

2017 ANNUAL REPORT





EMBRACING PRECISION WITH INNOVATION

CARE PROVIDER

Close proximity to hospital

Design team understanding

Help innovators navigate academic medical center

Create programs for clinicians to lead change

TECHNICAL

Function as engineering arm to IT organization

Embrace cutting-edge technologies

Develop engineering partnerships with industry

ORGANIZATION

Produce alternative revenue for health system

Allow large organizations to think like start-ups

Empower frontline culture of innovation

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Leading Strategic Innovation **Initiatives** at Johns Hopkins

In 2017, the Technology Innovation Center ignited Johns Hopkins innovation by leveraging its technical resources for new strategic efforts at institutional, grassroots, and national levels.

THE FIRST STEP was creating a home base for innovation. The TIC moved into its new location on the main medical campus in the Rangos Life Sciences building. In our whiteboard-covered office overlooking Eager Park, we host design sessions, industry collaborations, and leadership development programs. Visit, and be inspired by the close interaction between our clinical partners, designers, developers, and patients as they pursue the future of medicine empowered by technology.

From our new home base, the TIC embarked on technical leadership for the inHealth Precision Medicine strategic priority of Johns Hopkins to re-engineer its clinical research mission, catalyze data-driven discovery, and streamline learning into clinical practice. The TIC leads efforts to arm faculty with tools, data, and analytic capacity - helping them to derive new insight from biological disease.

Fait 33 Non

Paul Nagy, PhD

Deputy Director, Technology Innovation Center, Associate Professor of Radiology



The TIC also supported grassroots innovation by cohosting Johns Hopkins' first Digital Health Day. The event convened 26 organizations and over 340 faculty, students, and staff to explore the art of the possible through Johns Hopkins Medicine pilots, connect with and build research teams, and engage funding sources to realize new digital health inventions.

We recognized that start-up partnerships represent the potential for extending Johns Hopkins innovation nationwide. TIC partner Artifact Health, a physician query tool, matured and expanded its marketplace reach. New ventures like Navio, a pain management application, launched in collaboration with the TIC. Hexcite (TIC leadership program) alum, ReHAP, won a Maryland Innovation Initiative grant.

TIC core principles of teamwork, culture, opportunity, and audacity drove these endeavors in 2017. We pledge to continue stoking innovation through these principles in new corners of the institution - and the world – in support of the Johns Hopkins clinical, education, and research mission.

Divipet Kaum

Dwight Raum Executive Director, Technology Innovation Center, Johns Hopkins Chief Technology Officer



TURNING TEAM PROCESS INTO CLINICAL SOFTWARE SOLUTIONS



The Johns Hopkins Medicine Technology Innovation Center engages world-class scientists and clinicians in an interdisciplinary community to re-imagine health care and deliver the promise of medicine. It is powered by 28 creative team members who boldly execute the center's innovation process at Johns Hopkins.

At the end of each sprint, clinical champions evaluate and help **refine the application**

THE TEAM assesses the

organizational fit for

ideas and produces a

plan for partnership

We look for pathways to commercialize the solution. As necessary, the project enters another phase of work and the cycle begins again.



The Technology Innovation Center team begins or enhances over a dozen software projects and products every year to serve Johns Hopkins Medicine. Many products are licensed to local start-ups and made available for sale outside the institution.

YOU MAY KNOW US FOR: TEAM CORUS, Hopkins Policies Online, EpiWatch, Radiology Peer Review and more...



MHi GO: Integrating **the Medical Record with Mood**

Patients and providers at the Johns Hopkins Bayview Mood Disorders Clinic meet to discuss treatment progress for depression, bipolar, and other mood disorders. During the longer stretches without in-person appointments, nuanced details about a patient's mood, medications, side effects, and more are challenging to capture.



r. Peter Zandi, Research Program Co-Director at the Mood Disorders Center, and his research team are filling in missing details through a mobile patient diary app – MHi-GO (Mental Health Integration on the Go).

"The motivation is... use MHi-GO to track our patients beyond the point of care and deliver more timely interventions," said Zandi.



The MHi-GO app provides patients with medication and appointment reminders (directly from their medical record's medication list), daily surveys and analytics about their progress.

Clinicians can access medication adherence and survey responses from their patients over time through the web. The app also provides positive reinforcement to patients through badges earned for filling in information.



THIS IS AN APP THAT IS PART OF THE HEALTHCARE SYSTEM FOR OUR PATIENTS," SAID ZANDI. "THE FACT THAT IT IS INTEGRATING WITH THE MEDICAL RECORD HIGHLIGHTS THE **UNIQUE PERSPECTIVE...**"

Zandi believes a successful feature of the app is the tracking of patient reported outcomes from surveys that can be created and deployed in realtime by a clinician.



While the study is not yet concluded, initial feedback from patients shows that they like the medication app reminders. What remains to be tested, however, is whether the app is changing behavior.

In the future, Zandi and his team plan to add a feature for clinical intervention based on data collected. He also wants to extend the app functionality so that it provides access to a national network of 26 mood disorder centers (potentially 10,000 patients) and collects passive data (activity, weather, voice).

For now, he is focusing on making this app a useful tool for patients and providers within Johns Hopkins with help from the Technology Innovation Center.

"The reason why I like working with the TIC is that it aligns with our angle for the app. It is about developing it within the healthcare system." said Zandi.

ReHAP: Prioritizing **Therapy Patients with Smart Algorithms**



Dr. Krishnaj Gourab joined Johns Hopkins Bayview Medical Center in 2013 and teamed up with the rehabilitation therapy services to ensure patients who needed therapy were not missed.

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herapy cards written with paper and pen detailing the patient's status for staff would get lost during therapy shift changes. Therapists couldn't communicate about which patients to prioritize between the multiple floors they covered.

"There was no way to make therapists on the neuro floor aware there was a patient on the medicine floor who needs [therapy] more," said Gourab.

Gourab translated his experience from an analytics training program run by the Technology Innovation Center and the clinical need for centralized prioritization of patients into a software tool for therapy caseload management: ReHAP.

ReHAP is a web application used at Johns Hopkins Bayview Medical Center by therapists for caseload management. ReHAP is also being piloted at Johns Hopkins Hospital.

The application tracks patients' functional statuses every 30 minutes and allows clinicans to predict potential outcomes based on that status - something therapists didn't have any insight into before.

"[Therapists] love doing it because it enhances their satisfaction as a clinician and it also impacts patient care," said Gourab.

THE FIRST PROTOTYPE **DEPLOYMENT SAVED** THERAPISTS AN AVERAGE OF **20 MINUTES A DAY (FREEING UP TIME TO CARE FOR MORE** PATIENTS).

Functionally impaired patients went from missing three days of scheduled therapy to missing one day.



Revenue increased after bed utilization in the acute inpatient rehabilitation unit went from



Barb Ruzicka, Ginny Carman)

36% to 72.5%

Now that the application has proven it can improve efficiency and provide better patient care at Johns Hopkins, Gourab is working with his start-up cofounder, John Adamovich, and the TIC to deploy the solution at six external pilot hospitals over the next year.

"The TIC helps us negotiate potential roadblocks when looking at the deployment so that ReHAP can work on the data," said Gourab.

From there, Gourab hopes to continue feeding data back into his algorithm to make it smarter and eventually translate the application's use to outpatient settings.

"What really excites me is that we are already capturing data from inside the hospital, but if we can start tracking wearable data post-discharge, we can change discharge outcomes," said Gourab. "That becomes a valuable tool."

AMBULATORY DASHBOARD: Driving Patient Access through Data



Ambulatory Dashboard, a project supported by the Ambulatory Services health system initiative and developed in partnership with the Technology Innovation Center, is empowering ambulatory teams with data-driven operational metrics to support practice management improvement.

he dashboard is a web-accessible tool tracking over 40 metrics that range from bump rate - or rate at which appointments are cancelled by the provider – to number of days until the next available appointment.

IT'S CURRENTLY AVAILABLE TO 1400 USERS WITH OVER 200 WEEKLY **ACTIVE USERS.**

Dr. Stephen Sisson, Executive Director of Ambulatory Services at Johns Hopkins Hospital, was charged with putting a process behind improving access to specialty outpatient services. He hired a consulting firm which suggested using a dashboard to display metrics, but he soon realized that to make the effort sustainable he needed to find a way to bring data to frontline workers from within.



"THE QUESTION WAS: how does a functional unit like ambulatory services build a dashboard? And we had no idea," said Sisson. "That's how we came to the Technology Innovation Center."



smart," said Sisson.

Sisson uses the dashboard to look at patient volumes for the week and make future predictions for how to staff a service the following week. If cardiology carried more clinical staff than its predicted need, Sisson could reshuffle those staff to another service that appeared impacted by appointments.

_____66 _____

OVER THE LAST 18 MONTHS WE'VE CUT INTRASTAFF ITHE HOSPITAL'S TEMPORARY STAFFING AGENCY1 USE BY 35 PERCENT," SAID SISSON

The dashboard is used by frontline providers to assess and change behavior around performance metrics that affect patient experience like bump rates.

The goal of the dashboard is to keep appointments on the books, make sure there's high utilization of offered services, help patients get quick access to the care they need, and reduce hospitalization.

"We want to marry this data with other data to define standards that are the Johns Hopkins way," said Sisson.



NAVIO: Partnering **to Make Fragmented Pain Management Whole**



Navio, a mobile health app for pain management, is forging a new path as the first external start-up to partner - through design, development, and integration - with the Technology Innovation Center.



our years ago my family crashed head on into the pain of fragmented care for pain management," said Susan Crosby, co-founder of Navio Health. "By necessity, my family became experts in solving transplantation."

Crosby and her brother Jonathon Libbey started Navio after their mother, Pat Libbey, experienced severe postsurgical pain from cancer surgery in her abdomen.

"My mom's daily agony was the worst thing I've ever seen happen to a loved one," said Crosby.

Crosby said that current pain management has three problems: pain patients struggle with attending multitudes of appointments, the lack of care coordination, and poor diagnostic communication (pain can be hard to describe, remember, and analyze in treatment planning with providers).

Fueled by her family's experiences, Crosby and Libbey began designing Navio and soon discovered she would need various vendors and consultants to accomplish her wellness goals. A fragmented team would be difficult to manage.

lifestyle, and management," said Dr. Akhil Chhatre.

Because everything is so multi-faceted about a project like this, you really need experts working together..." said Crosby. "We needed people who natively understood design for digital health apps," said Crosby.

Crosby connected with the Technology Innovation Center to help manage and propel her diverse team of experts after bringing on Johns Hopkins clinical champion, Dr. Akhil Chhatre, and researcher, Dr. Luis Buenaver. Prototype development began in 2016.



Navio stands out from other consumer pain management apps because it combines subjective, daily patient-reported data with continuously collected physiological data about vitals, movement and sleep to wearable sensors.





Our goal is to empower both the patient and the clinician to better **6** understand the patterns of pain as well as improve function,

The goal in later phases is to provide a prediction to the patient when a pain flare is coming. "We are going to be able to create a pain fingerprint for individual patients," said Crosby.

The app also includes a care plan developed by patients and providers together and an insights section for reviewing successful pain management techniques.



Ultimately, Crosby hopes to help healthcare payers lower the cost of treatment and produce improved, specific outcomes for patients without interfering with their already difficult schedules.



ACTIVE CARE: *Predicting Outcomes* to Inform Prostate Cancer Patients



The Active Care software tool was deployed in 2017. It uses decades of data from the Active Surveillance program that was started by Dr. Carter in 1995. The program serves low grade cancer patients who can live healthy lives without having their prostate cancer immediately treated.



r. Ballentine Carter, Director of the Prostate Cancer program at Johns Hopkins Medicine, starts patient conversations with hurricanes.

He opens the Active Care software tool and explains that it's just like a hurricane center. The application takes multiple historical and current data points and puts them through equations to produce predicted outcomes.



Carter begins by opening the patient's historical summary graph to show his biopsy, MRI, and PSA values compared to peers.

"Patients really love it," said Carter. "If you show them their PSA

levels relative to their entire cohort, they are incredibly reassured that they are not outside the boundaries of the cohort."

Next, Carter clicks to the biopsy prediction tab on Active Care. He uses this feature to show the likelihood that a biopsy procedure would result in upgraded cancer.



Many patients now forgo risky annual biopsies and instead opt for biopsies at longer intervals.

Finally, Carter opens the prediction model for prostate removal. A chart displays likelihood of each grade of cancer, and the five and ten year outcomes for patients with similar characteristics.

Carter said he recently saw a 72-year-old patient who immediately wanted his prostate removed. After reviewing his Active Care graphs with Carter, the patient left the clinic feeling comfortable without having surgery right away.

Carter attributes the application's success to the team of people who came together to produce it, including clinicians, patients, data scientists and the Technology Innovation Center.

ACTIVE CARE TEAM: Dr. Ballentine Carter (pictured), Dr. Scott Zeger, Yates Coley, Mufaddal Mamawala, Tricia Landis, Sacha Wolf

"It didn't take long for all of us to figure out that the only way to get this accomplished was involving the TIC," said Carter.

In the future, Carter hopes to add more measurements to the tool (including genomic data) and eventually make this tool available to other institutions with prostate cancer programs.

For now, he is focusing on lessening the uncertainty that patients enter the active surveillance clinic with.

"Patient-centered care. This is what we are supposed to be about," said Carter.



CREATE DISEASE-SPECIFIC 1 **PRECISION MEDICINE CENTERS OF EXCELLENCE** (PMCOE)

2 PIPE DATA IN:

Medical imaging Medical records Genomics Clinical narrative Physiological monitoring

3 OPEN A RESEARCH SANDBOX:

Interrogate data Test hypotheses Generate algorithms

4 **PRODUCE TOOLS FOR BETTER, CLINICALLY INTEGRATED CARE DELIVERY:**

Integration with Epic Prospective prediction software Clinical decision support software Clinically integrated mobile tools Patient education software



CRAFTING INNOVATION LEADERS THROUGH SHARED EXPERTISE



HEXCITE **EXCITED FOR HEALTH**

The Technology Innovation Center's Hexcite entrepreneurial pre-accelerator program provides care providers who have great ideas with the teammates and resources they need to design a software solution that will deliver better patient care.

Currently in its third cohort, Hexcite teams include clinical, business, design and technical leads who work together to solve clinical problems. At the end of the 16-week program, teams are ready to build with TIC, conduct a pilot in the clinical space, and launch a Baltimore start-up.

THERAMATE

application for

mood disorder

a mobile

DAIWARE

a mobile diary application for remote patient monitoring based on circadian rhythms



WELBY H.E.L.P.

a patient decision support application that includes medical librarian support



PROJECT COMMUNE

platform that displays

a care collaboration

real-time patient

progress



BARTLEBY a tool to expedite

medical coding based on orders



Entrepreneur-In-Residence, MARK KOMISKY, says the value in these start-up teams is that they are pulling ideas out of their clinical practice at Johns Hopkins,

G Hexcite starts with the earliest conception of an idea from someone who sees the need daily from working in a clinical setting. It's a real-world problem in a real-world setting," said Mark Komisky, Entrepreneur-In-Residence, Hexcite.



ANALYTICS AND DATA SCIENCE

In close partnership with the Data Trust, the Technology Innovation Center brings Johns Hopkins Medicine to the next level of analytics mastery with its six-month long training program that builds practical skills and valuable connections.

LEADS students learn about innovative technologies deployed at JHM for analytics as well as the theories and methodologies related to healthcare data compilation, analysis and use. In 2017, the program grew 30 junior-level analysts into leaders within the analytic community at Johns Hopkins Medicine.

JHM DATA TRUST STRUCTURE: LEADS faculty and students are members of one or more of the Data Trust Analytic Teams. Students who are not yet a member, gain the mentorship and experience needed to join a team through LEADS programming.



Research CCDA

I invest time because analytics is critical to the success of Johns Hopkins Hospital and we are most successful when we invest in our people. I wanted to be a part of that investment."

DIANA GUMAS, Senior IT Director

FACULTY HIGHLIGHT

LEADS Faculty Member, **DIANA** GUMAS, also serves as the Senior IT Director at the Institute for Clinical and Translational Research (ICTR) and leads the **Research/ CCDA Data Trust** Analytics Team. Diana brings her expertise to LEADS programming through training participants in processes for requesting data from the CCDA and using the IRB.



FORGING A CULTURE of **INNOVATION**

TAYLOR WILHELM.

Business Development Intern at the Technology Innovation Center (summer 2017) and undergraduate business major at Virginia Wesleyan College, said her internship stood out because of the freedom to explore different areas of expertise.

Whenever I mentioned I was interested in something, I was assigned work in that area. I explored everything from graphic design to marketing and communications." said Wilhelm. "There is such a wide range of opportunity here."

MOLDING YOUNG INNOVATORS

The Technology Innovation Center's internship program promotes the growth of diverse and specific talent in the medical software industry.

Multidisciplinary mentors (TIC staff members) are paired with software development, analytics, business, and design interns to cultivate learning experiences for students and leadership experience for full time staff.



The TIC accepts a handful of undergraduate and graduate interns each summer. Andy Dam (pictured above, second from the right) is now a full-time Web Designer for the Technology Innovation Center.



CREATING A NEW SPACE TO MAXIMIZE INNOVATION

In May 2017, the TIC merged its two office locations into one. The team is now located in a 6th floor suite atop the Rangos Building on North Wolfe Street.

KEYS TO HOUSING A DIGITAL HEALTH DEVELOPMENT ENGINE:



Close proximity to Johns Hopkins Hospital for ease of access to our clinical champions and their problem spaces.



3

Plentiful and accessible whiteboard walls to facilitate team collaboration and a 'think out loud' mentality.

Stand-up meeting spaces accommodating developer-client working sessions to accelerate project momentum.

CONSTRUCTING A JOHNS HOPKINS DIGITAL HEALTH DAY

JOHNS HOPKINS INTEGRATE

An all-day event held in the Zayed Chevy Chase Conference Center, the inaugural Digital Health Day was a symposium that brought Johns Hopkins' very own health tech innovators together in one space to collaborate and impart momentum on fellow innovators in digital health.

GOALS





CONVENING

Bringing together people from across Johns Hopkins (JHU, JHM, JHSPH, JHUAPL) interested in digital health

LEARNING

Raising awareness on digital health resources and activities at Johns Hopkins

EVENT STATISTICS 2.5M Twitter Impressions on the hashtag #JHDigitalHealth17 In-person and online 340 attendees 26 Partner organizations exhibiting in the Resource Pavilion 4 Co-Organizers: TIC, Global mHealth, Malone, and DHSi









DIGITAL HEALTH RESOURCE PAVILION



The digital health Resource Pavilion featured 26 organizations from various innovative research, technology, and funding groups at Johns Hopkins. Visitors of the pavilion gathered information on how to connect with and advance digital health ideas at Hopkins.









The Technology Innovation Center team brought their innovative digital health **approach** from Baltimore across the globe in 2017 through diverse, Health IT-centric conferences, seminars, and site visits.



24 TRIPS

Including Professional Development, Thought Leadership, and Sales trips

16 CITIES

3 COUNTRIES



ATLASSIAN SUMMIT

SAN JOSE, CA

A user conference designed to inspire innovation, transform the way teams work, and showcase Atlassian's latest developments.

Digital Health Day - Baltimore, MD

Machine Intelligence in Medical **Imaging** - Baltimore, MD

MedBiquitous Annual Conference **2017** – Baltimore, MD

ACMQ Headquarters – Bethesda, MD

Connected Health Conference Boston, MA

RSNA 2017 - Chicago, IL

SIIM Headquarters - Leesburg, VA

AWS Summit - New York City, NY

Microsoft Business Forward New York City, NY

SIIM-NYMIIS Regional Meeting New York City, NY

HiMSS 2017 - Orlando, FL

Microsoft Envision - Orlando, FL

SIIM 2017 Annual Meeting Pittsburgh, PA

SpringOne Platform San Francisco, CA

Atlassian Summit - San Jose, CA

Johns Hopkins Aramco Healthcare - Saudi Arabia

Toronto, ON

Washington, DC

CONNECTED HEALTH CONFERENCE

BOSTON, MA

A conference that brought together the industry's top thought leaders for inspirational, provocative and forward-thinking discussion.



Keystone Enterprise Imaging Summit - Snowbird, UT

Mobile Healthcare Summit

Epic Headquarters - Verona, WI

IS3R 12th Biennial Symposium

Big Data in Precision Medicine - Washington, DC

AMIA 2017 Annual **Symposium** - Washington, DC

MQ 2017 - Washington, DC

FamilieSCN2A Family & **Professional Conference** Wilmington, DE

HEALTHCARE **TECHNOLOGY** WE'RE **BETTING ON IN 2018**

2017 brought new technology challenges (and solutions!) for the Technology Innovation Center. The team dove into platform and integration work, including moving to cloud-based services, strengthening expertise in Apple Kits, integrating with Epic MyChart, and kicking off work on the institution's Precision Medicine Initiative.

TIC developers weighed in on the technology they believe will define healthcare innovation and success in 2018.

More Reliable Wearables

Patients are wearing more devices that record activity data for their own personal health records and comprehension. As wearables gain more sensors, battery life and features, the data collected from these devices becomes vital in the care, diagnosis, and treatment plans for patients.

In 2017, the Technology Innovation Center worked on a seizure detection feature for EpiWatch, an Apple Watchenabling application that collects patient monitoring data to allow epilepsy researchers to build better, more personalized seizure prediction algorithms.

In 2018, the TIC will deploy Navio to support patients and providers as partners in pain care management.

"Making [wearables] data accessible to health systems and providers is important to personalize care."

O— **CHRIS DOYLE,** TIC Product Development Lead

Machine Learning in the **Medical Record**

The Johns Hopkins University Applied Physics Lab (APL) will dive deeper into its machine learning work in 2018 - with the potential for new breakthroughs in clinical workflow efficiency. Brant Chee, an APL Computer Scientist, is partnering with the Technology Innovation Center to apply natural language processing to free text fields in electronic medical records.

Potential pathways in 2018 include natural language reasoning, summarization, anomaly detection, and more. Within the patient care setting, Chee's machine learning work could be used to reduce errors and ease data overload.

"[What] I'd like to see in the field is the use of machine learning to accelerate discovery."







Integrated Health Information for Personalized Care

Through it's work with Precision Medicine this year, the Technology Innovation Center developed tools for delivering predicted treatment outcomes for individuals based on data from a population with a specific disease. Johns Hopkins is also closely tied in with CRISP, or the Chesapeake Regional Information System for Patients (a Health Information Exchange).

In 2018, the TIC hopes to work with CRISP to explore new ways of sharing population data and delivering predictions that can help patients and providers make decisions about individualized care.

"Under a unique arrangement between the state and the federal government, we're driven to improve health of Maryland citizens, while lowering the total cost of care. With our partners in the state and in CRISP, we are reimagining healthcare."

O— **DWIGHT RAUM,** TIC Executive Director, Johns Hopkins Chief Technology Officer

Artificial Intelligence for Care Beyond the Clinic

Machines can now mimic human cognitive functions like learning and problem solving with artificially intelligent technology. In 2017, researchers at the Johns Hopkins University were awarded support from the Amazon Alexa Fund to further advances in voice interaction between people and machines.

In 2018, TIC Senior Software Engineer Kirby Smith expects artificial intelligence to make a big impact on healthcare IT. Artificial intelligence will be fundamental in disease management while patients are away from the clinic and providers.

"Artificial intelligence is a disruptive technology that has great potential to improve the practice of clinical care. While it is currently an engineering effort to implement these technologies, it is quickly approaching a tipping point where it will become common in clinical applications."



C— **KIRBY SMITH,** TIC Senior Software Engineer



FINDING SUPPORT FROM STELLAR **ORGANIZATIONS AND PEOPLE**

Johns Hopk Programs	DEPARTMENT OF ART as applied to MEDICINE	Business Development and Strategic Alliances	8 BIOENGINEERING EINNOVATION 8 & DESIGN
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	inCMED	HOPKINS Inhealth	JOHNS HOPKINS APPLIED PHYSICS LABORATORY
	JOHNS HOPKINS carey business school	HEALTHCARE SOLUTIONS	Johns Hopkins Medicine Marketing & Communications
	JOHNS HOPKINS TECHNOLOGY VENTURES	JOHNS HOPKINS MALONE CENTER for ENGINEERING in HEALTHCARE	sibley
Start-ups		🗚 ARTIFACT HEALTH	emocha Mobile Health INC.
, , , , , , , , , , , , , , , , , , ,	Heəl ytics	medopad	PROTENUS
	💸 ReHAP	Mile Marker	navio
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