Health Informatics

Sharon Wulfovich
Arlen Meyers *Editors*

# Digital Health Entrepreneurship

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# Health Informatics

This series is directed to healthcare professionals leading the transformation of healthcare by using information and knowledge. For over 20 years, Health Informatics has offered a broad range of titles: some address specific professions such as nursing, medicine, and health administration; others cover special areas of practice such as trauma and radiology; still other books in the series focus on interdisciplinary issues, such as the computer based patient record, electronic health records, and networked healthcare systems. Editors and authors, eminent experts in their fields, offer their accounts of innovations in health informatics. Increasingly, these accounts go beyond hardware and software to address the role of information in influencing the transformation of healthcare delivery systems around the world. The series also increasingly focuses on the users of the information and systems: the organizational, behavioral, and societal changes that accompany the diffusion of information technology in health services environments.

Developments in healthcare delivery are constant; in recent years, bioinformatics has emerged as a new field in health informatics to support emerging and ongoing developments in molecular biology. At the same time, further evolution of the field of health informatics is reflected in the introduction of concepts at the macro or health systems delivery level with major national initiatives related to electronic health records (EHR), data standards, and public health informatics.

These changes will continue to shape health services in the twenty-first century. By making full and creative use of the technology to tame data and to transform information, Health Informatics will foster the development and use of new knowledge in healthcare.

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# Preface

Digital health, the use of information and communications technologies to exchange medical information to diagnose and treat disease and improve care processes and decision making, has exploded in the past few years. Examples are electronic medical records, remote sensing devices, telemedicine, artificial intelligence and machine learning.

Digital health entrepreneurs, those who pursue opportunity under conditions of uncertainty with the goal of creating healthcare stakeholder value through the deployment of digital health innovation, are at the forefront of creating these new platforms and models.

However, there are still significant barriers to the design, development, testing, deployment and post-deployment surveillance of digital health technologies and products. This book is for those interested in closing the gaps by outlining the many stops along the digital health innovation roadmap, including:

- Stage 1: Industry and market analysis
- Stage 2: Opportunity identification and assessment
- Stage 3: Crafting a solution and demonstrating technical, commercial and clinical validation and verification
- Stage 4: Deployment
- Stage 5: Dissemination and implantation, promoting the diffusion of innovation across the various customer segments such that it becomes the standard of care
- Stage 6: Marketing and post-market surveillance
- Stage 7: Continuous quality improvement and product development

We would like to acknowledge and thank the many authors, each a practicing domain expert, for their contributions and expertise.

We hope these lessons learned in the trenches of digital health innovation and entrepreneurship help you prevent mistakes and alert you to the landmines.

Good luck in your new digital health venture!

Denver, CO, USA — Arlen Meyers
San Diego, CA, USA — Sharon Wulfovich

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# Chapter 1
# Introduction to Digital Health Entrepreneurship


**Sharon Wulfovich and Arlen Meyers**

## Overview and Importance of Digital Health Entrepreneurship

Digital health entrepreneurship is the pursuit of opportunity under conditions of uncertainty with the goal of creating user defined value through the deployment of digital health innovations. It is the pursuit of information and communication technologies (including telemedicine, wearables, mobile health and data analytics) to transform the medical field with the goal of improving patient outcomes, increasing quality of health care, improving the health professional experience and reducing costs. Using this quadruple aim framework, we will discuss how digital health entrepreneurship has the potential and opportunity to greatly improve the U.S. health care system.

In terms of improving patient outcomes, there is always room for improvement. Digital health technologies have the potential to not only measure patient outcomes in in more diverse and complete ways but also simultaneously improve patient outcomes. There are many current examples that illustrate this potential including multiple studies on the impact of telehealth on chronic conditions. For example, multiple studies have shown that telehealth can improve outcomes in patients with congestive heart failure [1–4]. A systematic review that analyzed 14 randomized controlled trials with a total of 4264 patients found that remote monitoring systems decreased hospital readmission rates by 21% and all-cause mortality by 20% [5]. This provides evidence for the use of telehealth on improving patient outcomes. Additional

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telemonitoring technology and other telehealth technologies need to be created, accepted and used in order to continue improving patient outcomes.

There are many factors that influence the quality of health care. The growing physician shortage greatly impacts access and as a result the current and future quality of health care. According to the 2018 report by the Association of American Medical Colleges (AAMC), there may be a shortage of up to 120,000 physicians in the United States by 2030 [6]. Digital health entrepreneurship has the potential to lower the effect of this shortage on health care. For example, the application My GI Health (My Total Health) (https://mygi.health) is a digital health platform that systematically compiles patient reported gastrointestinal symptom data and turns it into a report for the physician to read before seeing the patient. This allows the clinic visit to become more focused on addressing the problem versus collecting patient information [7]. A cross-sectional study compared the identification of risk factors by the My GI Health algorithm to those of physicians and found that the algorithm was able to identify a greater quantity of risk factors [8]. This shows that there can be great value in using digital health platforms and checklists. It could reduce the time needed for each patient and allow physicians to focus on doctor-patient communication while seeing more patients in a given day. This idea could be scaled to many specialties and used to maximize and improve doctor-patient communication and interactions, increasing the quality of care provided.

Similarly, the growing physician shortage results in an increased burden on all health professionals. Health professionals are overworked and have a high rate of burn out. Digital health entrepreneurship has the potential to improve the health professional experience. The application discussed above, My GI Health (My Total Health), can not only increase the quality of care but also greatly improve the health professional experience. In reducing the amount of time that health professional collect data from patients specifically data that could be accurately and efficiently be located by applications, health professionals can reduce the time needed for each patient. This could allow health professionals to feel less overworked and focus on providing quality care. This is just one example of how new digital health technology could greatly improve the health professional experience.

Healthcare costs are continuing to rise—in 2016 U.S. healthcare expenditures made up 18% of the total GDP or $3.4 trillion [9]. According to the National Health Expenditure Data from the U.S. Centers for Medicare and Medicaid Services (CMS), healthcare spending is projected to increase at an average rate of 5.5% per year (2017–2026), reaching a projected $5.7 trillion by 2026 [10]. Digital health could help lower these increasing costs. For example, the Veterans Health Administration (VHA) initiated a national home telehealth program entitled “Care Coordination/Home Telehealth” (CCHT) [11]. vThis program used health informatics, telehealth, and disease management technologies to allow veterans with chronic conditions to live at home and delay the need for long-term residential care [11]. The data collected over a four year period from 17,025 participants demonstrated a 25% decrease in total bed days of care and a 19% decrease in total hospital admissions [11]. The continued growth of this program (over 380,000 enrolled veterans)

has resulted in significant financial savings with an average yearly saving ranging from $1238 to $1999 per patient in 2011 [12]. This impact is continuing to grow and illustrates the potential of digital health in lowering health care costs while continuing to provide quality care.

This quadruple aim does not fully illustrate the benefits and importance of digital health entrepreneurship. Digital health entrepreneurship provides other benefits to healthcare industry and population health including bringing new perspectives, empowering individuals, increasing use of preventative medicine, and increasing access to care. Digital health entrepreneurs are not just healthcare providers, cooperation with non-healthcare related is highly common (and sometimes even needed). The increase in communication and collaboration between a diversity of disciplines brings new perspectives and solutions. Digital health empowers individuals with the rise of the do-it-yourself applications and devices. Individuals can now take greater control over their health, by using applications that are convenient and accurate to control or track the progression of an illnesses or simply monitor health. Additionally, these devices may even have an innovative new approach to treatment. It is through these applications and devices, that digital health plays an increasing role in preventative medicine. It can help detect and intervene promptly as well as be used as a tool to improve health. Lastly, digital health is also enabling an increase in access to healthcare for rural and remote communities. Communities where hospitals or clinics are not conveniently accessible can now use telemedicine to get access to care more conveniently.

## Recent Trends

Recent trends in digital health entrepreneurship highlight the growing acceptance of digital health as well as areas of improvement. They include:

1. **Stable levels of investment and new investment vehicles**—Investors are becoming more confident in the digital health sector, Quarter 1 of 2018, marked the largest Quarter 1 for digital health with $1.62 Billion invested in 77 digital health deals [13].
2. **Technologies are being applied to medicine**—Social media, blockchain, artificial intelligence, internet of things
3. **Policy and regulatory changes**—Regulations and policies are being changed to hamper or adapt to the dissemination and implementation of digital health innovation. For example, the FDA recently issued the Digital Health Innovation Action Plan [14] and the 21st Century Cures Act (Cures Act) [15]. These improved policies allow products to get to patients in a more efficient and timely manner.
4. **Large companies are getting involved**—Apple, Amazon, Google, Facebook, Microsoft

5. **More health IT education**—Education programs are offering more degrees and interdisciplinary courses in digital health entrepreneurship and data science [16]. These programs are being offered both at undergraduate and graduate levels.
6. **Academic medical centers, innovation centers, accelerators, incubators and generators are increasingly emphasizing digital health development and implementation**
7. **The rise of physician entrepreneurs**—Physicians are becoming more involved in early stage start-ups and many medical students are forgoing residency for startup involvement [16].
8. **Digital health clinical trials**—Entrepreneurs are starting to collect evidence of the effectiveness and necessity of their products and services [16, 17]
9. **Increased medical and non-medical collaboration**—Entrepreneurs in the healthcare field are bringing non-healthcare related entrepreneurs to help. Additionally, the complexity of the healthcare industry creates the need for team members with healthcare experience. The vast amount of regulations including HIPAA, FCC, FTC and FDA create many barriers to success. Additionally, the intricate healthcare delivery system contains reimbursement models coupled with various stakeholders. This makes it very challenging to create a functional, compliant and profitable product and especially challenging if there is not a team member with relevant healthcare related experience. The fact that medical and non-medical entrepreneurs are starting to work together has enabled an evolution of regional digital health ecosystems.
10. **Increased comfort in using digital health technologies**—Patients, healthcare providers and individuals are becoming more comfortable using digital health technologies as part of their daily practice.

## Barriers and Possible Solutions

Although digital health entrepreneurship has picked up in the past couple of years and continues to grow at a high rate. There are many barriers that digital health entrepreneurship faces. Here are some highlights and possible solutions:

1. **Physicians as entrepreneurs**—There are many persistent barriers for physicians to become entrepreneurs including: lack of an entrepreneurial mindset; lack of courage to persist with an entrepreneurial venture; lack of knowledge (intellectual property, business development, funding, recruiting team members, FDA clearance etc.); poor innovation culture; lack of recognition; anti-entrepreneurial culture of education and training; high opportunity costs and risk management [18].
   *Possible Solutions*: developing social support and mentorship networks, increasing early-on education about entrepreneurship and innovation

2. **Targeting multiple stakeholders**—the healthcare industry is constantly dependent and intertwined with multiple stakeholders (patients, providers, payers, partners etc.). Therefore, it is very challenging to simple target one stakeholder without making sure that the other stakeholders also see value for the given product or service.
   *Possible Solutions:* create fully integrated solutions that fulfill the needs of multiple stakeholders; understand every stakeholders point of view
3. **Security and privacy**—Privacy and security are very important concerns for the healthcare industry. A recent national survey, the eighth Annual Industry Pulse Survey from Change Healthcare and HealthCare Executive Group, found that for about half of the organizations surveyed, privacy and security concerns were the leading factor on why adoption of these technologies was not more extensive [19].
   *Possible Solutions*: make it a priority, lots of trials
4. **Risk adverse nature of the health industry**—In order to ensure quality patient care, the health industry is naturally very risk adverse. This results in a lot of oversight and the hurdles that come with it. Entrepreneurs need to worry about satisfying the FDA, FCC, HIPPA, FTC etc.
   *Possible Solutions*: Consider the risks early on in product development; clinical trials and evidence go a long way
5. **Successful implementation into clinical practice**—Healthcare providers may not have all the information that they require to know whether to recommend or use a given digital health technology in a given scenario.
   *Possible Solution:* Communication with healthcare providers on the scenarios when to recommend or use a given digital health technology, create better knowledge exchange programs

## The New Era of Medicine

We are entering the new digital era of medicine where telemedicine, virtual reality, robotics, smart phones, and other technological advancements are slowly becoming part of regular healthcare practices. Digital health technology offers a way to change many of the current issues that the U.S. healthcare system faces. However, there is an urgent need for entrepreneurs, both in the healthcare field and non-related fields, to challenge the status quo, work together and forge ahead. As discussed, digital health entrepreneurship has many benefits. It has the potential to transform the medical field by improving patient outcomes, increasing quality of health care and reducing costs (specifically long-term costs).

This book provides an overview of a large variety of topics ranging from artificial intelligence to regulatory affairs in digital health with the aim of helping digital health technologists, entrepreneurs, health care providers, investors, service providers and other stakeholders transform the healthcare system.

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# Chapter 2
# Real Challenge in Digital Health Entrepreneurship: Changing the Human Behavior


**Mehmet Kazgan**

## Technology Adoption

If someone were to tell you, when Apple launched the iPhone, that you would be using that phone to call a driver or book a room in someone's house, and you would pay using the very same phone, you would've listed 100 different issues with this process. Yet, today, the iPhone or similar products are at the center of many of our daily tasks.

So what has changed? In short, human behavior has changed to adopt new technologies. It is incredible to watch the rate at which technology accelerates. Software development models have changed drastically, as everything now happens in the "cloud." We do not have old servers that need modems or loud dial up tones to connect to the internet. We also, in time, learned to adapt faster. A 5-year-old child likely knows 10 times more than we knew when we were that age. Human behavior is using the foundational brain power to quickly adapt to the technological shift.

## Healthcare Side of Things

Healthcare is not following the same rate of adoption. Changing human behavior in the healthcare sector now has multiple layers, patient behavior, and clinician behavior controlled with heavy regulatory processes. Spending time in the healthcare community, it becomes clear it is not about sales but it is about convincing a series of stakeholders that your solution offers value for patient care and physician experience which should translate into outcome-based value. Hospital systems and big

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institutions have excruciatingly painful procurement processes. They typically require the solution to provide:

1. Better quality of life to the patients
2. Time savings to clinicians
3. Security and privacy around data
4. Business value and ROI fits into the care model
5. Easy implementation with almost no cost to the entity
6. Scalability
7. Integration ability into different applications and reporting systems
8. Ability to measure outcomes

However, this applies to any healthcare entity to increase interest in your solution. It starts with relationship management. Solutions need to attract enough of an audience in the healthcare system to be able to entertain your concept, your solution.

## Innovation Programs

Innovation programs are one of the easiest paths of entry for startups today. However, it comes with its challenges. Now, as an entrepreneur with the best idea, you need to face the first layer of contact in healthcare institutions, which is usually classified as "Innovation Program". These days it is an overrated term in any technology space, just like "disruptive" and "entrepreneurial".

Innovation teams in health institutions are tasked with exploring and discovering solutions out there which might not be mature enough to could handle their internal challenges. If done right, innovation and discovery models are great time and money investments.

Innovation programs sometimes act like typical accelerator programs. Startup accelerators might be a very good startup route for just conceptual types of businesses. Accelerator programs invest a small amount of money and get non-diluted shares to attract promising startups. Their investment model usually is based on 10% of the startups who might exit or value bigger. Programs like this also attract vendors and advisors who are passionate about the startup community, new ideas and partnerships. If targeted right, accelerator programs offer partnerships and pilots within hospital systems which might be a great way to develop, improve and validate the product.

In some cases, accelerator program entities partner with healthcare systems, raise non-profit based funds to fund the program to find solutions for the challenges. Whether it is a startup accelerator program or it is an innovation program, the path is the same: It starts with identification of the problem. All hospital systems have multiple layers of challenges from patient intake process to discharge during the care continuum.

**Problem identification** It is very easy to identify problems in healthcare models and systems. If you start to explore the quality processes in departments, you will find handful of challenges.

**Solution matching** Once the problems are listed, innovation programs plan to either form their own innovation teams to tackle these problems to find the right fit or partner with the accelerator programs either with equity or fee-based partnership.

**Impact to stakeholders** Once the solution is matched, the innovation teams start to discover the impact of the solution to stakeholders in care model such as patients, care teams, disease prevention models and population health management. This is an important step as there will be cases where innovation programs will start looking into very similar startup concepts within the same cohort.

**Product readiness** Another layer of filtering a set of companies is to monitor the product readiness (i.e., if the startup phase is concept, development or ready to launch.) Sometimes having a ready-to-go product is not a good option as application might not be flexible enough to customize the solution to care team's needs.

Clinicians live in their electronic medical records systems throughout the day, which are very limited, and must-have tools for billing and tracking patient care. In recent years, EMR systems have come a long way; however, statistics today still tell us, clinicians are not fans of EMR systems. Today's EMR systems' history starts with a billing mechanism for clinics. EMR systems now act like decision support tools and ecosystems are now available within EMR systems. Meaning, EMR companies create Play stores for themselves where vendors can build solutions within the EMR system ecosystem. The advantage is because the marketplace platform is built within the ecosystem and has been through the approval process, it has been vetted and verified and becomes immediately available to any customer who is paying for the EMR. The downside is that the vendor has to pay 20–25% of the revenues to the EMR company. This is actually a win-win solution as the vendor can access any client within that ecosystem. In fact, EMR companies market these solutions to their subscribers as "add-ons" so that they can charge additional fees.

**Scalability** The solution that is offered through the innovation program should be scalable within the healthcare organization so that the ROI will be higher.

**Privacy and security** One of the nightmares of healthcare startups is the process to become compliant with HIPAA and other regulatory processes. Even for the healthcare facility to be credentialed with payors and specifically subspecialties also are big challenges. If there is not a great framework around how the data is handled, companies cannot even make it to the procurement step and get dropped. Privacy and security are very important for healthcare. Therefore, institutions have teams for Technology Risk Office Management. Not only should these teams be up-to-date

with what is going on with data breaches, latest security threats, but also they need to create and manage security reviews for any product implemented. For healthcare startups this is a nightmare because a simple sales cycle can turn into a 1–2 year timeframe as the security and privacy reviews could take months. If I were to give one piece of advice to digital healthcare startups, I would tell them to make sure their platform has a plan for HIPAA coverage. Otherwise, they will face a direct rejection later in the engagement game.

## EMR Integration Challenges

Lots of startup pitch decks in healthcare have a common slide with similar content: barriers to entry- EMR integration challenges. In order to provide patient-oriented solution and increase patient satisfaction, companies try to build transactional platforms to communicate patient data in and out electronic medical records systems. Small clinics prefer to have light versions of EMR systems, which are relatively cheap compared to larger ones like Epic, All Scripts and similar. Even Epic lately announced that they are coming with a light version of EMR to be able to target small clinics. One way or another, talking to a highly regulated system, working on a software platform that interacts with EMR is a big challenge for any company. Because of this problem, many ex-EMR employees have been building middleware applications to create communication layers for vendors and hospital systems. Not only do they provide integration solutions, they also handle the project management part of the implementation. That way they open doors to install and engage an agent of theirs with client institution. Bigger healthcare systems tend to stay away from agents that reside within their backend systems for variety of reasons, security concerns being the biggest. We all know that patient data, or Protected Health Information (PHI), is vital for continuity of care. It gets even more complicated when patients have multiple levels and segments of data stored within different clinics. Imagine patients with lab reports, MRI's, other condition reports, and historical records for each clinic. Today, blockchain technology is another route the innovators are taking. Just like revolutionizing the bank and finance transactions, blockchain startups have started to build transactional based data verification systems which can be securely shared among relevant parties.

## Hype of Blockchain and AI

Personalization of EMR systems has been around for a while. Blockchain startups has been looking for ways to create a transactional system for personal health data that can be verified by users to validate and share. Like majority of technology

followers, I would still be skeptical about Blockchain for healthcare. For many, it is already happening, and I definitely do not want to miss that train. Now missing that train might be a relative term when it comes to technology, as we always miss one of those trains because of the way that technology has branched out over the past 10 years. As a technology veteran myself, I am having hard time following what is the latest with the tech trends. There are so many updates, integrations, add-ons, plugins, apps, cloud infrastructure services, open source tools and how all these things are related to each other within their own context. For example: Imagine a healthcare technology platform that uses Blockchain methodology, AI to provide decision support to doctors where they can make more informed decisions, and these workflows could be stored and run using Docker containers, really simple file system-based models. Even now, virtual servers and application servers are operating in Docker containers and PC operating systems are almost dead. You probably see lots of laptops with "Chromebook" text on it. Interestingly enough, Citrix, which is a widely used platform for internal applications, is enabling everything to be processed somewhere in a server farm. All of these processes take place behind the scenes, that way we do not need to invest in computers and hard drives, which have become obsolete or old within months.

Today, custom computers and PC's are alive because of the gaming industry, which is already dominated by Sony, Microsoft, Nintendo. That industry, like any other, has also changed the user behavior by offering something easier, better, and more convenient. That is the key of user adoption and engagement, even within healthcare. The user for healthcare could apply to a variety of people: the patient, clinician, practice admins or healthcare executives.

Blockchain and AI already have started to make their way in to the healthcare setup. Personalized EMR with blockchain in healthcare is already getting lots of venture dollars, despite the risk. Everyone is now familiar with how things can be valued within a year or so if the right investment is made. Blockchain is getting there in many areas, and healthcare is being one. Blockchain might be a more secure method than the traditional protected health information data storage. What makes it even more interesting is that this model is a great lead to make patient data available to anyone once the patient gives a consent and approves a transaction when requested. Like every technology, there are early adopters and risk-free users. It is the healthcare norm, for startups, that all the institutions are risk free users and let someone take the lead first before the tools becomes problematic.

For AI, health industry is a gold mine, because there is a lot of dynamic data points changing and correlating with drugs, treatment models, demographics, gene sequences, etc. Once the correct methodology is followed to collect, map and index data, AI can learn and output faster. Just like any other area of technology, AI within healthcare is also progressing fast, however regulatory processes also affect AI. Today, the FDA is trying to figure out ways to clarify the grey zones related to digital health and decision support. These factors have made data a gold mine for healthcare.

## EMR Integration Challenges and Hitting the Wall

Currently, bi-directional data flow with EMRs is the biggest challenge. Once the clinics and institutions establish the infrastructure and it get running, they do not want to affect their internal workflows and processes with another risky integration, and understandably so. Any digital health vendor that is trying to sell a product to a healthcare facility, needs to first pass the clinical reviews by the clinicians, and only then they move to the next step with Privacy and Security teams within IT. Many of the digital health startups fail because of this step. It is the viscous circle of validation, especially if the product requires the EMR integration for validation step that might take months. This problem arises from the innovation model of the institutions. Unfortunately, EMR companies will not help much because they do not want to do anything else that might require extra support for the product that they are already making revenues on through subscriptions. At the end of the day, EMR companies are responsible to provide full support for their product.

Government entities and non-profits have tried for years to solve this integration program by creating a common form of secure messaging framework for these types of integrations, like HL7 and FIHR. It is a completely different world out there with these messaging frameworks and the ones who are brave enough play the role of the middleware and provide integration services to vendors and health institutions. These are one of the most successful startups as it is a huge demand and there are not many of them. Usually, ex-integration engineers from the big EMR companies leave their companies and start the middleware services company to basically create the API layer which talks to the institutions EMR bi-directionally. By getting this load off of the startups' shoulders, they let startups worry about their external services and products. That way this process challenge creates new business areas and opportunities to other middleware companies. Usually, the ones who can partner early in the game with these companies can become successful as they hire the people who can handle one of the most challenging tasks in this realm.

EMR integration works in the following stages:

1. Identifying the discrete data specs that will flow into the EMR backend services
2. Building the API layer to consume calls in and out to the EMR backend services
3. Identify security and privacy vulnerabilities and resolve all of them
4. Build a secure tunnel between vendor data services and institutions' services
5. Configure EMR backend data parsing and posting processes
6. Configure the EMR front-end to provide the interface and taste of data for clinicians

Each step above requires internal resources to be allocated including the budgets. Usually, bigger healthcare institutions might come up around $500,000 internal implementation cost code. As anyone can see, in order to justify that dollar amount, every clinician or stakeholder for this shared decision-making process will be

working hard to find any weaknesses and pitfalls, and if you are not ready, opportunity is lost, especially in this challenging and competitive arena.

Typical EMR integration would require the following resources to be able to deliver this project:

- Integration Team (HL7 or FIHR Engineers): 150 h
- Information Security and Data Security Team: 30 h
- Privacy and Security Team (Legal): 20 h
- Networking Team (VPN, ETL): 30 h
- Database Administration Team: 50 h
- Configuration Analysts: 10 h
- Help Desk & IT Support: 10 h

These are the typical minimum number of hours required for an average EMR integration project. The rough part is to get this budget approved to be able to move forward for business validation as the validation process would be as follows:

1. Clinical Validation
2. Technology Validation
3. Business Validation

Supposedly, the business case and validation are the up-front sales to get #1 and #2 started.

## Internet of Things

Data and accessibility are two big terms in technology today. The point is to make one more significant, and the other easier and faster. This builds the value proposition for healthcare. Fortunately, today these benefits can be offered with IoT devices. As there are more products coming to the market, accessibility is getting easier naturally. There are companies raising millions of dollars by just providing common API services to provide these devices' data to users, platforms.

A critical point just like in any statistical research, is marrying one data point to another to create more meaningful patterns. In other words, adding biometric device data to any condition and observing data across time can lead to many critical decision points that might change the healthcare system. The FDA has been trying to find ways to regulate this as it expands.

The benefits of IoT are not only limited to these. Constant reporting and monitoring without any human interaction, especially in ambulatory models can make differences between life and death. Imagine a patient experiencing heart failure, and data is already triggering a paramedic call and pushing HR data to the ambulance as well as the hospital Emergency Department. We are slowly getting there with healthcare, as long as the model is framed properly with data security and privacy and build security measures to monitor updates, should make it a faster process.

One other perspective in this space is the medical diagnostics and costs. Today, medical diagnostics is a big slice of the cake considering the medical bills in hospitals. There is no argument that the constant and frequent data connection will provide lots of cost savings. From the patient compliance angle, clinicians can monitor anything from functionality to vitals. Accuracy of the data collection is improving everyday with revolutionary designs. Once the validation end points are also added to the data collection, such as physical or virtual assessments data becomes more significant.

Improvements in this area should help with one of the biggest challenges: security and privacy. Even though, lots of guidelines are shared and being implemented, the lack of data security protocols can cause lots of security issues. Having more end points as part of this process such as patients, clinicians and payors, data sharing is essential for any of these stakeholders. However, each entity can protect and guard entry points and exit points from their side. In this triangle, the weakest point is the end-user, the patient.

As individuals, we are as informed as we can be on our rights, however, with so much going on with data around us, social networking, financing and many other distractions, data security and privacy is getting harder to track and guard. Institutions have guidelines and guarded version control systems. With teams overseeing these processes with legal, IT, security and clinical perspective, it is much safer to have control of any healthcare data.

Another big challenge with IoT is the integration between many devices. Each device today can collect different types of data. A fitness watch can track functionality, a glucometer can detect blood sugar levels, a HR monitor can somewhat accurately track HR data. For a diabetes patient with cardiovascular disease, it is essential to have all data points to be able to have a better understanding of what is going on with each condition. Adding the handful medication to the mix and the complications, problems can get even more sophisticated.

Today, many clinicians think the collected data from IoT devices are not either accurate enough or data are not significant enough to make informed decisions. Moving forward, it is obvious that the accuracy of the IoT devices will increase, data would get validated with outcomes, AI will take over to process data quicker and more intelligently. That is the pattern as we see it.

## User Engagement

As the technology gets smarter, we need to find ways to make users more engaged with the product. Investors for startups question the user engagement and retention heavily. Customer experience becomes a serious task for any technology company who is providing continuous services to their users via mobile platforms or applications. Obviously, clinicians and providers as customers for digital health question the very same thing. Despite most people thinking healthcare is more challenging than any other industry when it comes to user engagement, it actually might be an

advantage as it is related to human lives and conditions. Typically, one would expect that patients would be engaged to their digital health tools more than any other standard user profile, because non-compliance would make their life worse. However, human behavior tends to get distracted from regular patterns and required tasks easily, even though it could have negative impacts on their lives. It is about a choice they make. Smoking would be a very good example. How many of the smokers you know that it is not healthy for them to smoke, but they still do for various reasons? With the same token, digital health startups need to convince their users, whether they are providers or patients, to be engaged to the tools they offer to be able to present value and ROI. That itself, is the biggest challenge of all. We all are looking for answers in fact, not to provide the best product, but to be able to adapt human behavior to benefit our own health.