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IS E-HEALTH A DISRUPTIVE INNOVATION WITHIN A HEALTHCARE DELIVERY?

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1. Abstract

Disruptive Innovation is a complex concept introduced in 1995 by Harvard Business School professor Clayton M. Christensen, and describes a situation when simpler technology unseats the dominant one in the industry. However, currently it became a very popular “buzzword” and many innovations are called that way without a throughout analysis. eHealth, an ICT-based innovation within the healthcare delivery is commonly called disruptive in many publications such as: professional articles and books. However, there has never been done a detailed analysis to support this hypothesis. This work aims to analyze if the label of disruptiveness is suitable for this specific technology. The main characteristics of the concept were listed and subsequently tested whether they apply to eHealth - innovation within very peculiar healthcare delivery industry. This analysis indicated that eHealth, although may become disruptive, does not fit into traditional disruptive theory framework proposed in 1995.

Keywords: eHealth, disruptive innovation, healthcare delivery, hypothesis testing

2. Research objective

E-health, ICT innovation within healthcare delivery has already led to significant advances in a patient's provision and a doctor's efficiency worldwide (Christensen, Bohmer & Kenagy, 2000). This technology is commonly called as disruptive, by consulting companies Deloitte and McKinsey (McKinsey & Company, 2014) (Deloitte, 2014), Christensen's Institute (Vijayaraghavan, 2011), in the professional articles (Yellowlees et al, 2011), books (Gurtner & Soyez, 2014) and commonly on the Google search websites, among others. That implies that it gives or has potential radically change the the market rules for both companies and customers (Gilbert, 2003). The theoretical concept itself is complex, but the term became lately a very popular "buzzword" (Yglesias, 2013) and therefore many innovations are labelled as disruptive without a throughout analysis (European Comission, 2015). Although eHealth is widely quoted as disruptive innovation there is no study that examines if it is in line with theoretical model and fulfills all the necessary conditions. These attributes were first described by Christensen in the publication "the Innovators Dilemma" based on the disk-drive industry and were verified on steel and retailing industries, among others (Christensen & Utterback, 1997). Therefore, it is unclear and need to be tested whether theory characteristics will apply to highly regulated healthcare, not regular profit-led market. This work starts by listing the most important attributes of the Christensen's disruptive innovation model and then use a qualitative analysis procedure to assess if they apply to eHealth, the innovation within healthcare. There will be no formal statistical hypothesis testing performed, but its steps will be used as a framework for qualitative research. The analysis will be conducted using professional articles and case studies searched in the PubMed, Web of Science databases, high-quality consulting company reports and statistical data in a way described below.

3. Innovation in Healthcare – Literature Review

Christensen's model of a disruptive innovation

There are numerous articles that tackle the topic of innovation within a medical industry and the nature of innovation has already been widely described. Although high importance of innovation in the development of economic entities, there has not been worked out one specific definition of this notion. Meanings quoted in the literature differ when it comes to the scope and subject of innovation. (Elspeth McFadzean, 2005). According to the definition widely used in the healthcare-related literature, innovation is “an idea, practice, or object that is perceived as new by an individual or other unit of adoption if an idea seems new to the individual” (Rogers, 1962).

In 1995 Clayton M. Christensen introduced a model of innovation, that can be described either as sustaining or disruptive. Sustaining innovation is characterized as a modification that advances the product within the traditional performance frameworks. On the other hand, “Disruptive innovation is a powerful means of broadening and developing new markets and providing new functionality, which, may disrupt existing market linkages” (Christensen & Utterback, 1997). It is a theoretical term to explain the situation when new company serves completely new customers or targets least profitable customers with new products. This new entrant is usually capable of challenging industry giants and disordering old systems with a smaller cost. (Kopalle, 2006) Specifically, incumbents, market leaders, with a time start to ignore the least-profitable customers and put existing product improvements in the center of attention in order to appeal to their leading, most profitable customers. Thus, they often miss the business opportunity coming from not yet existing markets or from least profitable ones. The entrants that eventually turn out to be disruptive start by targeting the segments that are overlooked by incumbents in the process of providing products of significantly lower performance level and lower cost (Christensen & Utterback, 1997). Nevertheless, with a time,

the entrants improve and move to the mainstream market while retaining and improving the innovation that accelerated their early success. At the moment when mainstream customers begin to adopt the entrants' products or services in volume, the disruption is arousing.

Disruptive innovation within healthcare

There are disruptive innovations that have already transformed healthcare, and resulted in increased quality, considerably greater convenience, consumer satisfaction while at the same time have decreased overall costs. Example cited by Christensen is angioplasty. Before this innovation, patients who had disease of coronary artery were treated with a bypass surgery. It was a very complex operation requiring multiple specialists, technologically sophisticated equipment and weeks of recovery (Krans i Watson, 2015). Angioplasty, as an innovation, supports most of the Christensen's theoretical model characteristics. For example, it is so simple, that it can be performed in cardiac-care centers which significantly decrease the costs. It is also much more convenient way of treatment as it causes less pain and disabilities for a patient (Berlin, 2006). Moreover, the agents of incumbents leading customers – surgeons were sceptic about the procedure because of its limited performance (Sensmeier, 2012). Indeed, it was much less effective then bypasses and therefore was used only in the simplest cases. (Zimlichman & Jeffrey Levin-Scherz, 2013). However, sustaining technological innovations together with gained experience and skills, allowed angioplasty to replace complex bypass surgery in many cases. Additionally, as the specialists focus on the sickest of patients, less-skilled medical staff is allowed to perform treatment of coronary artery diseases. That serves efficiency to the specialists work-time. All of the mentioned characteristics imply that angioplasty was a disruptive innovation.

4. Methodology

The work aims to evaluate whether eHealth adhere to already defined disruptive innovation characteristics. The research will take a form of a detailed case study of the eHealth industry. The following attributes of the theory will be enumerated and consequently assessed based on published evidence:

| Disruptive innovation characteristic: | Hypothesis: | Method of evaluation: |
|--|--|--|
| Disruptive innovation is: “initially lower performing” | H ₀ : eHealth represents lower performance than the paper-based healthcare delivery | 74 articles regarding patient health outcomes (Appendix 3) and 74 articles regarding clinical process efficiency (Appendix 4) were evaluated |
| Incumbents’ leading customers “cannot use and do not want disruptive technology” | H ₀ : leading customers of paper-based healthcare do not want or cannot use eHealth | 51 articles regarding end-user perception were evaluated (Appendix 5) |
| Disruptive technology “promises lower cost opportunity” | H ₀ : eHealth is simpler and stands for the lower cost than paper-based healthcare delivery | 39 articles on a cost difference between eHealth and the paper-based healthcare delivery were evaluated (Appendix 6) |
| Disruptive innovation is “first commercialized in financially insignificant or emerging markets” | H ₀ : eHealth takes root in the low-end markets or among non-consumers | The concepts of low-end and new market disruption were evaluated based on a statistical data and high-quality consulting companies’ reports |
| Disruptive Technology “creates new players” | H ₀ : eHealth creates new market players | New entrants to eHealth industry were listed based on the business news articles and statistical data |

Table 1 Description of disruptive innovation main characteristics, relevant hypothesis and methods of evaluation

The formal statistical testing of hypotheses will not be performed, but its steps will be used as a framework to qualitatively answer the research question. To assess the validity of hypotheses the following steps will be taken:

1. obtaining the hypothesis from a general literature,
2. review of articles that assess the use of eHealth,
3. subtraction of articles relevant to the topic,
4. defining whether the enumerated features will support the null hypothesis or not.

The articles used to evaluate hypotheses 1-3 were searched within the Web of Science (Thomson Reuters) and PubMed databases. The criterion of the selection was the quality of

indexed journals. The analyzed publications include: articles, proceeding papers and reviews. The example search queries were “eHealth outcomes” or “eHealth cost” and the results were filtered according to their relevance. Findings of the hypotheses 4 and 5 are based on high-quality consulting companies’ reports, statistical resources, Christensen’s Institute articles and business journal articles. Every hypothesis consists of relevant Christensen’s theory description and its healthcare industry specific deviations, description of the most interesting findings and conclusions. This work will cover seven products and services within eHealth industry. These 7 particular technologies were chosen with regard to their overall market share in the eHealth industry, as well as the quality of available literature. These are as follows:

- 1) **Electronic Health Record (EHR):** health-related information of a patient can be created, conferred, and managed in form of an electronic record by doctors or medical staff
- 4) **Computerized Physician Order Entry (CPOE):** systems that allow doctors to enter all the patient’s treatment instructions, which are also available for other departments (like pharmacies, radiology etc.) or medical staff
- 3) **Telemedicine:** systems that use audio/video virtual communication to deliver health services at a distance
- 2) **Self-monitoring:** data-based continuous patient tracking and evaluation systems
- 3) **mHealth:** known also as mobile health. These are all mobile-based and mobile-enhanced innovations that deliver care; it includes smartphone applications, SMS services, smartphone connected wearable devices and other
- 5) **Clinical Decision Support System:** describes a system created to enhance clinical decision-making. Different characteristics of a patient are coordinated towards a base of automated knowledge, in order for software algorithms to create individual recommendations

6) Research Data Collection System: a system used to collect, store, manage or report on research data from different locations

5. Hypothesis 1: Does eHealth have inferior performance than paper-based healthcare delivery?

Christensen's theory and its healthcare specific application

A core concept of the disruptive innovation is that incumbent firms provide many product improvements that excel market needs and its financial capabilities. When the oversupply of performance occurs, it provides business opportunity for companies that will deliver lower cost and lower quality products. That way they will satisfy the least demanding customers. Also, usually at the moment when innovators enter the market, products seem to be used in different, unexpected ways. In the end, through successive sustaining innovation they are able to gain incumbents leading customers and fulfill market demands. Nevertheless, healthcare is a highly regulated industry and there are many restrictions regarding launched products. Thus, the disruption process may deviate from established model for other industries. This hypothesis is supported by studies that analyze disruption within markets of tissue valves (Berlin, 2006) and automatic external defibrillators (Lim, Hang i Neo, 2008). Authors indicate that the product needs to go through complex process of pre-market approval before the market entry. It must display certain increased performance features and therefore it cannot represent inferior performance. Also, a development process needs to be specified upfront which restrain customers from experimenting with its use. Thus, it is hypothesized that disruptive innovation within healthcare industry will not demonstrate inferior performance.

The testing of hypothesis that eHealth initially represents inferior performance than paper-based healthcare delivery was conducted in two dimensions: patient health outcomes (74 studies) and clinical processes efficiency (74 studies). The detailed analysis together with the full list of used articles can be found in the Appendixes 3 and 4.

Findings on eHealth performance from the patients' health outcomes perspective

| | eHealth influence on patient's health outcomes | | |
|--------------|--|---------------|-----------|
| | Improved | No difference | Decreased |
| # of studies | 43 | 29 | 2 |
| % of studies | 58% | 39% | 3% |

Table 2 Summary of findings on patients' outcomes

A majority of studies regarding patient's health outcomes prove, as opposite to the theory proposed by Christensen, that eHealth technologies represent superior performance to the paper-based healthcare delivery (58%). Also, 72 out of 74 reviewed studies did not indicate inferior performance and 2 showed decrease in health outcomes. The most cited effect on patient's health is the increase in QALYs (quality-adjusted life year) as an indirect effect of increased health knowledge and access to healthcare, more accurate diagnosis and increased adherence to medical treatment. Studies also indicated that eHealth can reduce morbidity or complications after treatment. There are also studies that prove the effectiveness of eHealth technologies with the relevance to elderly, such as decreased number of falls or pressure ulcers (Dowding DW1, 2012). The implementation of a post-acute CDSS relatively reduced readmissions by 26% in one study (Bowles K, 2014). Another one that used computerized identification of patients with high-risk showed a decrease from 0.36% to 0.17% in end point of deep venous thrombosis (Robert C. Amland, 2014). Next example, presented a 0.5–percentage point absolute decrease in the postoperative infections (Andersen, 2008). Moreover, other studies examined that eHealth implementation has effect on the rate of complications related to treatment. The EHRs systems were able to decrease adverse drug event rates from 7.6% to 2.2% (Balthasar L. Hug, 2010). Despite a lot of evidences for the efficiency of telemonitoring and improvement care for elderly, there are also studies that do not confirm these benefits. For example, telemonitoring caused a fourfold increase in a death risk within patients over 60. This research might suggest that telemonitoring used by the

leading customer group - chronic-care elderly patients, may cause more harm than good. (Takahashi, et al., 2012).

Findings on eHealth outcomes from the perspective of medical process efficiency

| | eHealth influence on clinical process efficiency | | |
|--------------|--|---------------|-----------|
| | Improved | No difference | Decreased |
| # of studies | 41 | 26 | 7 |
| % of studies | 55% | 35% | 9% |

Table 3 Summary of findings on patients' outcomes

A majority of studies regarding clinical process efficiency indicate that eHealth represents superior performance to the paper-based healthcare delivery (55%). Also, 67 out of 74 reviewed studies did not indicate inferior performance and only 7 showed a decrease in efficiency. The most cited effect of eHealth implementation is a decreased time of a treatment which is a result of a growing adherence to protocols and guidelines, more accurate diagnosis, availability of continuous remote patient monitoring and process simplification that allows less skilled staff and patients themselves to fulfill some of the doctor’s routines. Improvements in healthcare delivery processes range from 3 to 66 percentage points within the reviewed literature.

The effects of eHealth on clinical procedure time are mixed. For example, two studies showed growths in doctor’s time associated with a computer use. Using IT systems increased doctors time of documentation by 17.5% (Poissant, Pereira, Tamblyn, & Kawasumi, 2005). Other studies underlined positive impact of eHealth on laboratory testing time or completion of advanced directives (Dexter, et al., 1998). Using of tablets and central systems has saved nurses 23.5% of their time spent on documents completion. (Poissant, Pereira, Tamblyn, & Kawasumi, 2005) In contrast, other study examining the effect of CPOE displayed no benefits on a nurse documentation time (Kilgore, 2010). Also Deloitte reports that the average results of eHealth solutions for nurses present as follows: minus 60% of paperwork time, plus 29% of patient face-to-face time and two extra patients seen per day. A telehealth hub across

210 care homes caused: minus 35% of hospital admissions and minus 59% in hospital bed days (Deloitte, 2014). Both doctors and nurses perceived EHRs information quality as improved, especially in the areas of: accuracy (8-studies), access (5-studies), comprehensiveness (3-studies), and access to up-to-date patients' data (7 studies). reductions in other areas were as follows: decreased medication turnaround time by 64%, radiology procedure time by 43%, laboratory reporting time by 25% (Mekhjian, et al., 2002). The system also influenced medication errors. Before implementation transcription errors accounted for 13% of orders, after - errors were eliminated. (Cordero, Kuehn, Kumar, & Mekhjian, 2012). The review has found out that CDSS systems have positively impacted healthcare professionals' performance in 57% of cases. The main improvement factors were ordering of drugs systems and preventive reminders.

Conclusions

The research indicated that eHealth most of the time enhances performance in both areas: when it comes to patient health outcomes and clinical process efficiency. However, the study of older articles illustrated that eHealth might be very close to traditional disperse of disruptive innovation. Articles that studied technologies before their implementation showed considerable problems with performance such as a lack of ability to process large amounts of data (McDonald, 1997) or poor quality of images/communication (Institute of Medicine, 1996). However, there might have occurred so called "publication bias". That means that most of the articles which are published confirm the technology efficiency, whereas articles that fail to confirm null hypothesis do not see the day light (Hilten, 2015). Such bias, if exists, might be in favor to confirm the hypothesis. However, based on the analyzed articles, conclusion is clear that eHealth often does not initially represent lower performance. However, as mentioned in the theoretical part, due to restrictions in law regarding medical equipment, the performance cannot often be initially inferior. As a result, hypothesis that

eHealth will initially have inferior performance than paper-based healthcare delivery, can be rejected.

6. Hypothesis 2: Do healthcare leading customers not want to use eHealth?

Christensen's theory and its healthcare specific application

Another key concept of Christensen's theory is that initially profitable customers of the incumbent firms do not want or cannot use the new, to-be-disruptive technology. Incumbent companies will mostly evaluate market potential by rigorous research of the most profitable customers' needs. Therefore, it is highly probable that incumbents will underestimate the possible impact of a disruptive innovation and make the seemingly rational choice to reject the investment in the disruptive technology (Berlin, 2006). The role of leading customers in Christensen's theory is principally relevant in the context of medical industry.

It is a big challenge to define the term "leading customer" for the eHealth innovations. If the patients were ranked by how much they cost to be treated annually, it turns out that 1% of population accounts for almost 23% of expenditure, and the top 10% relates to 70% of spending (Shanahan, 2014). Moreover, it is estimated that this costliest group of customers in healthcare are chronic-care citizens over 65 years old (Nam, 2015). For that reason, this group stands for the leading customers of companies which focus on profits and growth - incumbents. Also, multiple researches demonstrated a highly significant role of the doctor contribution in the development of disruptive technologies (Lettl, Herstatt, & Gemuenden, 2006). Therefore, for the purpose of this work, leading customers will be defined as end-users of eHealth technology - patients and doctors. The patients will be limited to the costliest group: the chronic-care elderly.

Findings

| | End-user perception of eHealth | | |
|--------------|--------------------------------|---------|----------|
| | Positive | Neutral | Negative |
| # of studies | 40 | 3 | 10 |
| % of studies | 75% | 6% | 19% |

Table 4 Summary of findings on end-user perception

51 articles (Appendix 5) were reviewed in order to test the hypothesis that eHealth is initially rejected by leading customers. Over 75% of them indicated that both doctors and patients are supportive and enthusiastic towards the technology. Most of the studies used the Technology Acceptance Model that measures “perceived ease of use” defined as “the degree to which an individual believes that using a specific system will be free of effort” and “perceived usefulness” of a solution which is “the degree to which an individual believes that using a system would improve his or her work performance” (Davis, Bagozzi, & Warshaw, 1989)

Findings on leading customers’ perception of eHealth comparing to traditional healthcare delivery

Most of the studies that negatively valued eHealth came from the doctors. The aspects of eHealth that were positively evaluated were “ease of use” and “functioning”. The improved care and the increased collaboration are named by them as the potential benefits of technology in healthcare (73% and 75% of doctors respectively) (Deloitte, 2014). In one survey, 9 out of 10 doctors admit that they are interested in eHealth technology and it has clinical value. However, the security and privacy issues seem to be a constraint for eHealth - over 43% of doctors pointed it out as a barrier for commercialization. (Sivasubramaniam, 2005). The most important problems cited were ‘lack of training’, ‘high cost’, and ‘workload increase’ (Brown SA, 2002). Moreover, 3 out of 4 doctors say that EHRs do not save time and increase costs (Vijayaraghavan, 2011). In one study 68% of them admit that technology does not enhance their productivity, 58% say it does not differentiate the treatment among patients and 48% that it does not support care coordination (Deloitte, 2014). The most commonly cited reasons for such a low adoption willingness are that systems are not well optimized yet,

cannot process such big volumes of patient's data and doctors fear of useless statistics (Bresnick, 2015). In another survey by eClicalWorks it turned out that over 93% of specialists would be more willing to embrace eHealth if the integration with EHR would be better. (Bresnick, 2013). However, there are opinions that doctors resist to give more power to patients which can result in worse patient control (Topol, 2015). Additionally, doctors are not sure if monitoring would be a benefit of eHealth solutions and only 38% admitted that there is a potential in this field. That highly contrasts to 60% of patients who want to use eHealth to track their medical and wellness records (Mobiquity, 2013).

A study conducted by Bujanowska-Fedak from 2014 indicated that around 41% of the elderly patients over 65 years old had an advantageous attitude towards eHealth and were enthusiastic to try it once the opportunity to do so is offered (Bujnowska-Fedak & Pirogowicz, 2014). In a study conducted by Agrell most of the seniors had a neutral (60%) or a positive (33%) attitude regarding technology before a use of remote eHealth services. After they used the technology, vast majority of them were very satisfied (67%) or rather satisfied (33%) with eHealth services (Agrell, Dahlberg, & Jerant, 2000). Another characteristic of elderly patients is a strong willingness to have a direct contact with the specialist. 61% of elderly report strong preference for the face-to-face contact and cite it as the main cause of not approaching the doctor via the Internet (Bujnowska-Fedak & Mastalerz-Migas, 2015). Seniors often show high resistance to new technologies which can be caused by age-related decrease of motor and cognitive functions (Campbell, 2015). Finances among elderly are the next barrier. Seniors, usually those who are needy, are afraid of the costs of buying a computer or other devices (Said, 2005). Most of them depend on a third party, typically company insurer or government to reimburse their healthcare and infrequently make out-of-pocket purchases (OECD, 2007). Their access to the Internet network and telecommunication can be also very limited (Internet World Stats, 2016).

Conclusions

The analysis of leading customer's attitudes towards the use of eHealth and barriers to adapt it appear to provide conflicting results. In vast majority of studies, they point out problems that stop them from using eHealth innovations. Among them there are: high cost of technology, not enough optimized systems or personal preferences for face-to-face contacts. However, both elderly patients and doctors are supportive and enthusiastic about eHealth, and satisfied with its ease of use. Given this data, the hypothesis that leading customers do not want and cannot use disruptive innovation can be rejected.

7. Hypothesis 3: Does eHealth represent lower cost opportunity than the paper-based healthcare delivery?

Christensen's theory and its healthcare specific application

The model of disruptive innovation assumes that new technology will represent the lower cost and lower margin than incumbents business. The consequence of this dynamic is that incumbents' firms will be restrained from investing in a disruptive innovation. Again, healthcare industry specifics can cause deviations from the theory. When evaluating the value of products or services the cost is not a key driver when comparing to the clinical utility. Furthermore, there is always an in-between agent – the doctor, that occurs between the provider and the patient. The agent does not take under consideration the cost as the most important factor when making decisions, but the patients' health outcomes. Hence, an ethical threat occurs, which depreciates the effect of a cost on the overall value proposition. Therefore, it is theorized that disruptive technology within healthcare delivery might turn out to be more profitable than incumbents technology. This can imply, so contrary to general rule of other industries, that there are motives for incumbents to commercialize and expand the disruptive technology (Berlin, 2006). Also measuring cost savings in healthcare is somehow problematic. Some of the reviewed studies did not measure cost savings in a direct way. As a

substitute, academics explained not monetized reductions in services into monetized approximations using the average cost of the service. For example, one study examined total costs per stay in hospital and found a decrease from \$6964 to \$6077 which was translated from 0.9-day reduction of admission (Tierney, Miller, Overhage i McDonald, 1993).

Findings on cost savings and a cost-efficiency of eHealth compared to the paper-based healthcare delivery

| | eHealth influence on healthcare unit costs | | |
|--------------|--|---------------|-----------|
| | Decreased | No difference | Increased |
| # of studies | 21 | 14 | 4 |
| % of studies | 54% | 36% | 10% |

Table 5 Summary of findings on healthcare units costs

Review of 39 articles (Appendix 6) implied that a transition to an electronic form of the healthcare delivery is likely to cause various financial benefits (21 out of 39 studies). For example, eHealth is believed to decrease healthcare costs connected to preventable diseases, as these are the problems eHealth is addressing. This accounts for around 70% of total expenditures (Heffler, Smith, Keehan i Borger, 2005). The savings are proved to come from better drug management, improved radiology practice, reduced billing errors and better capture of changes. According to McKinsey & Company in almost every scenario eHealth and the data it generates will decrease the need for beds in hospitals and force the public hospitals to be more efficient. Hospitals will be under competitive pressure to implement the latest information technologies and its adoption will furtherly drive down already small margins (McKinsey & Company, 2014). McKinsey estimates that the implementation of technologies that support patients’ self-services and digital networks of communication can result in 7 to 11 percent of net economic benefits in total healthcare spending (McKinsey, 2015). On the other hand, NHS England evaluates that ”eHealth can save 6.5 to 10.8 percent of total healthcare spending in the UK by 2020” (Josip, et al., 2008). According to a cost-benefit analysis of EHR in primary care by Wang at el. the average net benefit from EHR implementation for a 5-year period amount to \$86,000 for a provider (Wang, et al., 2003). In

the same study sensitivity analysis included the most optimistic and the most pessimistic scenario after EMR implementation and showed results in a range from \$331 thousand net benefit to 2300\$ net cost (Wang, et al., 2003). Studies regarding telemedicine were varying regarding the costs of technology. Variable cost savings compared to paper-based system were \$2.500 to \$3.000 PMPY and hospital profits increased from \$1.000 to \$4.000 PMPY (per member per year). Another study analyzed the cost effectiveness of implementing eHealth in panic disorder treatments. It computed results that range from \$3,300 to \$4.400 per DALY (disability-adjusted life year) comparing to traditional treatment (Mihalopoulos C, 2005). Moreover, in a cost-benefit study of adapting a standardized patient management program resulted in an incremental ratio of 3.7 (Runge C, 2006). Two studies from UK tried to access the ROI of an eHealth-based health promotion program. They reported positive ROI of almost 2 dollars for each invested dollar (Mills PR, 2007). Another study reported ROI of 2.15 of an eHealth-based rehabilitation program (Southard BH, 2003). Moreover, Bain consulting company estimates that implementing eHealth in the area of administration can create savings of 10% in costs PMPY which accounts for \$200 (Bain & Company, 2012). In addition, eHealth is estimated to generate savings of \$750 PMPY or around 7% by better management of high-cost patients (McCall, Cromwell, & Urato, 2010). However, 71% of doctors believe that the reduction of costs due to eHealth is inflated and its use will eventually cost more, not less than traditional medicine (Sivasubramaniam, 2005).

Conclusions

Again, in this case it cannot be assumed that the “publication bias” did not occur. It is confirmed that the major reason for “nonpublication” are the negative results that do not confirm the efficacy of a topic (Dickersin, Chan, Chalmersx, Sacks, & Jr, 1987). However, analysis of the chosen articles supported the hypothesis that eHealth represents lower costs than paper-based healthcare delivery. 39 studies regarding eHealth costs were analyzed and

21 of them (54%) indicated the lower cost opportunity. Therefore, the null hypothesis cannot be rejected.

8. Hypothesis 4: 4a) Does eHealth take root in low-end markets? 4b) Does it create new markets?

Christensen's theory and its healthcare specific application

In the concept from 1995, Christensen identifies two types of disruptions: low-end and new market disruptions. The low-end disruption occurs when the new product or service is able to do the same thing as incumbent technology but can be sold with a lower price or access level. Therefore, it will “allow access to a product or service previously accessible only to the rich or skilled, lowering quality” (European Commission, 2015). When it comes to healthcare, this is not a relevant feature in most of the European countries. However, the concept could apply to: developing countries, where the cost of travel and treatment are significant barriers to receive healthcare, and the U.S., where the income is the most important aspect to access the healthcare (European Commission, 2015). People who were excluded from the healthcare market after disruption will be able to access it. The second type of disruption is a new market disruption. In opposite to the low-end one, it will not gain the least-profitable consumers, but will address the non-consumers in the category. The consumers who did not want, did not need or could not use the incumbent's products will use the new ones. Healthcare delivery might experience new ways of undertaking things or fulfilling people's needs and more efficiency within healthcare units. In this case, the new market created by eHealth might be a better way of delivering illness prevention. The nonconsumers are people who do not need healthcare yet, but because of the risk factors and lack of knowledge are prone to become the healthcare consumers.

| | Area | Target | Main technology |
|-----------------------|-------------------------|---|------------------------|
| New market disruption | prevention | non-consumers of healthcare | mHealth |
| Low-end disruption | diagnosis and treatment | lowest income consumers from developing countries and rural areas | telemedicine and EHR |

Table 6 Summary of findings on low-end and new market disruption

eHealth new market disruption

The modern lifestyle risk factors such as smoking, physical inactivity, alcohol consumption, obesity and poor nutrition are among of the main factors causing death and chronic diseases worldwide (Lopez, Mathers, M, Jamison, & Murray, 2006). Chronic diseases such as diabetes, cancer, heart diseases are the leading mortality causes in the world and are responsible for over 60% of all deaths (WHO, 2016). In the U.S. only, they account for \$1.3 trillion spending (DeVol R, 2007). These diseases are preventable in many cases, however the patients before getting sick represent “nonconsumers” of healthcare. The current health system does not have interest nor the time to raise its competitiveness against new entities which offer new value proposition to this low-cost (future high-cost) generations (Hueltschmidt & Olsen, 2014). According to Christensen’s Institute, what this group really needs is the customized medical care that will enable them to stay low-contributors to the healthcare expenditures (Nam, 2015). eHealth, and especially mHealth among other innovations, target this group. This completely new market, promises the change in consumers’ behavior to prevent diseases. Despite recent development of guidelines for general doctors how to manage risk factors and prevent diseases the rates of actual practice remain low (Pham, Schrag, Hargraves, & Bach, 2005). For example, it is rarely met that doctors engage in counseling for obese people during their regular visits (Sonntag U, 2010). This gap between actual delivery rates and recommended care is also underlined by patient reports that indicate patients desire for more lifestyle advice. (Duaso MJ, 20002). According to Bain&Company 75% of consumers indicate that insurers and health systems should more focus on disease prevention than on healing, 67% claim that the information should be more

scientific, personalized and integrated (Deloitte, 2014). This disparity prompts for alternative delivery of healthcare and collection of patient's medical data. Within the last couple of years, many fitness, wellness and health-oriented products targeting healthy "nonconsumers" appeared on the market. The market of mHealth apps and devices is expected to reach US\$ 24 billion in 2017 (GSMA & PwC, 2014). In 2014 half of the smartphone users in America purchased at least one app that supports healthy-living, and about 19% of all adults is routinely using at least one app from this area (Agrawal, 2014). 18% of Americans claim to download the calorie counting app and 6% to use it regularly. Another popular type of healthy-living applications are exercising diaries and running maps (Agrawal, 2014). In the \$3trillion US Healthcare sector, wellness and fitness market already stands for almost \$270 billion. Another key fact that supports eHealth development is that it remains the most feasible method of prevention management, although the self-reporting data accuracy might be affected by various factors (Connor Gorber S, 2009).

eHealth low-end disruption in developing countries

High income countries focus mainly on monitoring services and low income countries focus on electronic diagnosis services (GSMA & PwC, 2014). This is most probably caused by the overall healthcare situation. Low and middle income countries experience extremely low number of resources and doctors. According to WHO, recommended number of doctors is 22 per 10.000 people in order to serve 80% of population (WHO, 2015). In Indonesia, India and China these numbers are 2, 6 and 14 respectively, in Africa the number drops to 2.5 (WHO, 2016). When it comes to availability of beds in hospitals, it is 9 for 10.000 in Africa whereas in Europe it falls over 62 (The World Bank, 2016). Opposite to the access to healthcare, the access to mobile technology becomes almost ubiquitous globally. In developed countries the mobile penetration of market stands over 100%. These numbers for Africa, Asia Pacific and South America account for 86%, 99% and 120% accordingly (GSMA, 2016). Therefore, this

disparity accelerated the use of mobile devices to leverage access to healthcare in developing countries. The example can be Linda Jamii program in Kenya. The leading mobile operator together with the insurance company provided cheap and affordable option for uninsured Kenyans to access healthcare by paying with the use of a popular in Africa M-PESA program (Safaricom, 2016). This can be classified as a low-end disruption that allows the lowest-income consumers to access the service that was previously impossible to reach. Moreover, in Africa over 75% of health deployments focuses on supporting remote access to patient, transmission and collection of patients' data (PwC, 2015). Around 59% of patients in the emerging economies already use mobile health services. On the other hand, this number counts for only 35% among developed countries population (Siemens, 2015). Correspondingly, more specialists in developing markets are prone to use eHealth than the first-world doctors. Moreover, more payers will cover those costs. (Siemens, 2015). For example, the Mobile Doctors Network (MDNet), embraced the power of mobile technologies and created Ghana wide network of doctors (Chen, Sarah Baird, & Sinit Mehtsun, 2014). In Nigeria "We Care Solar" reduces maternal mortality by providing doctors provision using mobile technologies (We Care Solar, 2016). In addition, the Asian eHealth market is expected to undergo the biggest growth until 2020 (P&S Market Research, 2012). In China \$9.8 billion was spent in 2012 to build public EMR system (Zhu, 2012). Moreover, this country launched five country-wide telemedicine pilots that enable the monitoring of patients from rural areas (Xinhua Finance, 2015). Chunyu, the biggest doctor consultation platform, receives 50 thousand of daily inquiries and enables convenient healthcare to over 80 million of Chinese patients by 40 thousand doctors (Siyang, 2015). To solve the problem of access to healthcare in India, the "hub-and-spoke global delivery" model was introduced (KPMG, 2011). These "hubs" are linked to "spoke" facilities located in the rural areas, where patients are provided with the basic cheap care and diagnosis and are referred to larger hubs for more complicated

treatments. In the model doctors use telemedicine to remotely help people at a distance (Ross, 2013).

Conclusion

Listed examples prove that eHealth not only creates new markets, but also targets the low-end, least profitable customers. Among others, mHealth created industry of applications and wearables for fitness and wellness that is already worth US\$1.49 trillion (PwC, 2015). Moreover, listed examples of initiatives in developing countries that target low income people living in rural areas prove the low-end disruption. Given this information, the hypotheses about low-end and new market disruption cannot be rejected.

9. Hypothesis 5: Does eHealth create new market players?

Christensen's theory and its healthcare specific application

The model of disruptive innovation assumes that incumbent firms will be restrained from investing in disruptive innovation. The reasons for that are: lower margin and unattractive market, which mixed represent relatively lower profit opportunities. Consequently, raising the concept of “resource dependence” (Davis & Cobb, 2009) it is doubted that incumbent organizational structure is able to develop disruptive innovations. The resources usually will be diverted away from the disruptive projects as they are connected to lower profits and companies will focus on sustaining innovation that in the initial research will promise higher profits. In consequence disruptive innovation should be commercialized by an independent organizational structure.

10. New market entrants’ overview

| Examples of significant new entrants on the market | | | | |
|--|----------------|-------------------------------------|--|---|
| EHR + CPOE | Telemedicine | Monitoring | mHealth | Health Management Systems |
| 3M (U.S.) | Chunyu (China) | Telefonica (Spain), Calico (Google) | over 20.000 new entrants globally since 2013 | SK Telecom South Korea), Walgreens (U.S.) |

Table 7 Examples of the new entrants on the eHealth market

In the Fortune 50 companies in healthcare industry, 14 are traditional healthcare companies and 24 are new entrants. Among these new entrants, 5 are technology companies and 3 are telecommunication companies. Among all 50, 24 has lately formed healthcare partnerships within care delivery (Statista, 2016). For example, Sanofi Canada together with telecommunication company Telus launched private self-management and health monitoring web-based platform (Telus Corporation, 2012) and 3M partnered Cerner Corporation, the EHR vendor (Heath, 2016). Moreover, SK Telecom company specialized in wireless communication from South Korea, formed a joint venture with Vista, company managing clinics in China (Sung-won, 2014). In 2013 Telefonica Group from Spain acquired Brazilian Axismed - chronic care management company (Sahota, 2013). In the mHealth market exist already 45.000 app publishers and more than half of them entered the market after 2013 (Research2Guidance, 2015). Aslo lately venture capital investments changed direction from life sciences to startups that tackle the topics of mHealth, EMR systems and health management (PwC, 2014). New entrants in healthcare industry include completely new entities as well as companies emerging from other sectors. For example, Samsung and Apple started to issue patents and to produce smartphone-embedded devices for health monitoring such as Align Blood Glucose Monitor (iHealth, 2014). Calico is another healthcare new entrant. The company launched by Google aims on ageing population and related illnesses (Google Press, 2013). Chunyu mentioned before, the biggest doctor consultation platform in China already gains 80 million of Chinese patients and 40 thousand doctors (Siyang, 2015). These entrants appear on the health market with strong competitive advantages: many of them have strong relations with loads of clients and huge databases including information about

them. For example, Walgreen’s Balance Rewards program, the loyalty program of U.S. pharmacy chain, has already gained data of over 81 million members (Walgreens, 2016) medications. (Delogne, 2015).

Conclusions

The research of the healthcare market news indicated that there can be clearly seen a big trend to invest in eHealth technologies. The cited examples confirm that the market is changing and new entrants try to win their share in a profit pool. Given this data, the hypothesis that mHealth creates new market players cannot be rejected.

10. Summary of the findings

| | Hypothesis: | Result | Conclusion: |
|----|--|---|-----------------------------------|
| 1. | H ₀ : eHealth represents lower performance than paper-based healthcare delivery | eHealth increased overall performance | H ₀ can be rejected |
| 2. | H ₀ : Leading customers of paper-based healthcare don’t want or can’t use eHealth | Elderly and doctors are supportive and enthusiastic about eHealth | H ₀ can be rejected |
| 3. | H ₀ : eHealth stands for the lower cost than paper-based healthcare delivery | eHealth represents lower cost opportunity | H ₀ cannot be rejected |
| 4a | H ₀ : eHealth takes root among non-consumers | eHealth targets non-consumers | H ₀ cannot be rejected |
| 4b | H ₀ : eHealth takes root in the low-end markets | eHealth targets low-end markets | H ₀ cannot be rejected |
| 5. | H ₀ : eHealth creates new market players | eHealth created new market players | H ₀ cannot be rejected |

Table 8 Summary of findings

Table 8 presents the summary of the findings. The research regarding eHealth performance illustrated the peculiarity of healthcare business. Although the technology initially demonstrated lower performance it could not enter the market unless the formal regulatory conditions weren’t fulfilled. eHealth represents comparable or improved performance to paper-based healthcare delivery. Therefore, the first hypothesis was rejected. Studies regarding leading customer’s attitude to technology pointed out many barriers to commercialize eHealth, such as privacy issues and required initial investment. However, the

same studies indicated that majority of leading customers is supportive and enthusiastic towards eHealth. Therefore, this hypothesis can also be rejected. The hypothesis about lower cost opportunity was supported by over 70% of studies which implies it cannot be rejected. Moreover, the examples of low-end, new market disruption and new market players created by eHealth indicate that hypothesis 4a and 4b and 5 cannot be rejected.

| | Area of Study | | | | | | |
|---|---------------|------------|--------------|------------|------------|------------|------------|
| | EHR | CPOE | Telemedicine | Monitoring | mHealth | CDSS | RDCS |
| 1: Patient outcomes (lower) | No | No | No | No | No | No | No |
| 2: Clinical Process efficiency (lower) | No | No | No | No | No | No | No |
| 2: Leading customer perception (negative) | No | Yes | No | No | No | No | No |
| 3: Costs (decreased) | Yes | Yes | No | No | n/a | n/a | Yes |
| 4: Targets New Market/Low-end Market | No | No | Yes | Yes | Yes | No | Yes |
| 5: New Entrants | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Disruptive Innovation: | 2/5 | 3/5 | 2/5 | 2/5 | 2/5 | 1/5 | 3/5 |

Table 9 Summary of findings with regard to the analyzed technologies

Table 9 presents the summary of findings with regard to every analyzed technology. Only Computerized Physician Order Entry and Research Data Collection System fulfilled 3 out of 5 conditions of disruptive theory. All research may indicate that eHealth is not a disruptive innovation in the theoretical understanding of the definition.

11. Discussion

In this paper, the disruptiveness of eHealth was elaborated in the context of its performance, end-user perception, costs and market changes that it has already caused. Understanding of the nature of a products disruptiveness might be of a central importance in a process of commercialization. Thus, the conclusions of this work might be a support for a strategic decision making for many stakeholders of the healthcare industry. Such examples are: entrepreneurs and investors considering entering the eHealth market, incumbents in the industry, and regulatory officials.

The study indicated that eHealth, in general, is not a disruptive innovation in a traditional understanding of a theory because it does not fulfill all the listed conditions. The conditions that were not fulfilled are: inferior initial performance and negative perception of the

technology by incumbents' leading customers. Three out of seven technologies did also not cause low-end nor the new market disruption.

Limitations of the study

Firstly, this research is limited by the scope of the literature. The articles were searched within only two databases which can imply that the findings may not be representative for all eHealth literature. Moreover, articles from very specialized fields that did not include any variation of the general search queries, might have been omitted. Furthermore, not published articles, non-english publications and “grey literature” have not been assessed. Besides, some of the analyzed studies are burdened with their own limitations such as: small sample size, short follow-up or no randomization. Another limitation is that despite rapid growth of available eHealth literature, this area still have not reach the maturity level. Therefore, is is difficult to synthetize the findings from divergent study designs, purposes and health areas. For example, general studies about eHealth or ICT within healthcare did not always include the range of the studied technologies. Another limitation is that in this work patient outcomes were classified as having positive or negative outcome with no regard to their importance – if it was a reduced mortality or an increased health management knowledge the outcome was categorized as positive.

Directions for a future research

The premise of this study was limited to the traditional disruptive innovation framework proposed by Christensen in 1995. However, taking under consideration the peculiarity of the healthcare industry, the specifics of disruptive innovation within this industry would be interesting to explore. Moreover, this research could be expanded to check mentioned specifics of healthcare areas like: dermatology, psychiatry, radiology etc. Furthermore, there are many innovations from various industries that are called disruptive in a common language

without detailed analysis, such as: autonomous vehicles, 5G infrastructure, Airbnb or Netflix.

It might be reasonable to ask similar questions regarding those innovations.

Acronym List:

mHealth – mobile health

EHR – Electronic Health Records

CPOE – Computerized Physician Order Entry

CDSS – Clinical Decision Support System

RDCS – Research Data Collection System

ICT – Information and Communication Technologies

WHO – World Health Organization

DALY – Disability Adjusted Life-Years

QALY- Quality-Adjusted Life Year

ROI – Return on Investment

PMPY – Per Member Per Year

12. References

- Adler, R. (2002). The Age Wave Meets Technology Wave: Broadband and Older Americans. *SeniorNet*.
- Agrawal, D. W. (2014). How Mobile Technology Can Improve Employees' Well-Being. *Business Journal*.
- Agrell, Dahlberg, & Jerant. (2000). Patients' perceptions regarding home telecare. *Telemedicine Journal and e-health: American Telemedicine Association*.
- Andersen, S. K. (2008). *EHealth Beyond the Horizon: Get IT There : Proceedings of MIE2008*. IOS Press.
- Bain & Company. (2012, May). The future of healthcare—there's an app for that. *Bain Brief*.
- Balthasar L. Hug, D. J. (2010). Adverse Drug Event Rates in Six Community Hospitals and the Potential Impact of Computerized Physician Order Entry for Prevention. *Journal of General Internal Medicine*.
- Bandodkar, A. J., Jia, W., Yardımcı, C., Wang, X., Ramirez, J., & Wang, J. (2015). Tattoo-Based Noninvasive Glucose Monitoring: A Proof-of-Concept Study. *Analytical Chemistry*.
- Basit Chaudhry, M., Jerome Wang, M., Shinyi Wu, P., Margaret Maglione, M., Walter Mojica, M., & Elizabeth Roth, M. (2006). Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. *Annals of Internal Medicine*.
- Berlin, D. B. (2006). *Characteristics of Disruptive Innovation within the Medical Device Industry*. Harvard-MIT Division of Health Sciences and Technology.
- Bowles K, H. A. (2014). Impact of Discharge planning decision support on time to readmission among older Adult Medical patients. *Professional Case Management*.
- Brender J, A. E. (2006). actors influencing success and failure of health informatics systems—a pilot Delphi study. *Methods Informatics Medicine*.
- Bresnick, J. (2013). 93% believe EHR-connected mHealth apps benefit patient care. *EHR Intelligence*.
- Bresnick, J. (2013). mHealth tools projected to save \$500 billion in productivity by 2021. *EHR Intelligence*.
- Bresnick, J. (2015). What Is EHR Optimization How Does It Start? *EHR Intelligence*.
- Brown SA, M. A.-W. (2002). Do I really have to? User acceptance of mandated technology. *European Journal of Information Systems*.
- Bujnowska-Fedak, & Mastalerz-Migas. (2015). Usage of medical internet and e-health services by the elderly. *Advances in experimental medicine and biology*.
- Bujnowska-Fedak, M. M., & Pirogowicz, I. (2014). Support for e-Health Services Among Elderly Primary Care Patients. *Telemedicine Journal and e-Health*.

- Campbell, O. (2015). Designing For The Elderly: Ways Older People Use Digital Technology Differently. *Smashing Magazine*.
- Chatterji, A. K., & Fabrizio, K. (2008). Professional users as a source of innovation: The role of physician innovation in the medical device industry.
- Chen, C., Sarah Baird, K. S., & Sinit Mehtsun, E. O.-O.-P. (2014). Physician tracking in sub-Saharan Africa: current initiatives and opportunities. *Human Resources for Health*.
- Chen, Z. (2012). *Healthy China 2020 Strategic Research Report*. WHO.
- Christensen, & Utterback. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston: Harvard Business School Press.
- Christensen, C., Bohmer, R. M., & Kenagy, J. (2000). Will Disruptive Innovations Cure Health Care? *Harvard Business Review*.
- Clayton M. Christensen, R. M. (2000). Will Disruptive Innovations Cure Health Care? *Harvard Business Review*.
- Connor Gorber S, S.-H. S. (2009). The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine Tobacco Res.*
- Cordero LI, K. L. (2012). Impact of computerized physician order entry on clinical practice in a newborn intensive care unit. *Journal of Perinatology*.
- Crooks, P. (2005). Managing High-Risk, High-Cost Patients: The Southern California Kaiser Permanente Experience in the Medicare ESRD Demonstration Project,. *The Permanente Journal*.
- Davis, F. D. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. . *Management Science*.
- Davis, G. F., & Cobb, J. A. (2009). Resource Dependence Theory: Past and Future. *Research in the Sociology of Organizations*.
- Delogne, M. C. (2015). *PatientsLikeMe Adds Information about Patient Experiences with Medications to Walgreens Pharmacy Website*.
- Deloitte. (2014). Annual check-up on physician adoption of health.
- Deloitte. (2014). Healthcare and Life Sciences Predictions 2020. A bold future?
- Deloitte. (2015). The mHealth opportunity in Sub-Saharan Africa.
- DeVol R, B. A. (2007). Unhealthy America: The Economic Burden of Chronic Disease - Charting a New Course to Save Lives and Increase Productivity and Economic Growth .
- Dexter, Wolinsky, Gramelspacher, Z. X., Eckert, Waisburd, & Tierney. (1998). Effectiveness of computer-generated reminders for increasing discussions about advance directives and completion of advance directive forms. A randomized, controlled trial. *Annals of Internal Medicine*.
- Dickersin, K., Chan, S., Chalmersx, T., Sacks, H., & Jr, H. S. (1987). Publication bias and clinical trials. *Controlled Clinical Trials*.
- DiEgidio, M. (2016). *Powering Advances in Healthcare with the Internet of Things*. Retrieved from www.thingworx.com.
- Dowding DW1, T. M. (2012). The impact of an electronic health record on nurse sensitive patient outcomes: an interrupted time series analysis. *Journal of American Medicine Information Association*.
- Duaso MJ, C. P. (20002). Health promotion and lifestyle advice in a general practice: what do patients think? *Journal of advanced Nursery*.
- Elspeith McFadzean, A. O. (2005). *Corporate entrepreneurship and innovation part 1: the missing link*. European Journal of Innovation Management.
- European Comission. (2015). Disruptive Innovation - Considerations for health and health care in Europe. *Expert Panel in Effective Ways of Investing in Health* .
- Gaurav Kumar, M. a. (2012). The Costs of Critical Care Telemedicine Programs. *Chest*.
- Gilbert. (2003). The disruption opportunity. *MIT Sloan Management Review*.
- Google Press. (2013). Retrieved from Google announces Calico, a new company focused on health and well-being: <http://googlepress.blogspot.com/2013/09/calico-announcement.html>
- Graham, & McGimpsey S, W. S. (2000). Could a low-cost audio-visual link be useful in rheumatology? *Journal of Telemedicine and Telecare*.
- Grando, M. A., Rozenblum, R., & Bates, D. (2015). *Information Technology for Patient Empowerment in Healthcare*. Walter de Gruyter GmbH & Co KG.
- GSMA & PwC. (2014). Touching lives through mobile health. Assessment of the global opportunity.
- GSMA. (2016). GSMA Mobile Economy.
- Gurtner, S., & Soyeze, K. (2014). *Challenges and Opportunities in Health Care Management*. Springer.
- Healthcare partnerships formed by Fortune 50 companies U.S. 2014*. (2016). Retrieved from Statista.com: <http://www.statista.com/statistics/378923/partnerships-in-healthcare-with-fortune-50-companies-in-the-us/>
- Heath, S. (2016). EHR Vendor Cerner and 3M Partner for Population Health. *EHR Intelligence*.

- Heeks. (2002). Information systems and developing countries: failure, success, and local improvisations. *Information Society*.
- Heffler, Smith, Keehan, & Borger. (2005). *U.S. health Spending projections for 2004-2014*.
- Hilten, L. G. (2015). Why it's time to publish research "failures" Publishing bias favors positive results; now there's a movement to change that. *Elsevier*.
- Hueltenschmidt, N., & Olsen, T. (2014). Growing Business Opportunities for Healthy Living. *Bain & Company Insights*.
- iHealth. (2014). *iHealth Announces Expansive Integration of Nine Mobile Health Devices with Apple's HealthKit*. Retrieved from <https://ihealthlabs.com/buzz/ihealth-announces-expansive-integration-apple-healthkit/>.
- INAHTA. (n.d.). Retrieved from HTA Glossary: <http://htaglossary.net/health+technology>
- Institute of Medicine (US). (1996). *Telemedicine: A Guide to Assessing Telecommunications in Health Care*. National Academies Press.
- Institute of Medicine. (2001). *CROSSING THE QUALITY CHASM: A NEW HEALTH SYSTEM FOR THE 21ST CENTURY*.
- Intelligence, W. (2014). *Wireless Inteligence*.
- Internet World Stats. (2016). *Internet Usage Statistics for Africa (Africa Internet Usage and 2016 Population Stats)*. Retrieved from <http://www.internetworldstats.com/stats1.htm>
- Jaspers, M. W., Smeulers, M., Vermeulen, H., & Peut, L. W. (2011). Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quality systematic review findings. *Journal of American Medicine*.
- Kilgore, F. D. (2010). The varying impact of two clinical information systems in a cardiovascular intensive care unit. *The Journal of Cardiovascular Management*.
- Kopalle, V. G. (2006). The Usefulness of Measuring Disruptiveness of Innovations Ex Post in Making Ex Ante Predictions. *the Journal of Product Innovation Management*.
- KPMG. (2011). *Hub and Spoke operating model. A new business paradigm for the Indian IT-BPO Industry*. NASSCOM.
- Krans, B., & Watson, K. (2015). Heart Bypass Surgery. *Healthline*.
- Lettl, C., Herstatt, C., & Gemuenden, H. (2006). Users' contributions to radical innovation: Evidence from four cases in the. *R&D Management*.
- Lim, W., Hang, C., & Neo, K. (2008). Discontinuous innovations framework: A review of automatic external defibrillators in the healthcare industry. *Proceedings of the Management of Innovation and Technology*.
- Lopez, Mathers, M, E., Jamison, & Murray. (2006). Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data.
- McCall, N., Cromwell, J., & Urato, C. (2010). *Evaluation of Medicare Care Management for High Cost Beneficiaries (CMHCB) Demonstration: Massachusetts General Hospital and Massachusetts General Physicians Organization (MGH)*. RTI International.
- McDonald, C. J. (1997). The Barriers to Electronic Medical Record Systems and How to Overcome Them. *Journal of American Informatics Association*.
- McKinsey & Company. (2014). *Healthcare's Digital Future*.
- McKinsey & Company, Inc., and GSMA. (2011). *mHealth: A new vision for healthcare*.
- McKinsey. (2015). *eHealth 2.0. the Economist Intelligence Unit*.
- Mekhjjan, Kumar, Kuehn, Bentley, Teater, Thomas, . . . Ahmad. (2002). Immediate benefits realized following implementation of physician order entry at an academic medical center. *Journal of American Medical Information Association*.
- Mihalopoulos C, K. L. (2005). Exploratory economic analyses of two primary care mental health projects: Implications for sustainability. *Medical Journal of Australia*.
- Mills PR, K. R. (2007). Impact of a health promotion program on employee health risks and work productivity. *American Journal of Health Promotion*.
- Mobiquity. (2013). *New mHealth Report from Mobiquity Finds Mobile Has Power to Drive Behavior Change*.
- Nam, S. (2015). Which customers should the disruptors in health care target? *Christiansen institute Blog*.
- Nguyen, L., Bellucci, E., & Nguyen, L. T. (2014). Electronic health records implementation: An evaluation of information system impact and contingency factors. *International Journal of Medical Informatics*.
- OECD. (2007). *Understanding the brain: the birth of a learning science*. Centre for Educational Research and Innovation.
- P&S Market Research. (2012). *Global Digital Health Market - Forecast to 2020*. Research and Markets.
- Pham, Schrag, Hargraves, & Bach. (2005). Delivery of preventive services to older adults by primary care physicians. *JAMA*.
- Poissant, L., Pereira, J., Tamblyn, R., & Kawasumi, Y. (2005). The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. *J Am Med Inform Assoc*.

- PwC. (2014). *Emerging mHealth: Paths for Growth*.
- PwC. (2014). *Healthcare's new entrants: Who will be the industry's Amazon.com?*
- PwC. (2014). *Medtech slowdown*.
- PwC. (2015). Global health's new entrants: Meeting the world's consumer.
- PwC. (2015). The leapfrog effect: developing countries can innovate faster.
- Research2Guidance. (2015). *mHealth App Developer Economics 2015*.
- Robert C. Amland, B. B.-T. (2014). Computerized Clinical Decision Support to Prevent Venous Thromboembolism among Hospitalized Patients: Proximal Outcomes from a Multiyear Quality Improvement. *Journal of Healthcare Quality*.
- Rogers, E. M. (1962). *The Diffusion of Innovations, Third Edition*. New York: Macmillan Publishing Co., Inc.
- Ross, C. (2013). *Building BRICs: pharma's key emerging markets are becoming giants*. PMGroup.
- Runge C, L. J. (2006). Outcomes of a Web-based patient education program for asthmatic children and adolescents. *Chest*.
- Safaricom. (2016). *Linda Jamii*. Retrieved from <http://www.safaricom.co.ke/about-us/innovation/social-innovation/linda-jamii>
- Sahota, D. (2013). Telefónica eyes e-health opportunity with Brazilian acquisition. *Telecoms.com*.
- Said, C. (2005). *Old age in the technology age / New devices to monitor health and well-being at home a growing new sector*. SFGGate.
- Sensmeier, J. E. (2012). Disruptive innovation and the changing face of healthcare. *Nursing Management*.
- Shanahan, J. (2014). Disruptive Innovation: Life After Clayton Christensen's 'Innovator's Prescription'. *MedTech Boston*.
- Shiffman. (1999). Computer-based Guideline Implementation Systems: A Systematic Review of Functionality and Effectiveness. *JAMIA*.
- Siemens. (2015). *Healthcare in Emerging Markets: Challenges & Opportunities*. Siemens Healthineers.
- Siemens. (2015). *Thinking Healthcare Ahead*.
- Singh, J. (2015). *Healthcare Megatrends: Are Emerging Markets Catching Up Or Taking The Lead?* SAP Business Trends.
- Sivasubramaniam, S. (2005). Remote working: Survey of attitudes to eHealth. *Family Practice*.
- Sonntag U, H. J. (2010). Counseling overweight patients: analysis of preventive encounters in primary care. *International Journal of Quality Health Care*.
- Southard BH, S. D. (2003). Clinical trial of an Internet-based case management system for secondary prevention of heart disease. *Journal of Cardiopulmonary Rehabilitation*.
- Statista. (2016). *Statista.com*. Retrieved from Number of U.S. healthcare partnerships formed by Fortune 50 companies in 2014: <http://www.statista.com/statistics/378923/partnerships-in-healthcare-with-fortune-50-companies-in-the-us/>
- Sung-won, Y. (2014). SK enters China healthcare market. *The Korea Times*. Retrieved from SK enters China healthcare market.
- Takahashi, Pecina, Upatishing, Chaudhry, Shah, Houten, V., . . . GJ, H. (2012). A randomized controlled trial of telemonitoring in older adults with multiple health issues to prevent hospitalizations and emergency department visits. *Archives of Internal Medicine*.
- Telus Corporation. (2012). *TELUS Health partners with Sanofi Canada to launch STARsystem platform*. Retrieved from <http://www.prnewswire.com/news-releases/telus-health-partners-with-sanofi-canada-to-launch-starsystem-platform-155419485.html>
- The World Bank. (2016). Retrieved from Hospital beds (per 1,000 people): http://data.worldbank.org/indicator/SH.MED.BEDS.ZS?end=2005&start=2005&view=map&year_high_desc=true
- Tierney, W. M., Miller, M. E., Overhage, J. M., & McDonald. (1993). Physician Inpatient Order Writing on Microcomputer Workstations. *JAMA*.
- Topol, E. (2015). *The Patient Will See You Now. The Future of Medicine is in Your Hands*. New York: Basic Books.
- Vijayaraghavan, V. (2011). *A case study series on disruptive innovation within integrated health systems*.
- Walgreens. (2016). *The incentive program that inspires healthy choices*. Retrieved from https://www.walgreens.com/healthcare/business/ProductOffering.jsp?id=balance_rewards&headrerid=balance_rewards
- Wang, S. (2015). *China's top online medical service platforms*. Retrieved from All China Tech: <http://www.allchinatech.com/chinas-top-online-medical-service-platforms/>
- Wang, S. J., Middleton, B., Prosser, L. A., Bardou, C. G., Spurr, C. D., Carchidi, P. J., . . . David G. Fairchild. (2003). A Cost-Benefit Analysis of Electronic Medical Records in Primary Care. *THE AMERICAN JOURNAL OF MEDICINE*.
- We Care Solar. (2016). Retrieved from <https://wecaresolar.org/tag/safe-motherhood/>

- WHO. (2015). Global Reference List of 100 Core Health Indicators, 2015.
- WHO. (2016). Atlas of African Health Statistics 2016.
- WHO. (2016). *Chronic diseases and health promotion*. Retrieved from World Health Organization.
- WHO. (2016). *Density of physicians (total number per 1000 population): Latest available year*. Retrieved from http://gamapserv.who.int/gho/interactive_charts/health_workforce/PhysiciansDensity_Total/atlas.html
- Xinhua Finance. (2015). *China approves 5 provinces to pilot telemedicine service*.
- Yellowlees, P., Odor, A., Patrice, K., Parish, M. B., Nafiz, N., Iosif, A.-M., & Hilty, D. (2011). *Disruptive Innovation: The Future of Healthcare?*
- Yglesias, M. (2013). *Stop "Disrupting" Everything. How a once-useful concept turned into a meaningless buzzword*. Retrieved from [slate.com: http://www.slate.com/articles/business/moneybox/2013/05/disrupting_disruption_a_once_useful_concept_has_become_a_lame_catchphrase.html](http://www.slate.com/articles/business/moneybox/2013/05/disrupting_disruption_a_once_useful_concept_has_become_a_lame_catchphrase.html)
- Zimlichman, E., & Jeffrey Levin-Scherz. (2013). The Coming Golden Age of Disruptive Innovation in Health Care. *Journal of General Medicine*.