CTSConnections

Building research teams of the future to improve human health • 2017 • Volume 7, Issue 2

INTEGRATED PROGRAM COLLABORATION

Harnessing the digital revolution to improve healthcare

HEALTHCARE DELIVERY has undergone major seismic shifts in the past few decades because of rapid advances in digital technology, according to Nicholas Anderson, director of the CTSC Biomedical Informatics program and Research Informatics for the School of Medicine.

Pioneered at UC Davis in 1992, telehealth offered patients in remote areas access to specialty care close to home via physician-to-physician videoconferencing in small primary healthcare clinics. The next decade brought the second shift: greater efficiencies and lower costs enabled anyone with a computer and internet connection to meet virtually with healthcare providers from their home.

"At this point, we're on the verge of a third revolution, made possible by the rapid digitization of all aspects of our

Madan Dharmar, M.B.B.S., Ph.D., Director of the Digital and Connected Health Initiative

lives and the near constant connectivity provided by smart phones," said Anderson. "Having the ability to connect patients and community members through computers that

are capable of physiological sensing, health data monitoring, analytics, and real-time reporting has provided unprecedented opportunity to

DIRECTOR'S MESSAGE

Ted Wun, M.D.

ALTHOUGH A DIRECTOR'S MESSAGE is typically forward looking, I wish to start by acknowledging the contributions of Lars Berglund, M.D., Ph.D., founding Principal

Ted Wun, M.D.

Investigator and Director of the UC Davis CTSC. A dozen years ago he and a few of our other School of Medicine leaders had the vision (some would say audacity) to submit a full proposal for a Clinical and Translational Science Award (CTSA), rather than a planning grant that many felt was more appropriate for UC Davis. The result was a position

in the inaugural class of 12 CTSA-funded centers. Over the subsequent years, Lars – in his dual roles as Senior Associate Dean for Research and CTSC Director – transformed clinical and translational research at UC Davis and guided us into the ranks of elite academic research medical centers. As I become more enmeshed in the CTSA world, my high regard for Dr. Berglund has grown exponentially, as well as my appreciation for how his reputation and accomplishments reflect positively on UC Davis.

I am fortunate to have been part of the CTSC from inception, and had Lars as both role model and mentor. To this day, many of our founding faculty and staff remain. Over my first few months, I have had the privilege to recruit

change how we plan for and deliver personalized health care."

This is the mission of the UC Davis Digital and Connected Health Initiative. The initiative links the significant telemedicine resources of the Center for Health and Technology (CHT), and the evolving academic and student communities of the Betty Irene Moore School of Nursing and School of Medicine Department of Public Health Science.

Currently in its second phase – to raise the visibility and catalyze research development in digital and connected health – the initiative provides a coordination platform for harnessing technical, physical and academic capabilities at UC Davis to support new digital technologies that advance translational research and improve public health. This is precisely where the CTSC will be most instrumental. With its mission of building research teams of the future to improve human health, the CTSC is a natural partner for two technology Centers of Excellence – the UC Davis Center

for Virtual Care (CVC) and the Center for Information Technology Research in the Interest of Science (CITRIS). The CTSC implemented a dedicated focus on Digital Health. Through this program, the CTSC supports a new generation of translational investigators capable of advancing research across a broad spectrum of technology-enabled health care, including rural and community-health, person-centered care, population health, and precision medicine.

Specifically, the CTSC promotes efforts to enhance technology-based training with workshops on topics such as coping with big data and cybersecurity. Through the CVC, CTSC trainees have access to a wide array of training sessions in simulation and virtual approaches to healthcare design and research.

A plethora of applications

Madan Dharmar, director of the initiative and associate professor in residence, Department of Pediatrics, School of Medicine and Betty Irene

Moore School of Nursing, also leads the CTSC efforts in digital health. He echoes Anderson's belief that the healthcare system is entering an era that promises a major transformation of healthcare delivery.

Bringing together faculty interested in exploring this transformation, the CTSC has sponsored two Digital and Connected Health Symposia, held in May and November of 2017, respectively. Presenters from the fields of telehealth, virtual care, precision medicine, person-centered mobile technology, sensors and wearables, and large-scale data analytics shared their experiences on the cutting edge of technology. According to Dharmar, the symposia demonstrated the broad scale of research and practice across UC Davis, including the future of "smart homes" and the challenges of implementing new systems to link clinical electronic health records (EHR) to community and personalized health.

Multiple projects are underway across these areas of study and reflect

several new leaders who emerged through their interaction with CTSC programs, including Daniel Nishijima, Eric Henricson, and Kathy Angkustsiri. With new talent comes renewed energy, and I am confident our team will continue to thrive as an exemplary CTSA hub.

Looking forward, the CTSC will spread its reach both inward and outward. By inward, I mean within the greater UC Davis and Sacramento communities. We are a top tier research institution. Among the many assets within our grasp, the CTSC will fortify our already strong ties to the Schools of Veterinary Medicine and Nursing, as well as the College of Engineering. I also hope to forge new collaborations with other centers such as the Western Center for Agricultural Health and Safety and the Environmental Health Sciences Center.

Facing outward, we look forward to developing new collaborations with local community-based organizations

and enhancing the partnership with our sister UCs through UC BRAID. Ongoing participation in regional and national efforts through the CTSA consortium are essential, especially as we strive to facilitate completion of high-priority, multi-site clinical trials.

Our core mission is training the workforce and improving the processes that accelerate high-quality research for a tangible impact on human health. One avenue to accomplishing these missions is robust, expansive, and innovative support for the digital health initiative outlined in our most recent grant application. This issue of *CTSC Connections* highlights the progress we have made towards this objective.

As with all my leadership roles, I maintain an open door and "please comment" policy. The CTSC is a resource for the entire UC Davis community. I look forward to working with many of you. §

THE PERCEPT STUDY

Using mobile health data to manage depression, hypertension

WHEN NICHOLAS ANDERSON, associate professor in the UC Davis Department of Public Health Sciences, discusses the new frontiers in healthcare delivery, he points to the unprecedented levels of interaction and information sharing that is increasingly accepted as normal in the modern digitally-enabled society. There are about 270 million mobile wireless subscribers in the United States alone, and more than 85 percent of users use social media and mobile technology for monitoring, seeking, or sharing information on their health issues or those of their families or communities.

"People continue to increase their accumulation of diverse personal data through mobile phones and devices they use in their daily lives," said Anderson, who also serves as director of informatics research in the School of Medicine. "The challenge is in how to make this vast amount of data valuable to them and relevant to their health needs so that we can learn from it and create personalized and unique health management plans."

With a $1.2 million grant from the California Initiative to Advance Precision Medicine (CIAPM), Anderson is leading a team consisting of clinicians and researchers from UC Davis, UC San Francisco, UC Berkeley, and private partner Overlap Health to explore the use of personalized mobile health data to improve chronic disease management. A primary goal of the study titled PERCEPT (Personal Contextual Precision Health), is to develop a framework for improved personalized healthcare delivery by focusing on two chronic conditions: depression and hypertension.

Precision medicine, also known as precision health or personalized medicine, is an emerging medical model that aims to customize healthcare through individually tailored medical decisions, practices, and products. This approach for disease treatment and prevention accounts for individual variability in genes, environment, and lifestyle. According to Anderson, access to new digital technologies that focus on participants lend themselves to collaborative efforts between patient and provider to develop innovative applications in precision health.

Mobile healthcare delivery system

PERCEPT uses Android and Apple iOS platforms to develop, provide, and validate easy-to-use tools that securely capture a user's physical activity, physiological data (including blood pressure measurements), medication usage, and

self-assessments of function, fatigue, pain, and mood. Aggregated data generate biomarkers based on an individual's patterns and will be used as a baseline for personalized chronic disease management.

The study is recruiting 200 patients from UC Davis and UC San Francisco undergoing medical treatment for depression or hypertension. Patients enrolled in the study who are managing newly prescribed medication plans will provide mobility, biometric, quality of life, and mood data in the context of

their clinical histories. Daily collection of this bi-directional data provides the ability to assist patients in meeting their medication and health plan goals through a combination of digital prompts and reinforcement. According to Anderson, patient engagement is the core focus, as patients will provide more robust and consistent data if they believe they are valued and will subsequently share in the benefits of improved personal health information management plans.

"Our goal is to design a new model of self-managed, digitally-driven health care – one that adapts and supports every patient's unique daily life," Anderson explained. "Our mobile health system will allow patients and their doctors to use personalized data for new approaches to manage chronic conditions and enable patients to improve their own care."

Obstacles to overcome

The new healthcare model is not without challenges, cautioned Anderson. Most popular health apps are not validated in the way that clinical instrumentation is, and the developers of such systems often view their techniques – such as how

Promoting translational research through biospecimen management

A TYPICAL ACADEMIC RESEARCH institution works like this… Dr. Einstein studies a cancer frequently seen in his clinical practice, stores tissue samples in his laboratory freezer, and tracks biospecimen data in a Microsoft Access database. Across campus, Dr. Curie studies a related cancer in dogs, stores her biospecimens within her department-maintained biobank, and tracks her data on Excel spreadsheets. Unless Dr. Einstein and Dr. Curie happen to meet and discuss their work, they might never know that the other may hold an important key to their respective research ambitions. And even if they were aware of each other's work, sharing biospecimens and critical data can be a logistical nightmare.

Enter the UC Davis Biorepositories Core Resource (BCR). Designed to streamline collaborative biospecimen research throughout the institution, the BCR will provide a multitude of services to facilitate and promote the sharing of biospecimens and data.

"Traditionally, UC Davis has had many biorepositories, organized around specific diseases and operated in different ways," said Nick Anderson, director of the CTSC Biomedical Informatics program, who also heads the BCR in his role as director of Informatics Research in the School of Medicine. "We want to serve as matchmaker between investigators by offering uniform best practices that can be managed, shared, and sustained throughout the campus." Anderson oversees a number of programs run by the BCR that are aimed at facilitating clinical and translational science across UC Davis and beyond.

Freezerworks

With the goal of offering commercial biospecimen tracking software throughout the university, the BCR adopted a biospecimen management

Stephanie Soares, BCR Asst. Director, and Leslie Solis discuss Freezerworks.

system called Freezerworks. Already in use by the Molecular Pharmacology Shared Resource, the MIND Institute, Public Health Sciences, and Veterinary Cancer Clinical Trials, the BCR hopes to expand availability to biobanks in other departments at UC Davis Health, the School of Veterinary Medicine, and across the Davis campus.

To that end, the BCR is offering a spectrum of services to assist researchers with the use of Freezerworks, a system that is accessible through Citrix or the Web. Training will be offered through classes provided by the CTSC or individually upon request. The BCR will also assist with data migration into Freezerworks and provide maintenance support.

The annual fee is $400 for a "user seat," which can be purchased for an individual biobank or entire department, and can accommodate multiple staff members. Because this unique service facilitates translational research, the CTSC promoted access by funding purchase of the software along with some scanners and barcode label printers to enhance the utility of Freezerworks. In addition, the CTSC provided resources for consultation and training in the use of the new software.

"We are pleased to help get the BCR launched as an institutional resource," stated Ted Wun, director and PI of the CTSC. "Correlative laboratory studies are now an expectation in the conduct of clinical trials. In fact, in many studies they are essential. The availability of standardized and efficient biorepository pathways allows us to conduct cutting edge research. This resource also makes our investigators more competitive for grant proposals. Finally, the ability to quickly determine the inventory of biospecimens from other research groups will hopefully enhance collaborations that otherwise may not have occurred."

Stephanie Soares, assistant director of the BCR, emphasized that Freezerworks is confidential, secure, and user-friendly. Every biobank or laboratory is modularized in the Freezerworks software; thus, individual researchers and their staff have access only to their own data and

Freezerworks benefits:

- Software provided and maintained by UCD Health I.T.
- Easy access via UCD Health Citrix
- End user support provided
- Classes, training, and consultation available
- "Onboarding" of biobanks, if needed
- Thermal barcode printers/scanners available

biospecimens. She also emphasized that the BCR provides support and training with materials to help investigators make a smooth transition from their current tracking systems without requiring centralization of their biospecimen storage.

"The use of Freezerworks is completely voluntary," Soares stressed. "Researchers using Freezerworks retain total control of their biospecimens and corresponding data while receiving the many benefits of a university-maintained resource to track their inventory and facilitate use."

Virtual Biospecimen Discovery

The BCR also developed the Virtual Biospecimen Discovery (VBD) – a centralized online clearinghouse through which biorepositories can make their inventories visible to others. Researchers will continue to store and maintain control of their samples, but the VBD allows others to have a peek into what might be available for sharing. About a dozen data variables are associated with each biospecimen, including tissue type (organ, tissue or fluid), donor (animal species or human), demographics (gender, age, ethnicity) and known diseases. Because no information that links a biospecimen to a donor's identity is included on the website, the data may be legally publicized and openly shared.

Currently, 12 UC Davis biobanks encompassing nearly a quarter million biospecimens are participating in the VBD. These include seven human biobanks, including the Alzheimer's Disease Center biobank and the Athena Breast Health Network, as well as five animal biobanks from the School of Veterinary Medicine.

Biobank representation in the VBD is free for any UC Davis biorepository and includes BCR support to upload inventories. The VBD can be accessed at http://vbd.ucdmc.ucdavis.edu.

If a researcher indicates interest in obtaining specific samples, the custodians of the samples are notified and can decide if they are interested in sharing their biospecimens and data. "We fondly call our VBD 'biospecimen speed-dating,'" said Soares. "Investigators can quickly select biospecimen characteristics of interest and find biospecimens that may be useful to their research."

Biospecimen Remnant Consent

More than 10 million biological samples are processed through the UC Davis Department of Pathology and Laboratory Medicine every year. Most "remnants" – what is left of a tissue sample or body fluid after it has been used for its original clinical purpose – sit in a refrigerator for a few days and are then discarded. Only if a patient specifically gives consent can a sample be biobanked for research use.
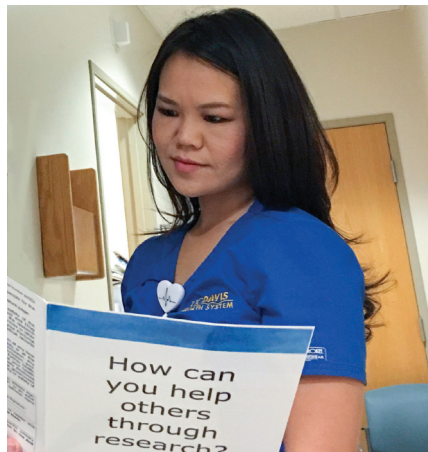
Sandy Ly, LVN, reviews remnant consent.

The goal of the Universal Biospeciman Remnant Consent is to provide a streamlined system throughout UC Davis Health to record patient preferences directly in the electronic medical record (EMR) for nearly all biological samples. The consent condenses a cumbersome multi-page form into a simple format that the patient can sign electronically

for direct capture in the EMR. Patient preferences are stored in the EMR for rapid determination of whether a sample can be used for research.

Using EMR queries to identify consented patients, clinical samples can then be provided to the designated biobanks after their original clinical purpose is completed. Researchers can use the EMR to identify desirable criteria and match sample remnants so they can be retrieved, de-identified, and shared.

"Use of the EMR to capture patient preferences for the Universal Biospecimen Remnant Consent as discrete data fields and link this data for biobank use are novel to UC Davis," explained Soares. "We anticipate that it will provide a tremendous boost to translational research."

Extending resources

The systems under development by the BCR are scalable and can link with other systems seamlessly, according to Anderson. He foresees connecting the campus, the entire UC system, and possibly other institutions nationwide. He also envisions the potential expansion of the VBD and Freezerworks software to banks of plant specimens or even chemicals in the future.

"We have a very engaged community that is ready to collaborate if given the platforms to do so," Anderson added. "Different investigators' fields are diverse, but their data management issues and needs are common. Our goal is to help address their needs in a very efficient manner." §

If you have questions about Freezerworks or want further information, please contact Stephanie Soares at 916-734-7524 or sesoares@ucdavis.edu.

the interdisciplinary and data-intensive challenges and capabilities of today's new digital health communities, including:

• High volume critical care data to characterize real-time health. Access to intensive care environments is highly challenging due to the time-sensitive nature of care and the considerable interactions of systems, care providers and patients. Research into quantifying the streaming data in these environments began by leveraging resources at the CVC. This process consists of modelling patient status through programmable simulators tested under complex organizational and physical constraints for implementation in intensive care unit (ICU) environments. The interaction of the physical and digital systems for this work requires broad interdisciplinary support from clinical information technologies (IT) and network engineering to critical care nursing and ICU management. Now implemented, the ability to iterate on development and deploy in simulated and real environments opens a broad range of real-time patient monitoring and prediction opportunities.

• Tele-audiology for newborn hearing assessment. Newborns who fail their initial hearing screening test require a thorough diagnostic evaluation within three months to address problems promptly. A collaborative project between the CHT, the UC Davis Pediatric Telemedicine Program, and the College of Engineering is developing and evaluating a newborn hearing screening device with telehealth capability. This device will allow infants in remote areas far from specialty care to undergo assessment closer to home.

• Enhancing patient self-care of chronic conditions. Multiple projects are underway aimed at utilizing personal devices to monitor and improve wellness and the management of chronic care in patients. The School of Nursing links nurse health coaching, motivational techniques, and wireless sensor technology to support patients who self-monitor diabetes and provide targeted clinical feedback through a broad patient outcomes study. This project integrates patient-provided data into the electronic medical record.

• The PERCEPT Project. PERCEPT (Personal and Contextual Precision Medicine) partners with UCSF Health to recruit and monitor patients for medication adherence in newly diagnosed hypertension and depression through smart phone applications designed to minimize patient effort. "With existing cell phone technology, we can engage individuals in self-care and challenge the traditional roles of providers, patients and researchers," said Anderson, who is leading PERCEPT and is also an associate professor in the department of Public Health Sciences, UC Davis School of Medicine. *(See full article about PERCEPT beginning on page 3 of this issue.)*

Looking to the future

While this digital revolution offers great opportunities in the research and healthcare sector, rapid development creates significant challenges in effective, trustworthy, and accepted adoption by patients.

"The significant volume, velocity, and variability of data streams produced by personal devices and medical instrumentation are increasing faster than we can evaluate and integrate them," Anderson said. "We need to focus on methods to evaluate the quality and intent of data gathered in these environments, and provide recommendations on how to

"With the resources of the CTSC and the technology centers at its fingertips, the Digital and Connected Health Initiative is well-positioned to provide these capabilities and establish UC Davis as a center for excellence in digital health."
—Nicholas Anderson

partner with industry and community developers of systems to support health improvement," he added.

The Digital and Connected Health Initiative will invite industry to promote opportunities in the translation and adoption of innovative and promising projects leading to real-world applications. The CTSC will support these activities with funding set aside in the grant to enhance digital health initiatives through training and pilot awards with the intent to expand partnership with industry.

"Bringing new capabilities for digital health into practice requires novel research skills, access to tools and resources that support clinical trials, and innovative modes of connecting broad and geographically distributed populations," added Anderson. "With the resources of the CTSC and the technology centers at its fingertips, the Digital and Connected Health Initiative is well-positioned to provide these capabilities and establish UC Davis as a center for excellence in digital health." §

Videos of the presentations given at the 1st Digital and Connected Health Symposium may be viewed in the CTSC Resource Library at http://bit.ly/2jc4jYw

A next-generation assay for heart attack detection

WHEN CARDIOLOGIST JAVIER E. LÓPEZ, assistant professor in the Department of Internal Medicine and former CTSC MCRTP and KL2 scholar, sees a patient who he suspects is having a heart attack, he orders a troponin test. This test can detect the presence of a protein released into the bloodstream caused by dying cardiac muscle.

But getting positive test results to make this diagnosis may take several hours. Even if a patient is having a heart attack, early results may be negative and only become positive with a subsequent blood draw. An improved troponin assay that the Food and Drug Administration (FDA) approved early this year promises to change that. The most significant advantage of the new troponin test is its greatly improved sensitivity, allowing detection of a heart attack hours earlier than is possible when using the current test.

"The new generation troponin assay promises to dramatically improve our ability to not only detect a heart attack earlier and take immediate appropriate action, but to state with confidence when a patient is not having a heart attack and can go home," said López. "This will have a huge impact on emergency clinical care and length of stay in the emergency department."

The good news of FDA approval came with a catch – only laboratories that can ensure quality benchmarks can use the test. López and his collaborator, Nam Tran, Ph.D., jumped in to conduct the FDA-required tests to ensure that the new troponin assay could be utilized at UC Davis Health.

Administered through the CTSC, the Biorepositories Core Resource

Dr. Javier Lopez and Matthew Hwang examine the algorithm used in the troponin study.

(BCR) provided informatics technical expertise and processing services to assist Dr. Lopez's team. The BCR also helped establish the experimental design, create informatics and computer algorithms, and ensure compliance with federal and university requirements.

The BCR, working with the Department of Pathology and Laboratory Medicine, coordinated the logistics for López to obtain appropriate samples, and used the Freezerworks biospecimen management system to track them. Within six months, he had well over 700 blood samples (about 650 from patients with suspected heart attacks and the rest from healthy patients undergoing a routine checkup) to test with the current troponin assay. Comparing the current and the newly proposed assays will help our clinicians decide how to utilize the new test in practice, an essential step in evaluating a new assay at a single institution.

"The ability of the BCR to identify and provide access to so many patient samples in such a short amount of time has been incredible," said López. "I know from previous research that finding 100 patient samples in a year on my own was a challenge." The accelerated process has put UC Davis Health in the position of likely being the first health center in Northern California to use the new troponin assay.

Lopez marveled on the professionalism of the BCR, and the extent that the program made this research so user-friendly for him and his team. "They understood what I needed in all aspects of the study and put the elements together behind the scenes so that I could start investigations within weeks," he said. "I did not have to learn sophisticated new skills in informatics or study complex regulations – BCR staff took care of all that for our team, making it possible for me to conduct this research efficiently." §

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PERCEPT *Continued from page 3*

they measure activity and sleep parameters – as proprietary, and thus unavailable to scrutiny as to their quality or accuracy by the scientific community.

In addition, Anderson describes the potential legal ramifications surrounding patient privacy in mobile and connected health as a Pandora's box. Although health data is already frequently shared on social media or through vendor applications or wearables, the overlapping and sometimes conflicting interests of patients, researchers, clinicians, payers, and employers must be acknowledged as these systems become increasingly interoperable. Stakeholders in this new ecosystem have a variety of motivations which make the sharing of data between different entities subject to as yet unclear expectations of legal and ethical risk, all of which affect the potential quality of data that is intended to be used for clinical care.

Leading into new frontiers

Anderson credits the resources of the CTSC and the Digital and Connected Health Initiative for enabling him to take a leadership role in PERCEPT. From a public health perspective, he is excited to be developing a system with the potential to radically alter healthcare management of chronic diseases.

"We are quickly moving away from the brick-and-mortar, episodic and reactive model of healthcare delivery," Anderson said. "With existing cell phone capabilities, we can place patients front and center by continuously monitoring their health parameters and providing real-time feedback regarding their health." §

CTSC Connections is published twice a year by the UC Davis Clinical and Translational Science Center. To add your name to the mailing list, send an e-mail to CTSCMail@ucdavis.edu.
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