Emerging Information Technology, Storage and Evaluation within Healthcare: A Discerning IMT Analysis

By

Myles Maietta

APPROVED:

Dean Kashiwagi,______________________________, Director

Jacob Kashiwagi,______________________________, Second Committee Member

ACCEPTED:

__________________________________________

Dean, Barrett the Honors College
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Myles Maietta

Barrett the Honors College

At

Arizona State University
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Abstract:

The introduction of novel information technology within contemporary healthcare settings presents a critical juncture for the industry and thus lends itself to the importance of better understanding the impact of this emerging “health 2.0” landscape. Simply, how such technology may affect the healthcare system is still not fully realized, despite the ever-growing need to adopt it in order to serve a growing patient population. Thus, two pertinent questions are posed: is HIT useful and practical and, if so, what is the best way to implement it? This study examined the clinical implementation of specific instances of health information technology (HIT) so as to weigh its benefits and risks to ultimately construct a proposal for successful widespread adoption. Due to the poignancy of information analysis within HIT, Information Measurement Theory (IMT) was used to measure the effectiveness of current HIT systems as well as to elucidate improvements for future implementation. The results indicate that increased transparency, attention to patient-focused approaches and proper IT training will not only allow HIT to better serve the community, but will also decrease inefficient healthcare expenditure.
Introduction:

Moore’s law states with appropriate discretion that as the speed of innovation within an industry accelerates, the more difficult and costly the transition to this enhanced state will be (Thimbleby, 2013). With respect to the evolution of contemporary healthcare systems, the acceleration of innovation is not in question here so much as if, or how, to utilize such progress is. In a thought experiment designed to highlight the prevalence of this acceleration, Harold Thimbleby compares the reaction a physician that lived a century ago would give if placed in a modern clinical setting to the reaction this same physician would give if placed in a health setting a century before their own time. This physician from perhaps 1915 would be entirely lost in a modern hospital and would not be familiar with even rudimentary tools like infusion pumps, electronic health records or testing such as MRI’s or PET scans. But place them in a hospital from 1815 and the setting would be so familiar to them, they might not even notice anything has changed! With this, it becomes more evident that healthcare is accelerating towards the future at a breakneck pace, but at what cost? The intuitive solution is to find ways of making and saving money via modern health information technology (HIT) so that this revenue can be turned back onto the patient, but this is much easier said than done. Applications of HIT are nonetheless already making an impact and are thus poised to be analyzed.

The advancement of HIT has become synonymous with systems that adopt “Medicine 2.0” or “Health 2.0” or even “Web 2.0” for use in everyday practice. These movements can be colloquially defined as “applications, services, and tools that are web-based services for healthcare consumers, caregivers, patients, health professionals, and biomedical researchers that use Web 2.0 technologies or semantic web and virtual-reality tools to enable and facilitate,
specifically, social networking, participation, apomediation, collaboration, and openness within and between these user groups” (Stump, Zilch and Coustasse, 2012). Additional definitions also take into account the reformation of health systems as well as the migration of medical information from current forms to online, more accessible formats as a means to maximize ease of use. For the purpose of this study, discussion of HIT, health 2.0, eHealth and/or web 2.0 will focus on the representation provided by Dooley, Jones and Iverson (2014)—any “digital platform comprising two-way communication and interaction, social communication, and content creation” leading to health information analysis or medical advancement. Although current applications of HIT are decidedly clinical in nature, those bridging the gap between home-based care and civic practices will also be considered.

**Current Healthcare Trends and Applications of HIT:***

Patients generate exponentially large quantities of medical information to be organized, analyzed and stored, creating a pool of information termed “Big Data” that is so large that it can only be reasonably assessed by electronic means (Thimbleby, 2013). Electronic health records (EHR’s) provide a partial solution to this dilemma by converting pertinent patient information, such as X-rays, PET scans, MRI’s, blood test results, reactions to specific drugs, prescriptions, pathological results and treatment regimens, to electronic forms. This avoids having to sift through mountains of paperwork to find a single patient’s file and also brings together records from multiple locations, thus making patterns in treatment more visible while maximizing connectivity and fluid responses. This allows healthcare professionals to compare the parameters of one patient to that of another across a great geographic range in relatively little time and with minimal loss of accuracy in the records. Although use of EHR systems is not yet
universal, it is certainly gaining traction. According to recent studies, “by 2012, 72% of office based physicians were using an EHR” (DeVoe, Angier, Burdick and Gold, 2014). Additionally, Kaushal and Blumenthal (2014) found that a majority of physicians across all disciplines thought the remote access to patient information that EHR’s afford was very helpful and were particularly appreciative of medication error alerts and the convenient presentation of important lab values, with 75% of all current providers reporting that EHR’s enhance their patient care. So called “trigger tools” that are intimately connected to EHR’s also send out crucial notifications regarding adverse drug events in patients which reach physicians immediately, thus expediting any given healthcare network’s reaction to an emergency (Seidling, Kaltschmidt, Ammenwerth and Haefeli, 2013).

In terms of technical production of specific HIT components, several arrangements have been noted as having a definitive impact. The increased miniaturization of medical tools in recent years has not only lowered the cost of production, but also makes the storage of information more convenient. Relatedly, 3D printers have lowered the costs of producing custom instruments even further due to the initial cost of a blueprint being quickly offset by rapid reproducibility using such technology (Thimbleby, 2013). An example of such innovation is the aforementioned infusion pump, which keeps getting more dynamic and effective despite its increasingly small and efficient production. This technology makes it unnecessary for nurses to incessantly administer shots because the pump has automated this process, thus allowing nurses more free time to spend on other obstacles. Summarily, once the software (the crux of information storage and analysis here) of the modern infusion pump has been finalized, the cost of reproducing it is virtually nonexistent (Thimbleby, 2013). With this in mind, it is easy to extend this process to future applications, such as advances in nano health, genomics or even the
production of artificial organs—all of which could potentially reap the same cost effectiveness of the infusion pump so long as each system’s information is handled appropriately.

Regardless of the patient being treated, the synthesis of EHR use and advanced medical instruments creates a bond between diagnoses, prediction and treatment that has never been seen before. Once the initial infrastructure has been set up, adding each additional patient to the enormous pool of population data, side effects and treatments would offset the costs of initial set-up almost immediately (Thimbleby, 2013). An intriguing illustration of this is the apparent need for extensive information storage within the field of genomics. Many clinical minds are already pondering the customization of drugs to the genomes of specific organisms (bacterial, human or otherwise) as a means to more intimately and efficiently combat acute ailments. As previously intimated, the cost and logistics of storing and analyzing such an enormous pool of genomic information cannot be overcome with today’s health technology and thus must be conceptualized within a health 2.0 framework. Conglomerations of such large pools of information would also draw the attention of researchers from multiple disciplines, opening up exciting avenues as to how such data would be shared and analyzed between epidemiologists, psychologists, sociologists and physicians of all fields. Also to be factored are the groundbreaking medical conclusions such unique teams would have the potential of making. HIT has the ability to bring added benefits to clinical security as well. With so much valuable medical information on file, healthcare professionals will be able to use biomarkers and biomedical identifiers to identify disorders and individuals quicker than ever before, accelerating the whole of treatment altogether. Although such breakthroughs are exciting to consider, web-based technologies remain the primary foundation that today’s health technology is built upon.
Web-based technologies and online applications within modern healthcare are varied and widespread and their significance cannot be overlooked. With the vast majority of individuals having access to smartphones, the accessibility to web applications is nearly limitless, further escalating the pervasiveness of HIT in society. According to Stump, et al. (2012), 53% of people report discussing information related to their health condition they acquired from the internet with their doctor, with this number almost certainly being much higher in 2015. This study also reports that a 2011 survey of 5800 U.S. hospitals found 486 had YouTube channels, 777 had Facebook pages and 714 had Twitter accounts, with these numbers growing rapidly year after year. This should not come as a surprise however, as healthcare professionals and medical libraries are becoming strong fixtures on sites like Twitter, as it allows people to receive immediate medical information, sometimes tailored to their specific condition. Children’s Mercy Hospital in Missouri even reported a great benefit to their surgeons posting updates during lengthy surgical procedures as it eased the anxiety of the waiting families (Stump, et al., 2012).

Perhaps the most prevalent functionality of access to health information on the internet is WebMD, which provides accountable and detailed information to people worldwide. Such websites are critical to both the prevention and treatment of illness as being exposed to signs, symptoms and sensible solutions from the onset of illness undoubtedly cuts down on the number of hospital and urgent care visits drastically, thus saving any given community countless dollars in medical costs. Other considerable contributors to online HIT include websites like patientslikeme.com which allows individuals to chart their development against an illness as well as compare their progress to others with the same condition, allowing for the discussion of medications used, rest regimens and other pertinent information. An example of this has already
been examined when ALS patients used this site to discuss the efficacy of lithium in mitigating negative effects of the disease, a drug not known at the time to actively combat the effects of ALS but that was nonetheless confirmed to have some positive attributes by this group of individuals (Stump, et al., 2012). This further sheds light on the fact that online HIT applications allow patients to be an agent of their own treatment and healing to a degree never attained before. Similarly, the website *dailystrength.com* holds similar goals in mind and has had comparable positive outcomes. If websites like WebMD are too broad and diverse for acute symptoms, a recent web tool referred to as “Isabel” has been designed to go through pools of research findings that are tailored to personal symptoms in order to posit a more comprehensive diagnosis (Gengler, 2014). Critically, this resource also bridges the gap between laymen terms and technical medical verbiage since it accepts either in order to guide individuals of virtually any medical background toward an acceptable explanation of symptoms. The creator of the website, Jason Maude, warns however that although the site can help the patient construct better questions about their health, it cannot replace the doctor entirely (Gengler, 2014). The use of various wikis and blogs similarly aid in the dissemination of vital health info and perhaps more importantly are exigent examples of collaborative creations by people from all walks of life, offering a multitude of perspectives to learn from and, most importantly, the development of a sense of community and support.

Online resources are paramount to the success of the modern healthcare professional as well, not just the patients they treat. The crucial and elaborate databases Sermo and Medscape, among a myriad of others, allow physicians to exchange clinical observations and timely medical advice within an exhaustively educated and professional context (Lupiáñez-Villanueva, Miguel and Torrent, 2009). This unequivocally fosters medical partnerships across state and country
borders. Physicians have already used Sermo in emergency situations in order to get accountable and immediate feedback from distant professionals that can offer advice from personal experience regarding the predicament in question. Medscape operates in a similar fashion, providing complex medical feedback in admirably short timeframes, which is obviously an extremely valuable trait in a field where every second counts. Resources like Medscape and Sermo thus decrease error in judgment and take a great deal of pressure off the individual physician since they now have the opinions and recommendations of dozens of other professionals within reach at all times, helping to craft a truly global medical taskforce (Lupiáñez-Villanueva, et al., 2009; Stump, et al., 2012). Furthermore, electronic databases exist for nurses and nurse practitioners as well in the form of nurseconnect.com so as to ensure the entire healthcare team is equivocally adorned with equitable health information. Professionals outside the hospital or urgent care setting also benefit immensely from online resources. Databases such as the international classification of diseases or even the website whoissick.org, which correlates illness trends with geographic and spatial patterns, have the ability to unite epidemiologists from all across the world (Lupiáñez-Villanueva, et al., 2009). Figure 1 listed below highlights a possible epidemiological application of HIT such that the prevalence of specific disorders can more easily be referenced against societal patterns or geographic regions. Epidemiologists could then relay pertinent information to hospitals and urgent clinics so that they may more readily prepare for outbreaks or other such occurrences.
The number of articles posted online corresponding to a particular illness allows for greater potential in epidemiological studies while also showcasing the ability of HIT to make an impact outside of purely clinical environments.

Aside from the intake of information, the data that healthcare professionals contribute to an electronic system are equally as important in shaping the services patients receive and the resources other experts value. Figure 2 below lists specific instances of HIT as utilized by physicians, serving to highlight various contribution types made by these healthcare professionals. This also provides a backdrop for comparing how data flux regarding certain aspects of a patient’s record may change from year to year, possibly reflecting crucial changes within the diagnostic and treatment landscape. Of particular significance is the 13% growth in use of EHR’s by U.S. physicians in just a three year period.
Table 1: Health Information Technology (HIT) Capacity among U.S. Primary Care Physicians 2009 and 2012

<table>
<thead>
<tr>
<th>Function</th>
<th>2009 (N = 1,442), %</th>
<th>2012 (N = 1,012), %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses electronic patient medical records</td>
<td>46</td>
<td>69***</td>
</tr>
<tr>
<td>Computerized ability to generate patient information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List medications taken by an individual patient, including those prescribed by other doctors</td>
<td>30</td>
<td>45***</td>
</tr>
<tr>
<td>List lab results for an individual patient, including those ordered by other doctors</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Can provide patients with clinical summaries for each visit</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>Can electronically generate patient information: 2 + of above 3 functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computerized ability to generate patient registry and panel information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List patients by diagnosis</td>
<td>42</td>
<td>50***</td>
</tr>
<tr>
<td>List patients due/overdue for tests or preventive care</td>
<td>29</td>
<td>42***</td>
</tr>
<tr>
<td>List all patients taking a particular medication</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>List patients by lab result</td>
<td>29</td>
<td>42***</td>
</tr>
<tr>
<td>Can electronically generate patient registry and panel information: 2 + of above 4 functions</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Computerized order entry management: routinely…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order laboratory tests electronically</td>
<td>38</td>
<td>54***</td>
</tr>
<tr>
<td>Prescribe medication electronically</td>
<td>40</td>
<td>64***</td>
</tr>
<tr>
<td>Able to electronically send prescriptions to the pharmacy†</td>
<td>34</td>
<td>66***</td>
</tr>
<tr>
<td>Electronically track all laboratory tests until results reach clinicians</td>
<td>28</td>
<td>41***</td>
</tr>
<tr>
<td>Routinely uses computerized order entry management: 2 + of above</td>
<td></td>
<td>68</td>
</tr>
</tbody>
</table>

*Table taken from Audet, Squires and Doty (2014) “Where are we on the Diffusion Curve?”

HIT utilization among primary care physicians in 2009 and 2012 shows an important growth in use of EHR’s and electronic functionality. Despite a majority of physicians reporting EHR use in 2012, this trend did not extend to sub-topics such as reporting medication use or specific lab results.

Websites and databases are not the only means for online information exchange and analysis. Health apps and services have seen a surge in growth in recent years and many are compatible with tablets and smartphones, broadening access to HIT like never before. Various phone apps and fit-bands encourage individuals to upload their health information to online
databases for analysis and phone notifications can be programmed to alert both patients and medical professionals of patient traffic patterns so as to cut down on ER wait times and overcrowding. Darking, Anson, Davis and Flowers (2014) even propose methodology that would allow patients to directly log into secure hospital networks from any location on their mobile device to review their blood work or other test results. This could be applied to college education portals and their relations to on campus health clinics as well so that students may have access to the same benefits as any other patient. Additional extensions of this process could also entail electronic access to discharge instructions, viewing official lists of procedures, instructions, medications or allergies, viewing and editing upcoming appointments and access to summaries of previous visits. This would allow patients to receive sensitive and often complex information once they are at home and feeling better, with their family and friends around them for support and guidance. Patients could also receive electronic alerts directly to their tablet or phone reminding them to take their medications which would decrease ER visits due to missed medications (Seidling, et al., 2013). Expansions of so called “telemedicine” such as Telehealth or Teledoc allow for preventative and curative treatment plans that the diffusion of information on the web alone cannot always offer (Stump, et al., 2012). Although telemedical procedures can be as intensive as performing remote robotic surgery from a state or country away, the most prevalent application lies in being able to monitor patients in their own homes or hold teleconferences between patients and healthcare providers. Similarly, the United Health Group even offers “NowClinics” which offer virtual visits with doctors for extremely convenient and brisk dispersal of medical information and advice. This brings the expertise of a medical professional directly into one’s home without having to travel long distances for a consultation or
check up and is an application of HIT at the forefront of providing convenience and comfort to the patient.

Giving patients access to essential health information is one thing, but developing HIT systems that empower them and make them more astute patients is another. Sites like RateMDs.com or patientopinion.com encourage honest and potentially negative critiques of healthcare providers in a format that is entirely confidential so as to remove the risk of peer disapproval or possible sanctions in treatment (Black, Thompson, Saliba, Dawson and Black, 2009). Black, et al. also found that negatively biased reviews through these mediums were rare and that most reviews tended to be constructive. Anonymous online reviews may thus not only give patients the power to know exactly what quality of physician they are interacting with and who they want to receive care from, but will also encourage health professionals to be the best providers they can be.

Problems with HIT:

Although the information technology striking the healthcare landscape can be dynamic and appealing, not all thrilling scientific breakthrough necessarily lead to proper implementation. As Moore’s law further cautions, inefficient utilization of any technology may thus allow science to continue to outpace innovation, ultimately forcing society to live with fragmented and unfinished technologies (Thimbleby, 2013). When applied to HIT, it is important to remember that technology is much like biological evolution—it is not driven by innate motives nor does it have a predetermined goal of markedly and efficiently aiding humans. Recognizing any possible potential for satisfaction and productivity in HIT is the job of the discerning individual, both the patient and medical professional, not the technological system itself. Consequently, paying too
much attention to the intricacies of such systems is what may cause one to lose sight of the bigger picture—improving provider and patient interactions and wellbeing. Simply, HIT implementation should be the product of wanting to improve the lives of others, never the other way around.

Logistic problems arise when considering the rise in custom treatment approaches as well. Technology that is able to treat the majority of people will be funded the most extensively and produced the most whereas technology that must be customized to more detailed, even individual, cases will be much more expensive and costly to produce. The return profit for research and manufacturing companies of producing blueprints and software compatible with HIT that serves only a single person will be virtually nonexistent, raising alarm for how the treatment of rare conditions will be viewed and funded (Chou, Prestin, Lyons and Wen, 2013; Thimbleby, 2013). Possible issues with applying HIT to custom illnesses do not end there however. Customized treatment methods may cause custom side effects unique to the individual that have never been seen before and thus would lack proven treatment options. This propels the ironic and unfortunate situation in which using HIT to solve an initial problem creates an even bigger problem for the patient. Sufficiently advanced future computer systems having the power to make sense of Thimbleby’s concept of “Big Data” would theoretically have enough information to predict such custom patient outcomes, but computational power of this magnitude is not achievable in the near future.

Insecurities regarding HIT plague many current physicians largely due to the fact that adoption of relatively novel technology, such as telemedicine or cataloguing biomarker information, may present currently unknowable ethical and moral dilemmas in the future.
Advanced medical identifiers and access to increasingly detailed EHR’s will strain patient confidentiality practices tremendously. This imposes the larger complication of sacrificing one’s privacy for the sake of technology while also making providers uneasy. Perhaps the most well-known current barrier to HIT is provider and patient unease after using online sources, suggesting that “despite widespread access and generally high satisfaction with existing information, there is a need to evaluate the impact of existing services in terms of addressing unmet information needs and reducing patient anxiety” (Jones, Cassie, Thompson, Atherton and Leslie, 2014). Figure 3 below provides in more comprehensive terms the chief reservations many health professionals hold regarding HIT implementation from a more cost analysis perspective. Ultimately, this comes down to anxiety due to lack of critical information.

Figure 3

| Table 1. Barriers to Implementation of CQMS Identified in Existing Literature |
|---------------------------------|---------------------------------------------------------------|
| **Barrier Type** | **Typical Issues** |
| Situational | Time needed to implement, records conversion, adverse effect on workflow or efficiency, organizational structure, organizational culture, incentives |
| Cognitive/psychological | Lack of belief in value, need for control, anxiety over change, anxiety over technology |
| Liability | Privacy, security management, data integrity |
| Knowledge | Ability to evaluate and select systems, training |
| Financial | Start-up costs, training costs, uncertain or misaligned return on investment |
| Technology | Technical support, complexity, inflexibility of systems, customization limitations, reliability problems, data exchange problems |
| Workforce | Skillsets of physicians, staff skills, managerial/organizational support, leadership |
Recurring concerns revolve around training expenditures and perceived control of new systems, as well as privacy and security of data, all major contributors to anxiety over HIT adoption.

The unfortunate aspects of cost models within HIT also explore how patient data may be bought and sold in the future to organizations for profit. Potential stalemates of information exchange could occur if manufacturers of the hardware or software that compliments the health information used refuse to sell their product or even go out of business. In this scenario, HIT appliances could very well go out of production and patient data could be permanently lost (Kaushal and Blumenthal, 2014; Thimbleby, 2013). Similar price-driven HIT systems would likely impact the income of healthcare providers within this context as well since it is reasonable to assume that healthcare professionals would have to pay to access software and HIT equipment owned by outside sources to some degree. This does not even factor in the often enormous costs of maintenance for online resources such that donations alone may not be enough to solidify future emerging networks. Similarly, while there may be a positive correlation between advanced technology and treatment quality, the purchasing of increasingly complex and expensive HIT equipment may even increase human error in operating these devices if equal effort is not allocated to training professionals to use these devices as well. Additionally, no study has conclusively found that the transfer and conversion of current medical data into electronic forms would be easy and it almost certainly will not be cheap. Cost efficient construction and maintenance of such architecture will be almost entirely dependent on IT workers, further begging the question as to who the true healthcare professionals of the future will be—the physicians or the IT experts (Lilford, Girling, Sheikh, Coleman, Chilton, Burn, Jenkinson, Blake and Hemming, 2014; Dooley, Jones and Iverson, 2014).
Another obstacle to overcome with respect to emerging HIT systems is, somewhat ironically, the ease and speed with which health information can be published on the internet. This speed can act as a mechanism to work around necessary peer reviews and critiques that are especially important with medical documents used to possibly save lives. The methodology for eliciting only trusted and certified sources needs to be worked out in order to ensure that not only the quantity, but the quality of information as well, is up to par with professional and patient standards. Not only may online content be inaccurate, but it may even be deleterious for consumers. Recent findings indicate that YouTube videos relating to weight loss, for example, contained high levels of fat and obesity shaming content encouraging stigmatization of various health groups (Chou, et al., 2013). Thus one of the major pitfalls of rampant user-generated content concerning topics they are not well educated in can be abdication of acceptable medical theory and unwarranted social abuse. Positive changes will need to start with improved online accountability. For example, Lupiáñez-Villanueva, Mayer and Torrent (2009) found that only 66.3% of web pages offering health content provided the name of the author, while trust marks and codes of ethics were identified in only 11.5% of health web pages. Moreover, this study also found that only 43.7% of physicians and 45.3% of nurses thought patients researching their conditions online improved their knowledge and treatment. Paralleling this trend, McCaw, et al. (2014) concluded that only 47.2% of health websites analyzed had satisfactory quality reporting and that many news sources tended to over-emphasize health benefits whilst undercutting potential risks in order to increase readership—a clear reference to the invasion of misinformation from the internet being brought into clinical contexts and thus under necessary scrutiny.
Dissemination of inaccurate materials should not be wholly credited to lay users however. As Figure 4 intimates, many primary care physicians demonstrate an alarming lack of information sharing and discussion, making peer review of HIT materials that much more difficult. If healthcare professionals are incapable or, even worse, unwilling to communicate critical information with each other, how is the general public supposed to fare in a sea of ever-growing health information? Relatedly, not all HIT platforms will be easy to use and intuitive when first implemented and may even be time consuming or discriminate against users with disparate medical and educational backgrounds (Dooley, et al., 2014). Although participation should ultimately be encouraged so as to foment an individual’s ability to be an agent of their own health evolution, negative consequences of misusing or devaluing certain information systems could lead to misdiagnosis or even a loss of credibility for the source being used. Health information contributed by a mix of patients and providers could very well provide the necessary balance of personal opinion and expertise here, but several studies indicate that many people are not willing to merge their social media or personal parameters with serious professionals who often take on a leader type role as opposed to a friend (Dooley, et al., 2014).
**Figure 4**

Table 2: Practice Characteristics and HIT Capacity, U.S. Primary Care Physicians (2012)

<table>
<thead>
<tr>
<th></th>
<th>Unweighted N</th>
<th>Uses Electronic Patient Medical Records</th>
<th>Multifunctional HIT Capacity</th>
<th>Can Electronically Exchange Information with Other Providers</th>
<th>Electronic Access for Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. total</td>
<td>1,012</td>
<td>69%</td>
<td>27%</td>
<td>32%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formal arrangements with other practices/groups to share technical support for clinical information systems, and/or quality improvement consultants or support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>376</td>
<td>83***</td>
<td>38***</td>
<td>49***</td>
<td>47***</td>
</tr>
<tr>
<td>No</td>
<td>580</td>
<td>59</td>
<td>20</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part of integrated system (e.g., Kaiser, the V.A.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>276</td>
<td>87***</td>
<td>41***</td>
<td>51***</td>
<td>56***</td>
</tr>
<tr>
<td>No</td>
<td>721</td>
<td>63</td>
<td>22</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Receives or eligible for targeted financial incentives†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>342</td>
<td>76***</td>
<td>31*</td>
<td>39***</td>
<td>40**</td>
</tr>
<tr>
<td>No</td>
<td>653</td>
<td>65</td>
<td>25</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Practice size†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solo</td>
<td>238</td>
<td>49</td>
<td>11</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>2 to 10</td>
<td>485</td>
<td>70***</td>
<td>29***</td>
<td>32***</td>
<td>32*</td>
</tr>
<tr>
<td>&lt;10</td>
<td>99</td>
<td>84***</td>
<td>32***</td>
<td>41***</td>
<td>38**</td>
</tr>
<tr>
<td>11 to &lt;20</td>
<td>20 or more</td>
<td>90***</td>
<td>45***</td>
<td>45***</td>
<td>61***</td>
</tr>
</tbody>
</table>

*Table taken from Audet, Squires and Doty (2014) “Where are we on the diffusion curve?”

Despite a majority of U.S. primary care physicians using EHR’s in 2012, only 32% reported exchanging such critical information with other physicians, thus greatly limiting the development of regional or global medical communities.

From the healthcare professional’s perspective, chronic lack of use of most online medical databases represents a unique and dynamic cross between a perceived lack of value in such resources and, more simply, lack of experience in using such resources to their fullest capacity. Figure 5 is necessarily startling in that it expresses an austere lack of knowledge and utilization regarding critical HIT resources among U.S. physicians surveyed, despite reasonable credibility of most sources. These findings are shocking because they suggest that even if HIT systems are integrated in professional practices efficiently and effectively, they still may not be used to their full potential due to lack of training in how to implement HIT into everyday life or a perceived lack of value of such systems.
Emerging Information Technology

Although Google (including Google scholar) and Medline top the list of most used databases for research articles, they are used by about only half of health professionals surveyed on a daily basis, with all other databases registering under the 5% daily usage mark. When acquiring patient care information, these numbers are even lower.

*Tables taken from DeGroote, Shultz and Blecic (2014) “Information seeking behavior and the use of online resources”*
The differences in socio-economic status (SES) between groups responsible for disparate access to health technologies, termed the “digital divide,” is yet another hurdle HIT systems must overcome in the future in order to be effective (Chou, et al., 2013; Kaushal and Blumenthal, 2014; Green, et al., 2015). Individuals of differing education levels and medical literacy functionalities will not necessarily benefit equally even if they were presented with the same care, which is rarely the case. Different groups and communities may perceive the same message in drastically different ways and will thus establish differing levels of comprehension and trust for the same information, exacerbating the divide further. Chou, et al. (2013) further suggests that current HIT disparities already run along existing ethnic and racial health disparities. Problems with insurance availability and coverage appear to run along similar divides, such that the development of HIT functions that support widespread coverage has never been more pertinent (DeVoe, et al., 2014). Utilizing HIT and EHR’s to conduct health insurance inreach and outreach is one such way of expanding positive health outcomes to in-need areas. HIT “adoption gaps” have also been reported between large and small centers and primary care practices supported by drastically different resource pools, demonstrating that population statistics and sheer resource availability also play a role in HIT disparities (Green, et al., 2015; Kaushal and Blumenthal, 2014). When not handled accordingly, such gaps may coalesce into an “inconvenient truth” where potentially beneficial systems must be fastidiously assessed for cost effectiveness depending on the wealth of the environment around it (Lilford, et al., 2014).

Recent literature suggests that gender gaps play an exigent role in terms of HIT usage, with women being “the most frequent users of the internet as a health information source, perhaps resulting from their frequent roles as caretakers for children and aging parents” (Koopman, Petroski, Canfield, Stuppy and Mehr, 2014). By extension, Jones, et al. (2014)
similarly report an age gap among fundamental HIT operations, with older populations reporting a far greater perceived complexity and thus difficulty of use with web health applications. Overall, health practitioners and patients alike should be aware of the impact they leave via their interactions with HIT systems so as to foster collaborative approaches to knowledge sharing and learning since this has been strongly correlated to increased support, health and community development when used appropriately (Sandars and Langlois, 2006). With the beneficial applications and potential shortfalls of HIT infrastructure recognized, Information Measurement Theory can be applied in earnest to help materialize conclusive improvements.

**Critical Components of IMT:**

Paramount to this analysis of emerging HIT is the application of Information Measurement Theory (IMT) principles established by Professor Dean Kashiwagi of Arizona State University. In order to posit a clear and resourceful proposal toward HIT, the groundwork for such an analysis must first be put forth. Additionally, exhaustive coverage of central IMT concepts is provided in the glossary for further review. To start, figures 6 and 7 below provide the foundation of event and information processing within IMT. Deductive logic in conjunction with accurate perception of events increases predictability of future events and thus minimizes risk, anxiety and decision making (Kashiwagi, 2014). This is done most comprehensively with dominant information—easy to understand and real world truths that make events and the flow of time easy to predict and comprehend. A demonstration of this is the natural law of gravity, and that all objects that are not supported by some other force will succumb to gravity and fall. Thus a dominant description of truth of any object held in mid-air is that it will fall to the ground upon being released 100% of the time. Information and natural laws that dictate events are
always present and unpredictability of an event is due to lack of information or understanding of natural laws. This is why IMT can basally be defined as “the measurement of initial conditions that will predict the future conditions” (Kashiwagi, 2014). Similarly, the Kashiwagi Solution Model (KSM) is a system that uses dominance to minimize risk and decision making.

Figure 6

*Model taken from Kashiwagi (2014) IMT/KSM

With enough information, the individual will recognize that events can only occur one way and that past, present and future conditions are all intimately linked so long as the circumstances are understood.
Natural laws dictate the flow of events through time and can never be created or destroyed, but only discovered. Laws are the very essence of how conditions change over time. This parallels the discovery of information such that proper use of both make the future conditions entirely predictable.

Two fundamental distinctions predominate IMT, that of type A (left side, LS) people and type C (right side, RS) people. LS characteristics corresponding to type A people include the ability to perceive large amounts of information accurately and efficiently and, as such, can reasonably predict the final conditions of an event. This leads such individuals to not believe in control, influence or decision making because they realize the event can happen only one way (nature-driven). Truly type A people are typically visionaries within their field due to being supremely confident with both what they know and don’t know and are never afraid to ask fellow experts for advice and help, further increasing their knowledge (Kashiwagi, 2014). Type C people exhibiting LS characteristics, however, lack critical information and thus cannot predict.
events and believe they are controlled by the environment (nurture-driven). This makes sense as someone who understands very little of what is going on around them will be fearful of such processes and will easily perceive lack of control of their own life. Figures 8 and 9 below conceptualize these models further.

Figure 8

*Kashiwagi Solution Model (KSM)*

<table>
<thead>
<tr>
<th>Type A / Type C Characteristics</th>
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Type A people consistent with LS characteristics perceive maximum information and therefore understand the link between initial and final conditions and can predict the outcome of an event, with no room for decision making, perceived influence or control. Conversely, Type C people do not understand their surroundings or how events in real time progress. Thus they are more likely to sit back and believe the environment controls them.
People with LS characteristics (on the right side of the model) understand that they control their own lives as well as their environments (nature). They will not attempt to control others because they realize everyone would possess the same authority as themselves if only they had enough information.

With respect to type A vs. type C people, a continuum of information perception is formed where A and C are the extremes representing maximum and minimum perception, respectively. In between these extremes is type B, where most people reasonably lie in real life as everyone demonstrates a mix of type A and type C characteristics. With this continuum, a cycle of perception and learning is formed, with type A people being able to perceive, process, apply and change to information acquired most rapidly, corresponding to quick and efficient learning. In contrast, type C people are slow in completing this cycle and may even have to
repeat it several times before achieving mastery in comprehension. Figure 10 below is a visual representation of this cycle of learning.

Figure 10

*Model taken from Kashiwagi (2014) IMT/KSM

Type A and C people represent maximum and minimum speeds of comprehension, respectively. This is due to the efficiency with which each is able to navigate the cycle of learning, with LS characteristics corresponding to the most efficient learning.

Since perception is a key contributor to the learning and knowledge within IMT, it is imperative to understand the properties of the environment such critical information may come from. This is done via an equilibrium arrangement in which a truly type A, perceptive individual recognizes they must be in harmony with everything around them to maximize their rate of success. If M1 is taken as all internal systems comprising the individual (thoughts, opinions, contributions, etc.) and M2 is taken as environmetnal agents surrounding this person, it is possible and desireable to
have M1 and M2 equal to each other since the person creates the environment they live within in the first place (Kashiwagi, 2014). Further, the intelligent individual should be receptive and cognizant towards their environment, including the people around them, because individuals in isolation will have the most pressure placed upon them whereas living in equilibrium affords less pressure and anxiety irrespective of location. Model 11 below shows such an equilibrium as well as associated pressures.

Figure 11

*Model taken from Kashiwagi (2014) IMT/KSM

M1 and M2 arrows represent a balance between a person and their environment, respectively. The individual is responsible for the environment they find themselves in such that any pressures experienced from M2 are characteristics or weaknesses that the individual possesses. The analogue to this is the pressure a body of water and a dam place on each other, which remains in equilibrium at varying depths to be effective. Depth here can be thought of as varying levels of involvement and perception of that which occurs around an individual.
Figure 12

**Who is on my Molecule (WIOMM)**

*Model taken from Kashiwagi (2014) IMT/KSM*

WIOMM represents equilibrium at a specific point in someone’s life and represents both the types of people this person spends time with as well as the characteristics this person possesses. The “molecule” above represents a person whose landscape can be either type A or C depending on their traits. A mixture of both types is shown above, showing a more typical person.

A visionary person understands their environment to a point that they can comprehend everything around them is related to everything else because they themselves are responsible for its presence. As such, they realize that no individual stands isolated from the rest of the world and that everything occurs for a reason. Perceptions of chance or randomness in the environment is additionally attributable to a lack of information or understanding of oneself. IMT can readily be applied to systems larger than the individual and their immediate environment as well. In
terms of IMT application to monetary driving forces, the best value (BV) approach describes the consummate expert to be used if a contractor is needed. Such a contractor is proactive, exhibits expertise within their field, has a clear plan with reasonable scope, has strong plan for risk management, is truthful with all clients (transparent and ethical) and has everyone’s best interests in mind (Kashiwagi, 2014). This approach minimizes management, direction and control (MDC) for more sustainable working conditions and a high-caliber final product.

Proposal:

Applying IMT architecture to current and future HIT installation and administration will help promote a safe, productive and cost efficient healthcare system. Underlying presumptions regarding this model are that application of raw knowledge is not as valuable as adapting to and changing because of acquired knowledge. Despite the acquisition of information being fundamental to IMT, what the individual does with such information and how they better themselves with it is most critical. Control tactics here are taken as counterproductive (simply telling people what to read or believe accomplishes little) so extra care must be taken with content creation so that information that may be disseminated is based upon quality and clarity over sheer quantity. This can most reasonably be done with strong education programs and demonstration of type-A parameters. Ideally, more health conscious and responsible environments will follow from such a type A foundation and will parallel more cost effective initiatives (Kashiwagi, 2014).

Those currently skeptical of HIT should first view it within an IMT framework before denouncing it. When aligned with IMT information and event models, HIT has the potential to bring quality information to people which will allow them to better predict their own health
outcomes which, ideally, will lead to less anxiety and higher morale regarding prognosis and health treatment on a national scale. This lower anxiety model is consistent with HIT models already in place, such as online surgeon updates from Mercy hospital in Missouri easing the worry of the waiting families that was discussed earlier (Stump, et al., 2012). Increased predictability on the health landscape provided by HIT analysis would easily compliment advanced screening procedures for deadly diseases as well, altogether preventing illness and saving lives in the process. Simply, there is a large appetite for increased advice and data that only HIT can effectively provide. Jones, et al. (2014) support such sentiments, reporting that 61.2% of cardiac patients surveyed said they would greatly appreciate websites that provide more information regarding their conditions and symptoms. Additionally, 65% of these respondants also said that if such a national health service did exist, they would certainly use it. Additionally, when the concept of an IMT event is applied to the progression of a single disease, it is suggested that HIT offers superior predictability over current systems regarding patient wellbeing. Institutions that can more reliably predict health reactions and trends to treatment can readily be shared with such an institution’s partners in this journey—the patients themselves. Further, Sandars, et al. (2006) came to similar conclusions with a study group that found new knowledge was definitively being created due to online health discussions. Recent studies indicate that many professionals are open to conducting their operations in this way via HIT because applications like the “PRE-HIT” instrument, which measures HIT efficacy in real time, relieves much uncertainty regarding the true usefulness of such measures (Koopman, et al., 2014).

Those opposed to HIT simply because they perceive an impossible hill to climb in going from no meaningful use today all the way to advanced, widespread practice should reexamine
current findings further. Although the full potential of HIT has yet to be realized, meaningful use has already been in place for several years now, making it even more reasonable to expand upon existing foundations than starting from scratch. After all, it was found in 2012 that, of the 5800 U.S. hospitals examined, 486 had their own Youtube channels to keep patients updated, 777 had Facebook pages and 714 had Twitter accounts—all trends that continue to grow rapidly year after year (Stump, et al., 2012). By 2012, 72% of office based physicians were already using an EHR (DeVoe, et al., 2014). Further, 73.3% of physicians, 70.5% of pharmacists and 56.5% of nurses in 2009 considered the internet as an exceedingly relevant and useful tool for their jobs (Lupiáñez-Villanueva, et al., 2009). Summarily, by July of 2013, more than 80% of hospitals and nearly 60% of providers had “met requirements for adoption and/or meaninfu use of health IT” (Kaushal and Blumenthal, 2014).

By IMT standards, those with more knowledge of a health event will believe less in chance occurrances and will realize that everything occurs for a reason, two conditions that may very well make for more astute and accountable patients in the future-- so long as enough quality information is provided to them via HIT (Kashiwagi, 2014). Simply, HIT should be designed to allow people to have complete control over their own health and lives and to have the ability to know they possess such power. It is reasonable to believe that HIT systems, which will possess far greater knowledge and experience than any one person or team of people, will be able to supply this agency to the public. Within such a context, however, it is important to consider that intelligence and public education should not necessarily be equated to simple memorization of large swaths of information, but rather people should be encouraged to apply the cycle of learning to the information HIT can provide. Consistent with the IMT cycle of learning is that as people increase their medical knowledge, they will process faster and come to conclusions and
breakthroughs more easily (Kashiwagi, 2014). Keen observation, perception and learning will logically lead to more solutions on the global health landscape, with HIT ultimately providing the big picture framework. An example of this is a common medical occurrence where doctors get tunnel vision during long or complex procedures (such as long intubations). They may lose track of other vital processes due to the immediate pressure of the situation. This can be resolved with an “electronic ICU” control room driven by HIT which monitors the big picture of the patient situation. Professionals in another room would monitor the vital signs of the patient and collect endless data on their condition while the doctor in the OR is focused entirely on the surgery (Thimbleby, 2013). In fact, with properly used HIT systems, such an advanced control room could monitor perhaps a dozen patients like this at once, far exceeding what even the most experienced physicians could keep track of on their own.

Those opposed to HIT due to a perceived lack of usefulness or fear of investing in such a system need look no further than how IT is already used today. HIT implementation would not be the first time personal information has become intimate with technology, as online shopping and bill paying already possess great amounts of financial information, for example. Moreover, advanced multimedia is already being used in medical school to train future physicians, such as virtual surgeries or teleconferences with experts from across the world (Stump, et al., 2012). Tech is currently being used to enhance physician abilities as well, such as augmented reality endoscopies or telesurgeries (Thimbleby, 2012). Stump, et al. (2012) also reported on direct advancements in patient care as a result of using HIT, such as when Henry Ford Hospital used Twitter to test the responses of brain surgery patients to specific questions, or when members of patientslikeme.org banded together to discover Lithium as an acceptable treatment for ALS. Similarly, physicians in the ER have already received real time advice and updates from experts.
via Sermo which saved the procedure at hand from being unsuccessful. Despite security risks involved, most people still readily use their credit cards and online banking sites. The generation and analysis of “big data” in healthcare would reap similar rewards but with a much lower level of risk so long as these systems are adopted using IMT, which holds transparency and predictability largely responsible for risk management (Kashiwagi, 2014). This assumes, critically, that individuals are both producers and consumers of HIT and thus would not post anything that they themselves would find harmful or that may be deceitful. The key to this is thus IMT transparency: posting plain and easy to understand language that is genuine in its intent but still scientifically proficient for both professionals and the public. HIT will do the rest in ensuring that this information is properly organized and easily retrievable and that strategic planning is used to select the optimal channels by which this information is available (Dooley, et al., 2014).

IMT is especially valuable to HIT adoption when the prospects of a type-A environment are considered. The immediate problem environmental equilibrium of IMT mediates is the unsatisfactory healthcare people may find themselves currently in. Individuals with inadequate information on their health will be fearful of their environment for not knowing what is going on or the options available to them and thus will percieve a lack of control over their own life (Kashiwagi, 2014). By extension, such people are not in a good condition to choose their doctors or the kind of treatments they would like to receive, often times becoming a spectator to their own illness. HIT implemented with attention paid to WIOMM designs will give patients the information they need to realize that everything in their health environment is connected and originates from their own thoughts, actions, strengths and weaknesses (Kashiwagi, 2014). This gives individuals ultimate control over their own health treatments and information and, when
such ability is wielded appropriately, allows them to ask the right questions and seek the care best for them, given SES is not a drastic barrier to such concerns. Healthcare should adapt to patient needs, not the other way around. Individuals in poor health should not be expected to conform to difficult clinical environments and HIT coupled with IMT will give them the power to avoid such predicaments. Websites like rateMDs and patientslikeme.org provide the groundwork for such transparency and knowledge to empower people in this way—to allow people to truly know which kind of care is right for them and the ability to make an environment consistent with their own beliefs. As figure 13 below shows, such transparent information as physician ratings can be as detailed or simplistic as the the patient is willing to invest in their environment and treatment. After all, with greater knowledge comes greater responsibility and this is true for both patients and practitioners.

Figure 13

<table>
<thead>
<tr>
<th>Table 2 Description of healthcare providers</th>
</tr>
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<tbody>
<tr>
<td>Frequencies</td>
</tr>
<tr>
<td>No. of physicians (%) total</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td><strong>Physician</strong></td>
</tr>
<tr>
<td>Non-surgical subspecialty</td>
</tr>
<tr>
<td>Internal medicine</td>
</tr>
<tr>
<td>OB/GYN and IVF</td>
</tr>
<tr>
<td>Subspecialty surgery</td>
</tr>
<tr>
<td>Family practice</td>
</tr>
<tr>
<td>Psychiatry and addiction</td>
</tr>
<tr>
<td>Dermatology</td>
</tr>
<tr>
<td>Pediatrics</td>
</tr>
<tr>
<td>Cosmetic surgery</td>
</tr>
<tr>
<td>General surgery</td>
</tr>
<tr>
<td>Sports: physical medicine</td>
</tr>
<tr>
<td><strong>Non-physician</strong></td>
</tr>
<tr>
<td>Dentistry</td>
</tr>
<tr>
<td>Mental health (psychologists, counselors)</td>
</tr>
<tr>
<td>Non-physician extenders (podiatrists, optometrists)</td>
</tr>
<tr>
<td>Alternative (acupuncture, naturopathy, chiropractic)</td>
</tr>
<tr>
<td>Other or not specified</td>
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</table>

*Table taken from Black, et al. (2009) “An analysis of healthcare providers’ online ratings”*
Patient ratings from survey results for both physicians and non-physicians across multiple specialties on critical care categories like “punctuality,” “helpfulness,” and “knowledge.” Each rating is on a 1-5 scale, with 5 being the best. Access to such information via HIT maximizes transparency and gives patients much more power and responsibility in choosing the care right for them.

HIT has the potential to provide a global health community with a unique influence and participatory nature. Chou, et al., (2013) studied the influence of such a community and found that viewer comments on online health forums influenced other viewers’ perceptions of health videos on Youtube such that adherence to a type-A WIOMM landscape of quality information and minimized control tactics is essential to ensuring such an intra-influential health community works together and not against each other. Findings by McCaw, et al. (2014) are further encouraging in this regard, noting that 83.9% of online health articles analyzed were rated as having balanced judgement and being properly tailored to specific health inquiries. Current models are already being explored to advance this landscape effectively as well. The National Health Service has made patient education, defined as “empowering patients to understand, evaluate and use health information to make informed choices about their treatment and self-management,” a strategic priority (Jones, et al., 2014). Moreover, Gibbons, et al. (2011) has postulated advancements in “populomics” which hopefully will advance the marriage of medical information and population research to better understand health disparities and treatment gaps--a marriage ultimately made possible by HIT and IMT. Optimistic analogues to this intelligent and responsible environment also include applications like Google Health, Microsoft Health Vault, Health Space and Semantic web technologies, which are already pursuing avenues to developing personal health records and search engines (Lupiáñez-Villanueva, et al., 2009). If kept within an IMT framework in avoiding RS characteristics, these paths will no doubt prove reliable and
trustworthy. Examples of simple improvements to online communities would be to improve access to article origins or authors, affiliations behind the content as well as the time of publication, which 100% of articles should ideally provide. Ultimately, a balance between quality system and user-generated content catalogued in accordance with such accountable organizations would represent the pinnacle of IMT equilibrium. Chou, et al. (2013) has even proposed a STAR model (spiral technology action research) that is in line with this equilibrium as it treats social media as a multi-directional dialogue between producers and consumers whose forces consistently balance each other out. Applied to HIT, the individual would seek out the information they want from a pool of information they themselves are able to contribute to and shape, with constant feedback from the people they choose to be around.

The last major hurdle to clear before HIT can be implemented is concerns over cost. So long as IT experts and medical professionals are comparable to best value (BV) contractors within the IMT model, cost efficient solutions can be proposed. HIT gives power to the people in the form of critical information and, by its most basal nature, is not intricately entwined within high level regulation or bureaucracy. This is consistent with efficient IMT methods, intimating that HIT systems with minimal regulation will give the best products and lowest costs (Kashiwagi, 2014). Incessant regulation increases costs since money must be spent to enforce them and also uses time that could be better spent generating more helpful content. HIT systems should be run on a merit system whenever possible so as to stay consistent with the balance between user and system power. Within this structure, strictly monetary incentives proposed to increase adoption rates, similar to type C characteristics, are not encouraged either because the model assumes only passionate and accountable people will invest in HIT communities and thus would not be driven by incentive-based competition. This dually allows communities to
contribute and analyze precisely however much information they desire without forcing anything onto them, as well as to minimize competition between individuals and practices, which may only distract from the true goal of HIT-- improving health outcomes for all.

One way to make HIT more cost effective to is examine whether or not it has the ability to minimize costly errors in treatment. Aita, et al. (2013) examined the effect computerized physician order entry (CPOE) systems have on the frequency of prescribing errors and found they simplify otherwise complex problem areas while reducing the chance of such errors. Such an implementation would recoup costs in initiation and maintenance very quickly by avoiding potentially damaging medication errors with a consistency hard to maintain with any other system. For a contemporary demonstration, electronic prescriptions have already eliminated countless medication errors due to poor handwriting, increasing efficiency and saving time (Thimbleby, 2013). Figure 14 gives a numerical breakdown of typical errors experienced in a clinical chemotherapy setting, further echoing the need for CPOE-like systems.
It should be noted that once CPOE was initiated in the study, actual prescription errors due to use were cut down to only 8% (not shown in table). However, risks regarding improper training and installation of this new technology had an noteworthy impact as well.

Other options to cost efficient HIT models include integrated delivery systems or the coordianted sharing of resources with other practices, which have been shown to increase HIT adoption without the need for explicit incentives or further spending (Audet, et al, 2014). Work-study type programs or internships could be an extension of this as well. Neighboring practices already experiencing success with HIT would allow others to observe their work environment or even send temporary HIT teachers into the community to explain efficient methods of use. Such planning would minimize SES gaps and would help bring HIT to marginalized or underserved communities. This, of course, is at least partly based on the principle that genuinely concerned and interested HIT adopters would want to spread their knowledge and satisfaction by such
methods in order to further a health community that they are a consumer of themselves. Although getting rid of the digital divide and other gaps entirely is nearly impossible, various “delivery reform projects” that provide organizational or technical resources are promising avenues that may limit these gaps still (Kaushal and Blumenthal, 2014). Although cost of implementation and maintenance should undoubtedly be a concern, recent surveys indicate that this is not necessarily the biggest reason behind lack of HIT use and so should not be treated as such. The most frequently cited barrier to use in 2009 was “lack of time in the workplace,” which is far from an impossible situation to correct (Lupiáñez-Villanueva, et al., 2009).

With respect to possible conflict over patient data ownership, as well as what exactly organizations might due with large pools of data solely in their possession, IMT infrastructure offers compelling models for HIT. While agencies like Creative Commons are already setting precedents for ownership of digital content and licenses, open and peer-reviewed arrangements consistent with IMT transparency and education of expert blogs could lower the access barrier even further (Lupiáñez-Villanueva, et al., 2009; Chou, et al., 2013). Since data mining and cloud based computing may become tools novel to HIT communities and could be used to gather pools of content from many different sources, the chances of critical information existing in only one place or by only one person are further diminished (Chou, et al., 2013). Appropriate levels of perception and predictability as encouraged by IMT parameters would further make the intentions of companies apparent, labeling them as possibly at risk sources or removing them from an otherwise successful HIT community altogether. Additionally, more transparent drug trials would prevent companies from earning unwarranted profit by only publishing literature that makes their drug or instrument seem effective, saving the community money in the long run (Thimbleby, 2013). Conversely, the consumer should not dominate the HIT landscape either as
this would violate IMT equilibrium, making it necessary to always consider what is actually practical and in the best interest of others.

**Conclusion:**

Health Information Technology (HIT) has the potential to transform the modern healthcare landscape by providing the resources necessary to serve the rapidly growing patient population. Although HIT is not a new concept and has largely proved its effectiveness already with the use of electronic health records (EHR’s) and electronic prescriptions, it still poses striking possibilities for the future. Despite the use of many HIT systems being quite encouraging, problems concerning information security, costs of implementation, and SES gaps, to name a few, pose pressing barriers to adoption. The best way to address these obstacles is to develop and implement widespread HIT within an Information Measurement Theory (IMT) framework endorsed by type-A characteristics. This proposal is in line with HIT community environments that uphold critical education, accountability, predictability and transparency. These are traits that will ultimately allow patients to be both producers and consumers in future health programs—intelligent agents of their own well-being. A discerning review of relevant studies and findings revealed that HIT is, in fact, useful and is paramount to future healthcare endeavors. With this, it is recommended that HIT models not be brought up in haste but rather under adequate IMT guidelines so as to maximize safety, efficiency and limit unnecessary expenditures.
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Appendix I: Glossary: (Kashiwagi, 2014)

Alignment: A personnel’s capability allows them to successfully do the required task. A person can do the required task with the minimum amount of management, direction and control.

Apply: Application of processed information (See "Cycle of Learning").

Assignment of Personnel: Assignment of personnel by vendors is dictated by business principles of making a profit and meeting the buyer's expectations. Higher paid experts should not be sent to environments where they are being directed, managed and controlled. Experts should be sent to outsourcing owners which allow the higher paid experts to proactively plan and mitigate the risk that they do not control. Experts, who are higher paid, finish projects faster, with greater quality and do it cheaper and faster due to their expertise.

Best Business Practice: The Best Business Practice (BBP) is what the majority of businesses attempt to do to efficiently complete their work. BBP are the more traditional methods to be efficient. IMT states that most people are blind and resistant to change, and use decision making, direction and control practices to become more efficient. BBP coexist with the price based marketplace.

Best Value Practice: The Best Value Practice (BVP) is when management, direction and control are replaced by expertise. BV practice includes the minimization of risk that the expert does not control. The BV approach is to use performance metrics, create a "win-win", use a supply chain approach and create a transparent environment. BV practice increases value and minimizes cost.

Best Value: The best value is the best value [quality] for the lowest cost. The best value is the best available option. The BV PIPS process uses dominant information [performance metrics] to determine the best value. If there is no dominant information, the low priced option should be the best value.

Best Value Approach: Practices the use of dominant information in a transparent environment which minimizes the use of decision making, direction, and control. The approach uses dominant information (verifiable performance metrics that everyone can understand).

Blind: Describing a Type C individual, who has a lower perception and processing speed. Blind people cannot observe reality. Their blindness is caused by their own biases, which override the observation of reality. Blind people cannot see into the future, use decision making as the primary method to predict future outcomes. Blind people have Type C characteristics, and make up the majority of the human population.

Bureaucracy: Objective of a bureaucracy is to stabilize the environment by stopping change. An example of a bureaucracy is an organization which is based on relationships, positions, and rules. Common sense and logic are not practiced in a bureaucracy. Bureaucracies are setup to stop change. Rules are setup to release personnel from accountability. Efficiency and effectiveness is not an objective except in stopping change, efficiency, and effectiveness. Bureaucracies are not measured, and any semblance of measurement will be inaccurate. That regiments excessive procedures, red tape/security checks and routines. These functionalities generate a
reactive, confusing, complacent and inefficient environment. The bigger the organization is in size, the more bureaucratic it will be.

Change: To create a difference from what originally was, resulting from the application of newly perceived information, and leading to a state of using newly perceived information (One of the actions in the “Cycle of Learning”).

Control: An incorrect and inaccurate concept that an individual can take away another individual's free will by forcing them to think, to feel or to act in a directed manner. IMT and KSM support the idea that an individual cannot control another individual, but that every individual has complete control over their own lives. If a person believes in control, they must also believe in chance, and will be more likely to blame others and not be accountable for failure. Influence is a mild form of control.

Conditions: Conditions are a description of reality such as time and location. There is no space without conditions. Conditions include factors that make each condition unique. A unique condition has many different factors including people, resources and environment.

Cycle of Learning: The cyclical procedure, by which a person perceives, processes, applies the concepts and changes according to understanding and application of the newly perceived information. As people go through the cycle of learning, the speed at which they go through the cycle gets faster. Those who do not change as quickly, have slower perception and processing speed. The cycle of learning when combined with the event happening one way, identifies that people are always doing the best they can based on their level of understanding. People who change quickly are identified as Type A with more LS characteristics, and those who change slowly are Type C using more RS characteristics. Everyone's rate of change is predictable because it is governed by natural law.

Decision Making: An action taken by an individual when they perceive potential multiple outcomes to an event [multiple potential outcomes are in their mind based on the lack of information and biases]. Decision making identifies an individual as not understanding the initial conditions, and requires the individual to use their own personal experience to solve the problem. Decision making increases risk. When someone makes a decision it is because they cannot identify dominant information that dictates the future outcome. Therefore, decision making is based on information that they do not understand. Decision making increases risk.

Decision-Maker: An individual who maximizes their risk by making decisions when they do not have enough information to identify or predict the future outcomes (see "Decision Making").

Deductive Logic: A type of reasoning where individuals make conclusions from observation of dominant or easily recognized general truths, laws or concepts. Deductive logic requires an accurate perception of reality and the ability to explain the concepts in terms of knowledge that is understood by all. Deductive logic does not require detailed technical expertise to understand the initial or final conditions.
Dominant: A description of truth that is simple, easy to understand and predicts the future. A principle that is so simple, apparent, relevant and important, that it can predict the final outcome. Everyone will be motivated to do the same thing because they can understand the dominant information and see into the future. Dominant information usually results in consensus. Dominant information identifies the future outcome, and motivates everyone to reach the same conclusion. Dominant information is often in terms of numerical measurements.

Equilibrium: A static [not moving] condition in the environment where every force is opposed by an equal and opposing force. Every location in space will be at equilibrium and have a unique pressure and has an equal and opposing force.

Event: Anything that happens that has time duration [takes time]. An event has unique initial conditions, changing conditions throughout the event and unique final conditions. The event initial conditions dictate the final conditions due to the natural laws that dictate how conditions change over time. All events have been observed to have only one outcome. Hindsight verifies that events can happen only one way. The description and logic of the event model proves that no one can influence, change or control the event or any of the event participants to change the final conditions to something that is not related to the initial conditions. Every event initial conditions are unique based on time and location.

Expert: A person who is proficient and specialized in a certain skill, practice or service. Their knowledge base and experience allows them to accurately predict future outcomes. Experts do not have technical risk in their area of expertise. The only risk they have is the risk that they do not control. Experts always think in the best interest of the buyer and will identify and mitigate the risk that they do not control.

Final conditions: The end result of an event. The unique final conditions are controlled by the unique initial conditions and natural laws.

Industry Structure: Industry structure model is based on perceived competition and performance. Structure divides the industry into four different environments: price based, best value, relationship based or negotiated, and unstable environment [non-sustainable] due to vendors having neither competition nor performance. This is also called the Service Industry Structure (SIS) or the Construction Industry Structure (CIS) models. The model explains that the price based environment has poor performance due to the wrong party doing the talking (the buyer directing the expert vendor on what to do). In the price based environment, management, direction and control [MDC] is utilized to minimize risk, while in the best value environment, the best performing vendors identify what can be done, write their own contract, and manage their own project.
Influence: Lesser form of control. Influence and control are both forces external to people. The person is being acted upon and has no control over the forces that are acting upon them. The majority of people believe that one person can influence another person. Deductive logic and the KSM identify that one person cannot control another person. People who believe in influence also believe in chance, not planning due to external forces changing the future, blaming others when something goes wrong and a lower level of accountability. Logic and observation identifies influence with Type C or RS characteristics. This identifies it as opposite to accountable, planning, visionary, and continuously improving people.

Information: Information includes the description of natural laws and unique conditions. Information can be in different formats. Dominant information is in terms of numerics that can be easily understood. Dominant information will be easier to understand, minimizes decision making, and will bring consensus as it will define the final outcome in everyone's mind.

Information Measurement Theory (IMT): The measurement of unique initial conditions that will predict the future conditions. IMT also includes the use of deductive logic, common sense, and dominant information to predict the future outcome. IMT was developed by Dean Kashiwagi and the Kashiwagi family starting in 1997.

Initial conditions: The sum of all factors and natural laws that make up the beginning of the event. The more initial conditions that can be perceived and measured, the more accurate the prediction of the final conditions. Every set of initial conditions is unique due to time and location.

Kashiwagi Solution Model (KSM): A mechanism where dominant solutions are derived using extreme positions. Extremes are used to minimize decision making in understanding the difference between "Type C", "RS" characteristics and "Type A", "LS" characteristics. KSM model assumptions are that all "LS" characteristics and all "RS" characteristics are related and relative.

KSM Level 1: The foundational KSM characteristics (information, decision making, and management, direction and control of others (MDC)). The foundation characteristics are recursive in nature (explanation is the characteristic).

KSM Level 2: The easily observed processes and actions of a person or group.

KSM Level 3: The KSM characteristics which are more difficult to define or perceive. Normally people make decisions to identify if the characteristic is LS or RS.

Knowledge: Includes description of conditions and natural laws. If someone has more knowledge, they have greater perception, and a greater ability to predict the future. Knowledge is finite because laws and conditions are finite, but the majority of human beings do not have the capacity to understand all or most knowledge. Many differentiate between knowledge and information; however IMT identifies them as synonyms.
Natural Laws: Natural laws dictate how conditions change over time. If understood, laws can be used to predict a future event and outcome. Laws include laws of physics and laws that predict human behavior. Natural laws are discovered and not created. Anything governed by laws are predictable. Anything that is predictable is governed by laws.

Left Side (LS): The left half of the KSM that represents the dominant characteristic of the Type A individual.

Low Bid: See "Price Based."

Manage or Management: Any personnel who use decision making, direction, control and rules to govern or motivate others to meet the expectations of an organization. Management or managers usually are Type C, and use management, direction and control [MDC].

MDC: Management, direction, and control (Used to minimize risk instead of utilizing expertise).

Minimum Standards: Standards that are used to identify the minimum acceptable level of quality. Minimum standards are usually someone's perception of "what is allowable." Minimum standards are a form of MDC. Because it is subjective, connected with low price and requires interpretation, minimum standards usually result in quality going down. They are subjective and usually allow the majority of manufacturers, materials and people to participate in an industry. Minimum standards are ineffective in maintaining quality and minimizing risk.

Negotiated Bid: An industry quadrant that provides high performance with low competition. It involves the client and supplier developing a relationship based on trust. This type of selection has been diminishing, because it is difficult to sustain in the competitive worldwide economy due to its lack of competition and a perception that it is not the best value.

New Contract Model: A model where the vendor is the offerer and the owner/buyer is the acceptor of the offer. The vendor, being the expert, identifies exactly what they are going to do and how they will mitigate the risk that they do not control. It is where the vendor is the expert and the buyer wants what the expert can deliver based on their requirement. The client ensures the vendor has a quality and risk management control program and is using it. This contracting model minimizes the need to manage, make decisions, direct, control and do owner inspections.

New Contractor Delivery Requirement Model: A model in which the buyer identifies what they think they want, also known as "intent." Vendors/contractors will propose scopes that will bring the buyer the most value for their intent. The buyer will then choose the vendor who brings them the most value for their budget.

New Leadership Model: The new leadership model minimizes decision making, management, direction and control [MDC]. The new leadership model replaces management, direction, control [MDC] and decision making [DM] with the alignment of expertise. The new leadership model does not include terms such as influence.
New Risk Management Model: A model that minimizes risk by hiring expert vendors and having the experts clearly identify the unique initial conditions, predict the final conditions, deliver the project requirements and identify and mitigate the risk that the expert does not control through transparency. In the new risk management model the owner/buyer does quality assurance (ensuring that the expert is using their risk management program.) The new risk management model does not use management, direction and control [M DC] to minimize risk.

No Decisions Structure: Model which removes the sharing of risk and assigns the risk to a singular party, generally the owner. An expert vendor minimizes their scope until their scope contains no risk. Communication is minimized to the language of metrics. Experts will minimize decision making.

Outsourcing owner: The owner who understands they are "not the expert." The outsourcing owner uses best value (BV) PIPS to identify the BV vendor, then transfers the control of the project to the vendor, and forces the vendor to preplan, identify and mitigate risk that they do not control, and increase value and quality by minimizing project time and cost deviation.

Partnering owner: The owner who feels the vendor is not technically competent enough and that their project is different from anything the vendor has done in the past. A partnering owner has an issue with control and does not want to turn over the control of the project to the vendor.

Past Performance Information (PPI): PPI is metrics which show a vendor or individual's past performance. It is an optional submittal requirement in BV PIPS Pre-qualification Phase. PPI can also be used to describe a vendor's performance and competitive advantage. PPI can also be used to communicate to a buyer's selection committee in a best value process.

Perceive: To sense, realize or observe information that exists (see "Cycle of Learning").

Performance Information Procurement System (PIPS): BV PIPS is a licensed and copyrighted delivery system created by Dean Kashiwagi in 1991, and modified and improved for the past 20 years. PIPS has four phases, four selection filters, and five selection criteria. PIPS is based on the IMT deductive logic of minimizing the functions of decision making, management, direction, and control by requiring dominant information.

Performance Information Risk Management System (PIRMS): PIRMS is the use of the last two phases of PIPS, the Clarification Phase and the Execution Phase. PIRMS was created with the US Medcom research project to show that the paradigm shift is practiced more in the second two phases then in the first two. The PIRMS does not require the use of BV selection.

Process: Component of the Cycle of Learning. To actively think about and study perceived information (see "Cycle of Learning").
Price Based: Description of a procurement system and industry environment where the client/buyer assumes that they are the experts and use MDC to minimize risk. The lowest submitted price dictates the contract award. The price based environment has high perceived competition and low performance because they are using MDC instead of utilizing expertise. The price is the most important factor. Even when other factors are considered, if the other factors are subjectively rated, the owner who is priced based will award based on low price without regard to the quality of what they are buying. Owners who award based on the low price do not understand the true value or cost of delivering a service or product. They gravitate to price because they are blind, the environment is not transparent, and the buyer is thinking in terms of "win-lose." A price based buyer is Type C.

Price Based owner: The owner that will select the vendor/contractor based on price is Type C, blind, and will manage, direct and control (MDC) the vendor/contractor to achieve high performance.

Rate of Change: The measured rate of change over time. Rate of Change is always predictable due to initial conditions which include a predictable rate of change.

Right Side (RS): The right half of the KSM that represents the dominant characteristic of the Type C individual (see "Type C").

Risk: An unforeseen event or situation in which the expert vendor does not control. The expert vendor will identify the entities in an activity that has potential to increase the cost, or time of a project. (Other vendors, Owner's personnel, weather, etc...) Expert vendors will identify the risk and risk mitigation before the project starts and use transparency to motivate the minimization of risk.

Risk Management: The traditional explanation of the management of risk. This is an action of a Type C person. Risk is defined by IMT and PIPS as the risk that an expert does not control. Because there is no influence or control over other parties, risk can be identified and mitigated by making the environment transparent. The parties who cause the risk will be personally motivated to minimize the risk that they cause.

Risk Mitigation: The identification of how the risk will be prevented before it occurs, the creation of a transparent environment to expose risk creating actions to the individuals who are the source of risk and the documentation of the results. Risk mitigation does not include direction and control. Traditionalists confuse risk management with risk mitigation.

Technical: A detailed description of a task or someone with detailed information required to do a specific task that takes experience, education and training.

Traditional Contract/Delivery Model: The most commonly accepted and used contract type and delivery model where the buyer/client directs the expert vendors on what is required and how to deliver the deliverables. The buyer is the offerer and the expert vendor is the acceptor of the offer. Normally the traditional contract model objective is to lower the price of the vendors. The resulting impact on value and quality is that the value and quality are minimized. This model requires Type C characteristics in all participants.
Traditional Risk Management Model: The most commonly accepted risk management model where the buyer controls the project and vendor. The buyer uses decision making, management, direction and control to meet their expectations. Traditional risk management personnel normally try to mitigate risk during the event.

Trust: Is an expectation of another entity with no dominant information and metrics to support it. It is only needed in a non-transparent environment. It increases risk, decision making and reliance upon relationships. Dominant measurements minimize the need to trust others.

Type A: An individual who processes information at a higher rate. The population of Type A people is the smallest group.

Type B: An individual who processes information at a moderate rate. Number of Type B are less than Type C. Type B are generally not used because they are moderate and not an extreme.

Type C: An individual who processes information at a slower rate. Type Cs are shortsighted, decision making personnel, who cannot see things from beginning to end. Type Cs have the largest population.

Visionary: Describing a Type A individual whose high perception and fast processing speed allow the individual to apply correct laws, identify conditions and perceive concepts that result in quick change and continuous improvement. Type A individuals can use their understanding of natural laws and perceived existing conditions to be able to see into the future.

Who Is On My Molecule (WIOMM): A leadership model stating that people and environmental characteristics around an entity or individual are a direct reflection of that entity or individual. This perspective allows an entity or individual to measure who they are by looking at the people with whom they spend the most time.