



The State of Digital Health in the Triangle

powered by Bluedoor, your partner in Digital Health





Mapping a Digital Health Vision for 2020

Michael Levy, Co-founder & CEO, Bluedoor

Entrepreneur-in-Residence, UNC Center for Health Innovation

The Research Triangle of North Carolina (encompassing Raleigh, Durham and Chapel Hill), ranks among the top metropolitan statistical areas in physicians per capita and is home to two of the nation's top academic medical centers, UNC Chapel Hill and Duke University, as well as NC State University, known for its excellence in computer science, engineering and design.

Durham is called "The City of Medicine." The region is an acknowledged leader in the biotech and life sciences field and includes some of the world's most successful high-tech companies. We have the talent, resources and expertise to be a leader in the digital health space as well, as it represents the ultimate convergence of all these attributes. And yet until now there has been no coordinated digital health effort facilitating the incubation, acceleration, and commercialization of the significant pool of talent and ideas available across the region. There are many parts of the Triangle community doing great work in the digital health space, from innovation labs to digital health start-ups and large industry R&D efforts. The way to have the greatest impact as a community is to tie all of these elements together with a unified vision that

serves the entire ecosystem and propels the Triangle into a leadership position among digital health hubs. We have all the ingredients in place to capitalize on the paradigm shift that digital health promises, and make a positive impact on the so-called quadruple aim: improving patient care quality and satisfaction, boosting population health, reducing overall healthcare costs, and enhancing the caregiver experience. We need to invest in the infrastructure and funding mechanisms to align and incentivize collaboration across the digital health ecosystem at a regional and state level. By leveraging our preeminent position in biotech, life sciences, and healthcare delivery, the Triangle can become a digital health leader by 2020 if we collectively nurture the ecosystem and provide the infrastructure to support it.

TABLE OF CONTENTS

Introduction.....	2
The Survey	3
Digital Health - Definition and Potential.....	4
Digital Health Market Trends and Forecast.....	5
Digital Health Ecosystem + Triangle Opportunity	7
Triangle Current Ecosystem	8
Academic Medical Centers & Healthcare Systems	8
Investment and Acceleration	10

Entrepreneurial Community	11
Service Providers	12
Industry Partners	13
Talent	14
Triangle Future Ecosystem	15
How to Get Involved	16
Thanks & Acknowledgments.....	16

THE SURVEY

This report is a high-level investigation into the current state of digital health in the NC Triangle. Its goal is to benchmark where we are and act as a catalyst for the advancement of digital health across the region. We conducted market research surveying more than 350 stakeholders and key influencers in the field. These findings, along with insights from subject matter experts, have driven the content contained in this report. As evidenced by the survey results, the next step toward advancing digital health in the Triangle is the calibration of perceptions and alignment of goals. Tables 1 and 2 below illustrate the disparate responses to the quantitative survey questions, which used a scale from 1 (worst) to 10 (best).

Table 1: Quantitative Question Responses

Question	Range	Avg.
Q2: How would you rate the Triangle compared to other digital health innovation hubs?	3-10	6.8
Q3: How would you rate resource availability for digital health start-ups (talent, accelerators, incubators, mentors, service providers, etc.) within the Triangle?	3-10	6.5
Q4: How would you rate the Triangle's investment environment for digital health start-ups?	2-10	5.4
Q5: How would you rate the ease of testing and validation within the Triangle?	2-10	5.8
Q6: How would you rate the ease of implementing digital health solutions within the Triangle?	2-10	5.8
Q7: How would you rate digital health adoption among providers within the Triangle?	1-10	5.7

Table 2: Ratings by Segment

Segment	Q2	Q3	Q4	Q5	Q6	Q7
Entrepreneur	6.9	6.3	4.7	5.7	5.7	5.2
Industry	6.2	6.3	4.3	5.1	4.9	4.9
Investor	6.0	6.5	4.6	5.3	5.1	5.2
Patient	6.5	6.7	5.4	5.6	5.5	5.7
Technologist	6.8	6.6	5.5	5.7	5.7	5.7
Provider	6.6	6.5	5.4	5.6	5.5	5.7
Other	6.5	6.7	5.4	5.5	5.4	5.4

The numbers to the right suggest, among other things, that digital health stakeholders in the Triangle have yet to advance the dialogue enough to develop a broad consensus. While there is not a huge disparity between the segments' ratings, there are significant differences between individual responses.

We also asked and categorized qualitative questions to better understand the reasoning behind the quantitative ratings. Qualitative questions and the prevailing thematic sentiments included:

Q8: What are the best things you would say our community is doing in digital health? The Triangle harbors a collaborative spirit that is working hard to utilize regional talent.

Q9: What could our community do better to foster digital health innovation? Collaboration between major providers, and between stakeholders in general, is not at the desired level.

Q10: Where do you think the best untapped opportunities are for digital health innovation? Consumer engagement and population health management.

Q11: What is the biggest digital health challenge, or one you foresee, in the next 5 years? Politics are seen as the major barrier, specifically policies surrounding privacy and reimbursement.

While quantitative ratings were relatively low, qualitative responses suggested the Triangle possesses both the assets and desire necessary to elevate the Triangle's digital health presence. Realizing this potential will require stakeholders to share an understanding of digital health, opportunities in the space, and how collaboration can be used to leverage the Triangle's assets.

DIGITAL HEALTH : DEFINITION AND POTENTIAL

Digital Health can be described as the convergence of science, technology, and healthcare delivery. It represents an ongoing revolution that combines technology with personal health and genetic information to improve the efficiency and effectiveness of healthcare, and to make medicine more personalized and precise. This revolution has the potential to transform how we communicate, how we diagnose, how we treat and care, and how consumers engage with their health and well-being. Digital Health offers the opportunity to address the greatest healthcare challenges and deliver significant improvements across the so-called quadruple aim. Because it fundamentally involves the convergence of disparate fields, digital health requires multi-disciplinary collaboration between various combinations of clinicians, healthcare administrators, public health workers, researchers, engineers, social scientists, and of course patients. This convergence has sparked access to endless permutations of health solutions, consequently initiating a digital health 'gold rush'. The list to the right shows, at a high level, examples of digital health application areas.

WHY ARE YOU EXCITED ABOUT THE PROSPECTS FOR DIGITAL HEALTH IN THE TRIANGLE?

John Reites, Chief Product Officer, THREAD

"The Triangle naturally includes an experienced, world-leading ecosystem for science, technology and innovation to intersect. Where else can you engage with health-focused, world-renowned academic medical centers, life sciences companies, investors and technology companies all within a short drive of each other? Where else can you work and scale your company in a location for a fraction of the cost of other cities with digital health ecosystems?"

As a husband and dad, I strongly believe that the Triangle also gives entrepreneurs and digital health company employees the opportunity to live in a beautiful area with affordable housing, short commutes and award winning cities for raising a family. Some of the most known and disruptively innovative digital health companies are here - with many new companies joining our ecosystem each week. I love that these companies know each other and help each other under the banner of being Triangle companies.

I have spent my entire career in the Triangle and my company is proud to be here as a digital health leader. I believe our unique healthcare and life sciences ecosystem can move digital health forward unlike anyone else and am excited about our opportunity to impact health together as the NC Triangle."

DIGITAL HEALTH APPLICATION AREAS

- Clinical Administration
- Digital Medical Devices
- EHR/EMR
- Gamification
- Genomics
- Healthcare Marketing
- Healthcare Mobile Communications
- IoT Health & Fitness
- Machine Learning
- Medical Big Data
- Mobile Fitness / Health Applications
- Online Health Communities
- Online Health Destination Sites
- Patient Engagement
- Payments & Insurance
- Population Health Management
- Remote Monitoring
- Robotics
- Services Search
- Telehealth
- Virtual/Augmented Reality

The above solutions are just the tip of the iceberg. While no one knows the full potential of digital health, it is increasingly seen as crucial to tackle the most significant current and looming issues in healthcare. Survey respondents identified population health management, chronic disease management, elder care, and patient empowerment as some of the best untapped opportunities for digital health.

Collaboration in digital health solutions benefits all stakeholders, not just the producers and consumers. Figure 1 below highlights some of the benefits various stakeholders can reap through collaboration.

Figure 1: Benefits Derived By All Stakeholders



Survey respondents identified population health management, chronic disease management, elder care, and patient empowerment as some of the best untapped opportunities for digital health.

DIGITAL HEALTH MARKET TRENDS AND FORECAST

We looked at some current environmental trends in healthcare and separated them into two key groups: enablers and barriers. It is up to the community to flesh out more enablers and barriers while advancing the digital health dialogue.

ENABLERS:

- **Non-traditional partnerships.** For example, Ascension and Lyft are partnering to offer transportation to non-emergency patients
- **Investment in digital health** increased by \$1 Billion from 2014 to 2016 while the number of investors increased 42%¹
- **Emphasis on quality and risk-based contracts** are on the rise. CMS contends nearly 30% of its reimbursement is tied to performance.²
- **Population health** is gaining focus. Duke, UNC, and WakeMed have established Accountable Care Organizations (ACOs) and Clinically Integrated Networks (CINs)
- **Increasing global demand for healthcare services** as more people gain access to providers and technology
- **Clinician shortages**, paired with an **aging population**, necessitates more efficiency and remote monitoring
- **Digital health facilitates independent living** through patient empowerment
- **Data aggregation** is becoming increasingly important
- **Consumer-driven insight** leads to better treatment and more effective outcomes

In response to these trends, healthcare is experiencing the emergence of innovation centers, incubators, ideation/innovation programs, accelerators, digital health consulting firms, enhanced collaboration, and resource sharing. For example, **Boston** has created a council to the governor with new public-private partnerships focused on drawing leaders from tech companies, providers, life sciences, academia, government, and other sectors in order to help Governor Charlie Baker capitalize on the digital health market. The initiative leverages interdisciplinary, non-tra-

BARRIERS:

- **Privacy regulations** can drive up development costs and/or hinder application
- **Reimbursement** for digital health services such as telehealth is currently limited, but is growing
- **Cost of implementation** can be prohibitive despite long-term economic benefits
- **Investment** is still limited and a major barrier for many digital health companies. Only 2% make it past Series A funding.
- **Insufficient collaboration** across the entire ecosystem
- **IT infrastructure** often faces interoperability barriers. CDW reported that 36% of hospitals had interoperability issues between technologies during EHR data migration.³
- **Risk aversion** is incentivized through policies, and digital health often requires a degree of risk
- **Goal alignment** has yet to be realized by stakeholders with competing incentives
- **Care coordination** is fragmented, which leads to downstream benefits being ignored
- **Speed to market** is prohibitively slow. Sales cycles in healthcare systems are often between 9 to 18 months
- **Lack of rapid testing and validation.** Health systems are currently running only a handful of pilots per year when they could run a hundred

ditional partnerships while also capitalizing on top talent and the strong start-up climate. This approach boosts adoption and accelerates market growth. Some additional approaches from other hubs include:

Chicago is home to the AVIA Innovator Network, which is a network of health systems that solve healthcare challenges by leveraging each other's assets. Collaboration between large systems enhances the solution discovery and vetting process, accelerates testing and validation, and streamlines implementation and scaling.



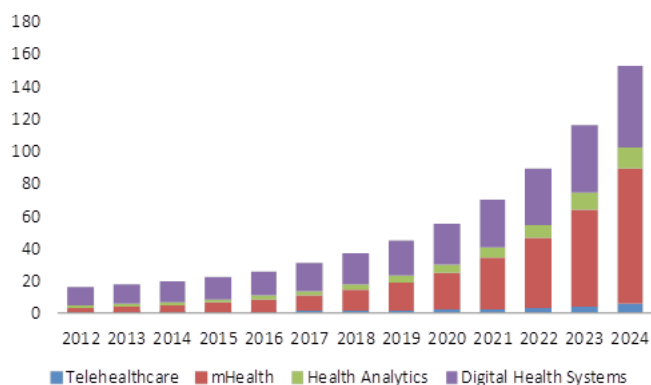
Denver is hoping to become the digital health capital and staking its claim by building a 300,000 square foot brick and mortar digital health ecosystem called Catalyst HTI. Beginning Q2 2018, Catalyst HTI will bring together private enterprise (startups to Fortune 100), government, academic, and non-profit organizations with healthcare providers and payers to accelerate innovation and drive real, lasting change.⁴

Salt Lake City is home to two progressive health IT hospital systems – Intermountain and University of Utah Health – and is forming relationships outside the region to bolster its digital health presence. For example, the University of Utah has partnered with South Korean Chung-Ang University for a digital health program. The organizations have a long-standing relationship of gaming and innovative business model strategies, which they hope to leverage to develop solutions to complex medical problems.⁵

SHORT-TERM FORECAST

Digital health will continue to steadily ramp up while the healthcare industry awaits policy and incentive shifts. EHR proliferation and sophistication will continue to underpin the advancement of telehealthcare, mHealth, and data analytics. Indeed, Global Market Insights, Inc. predicts the digital health industry will surpass \$379 billion by 2024 and the US will account for \$152 billion of the market.⁶ Figure 2 below provides a visual of Global Market Insights, Inc.'s forecast.

Figure 2: Digital Health Market Forecast ⁷



Source: Global Market Insights, Inc.

Rapid market growth, however, does not necessarily imply widespread success. Start-up Health reported that just five deals accounted for almost 25% of the \$8.1 billion invested in Digital Health start-ups in 2016.⁸ Furthermore, Becker's Hospital Review claims 98% of digital health start-ups fail.⁹ The article suggests failure primarily occurs due to a lack of attention to current idiosyncrasies and usage of out-of-date technologies. Start-ups mindful of those pitfalls still encounter failure because they do not gain patient and

provider adoption and have a limited runway. Success, in any circumstance, is dependent on comprehensive knowledge and support. And in the realm of digital health, this requires collaboration from a breadth of stakeholders.

Another major component of success is consumers and data shows consumers are becoming increasingly willing to adopt digital health solutions. According to a 2016 report by Rock Health, 46% of consumers are now considered active digital health adopters – up from 19% in 2015. Figure 3 illustrates the increasing adoption of digital health solutions.¹⁰

Enthusiasm for digital health extends beyond its producers and consumers. The FDA has recognized that “patients and consumers can use digital health to better manage and track their health and wellness related activities” and initiated a Digital Health Program that seeks to better protect and promote public health by:

- Fostering collaborations and enhancing outreach to digital health customers
- Developing and implementing regulatory strategies and policies for digital health technologies.¹¹

Locally, groups like the North Carolina Healthcare Information & Communications Alliance, Inc. (NCHICA) and Health 2.0 NC Triangle chapter have been instrumental in driving the digital health agenda forward by exhibiting and promoting new healthcare technologies, and hosting conferences, code-a-thons, and prize challenges.

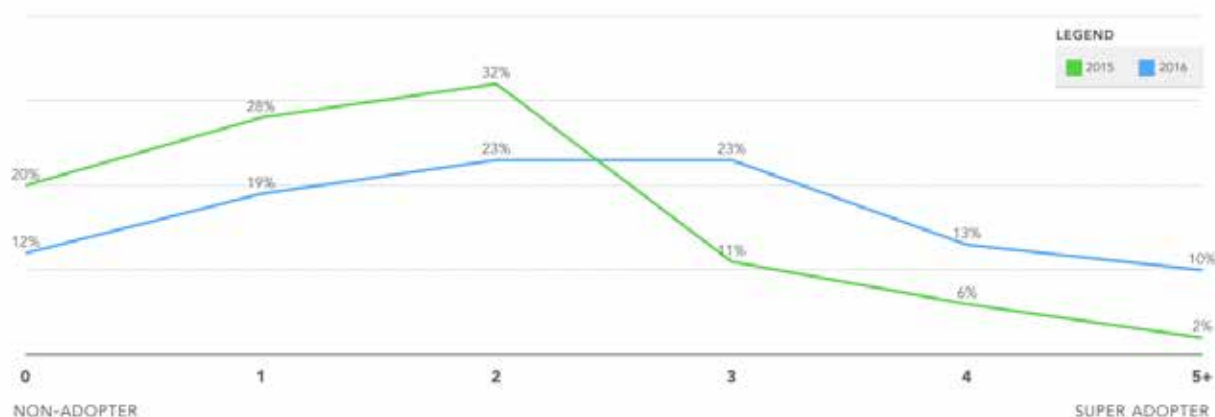
All evidence seems to suggest that America has just passed the adoption tipping point and digital health is poised to enter a new era.

Success is dependent on comprehensive knowledge and support. And in the realm of digital health, this requires collaboration from a breadth of stakeholders.

Figure 3: State of Consumer Adoption

STATE OF CONSUMER ADOPTION

Number of digital health categories used by respondents



Source: Rock Health 2016 consumer survey data (n = 4,013)

DIGITAL HEALTH ECOSYSTEM + TRIANGLE OPPORTUNITY

Becker's Health IT & CIO Review notes some thriving hubs outside of the Silicon Valley, including Boston, Denver, Miami, Atlanta, and Chicago.¹² While the Triangle is not on the list, Becker highlights several facets of these thriving hubs that would be natural transitions for the area. Boston is currently one of the biggest players in the global biotech industry and, as previously mentioned, leading innovation in digital health through projects like the Massachusetts Digital Health Initiative formed to help Governor Charlie Baker to take advantage of the opportunities in the digital health market. Denver, Miami, Chicago, and Atlanta are also featured as thriving hubs due to factors including young populations, healthy start-up ecosystems, international business and entrepreneurship opportunities, presence of large tech and healthcare companies, as well as development of healthcare incubators and accelerators and tech entrepreneurship centers. As illustrated throughout this paper, the Triangle possesses all of these ingredients in abundance and has the potential to not only join this list, but become a leader in this space.

Ingredients extend beyond assets. They include trends like the Triangle's rapid population growth, economic growth, and low cost of living paired with a high quality of life. In fact, in recent years, the area has seen the highest population and economic growth rates in the nation.¹³¹⁴ Together, these trends make the Triangle appealing to companies and talent.

HAVING SEEN OTHER SUCCESSFUL DIGITAL HEALTH HUBS AROUND THE COUNTRY, WHAT MAKES A SUCCESSFUL DIGITAL HEALTH ECOSYSTEM?

Al Lauritano, Director of Business Development, BD Technologies

"While the digital age is upon us and dramatically affecting almost every facet of our lives, organizations involved in the delivery of healthcare behave as if they are immune, thinking that change and disruption will be a slow and deliberate process. Based upon my work at global innovation hubs, the integration of medical technology and clinical practice with digital technologies is still at an early stage and there remains an opportunity to engage, influence, and co-create.

One good example of this is the PULSE@MassChallenge digital health acceleration which has spun out of the very successful Mass Challenge program for start-ups. **Even in Silicon Valley, tech giants are just starting to partner with the biotech and medtech communities to co-create solutions, but there remains no consolidating vision and effort to bring about integration.**

The Triangle has an opportunity to create such a hub for medical innovation. The area has a good mix of healthcare companies, payers, and providers along with major research universities and an established hi-tech footprint. And most importantly, The Triangle brings a public-private partnership model for executing such a vision...the NC Biotechnology Center. NCBC is an asset for our state and is recognized well beyond our borders. Why not aggressively broaden its scope and outreach into the digital community to form new partnerships to improve healthcare delivery? The time to act will never be better than now."



ACADEMIC MEDICAL CENTERS & HEALTHCARE SYSTEMS

Large research universities, including Duke, UNC Chapel Hill, and Wake Forest University have positioned themselves as leading innovators by drawing on institutional strengths to foster collaboration between researchers, health networks, and entrepreneurs for patient health optimization. Dually leveraging the academic centers and entrepreneurial digital health network embedded throughout the Research Triangle as cohesive units would enhance collaboration and validation of digital health concepts across academia, developers, researchers, and innovators. “The ecosystem for rapid testing and validation of digital health contains a couple of key ingredients: collaboration and clarity,” according to Blake Long, Chief Clinical Officer at Echo Health Ventures. The current landscape of digital health in the Triangle has been clustered amongst the efforts of the UNC Health network, Duke University, and Wake Forest, each bringing to the table opportunities for cross-collaboration to create a single digital health ecosystem.

UNC CHAPEL HILL

UNC Center for Health Innovation initiates, evaluates, and supports the adoption of disruptive, patient-centered innovations in the delivery and financing of healthcare. Its Digital Health Program provides advisory services, resources, and clinical subject matter expertise to budding “intrapreneurs”, entrepreneurs, and external industry partners. UNC’s Digital Health Innovation Sprints™ are novel, experience-based, high-energy events designed to guide entrepreneurial teams in defining a healthcare problem and generating a digital solution over a three-month period. The collaboration between UNC’s academic centers and extensive healthcare network provides optimal efficiency in the piloting, validation, and implementation of digital health solutions.

DUKE UNIVERSITY

Duke University Global Digital Health Science Center brings together a mix of experts from industry, policy, and science to create innovative behavioral digital health science and interventions for the most medically vulnerable populations. The center draws on experts from three core areas - academic researchers, including core faculty and postdoctoral students; policy stakeholders; and the programming team to disseminate implementation of digital health interventions. This interdisciplinary approach has brought improved health outcomes and containment of healthcare costs through the support of the Duke Health System and Duke School of Medicine.

WAKE FOREST

Wake Forest Innovations, part of Wake Forest Baptist Medical Center, fosters collaboration between scientists, providers, and business experts to translate discoveries into best practices by expediting access to specialized clinical and research capabilities and through experiential training. Wake Forest Innovations has brought more than a hundred products to market and launched 33 start-ups since 2000, surpassing \$1 billion in annual product sales of innovative technologies.



Moreover, the digital health revolution has been largely pushed by two independent ecosystems. First is the entre-

[illegible]

**Gary Bennett, PhD and Erica Levine, MPH,
Duke Digital Health**

We believe that we can improve the lives of millions of North Carolinians, and that we can do so with the help of academic, industry, and policy leaders in the Research Triangle.

INVESTMENT AND ACCELERATION

The question “How would you rate the Triangle’s investment environment for digital health start-ups?” received the lowest rating (5.4) of the survey. Notably, investors gave an average rating of 4.6. This section will highlight four organizations that are working to improve that number.

HATTERAS VENTURE PARTNERS

Hatteras recognizes that the region is undercapitalized, primarily investing in early stage companies with a focus on biopharmaceuticals, medical devices, diagnostics, healthcare IT, and related opportunities. Hatteras has approximately \$450 million under management and has established a dedicated effort to foster seed-stage biopharmaceutical investments and drive innovation.¹⁵

EXCELERATE HEALTH VENTURES

Excelerate Health Ventures was started by entrepreneurs for entrepreneurs. It focuses solely on healthcare start-ups that produce healthcare software, technologies, and associated services that enhance revenue and/or reduce healthcare cost while improving quality of care, workflow efficiency, and patient outcomes. It provides consulting and advising services to pre-seed and seed stage start-ups. Its services include mentoring, networking, business planning, as well as marketing and event planning, branding, sales channel development, organizational planning, and recruitment.¹⁶

ECHO HEALTH VENTURES

Echo Health Ventures has offices in Durham, Portland, and Seattle and invests in healthcare companies to accelerate their innovations nationally. Indeed, Echo Health Ventures embraces the term “accelerator” and works to leverage its companies’ talents across its portfolio.

BLUEDOOR

Bluedoor is a strategic innovation group affiliated with the UNC Center for Health Innovation that describes itself as a relationship company. Through building relationships across the digital health ecosystem, Bluedoor hopes to improve access to investment and accelerate innovation. To date, Bluedoor has completed two Digital Health Innovation Sprints, leveraging the interests of payers, providers, industry partners and entrepreneurs to rapidly develop technologies and provide go-to-market assistance. In addition to the Sprints, Bluedoor services a portfolio of digital health start-ups and provides strategic consultancy for companies ranging from pre-market ventures to large healthcare organizations.

GROUNDWORK LABS

Groundwork Labs is a free accelerator funded by NC IDEA, a private, not-for-profit organization with a mission to support technology start-ups in North Carolina. Services include customer discovery, customer development, business modeling, pitch production, and networking with mentors, advisors, investors, and customers. One of Groundwork’s success stories is a company called PT Wired which was recently hailed by ExitEvent as one of the start-ups shaping the telehealth industry.¹⁷

HOW DO WE AVOID THE DIGITAL HEALTH “VALLEY OF DEATH” AND PROVIDE THE RIGHT ENVIRONMENT FOR RAPID TESTING AND VALIDATION?

Bobby Bahram,
Managing Partner,
Excelerate Health Ventures

A successful initiative to achieve the stated goals would need, at a minimum, these ingredients:

- 1) A laser-focused mission on digital health only.
- 2) Entrepreneurs that have validated a deep unresolved need through first-hand discussions with more than a few dozen potential customers.
- 3) An ecosystem of diverse partners – experienced digital health entrepreneurs, providers, payers, pharmaceuticals, CROs, pharmacies, digital health vendors, regulatory experts, patient advocate groups, and digital health investors, among others – that are actively involved in providing guidance to entrepreneurs at the right level in each of their organizations.
- 4) Ongoing efforts by entrepreneurs, with the help of ecosystem partners, to validate and test their business plan and model, with a special focus on: recruiting the right team members that have relevant experience at that stage of the company, impact to and integration with existing workflow, go-to-market strategy, understanding of the adoption metrics dynamics, analysis of the market and competitive landscape, testing of the pricing model with the right customer purchasing decision makers, and clearly articulating their value proposition.
- 5) A public-private partnership to fund and foster these efforts – especially in putting together an environment that is solely focused for incubating and accelerating the growth of seed and early-stage digital health start-ups.

A few programs around the country have followed this recipe with a decent success record. With the right leadership, we can achieve similar wins and be at the forefront of creating innovative companies that improve healthcare at all levels.

ENTREPRENEURIAL COMMUNITY

According to our market scan, at least 70 digital health start-ups are currently operating in the Triangle. Durham is home to at least 30 digital health start-ups, while Raleigh is home to more than 28, and Chapel Hill to 12. These start-ups have raised tens of millions of dollars and employ over 2,000 people. ExitEvent has highlighted 18 it believes are shaping the telehealth industry, for example:

- **Touchcare**, a Durham company that created a mobile application from which providers can schedule appointments, set fees, conduct live video appointments, and bill for services
- **RelyMD**, a Cary-based company delivering emergency healthcare services via secure, live video platform
- **PT Wired**, a Durham company that helps physical therapists monitor and motivate patients through a mobile application
- **Medicom**, a Raleigh company that allows files, such as X-rays and MRIs, to be transferred to doctors wirelessly rather than burned on CDs and hand-delivered
- **KeonaHealth**, a Chapel Hill company founded in 2011 that helps streamline all facets of patient intake and discharge through a web-based triage solution
- **Neuro+**, a Duke-born start-up that helps children with ADHD manage their symptoms with specially designed games¹⁸

The Triangle community is supportive of entrepreneurs interested in promoting digital health. Although not specifically designated for healthcare entrepreneurs, the following co-working spaces and organizations have a footprint in the healthcare space:

AMERICAN UNDERGROUND

American Underground is one of just seven Google for Entrepreneurs tech hubs in North America, which means members have unique access to Google and its products. AU has four locations and is designed to accommodate solo-entrepreneurs or large teams. Over 250 companies are housed within those four locations and over 1,500 people are employed by those companies. AU has also sponsored and hosted numerous events to promote digital health, including UNC's Digital Health Innovation Sprint™ series, Triangle Health Start-up Weekend, and Digital Health in the Triangle Happy Hours.

HQ RALEIGH

HQ provides collaborative space in four locations, including two in Raleigh. Raleigh is home to more than 150 member companies and the state has over 500. HQ Raleigh currently houses RelyMD, one of the companies highlighted by ExitEvent, and Portable Databases. One of Portable Database's apps, Antibigrams, helps healthcare professionals and clinical microbiologists choose the most effective antibiotics to empirically treat infections, based on local susceptibility patterns. Rex Health Ventures also has a partnership with HQ Raleigh and works out of the space. The partnership presents a great opportunity to further collaboration. In addition to hosting companies, HQ Raleigh has hosted Health 2.0 and other healthcare-focused events.

Blake Long, Chief Clinical Officer, Echo Health Ventures

While there is no clear "right" environment, the ecosystem for rapid testing and validation of digital health contains a couple of key ingredients: collaboration and clarity. The complexity of healthcare - with vast regulation, misaligned incentives, and complicated workflows - challenges the idea of an "easy solution" approach. First, the fundamental mechanics of the prescriber, payer, and

user existing as three different entities creates silos and friction. The right environment will require collaboration between them, which can emerge in many forms, but is essential. Second, there is a growing sense of solution fatigue requiring more clarity for success. Focus by both the entrepreneur and the test environment on what is the true problem and who has the need will help to define the best pilot and avoid the enterprise-wide solution mindset. However, the chaos of

multiple pilots drains resources and energy from the environment. While pilots are key for validation, an ecosystem that fosters strategic thinking beyond the pilot is essential. Moving beyond the pilot requires long-term vision, getting the right people in the room, ability to adapt, time, and patience. **A collaborative environment of entrepreneurs, payers, and providers supported by a network of strategic capital and people with these characteristics will be transformative.**



HOW DO YOU BRIDGE THE GAP BETWEEN TECHNOLOGY DEVELOPMENT AND CONSUMER ADOPTION? WHAT DO WE NEED TO DO TO SET UP THE RIGHT END USER TESTING AND VALIDATION ENVIRONMENT?

Robert Furberg, Clinical Informaticist, RTI International

The popularity and adoption of consumer wearable devices and digital health apps is growing. A 2014 survey of 1,000 U.S.-based consumers indicated 21% of adults are wearable device owners. This number increased in 2016 to 49% owning at least one wearable device and 36% owning more than one. Alongside consumer-based adoption, wearable devices are also becoming more prevalent in research. The [Vandrico Wearables Database](#) holds an inventory of 421 devices from 266 vendors. Even a single vendor, Fitbit, [clinicaltrials.gov](#) had been used in 161 registered studies involving Fitbits as of May, 2017 and the [Fitabase Research Library](#) lists 330 peer-reviewed publications that describe the use of Fitbit devices in the conduct of public health and clinical interventions. While many registered clinical trials use wearables to augment health behavior change interventions, investigators are increasingly leveraging these devices for primary data collection to measure behavioral outcomes. Consumer wearable devices are no longer solely for personal wellness. The wide range of features and precise measures offered by wearables makes them a valuable data collection tool, offering detailed insights into the user's lifestyle, emotions, behaviors, and routines.

Before being used for intervention purposes, the validity of commercially available wearable devices should be established so that researchers using these products can be confident in their utility as behavioral tracking devices. In addition, evaluating these products may help consumers make educated decisions regarding device selection. Moreover, an argument could be made to test any new tracker, even if the company confirms similar hardware and software processes. With time, the trackers offer more features through enhancements made to the trackers. Each new tracker feature needs testing for reliability, validity, and usability.

With the proliferation of trackers, clinicians and researchers would benefit from an evidence-based position statement on the properties necessary to consider a tracker valid and reliable. Guidance on equivalency of accelerometers exists, however a variety of data collection practices and statistical methods have been used in validity and reliability studies, limiting generalizability. There are no vendor accepted technical standards for data type, how they are collected, or processed. In the absence of vendor standards, creation and promotion of a Universal Validation Protocol for Wearable Devices to promote rapid and open validation testing of devices should be considered.

SERVICE PROVIDERS

Successful digital health innovation relies on the ability to develop tangible assets and products from research, testing, and validation. With digital health technology advancements ranging from microchips, wearables, virtual reality, augmented reality, and sensors to mobile applications, there is a risk that the resulting solutions are technology-driven, rather than consumer-driven – solutions focused on functionality, rather than end-user experience. Survey respondents agreed that one of the biggest barriers to successful digital health adoption was developing solutions that are engaging, taking into account human-centered design principles and involving patients at every stage of development. *Companies that address this gap will have a distinct market advantage in the digital health race.*

HARDWARE DEVELOPMENT

Product design companies are available in the Triangle to assist with product design, prototyping/rapid prototyping, development, verification, and validation for a variety of products, including medical devices. Notable product design companies include Device Solutions, the Hardware Store, Forthright Engineering, Nocturnal Product Development, and Porticos. Additionally, Valencell is a local provider of proven, validated biometric sensor systems for any wearable device you want to build.¹⁹

SOFTWARE DEVELOPMENT

The Triangle is also home to many software development firms that can help with discovery, design, development, and maintenance across the full spectrum of platforms. Notable software development companies include Cactus Group, Little Green Software, CodeRefinery, and Smashing Boxes. In addition to established companies, there are dozens of software development related groups on Meetup.com which could be utilized by lesser-resourced start-ups.

DATA ANALYTICS

Data is central to driving effective innovation, but it is also everywhere and can be unwieldy. Quality data analytics services are available locally. In fact, data analytics is one of the Triangle's biggest strengths. For example, the Triangle's own world-leading SAS Institute can digest and leverage big data to guide innovation and quantify benefits. SAS has experience in over 20 industries including government, healthcare, health insurance, and high-tech manufacturing.²⁰ Local companies available offer a variety of specialties. Two examples are Roundtable Analytics, which specializes in analyzing ED data, and First Analytics, which specializes in predictive analytics and machine learning.

INDUSTRY PARTNERS

The intricacies of digital health require increased awareness and more-aligned strategies across the continuum of industry partnerships to form an ecosystem to better foster collaboration and innovative solutions. While the Triangle itself is home to multiple global biotech companies and research institutions, the question “How would you rate the ease of implementing digital health solutions within the Triangle” received only a rating of 5.8. The following section focuses on the four key partnership segments within the field of digital health and the need for cohesive collaboration.

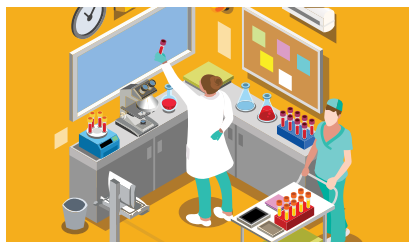


LIFE SCIENCE & BIOTECH

The linking of life science research with technological application has forged a digital health environment supporting the growth and knowledge of new digital health products, resources, and medicine. Home to biotechnology companies like Biogen, Hospira, and Sequenom, the Triangle serves as a crossroads between early stage life science research and rapid market adoption.

MED DEVICE

Medical devices intended for use in the diagnosis of disease or other conditions are rapidly expanding in form and function to fit the current digital health landscape. While devices such as tongue depressors and disposable gloves have remained constant for decades, the increased biotechnology, life science, and pharmaceutical research focused on technological application of medical devices has repositioned the need for digital health product development collaboration and prototyping. Companies like Medtronic, Teleflex Medical, and Zenalux Biomedical have emerged as key stakeholders focused on integrating clinical research with product development of medical devices for rapid market adaptation.



PHARMA

The digital landscape and pharmaceutical companies are rapidly merging together to create innovative patient-centric approaches in improving health outcomes. Applications such as telehealth, medication adherence applications, and stronger digital communication tools allow for the dual benefits of both patients and the provider. Pharma companies like GlaxoSmithKline, Novartis, and Merck, are already tapping into digital health innovations to improve quality and efficiency of care while decreasing costs.

CLINICAL TRIALS

The Triangle is one of the most developed clinical research regions in the world and the future landscape of health innovation lies in collaboration between digital development and clinical research. Digital health applications provide rapid patient-generated health data to researchers and clinical trials are tapping into this market. In a digital health study conducted by technology leader Validic, it was reported that 60% of respondents said they have used digital health technology to conduct trials, and over the next five years this will increase to 97%. The deployment of wearable devices and mobile apps among other resources has already positioned companies like INC Research, Quintiles, and RTI International to produce insurmountable research and data on patient health.



Digital health is at a crossroads, requiring collaboration among industry partners in order to match clinical need – corroborated by research – with product development and subsequent market adaptation. The Triangle is currently a leader in the areas of life science, med devices, pharma-

ceutical companies, and clinical trials as distinct practices. However, a single, cohesive ecosystem unifying the above would allow for the relevant areas to make digital health solutions a reality more efficiently and effectively, and spur the development and incubation of emerging products.

HOW DO WE GET INDUSTRY TO SUPPORT THE DEVELOPMENT OF THE DIGITAL HEALTH ECOSYSTEM AND ACCELERATE TIME TO MARKET?

Casey Boutwell, Director of Industry & Innovation, ASSIST

Engaging companies in the digital health revolution will speed and focus innovation cycles. Our ecosystem comprises technologists and academics, clinicians and practitioners, payers and regulatory agencies, and many more. However, industry operators are a key component of the ecosystem, and should inform not only the focus of our use cases, but also the cost and price boundaries of our specific features. Little of our activity will gain commercial traction without the focus of a final transaction. We follow a four-step cycle of innovation comprising partner identification, definition of collaboration scope, co-development with multifunctional teams, and technology transfer to industry operators.

Partner identification and definition of collaboration scope establish search criteria for relationships. Success requires clear-eyed understanding of your strengths and weaknesses,

as well as your credibility and position in the ecosystem. Identifying partners with complementary abilities enables self-supported teams whose shared objectives are mutually beneficial. Identification and teaming is similar to market segmentation and targeting used by marketing agencies. Here it serves a similar role to focus your objectives on specific populations. Understanding your own credibility in the ecosystem helps you understand your value in the eyes of your partners, and is similar to a marketer's positioning statement.

With the team identified, make every effort to share objectives and collaborate. Co-development of features distributes risk between parties and increases the likelihood of project relevance. Overcoming mutual challenges helps the team normalize and accelerate performance. Importantly, defining a project with clear deliverables results in a dialogue about knowledge/technology transfer and future work. This key stage of the engagement should result in additional contracting and collaboration. Future work begins with a refined collaboration scope, and the two organizations are more strongly teamed with communication and output performance constantly increasing.

TALENT

The Triangle has been called the smartest place in the country²¹, the second most educated²², and is home to internationally recognized research universities and institutions. Universities offer a tremendous amount of talent and resources that align to cash-strapped start-ups. Below are a handful of local schools and programs digital health companies can build relationships with:

- Medicine
- Nursing
- Public Health
- Engineering
- Information Technology
- Data Science
- Design
- Business
- Journalism
- Communication
- Pharmacy

North Carolina State University's ASSIST program is a great example of an innovative university-run program. ASSIST stands for Advanced Self-Powered Systems of Integrated Sensors and Technologies. The center develops and employs nanotechnology enabled energy harvesting and storage to create battery-free, body-powered, wearable health monitoring systems.²³

The Triangle is also home to nationally recognized professional talent, attracted by the relatively low cost and high standard of living. Top-tier professional talent is readily accessible in the following areas:

- Care Delivery
- Clinical Research
- Data Analytics
- Clinical Informatics
- Engineering
- Biomedical Engineering
- Marketing & Strategy
- Pharmacy
- Scientific Research
- Technology
- Cyber Security
- Regulatory & Compliance
- Video Game Design

Quality talent across nearly all relevant specialties is accessible to digital health companies of all sizes and budgets. By seeking relationships with these talent pools, digital health companies will strengthen the ecosystem and catalyze future innovation.

A Need for Bold, Consumer-Driven Innovation

Leyan Phillips, Co-founder + Chief Strategist, Bluedoor

We stand on the brink of an amazing opportunity that has the potential to transform healthcare as we know it, here in the Triangle and beyond. As we issue a call to action to the Triangle community to reimagine how healthcare can be better designed, delivered, and experienced for the digital age,

we envision the emergence of a new, next generation healthcare ecosystem driven by consumer choice, and enabled by digital health technology and meaningful, actionable data. An ecosystem that is provider and location agnostic, and that reaches out to people where they are now, and helps them create their own health.

This will create an entirely different “healthcare” experience for the patient – one that is grounded in personal need and preference. And it will radically democratize healthcare, putting it equally in the hands of consumers. It creates an opportunity for every individual to express their health priorities and personal preferences, based on a rich understanding (to the extent the consumer allows) of an individual’s health risk and health trajectory.

Empowering individuals to be the authoritative and decisive masters of their own health takes nothing away from doctors, nurses and other healthcare providers. In fact, the reorientation of the system that we envisage should be as emancipating for clinicians as it will be for patients.

Clinicians will have more objective data, better prepared patients, and a culture of engagement, collaboration and co-production working on their side. We can expect better communication, more informed decisions, more sensitive reflections of personal preferences for care, better adher-

ence to care pathways and recommended treatment, and with all of these, better outcomes.

All of this will require multiple support systems and communities – personal, social, environmental, medical, and technological – to come together and work harmoniously around the individual.

This vision is not as far-fetched as it may sound. Much of the technology underpinning it is already under development. The Triangle certainly has the expertise and resources to make it happen. But it will take bold commitment to the vision and deliberate investment in people, technology, experimentation, and innovation to create it.

Whether we’re looking to improve access to services, enhance the customer experience, improve clinical outcomes, or streamline complex processes – innovation is the driver of meaningful change that brings benefits for ourselves, our families, and our communities.

Bold innovation is a challenge for any system, because to innovate is to take risks, to avoid being bounded by our current experience and reach beyond it to try something new. Yet this is exactly what is required: to be guided by our experience but not to be limited by it. To be a leader, not a follower. Are we in the Triangle up to that challenge?

CURRENT STATE	FUTURE STATE
Working in silos	Collaborating as an ecosystem
Sickness care	Life care
Reactive – waits for you to come to it	Proactive – anticipates your needs and reaches out to you
Patient-centered, condition-focused	Consumer-driven, whole person oriented
Driven by science: evidence-based care	Driven by science and personal preference
Opaque and paternalistic	Fully transparent and democratic
Medical expertise is valued	Patient and medical expertise are valued
Ad hoc piloting of digital health technologies	A framework for experimentation, testing, and validation of digital health technologies
Technology resides in the system; “Build it and they will come”	Ubiquitous technology resides with consumers and the system reaches out to them via their preferred channel





THANKS & ACKNOWLEDGMENTS

We would like to extend our warm thanks and gratitude to the following partners, supporters and contributors:

Bobby Bahram, Managing Partner, Excelebrate Health Ventures; Gary Bennett, Duke Digital Health; Casey Boutwell, NSF ASSIST; Robert Furberg, RTI International; Adam Klein, American Underground; Erica Levine, Duke Digital Health; Carol Lewis, UNC Center for Health Innovation; Al Lauritano, BD Technologies; Blake Long, Echo Health Ventures; John Reites, THREAD; Tom Snyder, RioT; and special thanks to Brian Moynihan, Head of Health Technology & Informatics at UNC Chapel Hill Health Sciences Library, for his vision, partnership and support.

EDITOR-IN-CHIEF: Leyan Phillips

RESEARCHERS: Christopher Peters, Sohil Rohit Shah

DESIGN: J. Kevin Tugman



HOW TO GET INVOLVED

Those with expertise and knowledge of digital health and its potential have a responsibility to participate and help build a thriving ecosystem that will ultimately benefit the individuals, families, and communities we serve. Collaboration can win on a small scale, but it wins even bigger on a larger scale. So we encourage all those with interests in this area to contribute and help us drive the digital health agenda forward.

Continue the conversation by visiting the new Digital Health in the Triangle website, dhinthetriangle.org and let us know how you would like to get involved in this movement to make the Triangle and North Carolina a global beacon for digital health.

► COLLABORATE@DHINTHETRIANGLE.ORG

NOTES

- 1 <https://www.slideshare.net/StartUpHealth/startup-health-insights-funding-report-2016-year-end>
- 2 <http://www.modernhealthcare.com/article/20160618/MAGAZINE/306189982>
- 3 <http://www.hospitalemandehr.com/2016/08/10/ehr-data-migration-tackling-ehr-emr-transition-series/>
- 4 <http://www.catalysthealthtech.com/>
- 5 <http://eccles.utah.edu/news/university-of-utah-chung-ang-university-create-digital-health-partnership/>
- 6 <https://www.gminsights.com/industry-analysis/digital-health-market>
- 7 <https://www.gminsights.com/industry-analysis/digital-health-market>
- 8 Start-up Health 2016 Year End Summary
- 9 <http://www.beckershospitalreview.com/healthcare-information-technology/98-of-digital-health-startups-fail-here-s-why.html>
- 10 <https://rockhealth.com/reports/digital-health-consumer-adoption-2016/>
- 11 <https://www.fda.gov/MedicalDevices/DigitalHealth/>
- 12 <http://www.beckershospitalreview.com/healthcare-information-technology/thriving-outside-of-silicon-valley-9-other-digital-health-startup-hubs-to-know.html>
- 13 <http://www.wakeupwakecounty.org/issues/growth/>
- 14 <http://www.politifact.com/north-carolina/statements/2016/apr/29/pat-mccrory/mccrory-north-carolina-has-had-countrys-fastest-gr/>
- 15 <http://hatterasvp.com/hatteras-discovery/>
- 16 <https://www.excelebratehealth.com/>
- 17 <http://archive.exitevent.com/article/18-triangle-startups-shaping-telehealth-industry-161220>
- 18 <http://archive.exitevent.com/article/18-triangle-startups-shaping-telehealth-industry-161220>
- 19 <http://valencell.com/>
- 20 https://www.sas.com/en_us/home.html
- 21 <http://www.thedailybeast.com/galleries/2009/10/01/america-smartest-cities-from-first-to-worst>
- 22 <https://www.forbes.com/pictures/fjle45iglg/no-2-most-educated-city-/#5b0d8f6467cb>
- 23 <https://assist.ncsu.edu/about/>

