

*Original Research Article*

# Impact and Implementation of information and communication technology in Value Based Health Care: A systematic Review

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**Abstract**

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Information and communication technology (ICT) is an essential component of Value Based Health Care (VBHC). However, there has been a limited research on the use of ICT in VBHC. The aim of this systematic literature review is to explore the research work performed in the field of ICT usage in VBHC from January 1st, 2010 till September 31st, 2018. As per the researchers' knowledge and so forth there has been no similar review previously addressing the issue of ICT usage in VBHC. Our study showed that use of ICT has shown promising evidence to improve the healthcare outcomes, positive experience of the patients, increased efficiency of the current health systems and potential impact on patient safety. This evidence is depending on many factors including the type of outcome, place of implementation, willingness to accept the use the ICT, infrastructure and clinician reimbursement. However, there is still a need for more in-depth researches for successful integration of ICT solutions in VBHC.

**Keywords:** Information and communication technology, Value based healthcare, systematic literature review, Improve outcome, Patient experience, efficiency, healthcare system, Patient safety

Healthcare systems around world are facing numerous challenges leading to a lowered patient and public satisfaction, mainly attributed to high costs, unsatisfactory outcomes, limited access, improper healthcare delivery and high rate of medical errors (Porter, 2004). Healthcare spending in many countries are more than 10% of their gross domestic product (GDP) like Japan and United States (US) and the spending growth is faster than their respective economies (Care, 2016). Many factors are contributing to high healthcare costs including an aging population, increasing chronic disease prevalence, changing lifestyle, increasing costs of medications, advanced technology diagnostic machines and ICT.

In terms of healthcare spending, US leads the world with 17.8% of its GDP spent on healthcare. However, utilization efficiency is similar to high-income countries

(Papanicolas et al., 2018). The global healthcare spending is expected to increase from 7.83 trillion US Dollars (USD) in 2013 to 18.28 USD trillion in 2040 (Dieleman et al., 2016). Given this worldwide trend, Saudi Arabia will be facing a strong and a rapid financial burden in coming years and hence will need to proactively address this challenge (Hazazi and Chandramohan, 2017).

To solve this problem the healthcare leaders and policy makers in the world need to think about sustainable solutions in an innovative manner. Of primary interest would be an innovative, strategic and valuable plan of changing the healthcare system from the current volume-based system to a system that rewards the outcome and lowers the cost.

In 2007, Michael Porter and Elizabeth Olmsted studied

**Table 1.** PRISMA flow diagram

Records identified through database searching (n =844[pubmed only])	Records identified through google scholar (n = 17000)
Records after duplicates removed (n = 540)	
Records screened (n = 540)	Records excluded (n =487) not related to the topic, related to ICT or VBHC but not to them together.
Full-text articles assessed for eligibility (n = 53)	Full-text articles excluded, with reasons (n =37, 15 not peer reviewed, 3 not available online, 4 white papers)
Systematic literature review (n=16)	

the health care in United States and created a new model for managing health care the so-called Value-Based Health Care (VBHC) and defined value as the patient health outcome per dollar spent (Porter, 2004). The system depends on 6 pillars: creating an integrated practice unit reorganized around patient condition, measuring outcomes and costs for every patient, bundle payment for a full treatment cycle, integrations of health care delivery systems, geographic expansion, building and enabling technology platform (Porter, 2014).

Many countries around the globe have adopted VBHC because it promises to provide better patient outcomes. In 2016, the economist intelligence unit conducted a global assessment in 25 countries' and found that the VBHC is implemented in many countries with different speed. Sweden is the only country with 'very high alignment with VBHC' and United Kingdom (UK) is the only country with 'high alignment with VBHC' while other countries are with 'low to moderate alignment with VBHC' (Care, 2016).

ICT as a pillar for VBHC showed promising results since 92% of articles reviewed by Melinda et al to determine the effect of ICT on health care outcomes were positive overall (Buntin et al., 2011). Although, the noticed importance of ICT as essential part of VBHC, little researches have been conducted to show the effectiveness and implementation of ICT in VBHC. Thus, this paper aims to conduct a literature review to explore the use and effect of ICT on the healthcare in the era of VBHC.

This paper is organized as abstract followed by an introduction of VBHC concepts, methods, findings, discussion, conclusion and recommendation.

### Value Based Healthcare

Current healthcare providers are among the best workers from the perspective of knowledge, training and

performance (Porter, 2004). However, the healthcare systems are not helping them in their complex situation. Healthcare system is based on volume rather the outcome which makes it fallible because it rewards the providers with more patients even if their performance is not optimal.

VBHC concept deals with this situation where the patient is looking for high value and the best available outcome. VBHC is the system that measures the patient outcome and cost to reward high quality and low cost (Porter, 2015).

Value is measured as the outcome that matter to the patient per the cost to deliver that outcome. Outcome is a result of full care cycle around a given patient's condition and the cost is the sum of all expenses for that condition in a full care cycle [8]. The full care cycle begins when a patient's condition starts and ends when patient's condition does not need any more care.

### ICT and VBHC

As an essential element of VBHC, the ICT is expected to play an important role in restructuring the healthcare delivery and capability of measuring quality and cost metrics. An ICT platform should have common definitions easy to understand by any healthcare provider, integrate all data types, and communicate the information with all providers regardless of their geographical locations and a built-in ability to enable all financial and quality measurements (Porter, 2015).

### METHODS

This systematic review of published peer-reviewed articles was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) as shown in Table 1 above.

**Table 2.** Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Directly related to the use of ICT in the value-based healthcare practice.	Irrelevant to the topic.
Peer-reviewed	Not Peer-reviewed
Written in English.	Not written in English, white paper and not available online.

**Table 3.** Summary of Analyzed Papers

Reference	Country	Scope	Research method	Theme of the paper
Patricia Franklin 2017 (19)	USA	The paper applied framework to guide the implementation planning, collection, and use of patient reported outcomes to serve multiple goals and stakeholders is needed.	46 Interviews	Implementation of ICT in VBHC.
Joshua M.Liao 2016 (17)	USA	In this paper, the authors explored the most common trends in healthcare	Literature review.	Implementation of ICT in VBHC.
Marianne P. VOOGT (21)	Netherlands	The authors identified seven barriers by interviewing health professionals in the Dutch healthcare system.	X Interviews	Implementation of ICT in VBHC.
M.Gold 2013 (16)	USA	This paper explored the real-world connection between health information technology (HIT) and the transformation of care delivery.	11 Interviews	Implementation of ICT in VBHC.
S.Khan 2018 (20)	USA	This paper discussed the health care transformation and the information technology modernization in military health care US.	Descriptive and analytic.	Implementation of ICT in VBHC.
Maxson ER.2010 (15)	USA	The authors profiled 6 Beacon Communities' health IT-enabled care management programs, highlighted the influence of local context on program strategy and design, and describing challenges, lessons learned, and policy implications for care delivery and payment reform	Descriptive and analytic.	Implementation of ICT in VBHC.

R.Gupta 2017 (18)	USA	The paper showed the feasibility of using information technology to teach a new strategy of value based health care by virtual online learning.	277 online survey.	Implementation of ICT in VBHC.
M.Buntin 2011 (7)	USA	This paper studied the health information technology effect on outcomes, including quality,efficiency, and provider satisfaction	Literature review	The impact of ICT on health care.
C. Kruse, 2018 (9)	USA	The authors of this paper defined an HIT intervention and an effect on medical outcomes in terms of efficiency or effectiveness.	Literature review	The impact of ICT on health care.
Jayakumar P.2017 (11)	United Kingdom	This paper described how technology decrease cost and improve outcomes in total knee and hip replacement	Analysis of data of 2080 patients	The impact of ICT on health care.
T.ketchersid 2014 (14)	USA	This paper examined use of IT in nephrology in the era of vbhc	Literature review	The impact of ICT on health care.
G.seara 2011 (22)	Spain	The authors analysed the contradictions between the design and the theoretical structure of mental health services and the possibilities to evaluate the actual value of the delivered care.	11 Interviews	The impact of ICT on health care.
DonHee 2015 (12)	Lee South Korea	This paper examined the effects of operational innovation and quality management practices on organizational performance in healthcare organizations	239 Surveys	The impact of ICT on health care.
kruse CS, 2015 (10)	US	Te Effect of Patient portals on Quality outcomes and its Implications to Meaningful Use.	literature review.	The impact of ICT on health care.

### Inclusion and exclusion criteria

Studies were eligible for inclusion if they were peer reviewed reviews, clinical trials, randomized clinical trials, systematic reviews and free full text available, written in English and focused directly to the use of ICT in the VBHC. Those studies that were not peer reviewed, were written in any language other than English, and were a white paper, not available free full text articles online and irrelevant to the topic of the literature /systematic review were excluded from the final study analysis. Only the studies that met our inclusion criteria were analyzed for the purpose of this systematic / literature review.

More than 17000 papers identified, however, after review only 16 papers were meeting the inclusion criteria. Inclusion and exclusion criteria are summarized in Table 2.

### Search strategy and study selection

We used the following terms: 'value based healthcare system', 'healthcare delivery', 'information and communication technology', 'digital technology', 'healthcare transformation', 'e health', 'm health', and 'healthcare reform' to perform a thorough search of literature in the PubMed as a primary resource database and Google Scholar as other search databases. The search terms were developed based on the taxonomy for healthcare and also the consensus of the authors.

### Quality assessment

Articles were independently quality appraised by the authors to assess internal and external validity using the critical appraisal skills programs for systematic reviews



**Figure 1.** Articles of implementation of ICT in VBHC and impact of ICT on the VBHC delivery, outcome and cost, based on country of publication

and evidence-based library and information practice critical appraisal checklist for epidemiological studies. Any disagreements were resolved through discussion with arbitration and comments by an additional reviewer if necessary.

### Data extraction and synthesis

Data was abstracted onto the customized Microsoft Excel data sheet under the authors agreed paper categories (implementation of ICT in VBHC and impact of ICT on the VBHC delivery, outcome and cost), article's title, author (s), country, scope and sample, research method, data collection, hypothesis and variables, study purpose, gap and research problem, results and outcome, opportunities and recommendations, and theme of the article. Table 3 shows summary of the analysis process of the papers.

### FINDINGS

A total of 16 studies were finally selected for this review after the rigorous inclusion process. In terms of demography of studies included, 11 studies were performed in United States (US), 2 in Spain, 1 in Netherlands and 1 in United Kingdom and one was Donets South Korea as shown in Figure 1.

Based on study designs, 3 studies were systematic literature reviews and other studies designs were mostly cross sectional and descriptive. When considering the clinical practice and education, 15 of the included studies in the review were related to clinical practice except 1 study which was in the education field. To further diversify the studies according to various medical area settings, 2 studies were conducted in mental health care,

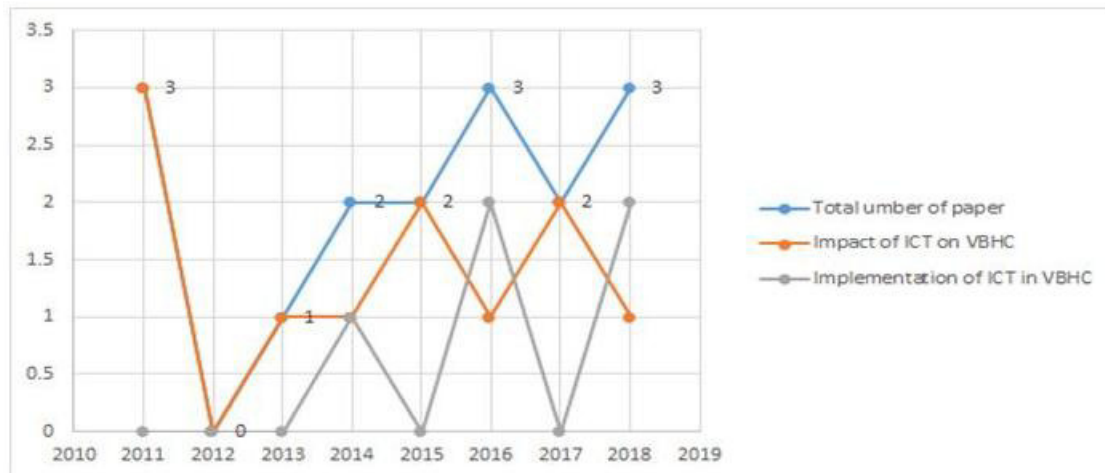
1 in the nephrology practice and 1 in use of ICT in teaching VBHC. When considering the clinical process, decision making was the focus of 3 studies, while 3 studies discuss the difficulties implementing ICT in the era of VBHC.

The authors classified the results of the reviewed literature into studies that focus on the impact of ICT on VBHC delivery, cost and outcome and studies that explore the implementation of ICT in VBHC. Implementation obstacles and the impact are important aspect of VBHC concepts. It was found that 9 out of 16 (56.25 %) studies were about the implementation of ICT in VBHC while, 6 out of 16 (37.50 %) were about the effect of ICT on healthcare delivery, cost and outcome. Figure 2 presents the distribution of the paper based on the year of publication and topic of the paper.

### The impact of ICT on VBHC delivery, cost and outcome

A value-based approach is built based on measuring the values so it is important to consider values such as cost when studying VBHC. This section discusses the studies that focused on the impact of ICT on VBHC. Figure 2

Clemens Scott Kruse et al in (2015), examined the relationship between patient portals and the quality and outcome based on several indicators from agency for healthcare quality (AHRQ) and US health Services and Resource administration (HSRA). They were able to conclude that more health care organization are offering a patient portal than the reviewed published in 2011 and the use of patient portal was associated with improvement in : Medication adherence, disease awareness, improved self-care, general clinically relevant benefits, decrease in the number of office visits, customer retention which is related to continuity of care, increase in



**Figure 2.** Distribution of the paper based on the year of publication and topic of the paper.

preventive medicine. The patient portal has a great potential to meet the both intent of Meaningful Use, but there is not sufficient evidence to declare its efficacy. In 2017 Kruse and Beane (2018), did another systematic review summarized the impact of HIT on medical outcomes in terms of effectiveness or efficiency, which were grouped under critical, psychological and continuous care outcome. It showed that the HIT use is associated with positive medical outcomes, moreover, HIT also increases the sustainability of provider and prepares the organizations towards the stage 3 of meaningful use of the HIT. Another study by Prakash Jayakumar et al. (2017), assessed the impact on length of stay as primary objective, the impact on clinical, patient-focus and financial outcomes as secondary objectives for 2080 patients undergoing primary total hip replacement and total knee replacement. They use video and website to educate, train, prepare and engage patients in the treatment pre and post operation. They found that there is a reduction in overall length of stay for all patients, 6 months readmission rates, complication rates and the rates for re-attendance to emergency which was also associated with total cost reduction by 250,331£.

A literature review on health information technology and its effect on healthcare quality, efficiency, and patient satisfaction as outcome by Melinda Buntin and her team (Buntin et al., 2011) they reported that 62% of the articles reviewed showed the use of healthcare information technology is associated with improvement in outcomes in one or more aspect of care. Moreover, 92 % of the studies showed a positive or mixed positive result in which the author concluded a positive outcome but the study showed at least one negative impact from using information technology. Most of the positive outcomes were in efficiency of care, effectiveness of care and patient safety. Dissatisfaction with the use of electronic

health record in some user was an obstacle for achieving the potential of information technology. Don Hee Lee et al (2010) studied how operational innovation will improve the organization performance through enhanced process improvement, quality management practices and medical ICT. Their study showed that enhanced process improvement and medical ICT systems are associated with improvement in quality and patient safety practice and eventually organization performance. The relationship between the medical ICT and the patient safety practice was not statistically significant. They claim that the reason behind this is a lack of strong system to draw a strategic plan for safe practices in some hospitals.

Suzuki (2016) did an interventional study where he used a data analytic software to generate knowledge from different data sources to help decision making in management of mental health conditions. The software platform facilitates early intervention and help better resource management. Moreover, Ketchersid (2014) reviewed the nephrologist experiences in using information technology through Physician Reporting Quality System (PRQS) e-prescribing and the use of Electronic Health Record (EHR) after center of Medicare and Medicaid (CMS) has implemented the value-based purchasing program. The overall experience was positive, however, the success rate is different from one program to other and deciding if ICT help or hinder the delivery of healthcare could not be done at this stage.

### Implementation of ICT in VBHC

The implementation of ICT in VBHC has been discussed in various perspectives from the meaningful use of IT, role of federal officials and healthcare leaders, to the organizational response, training and obstacles for implementation of such programs. Maxson et al. (2010),

stressed on the meaningful use of IT in beacon communities, highlighting the ways in which increased standardization in elements of care management particularly data standardization, health information exchange and system interoperability can be used to implement VBHC, however there is no one-size-fits-all approach due to diversity among the individual beacon communities. Gold, (2013) discussed about the perspectives of federal level health system leaders and officials as part of a global assessment of the Health Information Technology for Economic and Clinical Health Act to explore the real-world connection between health information technology (HIT) and the transformation of care delivery. The results showed that HIT functionalities are integral for creating the information flow required for innovations such as medical homes, accountable care organizations, and bundled payment. However, in addition to just requiring the EHRs, the progress in this field is slow and will require creative long term strategies from the policy makers that take into account the real-world environment of organizations and communities.

Liao et al. (2016) reported that healthcare organizations responded to six trends driving the healthcare transformation in United States (value-based payment, utilization of health care information and digital technology, non-traditional care options, individualized clinical guidelines, increased transparency, cultural awareness of the medical overuse harm) by implementing changes in workforce and provider, pursuing integration with payer and increased utilization of ICT. Gupta et al. (2017) emphasized on the online training of providers about VBHC by clinician educators and healthcare leaders in 22 U.S. states and reported a growing learning community with most of the active members (physicians and nurses ,trainees ,health system leaders and educator) reporting that the strategies gained were helpful and some even adapted or adopted these strategies in their home organization.

Framework for implementation of patient-reported outcome measures (PROM) was introduced by Franklin (Patient-Reported Outcome Measures in the Learning Healthcare System, n.d). using electronic medical record (EMR) or web after reviewing, collecting and analyzing the drivers of successful implementation of (PROM) in a diverse clinical setting where a panel of expert in PROM interviewed 46 stakeholders (clinician, policy funder, patients, payers, professional societies) representing 38 organizations interested in PROM. They formulated a four primary use case proposed order to create a unique value proposition for stakeholders including individual patient case decision, quality improvement, value-based payment and population health and research. Khan (2018), in his study of military healthcare system transformation in USA concluded that there is a need for clinical leadership and informatics experts to plan, analyze and implement the military healthcare services transformation towards VBHC and the modernization of

HIS. At the same time, developing people, harassing new information resources and exploring innovative technology is essential and its impact on quality, safety and outcome should be considered.

In Netherlands Voogt et al. (2018) identified and reported the obstacles of implementing an under trial self-management eHealth intervention system by interviewing the potential stakeholders (health care providers) after performing a usability study with the system (the interviewees are knowledgeable about its functionality). The obstacles were, using this system will decrease the reimbursement of healthcare provider since the payment is based on number of consults, the fees of intervention is of significant concern, the applicability of the system for different patient cohort, insufficient resources for implementation, lack of autonomy, a mismatch between the opinion of researchers and providers regarding the use of the intervention and resistance to new technology. While Seara et al. (2016) explore the patients information database in Madrid and the result showed that the current patients information describe therapeutic or diagnostic categories of patients, however, they are not able to detect their functional status and/or the clinical expected outcome.

## DISCUSSION

VBHC is gaining importance as a choice of healthcare delivery system in many developed countries. When we specifically see the impact of ICT on VBHC, the majority of the literature describes a positive result. Moreover, to effectively implement the ICT use in health systems that adopt VBHC, there is a great need for organizational approach in terms of leadership commitment, ICT experts, resources and training.

Use of ICT have shown promising evidence to improve the healthcare outcomes, positive experience of the patients, increased efficiency of the current health systems and potential impact on patient safety. This evidence is depending on many factors including the type of outcome, place of implementation, willingness to accept the use the ICT, infrastructure and clinician reimbursement. As the healthcare system adopting ICT usage with VBHC is also likely to be accountable, effective, timely and safe, hence we expect ICT usage in VBHC improves patient outcome and safety, while at the same time reducing the burden of healthcare cost. Despite ICT is one of the pillars of VBHC, we found scanty research addressing the impact of ICT on VBHC.

The implementation of VBHC and the use of ICT in healthcare are also expected to increase in the coming years this is to go in parallel with the increase in research in these fields. Our study showed that the interest of implementation of ICT on VBHC started later after studying the impact of ICT on VBHC.

The finding of our study showed that ICT is a vital component of VBHC. However, the adoption of such technologies requires healthcare organizations to improve their decision making and medical processes to get the best value.

## RECOMMENDATIONS

Based on the findings of our study, we come with the following recommendations:

- Implementation of ICT in VBHC is necessary for sustaining an impactful standardized model of VBHC across different regions
- The patient related health outcomes must be linked to the VBHC through ICT to better define the cost and value for meaningful use of ICT in VBHC.
- An increased inventory of clinical trial research is needed to better delineate the impact of ICT on VBHC.
- More research to be done to study how to improve VBHC by using ICT especially for developing countries since our study did not show any research that study ICT and VBHC in such countries.

## Limitations

Although, the approach which is followed during this systematic review intended to be rigorous, there few limitations of the research. Firstly, English-language articles and studies were the main sources of this research so there is a chance that we may have missed some related studies written in other languages. Secondly, equal weight was given to all studies without considering study design or sample size. The reason behind this is the fear of applying subjective method of weighting which may make us missed some related findings.

## CONCLUSION

Value Based Healthcare is an emerging model of providing healthcare services. Although, ICT is one of the main components of VBHC, the relationship between the two concepts still require extra investigation. This paper provides an attempt to study the implementation and effect of using ICT in VBHC. Systematic literature review was conducted based on PRISMA technique where 16 papers were reviewed for the final phase of the study. The reviewed articles were divided into two main themes which are the impact of ICT on VBHC delivery, cost and outcome and implementation of ICT in VBHC. Our findings showed that ICT can be considered as the heart of VBHC however there is still a need for more in depth researches for successful integration of ICT solutions in

VBHC. The results also showed that there is a positive impact of ICT in many perspectives of VBHC such as the cost and value for meaningful use. Additionally, implementation of ICT in VBHC can be affected by other factors such as leadership commitment so it is important to consider such factors when studying ICT implementation in VBHC. Future work can be done to study the impact of such factors.

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