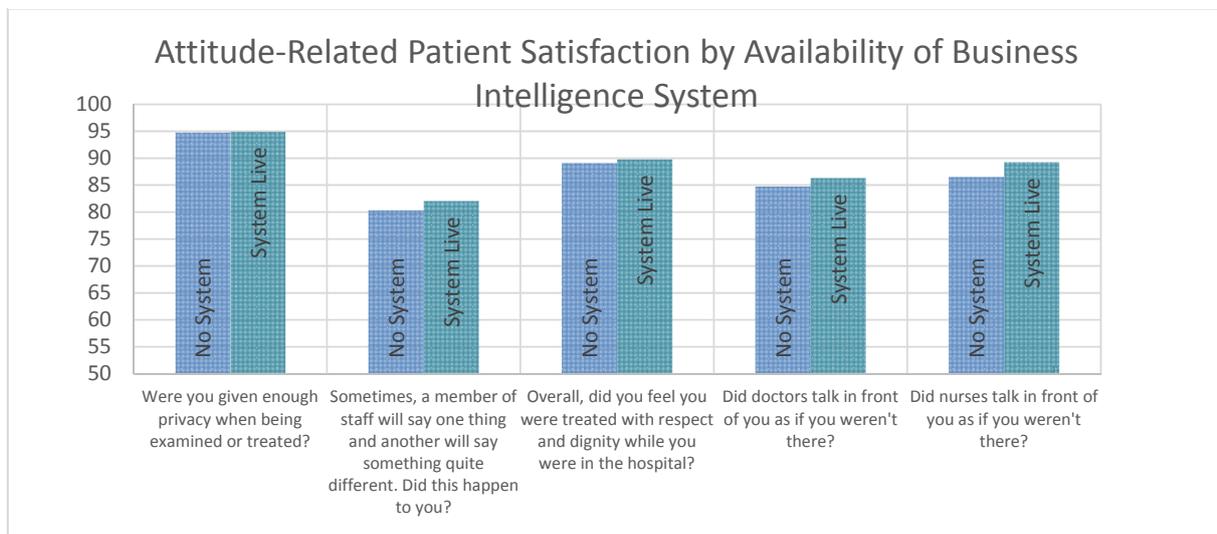
Figure 11: Attitude-Related Patient Satisfaction by Availability of Business Intelligence System

In conclusion, there are a number of interpretations possible from these present findings; namely that unless either business intelligence software is not used to drive improvements to patient experience (and we have at least anecdotal evidence that it is) or the use of such software is ineffective in producing better patient experience results, we may have to wait for further data to become available before being able to determine how much gain in patient experience can be obtained using business intelligence software; for the moment, we have to restrict ourselves to the knowledge that it does not seem to bring about any detriment.

Stage 5 Hospitals Results

To illustrate further the importance played by progressing IT developments in order to improve healthcare outcomes, below an overview over some of the data discussed earlier on in this report filtered to include only EMRAM stage 5 hospitals and converted to show data by the providers' relative ranking:

Mortality

Summary Hospital-level Mortality Indicator (SHMI) - Deaths associated with hospitalisation, England	3
Summary Hospital-level Mortality Score - Deaths associated with hospitalisation, England	2
Deviation from SHMI Target - Deaths associated with hospitalisation, England	2

Imaging Performance

Volume-weighted Imaging Department Performance Index: Computerized Axial Tomography	1
Volume-weighted Imaging Department Performance Index: Diagnostic Ultrasonography	1
Volume-weighted Imaging Department Performance Index: Fluoroscopy	4
Volume-weighted Imaging Department Performance Index: Magnetic Resonance Imaging	2
Volume-weighted Imaging Department Performance Index: Nuclear Medicine	2
Volume-weighted Imaging Department Performance Index: Plain Radiography	1
Volume-weighted Imaging Department Performance Index: Positron Emission Tomography	3

Treatment Wait Times

Average of % within 18 weeks	1
Average of 95th percentile waiting time (in weeks)	1
Average of Average (median) waiting time (in weeks)	3

Patient Satisfaction

Did a member of staff explain the purpose of the medications you were to take at home in a way you could understand?	2
Did a member of staff tell you about any danger signals you should watch for after you went home?	2
Did a member of staff tell you about medication side effects to watch for when you went home?	1
Do you think the hospital staff did everything they could to help control your pain?	2
When you had important questions to ask a nurse, did you get answers that you could understand?	1
When you had important questions to ask the doctor, did you get answers that you could understand?	2
Were you involved as much as you wanted to be in decisions made about your care and treatment?	1
From the time you arrived at the hospital, did you feel that you had to wait a long time to get to a bed on a ward?	2
How do you feel about the length of time you were on the waiting list before your admission to hospital?	1
Was your admission date changed by the hospital?	2
Were you ever bothered by noise at night from hospital staff?	1
Were you ever bothered by noise at night from other patients?	1
Were you given enough privacy when being examined or treated?	1
Sometimes, a member of staff will say one thing and another will say something quite different. Did this happen to you?	1
Overall, did you feel you were treated with respect and dignity while you were in the hospital?	1
Did doctors talk in front of you as if you weren't there?	1
Did nurses talk in front of you as if you weren't there?	1

Figure 12: Stage 5 Hospitals' Ranking in Quality Measures

Summary of Findings

This second report in an ongoing series by HIMSS WorldWide, a cause-based, not-for-profit global enterprise, was produced from data on a cohort of 91 English NHS trusts in the HIMSS Analytics' EMRAM^{SM} database combined with publicly available data with the objective to uncover quantifiable evidence supporting the claim that advanced IT capabilities facilitate efforts to realize desired health outcomes.

As expected, our analysis returned a connection between IT maturity and mortality; organizations **with a higher EMRAM score tended to have a lower mortality rate.** However the connection between the two metrics is not precise; rather, it is best understood as a tendency.

Our analysis of hospital processes and efficiencies produced evidence of a positive correlation between EMR capabilities and imaging workflow performance wherever technology can streamline tasks and assist staff staying on top of workflow management: **Suitably digitised Imaging Departments appear to be more efficient.**

In terms of patient feedback and only by a slight margin, providers tending towards a higher EMRAM score performed consistently better than their counterparts tending towards lower EMRAM scores for treatment-related patient satisfaction questions.

List of Citations

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How to Cite this Report

Individuals are encouraged to cite this report and any accompanying graphics in printed matter, publications, or any other medium, as long as the information is attributed to the 2014 HIMSS Evidence of the Effects of Healthcare IT on Healthcare Outcomes Report.

About HIMSS

HIMSS WorldWide is a cause-based, not-for-profit global enterprise that produces health IT thought leadership, education, events, market research and media services around the world. Founded in 1961, HIMSS WorldWide encompasses more than 52,000 individuals, of which more than two-thirds work in healthcare provider, governmental and not-for-profit organizations across the globe, plus over 600 corporations and 250 not-for-profit partner organizations, that share this cause. HIMSS WorldWide, headquartered in Chicago, serves the global health IT community with additional offices in the United States, Europe, and Asia.

HIMSS WorldWide has commissioned this report from Bilue, a London-based research & consulting start-up specializing in data-driven marketing and strategy solutions for the healthcare and biosciences markets.

Appendix: Sample Overview

The sample for this analysis was drawn from the EMRAM^{SM} Database and consists of 91 English NHS trusts. The demographic distribution was as follows (HSCIC, 2014):

Hospital Size by Bed Numbers	Community Hospital	General Acute Hospital	Multi-Service Hospital	Specialist Hospital	Grand Total
LARGE	0	24	0	0	24
MEDIUM	0	15	4	2	21
SMALL	4	13	5	8	30
Grand Total	4	52	9	10	75

The cohort's distribution by number of available beds was (HSCIC, 2014):

<200	<500	<1,000	>1,000
3%	10%	48%	39%

The cohort's distribution across the 8 EMRAM Stages was as follows:

0	1	2	3	4	5	6	7
8%	15%	16%	9%	4%	48%	0%	0%

Availability of IT major systems amongst the sample was as follows (in % of hospitals):

Business Intelligence	98%
Cardiology - Central PACS	61%
Clinical Decision Support System (CDSS)	59%
Computerized Practitioner Order Entry (CPOE)	74%
Electronic Patient Record / Clinical Data Repository	92%
Laboratory Information System	10%
Nursing Documentation	6%
Order Entry (Includes Order Communications)	90%
Radiology - Central PACS	100%
Radiology Information System	98%