UNIVERSITY OF CALIFORNIA HEALTH

Annual Report

Center for Data-driven Insights and Innovation

July 2021

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Introduction

The Center for Data-driven Insights and Innovation (**CDI2**) was established in January 2018. Part of University of California Health (**UCH**), comprised of six academic health centers, 20 health professional schools, a Global Health Institute and systemwide services that improve the health of patients and the University's students, faculty and employees. CDI2 is a cornerstone of the collaborative approach that the University of California (**UC**) has taken to build the pre-eminent data-driven learning healthcare system committed to improving the human condition. Under the leadership of Dr. Carrie L. Byington, the Executive Vice President of UCH, CDI2 was vital to the UCH COVID-19 response and now is moving forward in its third year to focus on a world where COVID-19 is endemic.

The primary function of CDI2 is the building and maintenance of the data analytics capabilities and technical infrastructure for the UCH Data Warehouse (**UCHDW**), a unique data asset created to enhance operational improvements, promote quality patient care, and enable the next generation of clinical research. Using electronic health records (**EHR**) from the six academic health centers within UC, this system-level asset also includes claims data from the UC self-funded health plans (**SFHP**), as well as from external sources including Vizient and the California Office of Statewide Planning and Development (**OSHPD**).

The UCHDW currently contains data on more than 6 million patients seen at a UC facility since 2012. These patients received care in approximately 200 million encounters. In those encounters, UCH conducted 500+ million procedures, ordered or prescribed 800+ million medications, made more than 2 billion vital signs and test result measurements, and were able to make and assign more than 700 million diagnosis codes. Nearly 700,000 of these patients receive primary care through UCH.

As the SARS-CoV-2/COVID-19 (**COVID-19**) pandemic emerged in 2020, CDI2 found itself uniquely positioned to leverage the UCHDW to provide critical reporting and analysis to senior leaders throughout UCH. CDI2 has continued to provide reporting and analysis in response to ongoing needs as defined by the pandemic. As described in the following pages, in addition to the work implemented in 2020, including daily dashboards detailing positivity rates and inpatient census data, CDI2 was instrumental in providing reporting on the vaccination efforts that began in December 2020. CDI2 provided these data to UCH leadership as well as state and federal public health authorities. CDI2 developed a research dataset – comprised of all UCH patients tested for SARS-CoV-2 – and made this available to researchers at each UCH location. As this report goes to print, there have been numerous publications developed from this research resource. The pandemic work continues to evolve, including analytic efforts around the changing care delivery environment post-pandemic.

CDI2 also continued its ongoing mission to support operational teams across UCH, including Quality and Population Health (**QPH**) and Leveraging Scale for Value (**LSfV**). In addition, CDI2 has taken significant steps in advancing clinical research projects across the UC system, through enabling access to deidentified datasets, providing the resources to build cohorts for clinical trials, expanding its own research portfolio, and further developing a data science environment to enable analytics for this data. Finally, as CDI2 data analytics capabilities have grown over the past year, CDI2 has similarly grown its health data governance capabilities to ensure that any use of UC patient data is done in an ethical, safe, respectful, and responsible manner.

In this third annual report you will see the increasing role of CDI2 in the clinical operations and academic missions of UCH and UC. The report outlines our successes over the past year, including CDI2's increased contribution to fighting the coronavirus pandemic, ongoing projects and collaborations, and the Center's vision for the future. None of this would be possible without numerous collaborations across the UCH system and the support of the UCH academic health centers.

Executive Summary

During fiscal year 20-21, CDI2 devoted significant resources to systemwide reporting on the COVID-19 pandemic and its progression. In addition to this critical work, the Center advanced ongoing projects and began several new initiatives, all in furtherance of its mission to use systemwide clinical data in a safe and respectful way to improve clinical and business operations, support research efforts, and generate efficiencies of scale.

Team

Under the leadership of Dr. Atul Butte, CDI2 expanded the UCHDW analytics team with the addition of two data analysts. The team plans additional growth this fiscal year, including the addition of a Senior Cloud Security Engineer, Director of External Partnerships and Projects, and project manager.

Continued Pandemic Response

The Center continued to support UCH with COVID-19 response, including through the following projects:

- CDI2 leveraged the UCHDW and partnerships with the local IT teams to produce a daily COVID tracker reflecting systemwide data about testing, inpatient census, and discharge status;
- CDI2 expanded its COVID patient research limited dataset (**UC CORDS**), which has now been utilized by researchers at all academic health centers and beyond and currently has over 200 documented users;
- CDI2 supported equitable and appropriate vaccine distribution by partnering with local IT teams, local population health and occupational health teams, and the LSfV team to track systemwide vaccination efforts.

Ongoing Partnerships and Projects

CDI2 made significant progress with many of its ongoing projects to support quality of care, supply chain, quality population health, and research efforts across the UC system. Key projects over the last year include:

Systemwide Operational Partnerships

- CDI2 provided utilization data to the LSfV strategic sourcing team to increase supply chain savings for joint replacements, leading to a successful contracting initiative expected to save $4.4 million in annual expense across UCH.

Quality and Population Health (QPH)

- CDI2 worked collaboratively with clinical experts from the UC Primary Care Collaborative to develop 5 dashboards comparing hypertension quality performance systemwide;
- Now in performance year 4, CDI2 coordinated local efforts to report 51 quality measures for the California Quality Incentive Program (QIP), which now includes Medi-Cal PRIME;
- CDI2 scaled and began implementation of a machine learning algorithm to predict the risk of unplanned admissions or emergency department visits over the next 12 months in primary care patients.

Clinical Outcomes and Research Support

- CDI2 partnered with the UC Cancer Consortium (**UCCC**) and local sites to incorporate laboratory reports containing the genetic variants of tumors for patients diagnosed with cancer into the UCHDW;
- CDI2 supported a UCSF research team in the first use of the UCHDW for systemwide clinical trial patient recruitment.

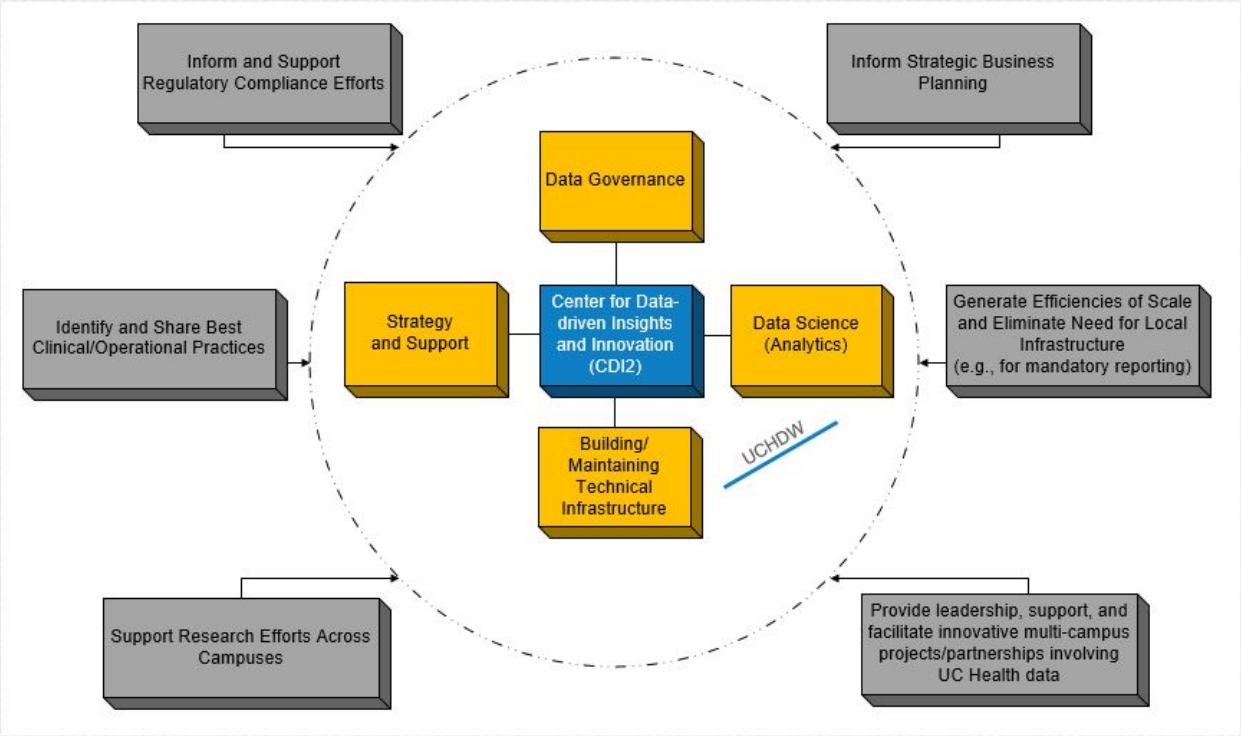
Systemwide Governance Efforts

CDI2 supported an effort by UC BRAID, on behalf of the five Clinical and Translational Science Institutes to provide systemwide EHR data to the National COVID Cohort Collaborative (**N3C**), a nationwide effort launched by the National Center for Advancing Translational Sciences (**NCATS**) to build a centralized data resource to study COVID-19. The project involved the first transfer of systemwide EHR data outside of UC.

Key Accomplishments

CDI2 Team

The Center for Data-driven Insights and Innovation is led by Dr. Atul Butte, the Chief Data Scientist at UCH. Over the past fiscal year, CDI2 has continued to grow the UCHDW analytics team, adding two new business data analysts. CDI2 anticipates further personnel growth this fiscal year, including hiring a Senior Cloud Security Engineer, a Director of External Partnerships and Projects, and a project manager. These roles will enable CDI2 to expand its portfolio while ensuring the continued focus on data security in a constantly changing security environment. As depicted in the chart below, CDI2's work in the areas of data governance, strategy, and support continue to complement the data science and technical infrastructure work at the heart of CDI2.



CDI2 reports on a quarterly basis to an Oversight Board with representation from each campus. Since our last annual report, there have been a few changes to the Oversight Board. The Chair of the Oversight Board for fiscal year 2020/2021 was held by the Chief Information Officer for UCLA Health. In the coming fiscal year, the Board will be chaired by the Vice Chancellor of Information, Technology and Data at UC Irvine. In addition, new members include an at-large member from UCH, a new representative from UCLA, and an additional member representing healthcare compliance. The full current membership of the Oversight Board is shown in appendix 1.

Responding to the Evolving COVID-19 Pandemic

In 2020, CDI2 was called upon to provide systemwide reporting on the pandemic and its progression. As detailed in the 2019-2020 Annual Report, CDI2 leveraged the UCHDW and partnerships with the UCH analytics teams to provide a dashboard detailing the number of SARS-CoV-2 tests administered across the system. Other dashboards included detailed inpatient census for COVID-19 patients at each medical center; employee positivity rates across the academic health centers; and reporting on telehealth utilization as an alternative to in-person ambulatory care. This critical work continued to evolve throughout this past fiscal year, demanding a significant amount of CDI2 time and resources.

In January 2021, shortly after COVID-19 vaccines became available, CDI2 added to its existing reporting

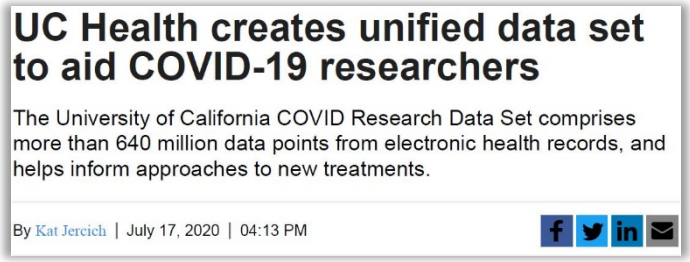
with tracking of healthcare worker vaccinations at medical centers, and as eligibility for the vaccines expanded, patient vaccination efforts. CDI2's efforts, aimed at supporting equitable and appropriate vaccine distribution, was completed in partnership with local UCH analytics and population health reporting teams, occupational health partners, and the LSfV team.

Toward the end of the 20-21 fiscal year, CDI2 began to reduce its COVID-19 reporting efforts. Indeed, after 14 months of emailing COVID-19 test and hospital data every weekday to UCH leadership, and in light of decreasing numbers of COVID-19 cases and admissions, CDI2 began reducing its reporting cadence to weekly on June 15th, the day of California's "grand reopening." The Center is prepared to pivot quickly to increased reporting should there be another surge in the coming fiscal year

Facilitating COVID-19 Research Efforts

As detailed in last year's Annual Report, CDI2 created and deployed UC CORDS, a COVID-19 patient research HIPAA Limited Data Set (**LDS**) that combines the SARS-CoV-2 testing data for UCH patients with their prior history dataset. CDI2 was able to securely transfer this UC-wide COVID LDS to each of the health campuses for their use within their own secure virtual systems for research. To date, this dataset has been utilized by researchers at all six academic health centers, and currently has over 200 documented users. Additionally, to date, 12 research papers have been generated and are published or in press. Research topics have included management of skin conditions and risk of SARS-CoV-2 infections, cancer treatment and COVID-19, and characterizations of both patients hospitalized for COVID-19 and patients who are at risk for becoming COVID "long-haulers." A complete lists of papers published is included in appendix 4.

In April 2020, the Robert Wood Johnson Foundation awarded CDI2 a $100,000 grant to support a collaboration between the Health Care Cost Institute, CareJourney, and a sentinel network of geographically diverse health systems including Rush Medical Center, ICHIN, Geisinger, and Prisma Health. Under the grant, UCH leveraged the UCHDW (UC-CORDS) to construct clinical queries around COVID-19 care management and then have its results aggregated and merged with those of other health systems. The goal of this effort was to help create weekly extracts of a series of standardized data elements and queries that would allow researchers, clinicians, policy makers, and journalists to better understand the impact and progression of COVID-19.

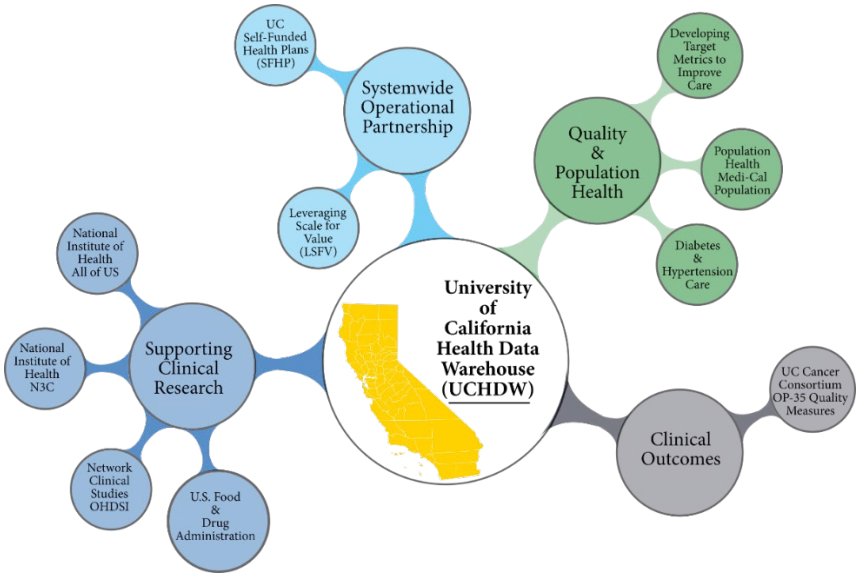


The database queries were formalized for over 100 different clinical data elements related to individuals infected with SARS-CoV-2, including total cases of SARS-CoV-2 infection, admission characteristics, demographics (i.e. age, sex, race, ethnicity, enrollment in food stamps and employment status), comorbidities, treatments during hospitalization, clinical complications, serology testing, ICU admissions, discharge outcomes, and length of hospitalization. Analysis of these elements across UCH revealed wide variations in their weekly counts throughout the evolution of the pandemic. For instance, initial results suggest that the average age of individuals hospitalized dropped to a range of 40 to 42 years from a range of 50 to 60 years since the beginning of the pandemic, suggesting a shift in the population contracting the virus over time. We also observed that average ICU days dropped to 3 to 17 days after September 2020

compared to 15 to 42 days at the beginning of the pandemic until September 2020, suggesting advancements in the COVID-19 related clinical care. On average, most of the individuals who were tested positive for SARS-CoV-2 and were admitted to the hospital had a pre-existing condition of hypertension (mean = 67.6), diabetes (including both type I and type II) (mean = 44.14), followed by asthma, COPD, and cancer (mean [10.4 to 22.8]). CDI2 successfully completed this work in November and December 2020, and shared aggregated results with other data partners in early February 2021.

Partnerships and Projects

In addition to its ongoing COVID-19 work, CDI2 was able to make significant progress on planned initiatives, addressing the majority of those projects detailed in the 2020 Annual Report. CDI2 continues to provide analytics expertise and system-level assets in support of existing UCH research, clinical, and operational quality improvement efforts, and also develop new projects that further these goals. These projects are grouped into four categories: systemwide operational partnerships; quality and population health; clinical outcomes; and research support.



Systemwide Operational Partnerships

CDI2 continues to work closely with the SFHP team, which manages the UC Care PPO and UC Blue and Gold HMO, as well as the LSfV team, assisting with reporting requirements and initiatives to improve care delivery and reduce the cost of health care. A number of projects are ongoing, continuing work initiated in 2018 as well as in subsequent years. Below are two that have made significant progress since the last reporting period.

Supply Chain Analytics and Large Joint Replacement

Starting in 2019, the LSfV strategic sourcing team began leveraging implant utilization data provided by the CDI2 team, with a goal of increasing supply chain savings for joint replacements. These efforts have yielded recent success, including the completion during FY21 of a large joint reconstruction contracting initiative. This initiative, benefiting all five UCH medical centers with lower pricing on implant components for knee and hip replacements, is expected to save **$4.4 million** in annual expense systemwide. CDI2 has continued to enhance the dataset to include the procedure's surgeon of record, billing and diagnostic codes, and to provide refreshed data on a quarterly basis. These enhancements will offer increased opportunities for savings as well as ensure UCH clinicians are being engaged for supporting savings based on data that reflects contemporary clinical use.

Using Data to Speed Transition from IV Acetaminophen to Oral Doses in Inpatient Care

Throughout the 20-21 fiscal year, CDI2 continued to work with the Chief Pharmacy Officers (**CPOs**) on transitioning from IV acetaminophen to oral acetaminophen, an ongoing priority for the health systems.

CDI2 worked with the CPOs to define and refine a dashboard showing IV acetaminophen usage by campus in order to aid local sites in their clinical quality improvement efforts in this area. While IV acetaminophen has typically been utilized clinically in place of IV opioids pre- and post-surgery, pharmacists and care teams continue to use CDI2's data to identify appropriate use in these settings. The data drawn from the UCHDW and reflected in the pharmacy dashboard has enabled sites to more effectively address the use of IV acetaminophen by administering oral medications to patients who are able to tolerate them. Working in conjunction with pharmacists at each site, CDI2 helped to identify and monitor the various interventions implemented at each campus in order to determine what initiatives could be implemented at a system-wide level to lower IV acetaminophen usage across the system. As a result, of this work, the system was able to realize an annualized savings of **$630,000** while significantly reducing the use of IV acetaminophen overall.

Quality and Population Health

CDI2 has maintained a robust ongoing partnership with the Quality and Population Health (**QPH**) team at UCH. This partnership supports efforts to advance value-based care delivery, improve patient outcomes, and reduce per capita cost of care for patients, including those members covered under the SFHP. A few highlights from this fiscal year include:

Supporting Population Health Analytics

Over the past year, CDI2 has expanded upon the population health dashboards and enhanced analytic capabilities it provides to QPH and the SFHP. For example, CDI2 updated the KPI dashboard to include out of state SFHP members. CDI2 also upgraded the Milliman MedInsight Analytics Tools. These tools calculate patient risk scores and include the integration of commercial benchmarks to help target high cost areas and high need populations. In addition to leveraging these tools for the SFHP, CDI2's dashboards are used by QPH as described below to advance value-based care systemwide by improving the quality of care delivered and reducing costs.

Using Data to Increase Health Care Value

CDI2 and QPH partnered with the Value-Based Care Research Consortium (**VBCRC**) at UCLA to examine the delivery of services for patients within the SFHP. The VBCRC already works closely with UCLA Health operations to implement and measure interventions to improve health outcomes and increase value. CDI2 enabled the VBCRC team to investigate claims data from the UC Care plan to examine services across UCH. Using the Milliman Health Waste Calculator tool, the team was then able to identify low-value care, defined as patient care that offers no net benefit in specific clinical scenarios. Measuring low-value care is an important approach to informing and refining cost-containment efforts so they specifically target wasteful or harmful care and improve quality.

The VBCRC team has proposed an initial list of potential interventions targeting the identified sources of low value care at the health centers. This collaboration has also resulted in 3 abstracts and poster presentations at professional clinical meetings and received grant funding to further the analysis by measuring racial /ethnic differences in the delivery of low-value care and how COVID impacted the delivery of those services.

Developing Target Metrics to Improve Care

CDI2 has continued to partner with QPH and SFHP in fiscal year 20-21 to develop and enhance comparative dashboards to identify variation across UCH in utilization and total costs of care in the self-funded plans. The dashboards also illuminate performance on systemwide metrics for the UC Care plan. The three agreed-upon areas for intervention are: Ambulatory Care Coordination, Inpatient Care Management, and Emergency Department use. The UC Care Initiative subject matter experts (**SMEs**) all have access to the dashboards and review them monthly as a group. CDI2 provides site-specific patient lists to help the local teams target and close care gaps. Over the past fiscal year, the SMEs have developed 10 additional site-specific action plans for a total of 68 strategies to improve care for patients. Of these, 42 strategies have been implemented overall, with 15 implemented this past fiscal year. The workgroup is currently analyzing the impact of these efforts.

An initial analysis of the data confirmed that the strategies currently being employed across the health centers target key cost drivers in care delivery. Further analysis has identified the top chronic conditions by spend and this is the target for ongoing and future efforts by QPH and systemwide teams.

Using Data to Reduce Drug Spend

CDI2 has further developed interactive dashboards that streamline the work of identifying and targeting opportunities for cost savings for the self-funded plans. Working closely with the systemwide population health pharmacy workgroup, CDI2 developed a dashboard that highlights cost savings resulting from the "UC Scripts" initiative. UC Scripts encompasses a combination of strategies employed by the pharmacists and aimed at an agreed-upon list of target drugs. These strategies include EMR alerts for high value drug alternatives and provider and patient engagement. This initiative has resulted in a cumulative savings to date of **$1.8M** since the onset of this project. CDI2 will engage with the QPH and the systemwide population health pharmacy workgroup on an ongoing basis to identify opportunities to further reduce drug spend, while maintaining quality and safety for patients.

Assisting in the Development of Diabetes Care Management

In response to the growing patient population with diabetes, CDI2 worked with QPH to create 4 dashboards to compare variations of key performance indicators across 5 UC sites. Clinical experts in Endocrinology, Pharmacy, and Primary Care worked together to identify, recommend, and implement evidence-based strategies to improve diabetes care management. These strategies are referred to as *UC Way Diabetes*, and include:

- **Pharmaceutical Use:** An algorithm to prescribe cardio-protective medications to eligible patients
- **Patient Education:** Automated patient outreach to promote diabetes education videos matched to appropriate patient cohorts
- **Medical Home:** A patient-centered approach to overdue A1c testing offered at the point of care, promoting active diabetes management and decreasing additional patient visits

To help support systemwide implementation of these strategies, CDI2 created an additional 4 dashboards focused on process measures intended to inform the quality improvement efforts and patient lists to enhance patient outreach. Together, both key performance and process dashboards will track change over time and our ability to improve diabetes care management. Despite resource constraints due to the pandemic, the sites were able to begin launching the improvement strategies in 2020. A key step in that process was the ability for the site champions to use the comparative dashboards as compelling rationale when socializing the strategies with their clinical and administrative teams.

Assisting in the Development of Hypertension Management Protocols

CDI2 has worked collaboratively with clinical experts from the UC Primary Care Collaborative (**PCC**) to develop 5 dashboards comparing hypertension quality performance systemwide. The data analysis illustrate two key areas prime for improvement:

1) Disparities in blood pressure control among African American patients
2) Variance in blood pressure control among Stage 2 hypertension patients

More in-depth review is being taken to better understand disparities among African American patients, use of monotherapy for patients with stage II hypertension, and improved capture of blood pressure measurement. The CDI2 team led the analysis of unexpected variations in hypertension across the UCH sites and identified operational differences in repeated blood pressure measurements after an initial elevated reading. The UC Primary Care Collaborative recognized this as an opportunity to leverage best practices from UC Davis Health to improve the accuracy of blood pressure measurement. CDI2 continues to support this effort by developing new dashboards to monitor improvement efforts.

Building a Systemwide Primary Care Risk Model

Building on work begun last fiscal year, CDI2 scaled and began implementation of a machine learning algorithm to predict the risk of unplanned admissions or emergency department (**ED**) visits over the next

12 months in primary care patients across UCH. The original algorithm was developed by UCLA Health in a secure environment with a goal of helping patients avoid unnecessary ED visits and hospitalization by using risk scores to identify, and then proactively conduct outreach to at-risk patients to coordinate their care, encourage self-management, address social determinants of health, and ensure completion of physician care plans.

In scaling this risk model systemwide, CDI2 collaborated with UC Davis Health on feature engineering to develop data for training the model. CDI2 worked with UCLA Health to develop the algorithm in the secure UC Data Discovery Platform environment using de-identified data, and then brought the model into the secure identifiable UCHDW environment to run against the UC-wide Primary Care population (~680k patients). Of the UC-wide Primary Care population, approximately 16.5k patients were found to have a high-risk of an unplanned, preventable admission or ED visit in the next 12 months. Quality and population health teams at each location are reviewing the most effective adoption of the risk model.

Mitigation of Algorithmic Bias

In developing the initial risk model, the UCLA Health team recognized the potential for the model to incorporate bias and systemically and unfairly advantage certain groups. For example, a 2019 study by a team of UC Berkeley researchers led by Ziad Obermeyer found evidence of racial bias in a predictive risk model deployed nationwide to identify and help patients with complex health needs (Obermeyer et al., 2019). The model used patient expenditure as the predicted outcome and assigned risk scores to patients, with those above a certain threshold targeted for intervention. Since less money is spent on Black patients who have the same level of need, the algorithm falsely concluded that Black patients are healthier than equally sick White patients.

The researchers found that reformulating the algorithm so that it no longer used costs as a proxy for needs eliminated the racial bias in predicting who needs extra care. Consistent with these findings, the UCLA Health team decided to use ED visits and admissions as a proxy for unmet health needs, and incorporated in its model validation process an effort to detect bias. Model validation confirmed that the algorithm's outcome greatly reduced or perhaps even eliminated the bias documented by Obermeyer et al. As the risk model is scaled systemwide, CDI2 will continue to evaluate the model for potential bias.

QIP Performance Year 4

CDI2 is continuing to coordinate the measure development of 51 quality measures for the Quality Incentive Program (**QIP**), which now includes Medi-Cal PRIME. CDI2 also provides support with a common code repository, data mapping, value set management, and documentation for this reporting. Development and measure logic review was split between the 5 academic medical centers, and uses data from the local instances of the UCHDW. The work is on track to be completed by the end of June 2021, giving the sites 6 months to validate and improve performance. In past years, due to the amount of development required, sites did not have this opportunity. The QIP data analysts also benefited from having a channel of communication with each other to discuss approaches to solve site specific challenges.

Moving Forward with Systemwide Health Data Governance

CDI2 continued its focus on using and sharing UCH patient data in a safe and responsible way. On the cybersecurity front, CDI2 completed the first phase of a routine internal audit focused on governance, and is continuing to conduct yearly penetration tests and risk assessments. In the next year, CDI2 also plans to hire additional cybersecurity personnel with cloud security expertise.

CDI2 also moved forward with systemwide data governance efforts. For example, CDI2 supported an effort by UC BRAID, on behalf of the five Clinical and Translational Science Institutes (**CTSIs**) to make a systemwide contribution of data to the National COVID Cohort Collaborative (**N3C**). N3C is a nationwide effort launched by the National Center for Advancing Translational Sciences (**NCATS**) with the goal of

building a centralized data resource for the research community to study COVID-19 and identify potential treatment. The work was funded by a **$500,000** grant split among the 5 CTSIs and CDI2. Since the N3C project involved the first transfer of systemwide EHR data outside of UC, BRAID sought approval from the interim UC-wide governance "Tiger Team" to proceed. Based on the Tiger Team's recommendations, UC negotiated additional protections for the privacy and security of the data at issue, and the project received final approval from the Chancellors or designees at each location and the EVP of UCH. CDI2 was able to submit the first systemwide UC data contribution to N3C this spring.

Clinical Outcomes

Leveraging the data available through the UCHDW, CDI2 maintains established partnerships with constituents across the system to improve clinical outcomes for cancer. In this fiscal year, CDI2 focused its efforts on incorporating additional test results for cancer patients into the UCHDW.

Integrating Genomic Test Results into the UCH Data Warehouse

CDI2 is continuing to working with the UCCC and local sites to incorporate laboratory reports containing the genetic variants of tumors for patients diagnosed with cancer into the UCHDW. CDI2 worked with local sites to define the data requirements for importing these records into the UCHDW infrastructure and, to date, more than 20,000 reports from genomic testing company, Foundation Medicine, Inc., for patients from all UCCC sites have been integrated. In this next year, the focus will be on bringing in additional reports from UCSF 500, Tempus, and Guardant Health. CDI2 has used this data to prepare a cancer genomics dashboard depicting counts of gene occurrences for particular cancers and intends to develop additional dashboards to support upcoming UCCC initiatives.

Clinical Research Support

CDI2 supports clinical research endeavors at UCH campuses in multiple ways, including providing access to cohort discovery tools that support grant submissions, feasibility studies, and enrollment potential for clinical trials; providing researchers across the UC with access to a data query & analysis environment; and developing specific datasets from the clinical data available within UCHDW, including UC CORDS. CDI2 also supports external research including efforts at the FDA and NIH. In addition to these ongoing efforts, in fiscal year 20-21 CDI2 supported the first use of the UCHDW for systemwide clinical trial recruitment, and began to participate actively in the open-science community, Observational Health Data Sciences and Informatics (OHDSI, pronounced "Odyssey"). These projects are described below.

First Use of the UCHDW for Clinical Trial Patient Recruitment

This past spring, CDI2 began support of a UCSF research team in the first use of the UCHDW for systemwide patient trial recruitment. The "KIDCOV" study is a NIH-funded study assessing the impact of COVID-19 on acute kidney injury. The goal of the study is to evaluate whether the presence of COVID-19 infection raises the 12-month risk of kidney injury. Since the study involves systemwide recruitment, the primary principal investigator (PI) is located at UCSF with site PIs also located at the other academic health centers. After the KIDCOV team received the necessary IRB approvals, the CDI2 team ran a script to pull a pool of potential patients for recruitment. Each health location's honest broker team then conducted quality checks to, for example, ensure that patients who opted out of being contacted for research were taken off of the list. UCSF Participant Recruitment is contacting patients but logos of all health locations are on the outreach materials.

Engaging UCH in an Open-Science Community

In the 20-21 fiscal year, CDI2 started to contribute actively to the Observational Health Data Sciences and Informatics Program (**OHDSI**). OHDSI is an international multi-stakeholder, interdisciplinary open-science community focusing on bringing out the value of health data through large-scale analytics. CDI2 took various steps to begin active participation, including modifying the de-identified patient-level data in the UCHDW according to the Observational Medical Outcome Partnership Common Data Model (**OMOP-CDM**) to enable and support clinical network studies within the OHDSI framework. The de-identified OMOP data is hosted on a dedicated server and made compatible with the OHDSI analytic toolbox to conduct network

studies. CDI2 also developed a governance process to vet proposed studies for technical, privacy, security, or ethical concerns. The first (of two) studies CDI2 participated in last year involved the evaluation of the effect of ACE inhibitors or ARB exposure on the risk of contracting COVID-19. After evaluating and approving the project, CDI2 ran the appropriate scripts, and provided the aggregate results to the study leads. As with all OHDSI studies, no patient-level data is ever shared.

Growth of the UC Data Discovery Platform

In August 2020, CDI2 launched the UC Data Discovery Platform (**UCDDP**). The Data Discovery Platform contains tools to allow researchers to query and analyze the legally de-identified UCHDW. This environment enables UCH researchers (and other UC researchers partnering with a health campus) to write code in R, Python, or Spark SQL, that queries the de-identified clinical data.

During UCDDP's initial launch period, 2-5 beta users from each UCH site were provisioned for access: this beta group included Health IT analytics team members, research informatics (honest broker) team members, and data scientists from across UCH. Since launch, usage of the UCDDP has grown significantly. As of June 2021, more than 50 UCH users have successfully accessed this platform for both clinical operations and clinical research purposes, including the training and testing of the risk model developed by UCLA Health data scientists described above.

CDI2 has developed guidance materials that set forth the process researchers must follow to utilize the UCDDP. Before gaining access, researchers must do the following:

- Work with their local campuses (or the UCH campus they are partnering with if they are not affiliated with a UCH campus) to develop and run their queries in their local environment
- Undergo local review of the scientific merit of their project and to confirm the value of running the query centrally
- Comply with all local processes and, upon access, sign an appropriate Data Use Agreement (**DUA**)

Researchers may upload files to this virtual desktop, but cannot download patient-level data. Researchers can also request the download of aggregate data files for publication and presentation purposes, and the CDI2 team reviews each of these requests before securely transferring approved files to the research team.

Looking Ahead

As we look ahead to fiscal year 2021-2022, and the demands of COVID-19 pandemic response may lighten, CDI2 anticipates a year of growth in each of its four core areas: informing and supporting quality patient safety, and population health management; generating efficiencies and economies of scale across UCH; developing data governance and strategic support; and innovating around technical infrastructure and analytic capabilities. As described above, CDI2 expects to add personnel, including additions to its data science team and cybersecurity team, and the addition of a Director level position responsible for developing and managing partnerships with external parties. These additions will enable CDI2 to pursue a number of emerging and new projects, including:

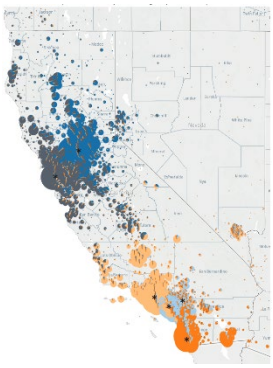
Growing Systemwide Clinical Trial Capacity

Building upon the success of the KIDCOV trial described above, CDI2 plans to work with UC BRAID and other UCH stakeholders to develop researchers' ability to use the UCHDW, and the diverse patient base included therein, for systemwide clinical trials.

Developing Safe and Responsible Partnerships to Analyze UCH Data

During the course of the pandemic, CDI2 has utilized UCHDW clinical data to help the FDA and other government entities answer critical research questions around COVID-19. CDI2 intends to continue these partnerships, and explore similar real world evidence collaborations with other external partners, including nonprofit and commercial entities, to leverage the UCHDW in a safe and responsible way.

Support Strategic Initiatives to Advance Health Equity



Over the past year, CDI2 began several projects aimed at better understanding the diverse patient mix within UCH to enhance care for socioeconomically challenged patient groups. We intend to build upon this work in the next year. For example, CDI2 built a systemwide dashboard that depicts patients across a number of indices that can aid in identifying communities that need additional support, including the Area Deprivation Index (API), the California Healthy Places Index (HPI), and the CDC/ATDSR Social Vulnerability Index (SVI). CDI2 has also begun to partner with UC Davis Health to gather systemwide data around the homeless population. These projects will aid local and systemwide efforts to connect those patients most in need with community resources.

Continue Pursuit of Systemwide Research Grants

CDI2 will continue to seek out and pursue research grants, as well as support health locations with research projects that benefit from utilization of the UCHDW. For example, CDI2 and UCSF are at the beginning stages of participation in CURE ID, a collaboration between the FDA and the NCATS, part of the National Institutes of Health (NIH). CURE ID is an internet-based repository that lets the clinical community report novel uses of existing drugs for difficult-to-treat infectious diseases through a website, a smartphone or other mobile device. The platform enables the crowdsourcing of medical information from health care providers to facilitate the development of new treatments for neglected diseases.

Assist Pharmacy Team Efforts to Gain Access to Limited Distribution Drug Networks

Supporting efforts by the Chief Pharmacy Officers to gain access to limited distribution drug (LDD) networks on a systemwide basis, CDI2 is in the early stages of leveraging the UCHDW to help determine which LDD opportunities to prioritize and will continue this work in the upcoming year.

Conclusion

In collaboration with the UCH IT teams, and many others throughout UCH, CDI2 made significant contributions over the past fiscal year towards fighting the pandemic, as well as towards its goals of improving clinical and business operations, supporting research efforts, and generating efficiencies of scale. These contributions align with UCH's core values of accountability, collaboration, diversity and inclusion, excellence, integrity, innovation and being mission-driven. We look forward to building upon these efforts in the next year.

Appendices

Appendix 1 – Oversight Board Membership

Committee Leadership		
Chair	Tom Andriola	Vice Chancellor, Information, Technology and Data, UCI
Campus Appointees		
UCSD	Chris Longhurst, MD, MS	CIO, Associate CMO
UCLA	Albert Duntugan	Chief Data Officer
UCR	Katherine Hansen, MHA, MS	COO
UCD	Jason Adams, MD	Director, Digital Health Innovation
UCI	Nasim Afsar, MD, MBA, SFHM	COO
UCSF	Gina Intinarelli, PhD, RN	VP, Population Health and Accountable Care
UCOP	Anne Foster, MD	Chief Clinical Officer, UC Health
At-Large Appointees and Areas Represented		
CMO/CQO	Robert Cherry, MD, Chief Medical and Quality Officer	UCLA
Research (UC BRAID)	Stephen M. Dubinett, MD, Director, Clinical and Translational Science Institute	UCLA
Non-Health Campus	Jennifer Chayes, PhD, Dean, School of Information	UCB
Ethics	Barbara Koenig, PhD, Professor Emeritus of Medical Anthropology & Bioethics	UCSF
Patient Voice	TBD	
Ex Officio		
Compliance (Research)	Shanda Hunt, JD – Systemwide Research Compliance Officer	UCOP
Compliance (Healthcare)	Noelle Vidal, JD – Healthcare Compliance and Privacy Officer	UCOP

Appendix 2 – Center for Data-driven Insights and Innovation Team

Atul Butte, MD, PhD	Chief Data Scientist	UC Health
Cora Han, JD	Chief Health Data Officer, Executive Director	UC Health
Pagan Morris, MPH	Program Manager	UC Health
Lisa Dahm, PhD	Director, Health Data and Analytics	UCI Health
Ayan Patel, MS	Lead Data Scientist	UCI Health
Aiden Barin	Data Scientist	UCI Health
Chaya Mohn	Data Scientist	UCI Health
Ray Pablo	Data Scientist	UCI Health
Teju Yardi	Data Scientist	UCI Health
Nadya Balabanova	Data Scientist	UCI Health
Tim Hayes	Technical Project Manager	UCI Health
David Gonzalez	Infrastructure Architect	UCI Health
Rob Follett	Lead Data Architect	UCI Health

Appendix 3 – Campus and Medical Center Partners

Technology Leadership Partners		
Ellen Pollack, MSN, RN-BC	Chief Information Officer (Acting)	UCLA Health
Chris Longhurst, MD	Chief Information Officer	UCSD Health
Scott Joslyn	Chief Information Officer	UCI Health
Joe Bengfort	Chief Information Officer	UCSF Health
Ashish Atreja, MD	Chief Information Officer	UCD Health

Business Intelligence Partners		
Albert Duntugan	Chief Data Officer	UCLA Health
Andrew Weaver	Director, Program Operations, OHIA	UCLA Health
Rick Larsen	Interim Chief Data & Analytics Officer Director, Research Informatics, EIA	UCSF Health
Kent Anderson	Director, IT Health Informatics	UCD Health
Josh Glandorf	Senior Director, Hospital Affiliations and Analytics	UCSD Health
Jennifer Holland	Director, Analytics and Population Health	UCSD Health
David Merrill	Director, Enterprise Data and Analytics	UCI Health
Dan Phillips	Manager, Enterprise Data and Analytics	UCI Health

Campus Technical Implementation Team		
Kathy Pickell	Data Architect	UCI Health
Leanie Mayor	ETL Developer	UCI Health
Steve Covington	Clinical Informatics Specialist	UCD Health
Hemanth Tatiparthi	ETL Developer	UCD Health
Ranjit Singh	ETL Developer	UCD Health
Jay Shah	Data Engineer	UCLA Health
Vajra Kasturi	Data Engineer	UCLA Health
Nelson Lee	Data Engineer	UCSF Health
Peter Ryan	Senior ETL Developer	UCSD Health
Eddie Ramirez	Azure Architect	UCLA Health
Bill Cinnater	Senior Cloud Engineer	UCLA Health

Appendix 4 – Publications

1. Watanabe, J.H., Kwon, J. & Mehta, S.R. **Association of Age and Hospitalization Amongst Those with Underlying High-risk Conditions at COVID-19 Diagnosis in a Large, State-wide Health System**. J GEN INTERN MED (2021). https://doi.org/10.1007/s11606-021-06942-y

2. Huang Y, Pinto MD, Borelli JL, Mehrabadi MA, Abrihim H, Dutt N, Lambert N, Nurmi EL, Chakraborty R, Rahmani AM, Downs CA. **COVID Symptoms, Symptom Clusters, and Predictors for Becoming a Long-Hauler: Looking for Clarity in the Haze of the Pandemic**. medRxiv [Preprint]. 2021 Mar 5:2021.03.03.21252086. doi: 10.1101/2021.03.03.21252086. PMID: 33688670; PMCID: PMC7941647.

3. Milad Asgari Mehrabadi, Seyed Amir Hossein Aqajari, Iman Azimi, Charles A Downs, Nikil Dutt, Amir M Rahmani. **Detection of COVID-19 Using Heart Rate and Blood Pressure: Lessons Learned from Patients with ARDS**. arXiv:2011.10470v1, https://arxiv.org/abs/2011.10470 [Preprint]

4. Watanabe JH, Kwon J, Nan B, Abeles SR, Jia S, Mehta SR. **Medication Use Patterns in Hospitalized Patients with COVID-19 in California During the Pandemic**. JAMA Netw Open. 2021;4(5):e2110775. doi:10.1001/jamanetworkopen.2021.10775

5. Nguyen C, Yale K, Casale F, Ghigi A, Zheng K, Silverberg JI, Mesinkovska NA. **SARS-CoV-2 infection in patients with atopic dermatitis: a cross-sectional study**. Br J Dermatol. 2021 May 6. doi: 10.1111/bjd.20435. Epub ahead of print. PMID: 33955543.

6. Yale, K., Elsanadi, R., Ghigi, A., Zheng, K., Goren, A. and Mesinkovska, N.A. (2021), **Androgens and women: COVID-19 outcomes in women with acne vulgaris, polycystic ovarian syndrome, and hirsutism**. Int J Dermatol. https://doi.org/10.1111/ijd.15473

7. Nguyen C, Yale K, Ghigi A, Zheng K, Mesinkovska NA, Wambier CG, Cadegiani FA, Goren A. **SARS-CoV-2 infection in patients with thyroid disease: a cross-sectional study**. Ann Thyroid. 2021. DOI: 10.21037/aot-21-8

8. Vashisht R, Patel A, Crews BO, et al. **Age- and Sex-Associated Variations in the Sensitivity of Serological Tests Among Individuals Infected with SARS-CoV-2**. JAMA Netw Open. 2021;4(2):e 210337. doi:10.1001/jamanetworkopen.2021.0337

9. Kwon, D., Vashisht, R., Borno, H., Aggarwal, R. R., Small, E. J., Butte, A., & Huang, F. W. (2021). **Androgen deprivation therapy and risk of SARS-CoV-2 infection in men with prostate cancer: A University of California (UC) Health System registry study**. Journal of Clinical Oncology, 39(6_suppl), 37. https://doi.org/10.1200/jco.2021.39.6_suppl.37

10. Nuño, M., García, Y., Rajasekar, G., Pinheiro, D., & Schmidt, A. J. (2021). **COVID-19 Hospitalizations in Five California Hospitals**. MedXRiv. Published. https://doi.org/10.1101/2021.01.29.21250788 [Pre-print]

11. Reznikov, L. R., Norris, M. H., Vashisht, R., Bluhm, A. P., Li, D., Liao, Y. S. J., Brown, A., Butte, A. J., & Ostrov, D. A. (2021**). Identification of antiviral antihistamines for COVID-19 repurposing**. *Biochemical and Biophysical Research Communications*, *538*, 173–179. https://doi.org/10.1016/j.bbrc.2020.11.095

12. Nourmohammadi, N., Yale, K., Ghigi, A., Zheng, K., & Mesinkovska, N. (2020). **A Cross-Sectional Study on Herpes Zoster Diagnosis in the time of COVID-19**. *SKIN The Journal of Cutaneous Medicine*, *4*(6), 556–558. https://doi.org/10.25251/skin.4.6.9