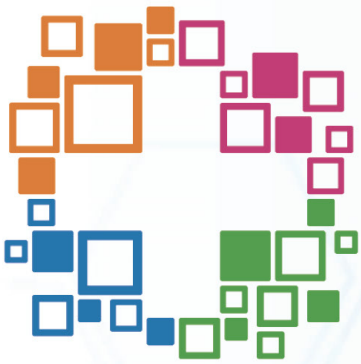

California Initiative to Advance
Precision Medicine

CANCER RESEARCH PROGRAM

Evaluation Report
2019-2023

Prepared by the California Health & Human Services Agency

California Initiative to Advance Precision Medicine (CIAPM) launched the Cancer Disparities Research Program in 2019 to research and implement ways to reduce cancer disparities in California, with community collaboration and partnership.

CIAPM's Cancer Disparities Research Program

What are cancer disparities in Californians? The California Cancer Registry estimates that 50% of Californians will develop cancer, and nearly 25% will die of cancer. Race/ethnicity, socioeconomic status, care access, and neighborhood quality impact cancer incidence and mortality. Black, Asian, Hispanic, and Native American populations are more often uninsured, from low socioeconomic status, and diagnosed with cancer at later stages.

University of California, San Francisco, Lead Investigator: Elad Ziv, PhD. 2019-2023, $3 Million.
Improving Breast Cancer in Latinas: A Multi-Tiered Approach

- **Why:** Genetic and tumor testing tools and robust patient samples are **limited in Latina communities**.
- **How:** Identify genetic variants that may **predispose Latinas to breast cancer** and train community health workers (CHWs) to conduct **outreach and education** among Latina communities.
- **Impact:** Developed **tools and education for diverse Latina populations** to **identify cancer risk**, using family history screens and fine-tuned genetic tests.

University of California, San Diego, Lead Investigators: William Kim, PhD and Pablo Tamayo, PhD. 2019-2023, $3 Million. *Integrated Machine-Learning Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project)*

- **Why:** Artificial intelligence (AI) can be used to **identify treatments** for Latina cancer patients.
- **How:** Develop and refine an **AI model to identify candidate treatments** for patients with triple negative breast cancer, which is common among Latinas.
- **Impact:** Proof-of-concept that an **AI can guide prediction of tumor treatments,** if refined with more genetic samples. Highlighted need for **inclusive patient recruitment**.

Stanford University, Lead Investigator: Manali Patel, MD, MS, MPH. 2019-2023, $3 Million.
*Reducing Cancer Disparities Through Innovative Community-Academic Partnerships - **A**ddressing **L**atinx **CAN**cer **C**are **E**quity (ALCANCE) Project*

- **Why:** Limited **patient understanding of precision medicine cancer care** impacts research participation, treatment, and outcomes.
- **How:** Integrate **CHWs into preventative and cancer care delivery** to address existing inequities in cancer diagnosis, treatment, and outcomes for Latino patients.
- **Impact: CHW-led culturally sensitive education** and intervention model **improved cancer care** in Latino communities and is **scalable for underserved communities**.

Program Impact in California: Three CIAPM-funded cancer disparities research projects involved 15 partners across healthcare, nonprofit, and academia, generated 55 scientific publications in renowned journals, 126 presentations at national and international conferences, and obtained over $17 million in additional non-state funding.

https://ciapm.chhs.ca.gov/ CalHHS CIAPM@chhs.ca.gov

EVALUATIONS OF THE CALIFORNIA INITIATIVE TO ADVANCE PRECISION MEDICINE CANCER DISPARITIES RESEARCH PROGRAM, 2019-2023

Report for the California Legislature, January 2026

Prepared by the California Health and Human Services Agency (CalHHS)

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In Memoriam: *CIAPM honors the life and legacy of Dr. Atul Butte, who served as the founding Principal Investigator for the entire CIAPM program when launched and administered through UCSF from 2015-2018. A fierce advocate and entrepreneur in the biomedical data science space, his work in blending artificial intelligence and health data to further precision medicine and equitable outcomes were pivotal in designing the request for proposals for this Cancer Disparities Research Program.*

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Cancer Disparities Research Program Highlights



CIAPM's request for cancer disparities research proposals launched in 2018.

23 proposals received | **11** finalists | **3** funded research projects

$9M state funds allocated

$17+M additional non-state funding obtained

Partners in Cancer Disparities Research

13 community-based organizations engaged

3 academic collaborators

Trainees in Cancer Disparities Research

21 research trainees

33 community health trainees

Californians Served

Collectively, the CDRP looked at primarily Spanish-Speaking and Latino Communities in CA, with special focus amongst breast cancer patients, including the use of genetic ancestries, to identify susceptibilities and potential treatments and care strategies tailored to this community.

200+ patients received direct preventative genetic testing services

1,400+ participants received in-depth family history screens

2,000+ participants educated on cancer genetics

Deliverables and Dissemination

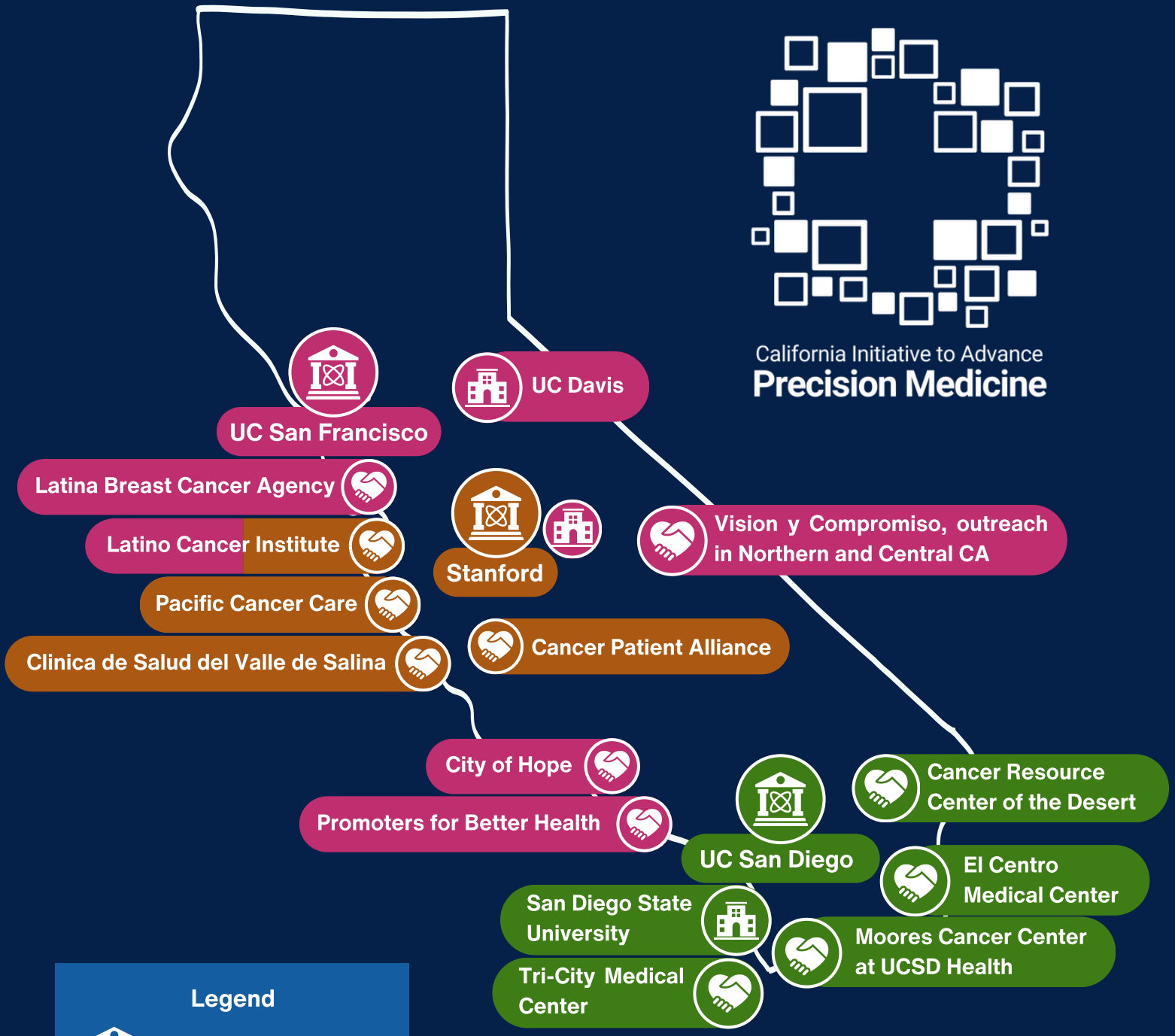
126 presentations

17 press releases

55 scientific manuscripts

5 additional research projects

CIAPM-funded Cancer Disparities Research Program Sites



EXECUTIVE SUMMARY

The California Initiative to Advance Precision Medicine (CIAPM) was established in 2015 within the Governor's Office of Planning & Research (now Governor's Office of Land Use and Climate Innovation) and transitioned to CalHHS in July 2024.

CIAPM supports cutting-edge biomedical and health research that harnesses data to generate new insights, prioritizes whole-person care, and advances community-driven solutions to reduce health inequities. CIAPM's mission is to drive the development of innovative technologies and personalized strategies and to coordinate cross-sector partnerships for prevention, diagnosis, and treatment to improve the health and well-being of all Californians.

CIAPM launched the *Cancer Disparities Research Program* in 2019 with the goal of researching and implementing ways to reduce cancer disparities in the State of California, using a community collaboration and partnership approach.

This research program largely focused on identifying barriers to effective cancer care, demonstrating effective cancer care practices, and developing early successes in the implementation of novel research approaches. Given the disease burden in the state of nearly 60,000 cancer-related deaths in 2019, the request for proposals solicited research proposals that focus on cancer preventative, diagnostic, and treatment strategies in minoritized and underserved populations. The proposals with the most innovative and effective inclusion of community engagement, 'big data,' genomic/genetic informatics, and healthcare navigators were awarded.

Three projects were awarded $9 million total ($3 million each) in funds across Northern and Southern California, focusing on educational, biomedical, and healthcare interventions for communities that are historically underrepresented in research, and/or harder to reach, to provide precision healthcare. These projects, largely focusing on cancer disparities among Hispanic/Latino communities, involved three lead intensive research institutions and 15 partners across the healthcare, nonprofit, and academic sectors.

As a result of this research program, the cancer researchers have published 55 scientific manuscripts to date in renowned peer-reviewed scientific journals, given 126 presentations at national and international conferences, and obtained $10.7 million in leveraged, supporting, or follow-on funding.

Key learnings from the Cancer Disparities projects include:

(1) Understanding genetic diversity in Latinas can help refine genetic cancer risk assessments for breast cancer.
(2) Community health worker-led health care interventions can lead to earlier diagnoses and improved cancer care.
(3) Leveraging academic-community partnerships, in tandem with community health workers, can help align investigators and the community on research goals, recruit participants, and educate the community about precision cancer care and treatments, especially in underserved settings.
(4) Machine learning/artificial intelligence can potentially predict the efficacy of cancer treatments based on tumor genetics.

Lasting collaborations were made with community-based organizations throughout the state, and groups of minoritized and Hispanic/Latino populations with, or at risk for, cancer learned:

(1) about precision medicine concepts and how to access and advocate for those tools,

(2) how some people are susceptible to hereditary cancer,

(3) that there are logistical, financial, and recruitment barriers to accessing precision medicine tools or sustaining programs that provide access to minoritized populations,

(4) culturally appropriate navigators are crucial to accessing precision medicine tools, and

(5) research databases and computer-models require additional participant samples to identify new molecular targets and precision treatments for diverse and underrepresented groups.

BACKGROUND

The California Initiative to Advance Precision Medicine (CIAPM)

CIAPM was launched in 2015 by Governor Brown and the State Legislature, with the goal of gaining a better understanding of disease mechanisms and fostering a modern and equitable approach to health care, using technology and data.

According to the 2018 California Precision Medicine Action Plan, **precision medicine**, sometimes interchanged with *precision health* or *personalized medicine*, is defined as an approach that "aims to use advanced computing tools to aggregate, integrate, and analyze vast amounts of data from research, clinical, personal, environmental, and population health settings, to better understand health and disease, and to develop and deliver more precise diagnostics, therapeutics, and prevention measures."[1] In practice, these approaches provide tangible applications considering the whole-person, their lifestyle, and life circumstances to provide equitable health outcomes.

CIAPM supports cutting-edge biomedical and health research that harnesses data to generate new insights, prioritizes whole-person care, and advances community-driven solutions to reduce health inequities. CIAPM's mission is to drive the development of innovative technologies and personalized strategies and to coordinate cross-sector partnerships for prevention, diagnosis, and treatment to improve the health and well-being of all Californians. Since its inception, CIAPM has been appropriated $67 million by the Legislature and funded 21 demonstration projects, both in specific disease areas and wider research programs, thus furthering the validity of applying cutting-edge technologies and big data sets for equitable health outcomes and community partnerships that allow for community input and facilitate community benefits. The program has also been a nexus in fostering collaborations across more than 100 partners in industry, health care, academia, and the nonprofit sector.[2]

The application of precision medicine in healthcare and research aims to bring us closer to the goal of health equity and a more productive and healthier society. This includes more effective and personalized prevention, diagnostic, and treatment strategies, and personalized medical care, fewer unnecessary general treatments for the "average" patient, increased patient access and affordability, increased efficiencies and development in the healthcare workforce, and increased patient understanding of health, disease, and how to seek care.

Cancer Prevalence and Disparities in California

According to the National Cancer Institute, cancer is "a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body." Cancer is a disease resulting from inherited errors in DNA or environmental exposures that damage DNA that cause uncontrolled cell growth.[3]

The California Cancer Registry estimates that 50% of Californians will develop cancer at some point in their lives, and nearly a quarter of Californians will die of cancer.[4] Roughly 180,000 people in California are diagnosed with cancer yearly and nearly 60,000 deaths occurred in 2019, with the highest diagnoses occurring for prostate (male), breast (female), lung, colorectal, uterus (female), urinary, bladder, and thyroid cancers.[5]

Between 1988-2019, Native Americans had the highest mortality rates for all cancer types. Rates of cancer incidence and mortality increased in uterine and breast cancer for Hispanic/Latino, Asian/Pacific Islanders, and Native Americans, with the highest rates of incidence occurring in the far north of the state (including Humboldt, Shasta, Tehama, Glenn, Butte, Lake, and Amador counties). Greater percentages of Black/African American, Asian/Pacific Islander, Hispanic/Latino, and Native Americans with lower socioeconomic status were diagnosed with late-stage, often untreatable melanoma, lung, and breast cancers. Breast cancer had the highest rate of incidence across all ethnicities, with nearly 30,000 new diagnoses in California in 2019.[5]

Hispanic/Latino cancer diagnoses in California tend to be in younger patients who often live in dis-

1 Precision Medicine: An Action Plan for California (2018).
2 Evaluations of the California Initiative to Advance Precision Medicine Projects, 2015-2018 (2019).
3 National Cancer Institute: What is Cancer? (2021).
4 California Cancer Registry: About Cancer (2018).
5 UC Davis Comprehensive Cancer Center: Cancer in California, 1988-2019.

advantaged areas. Rates of short-term (five year) survival are lower for several cancer types among Hispanics/Latinos compared to Caucasian populations. Further, except for Medicaid patients, most detectable cancers (such as breast, cervical, colorectal, lung, melanoma, oropharyngeal, and prostate) are detected later in Hispanics/Latinos across all insurance types. Hispanics also make up two-thirds of the uninsured population in California, further contributing to delayed diagnosis.[6]

State of Precision Medicine for Cancer Care

Precision medicine, in the context of cancer care, is an approach that takes into account genetic differences between patients, genetic differences between tumors within a patient or between patients, the surrounding tissue environment, overall disease burden, lifestyle, and a patient's life circumstances.[7]

Precision medicine differs from 'standard care' in that 'standard (or usual) care' often focuses on diagnostic strategies for the "average" patient. Treatment approaches can often be invasive and risky while not guaranteeing an effective outcome and neglect a patient's life, financial circumstances, and ability to access treatment. Historically, 'standard care' in cancer has involved chemotherapy or radiation to kill cancer cells, temperature treatment to destroy cancer cells, surgery to remove solid tumors, stem cell transplants for blood cancers, hormone therapies to slow the growth of some cancers, and palliative care to deal with the psychological and physical symptoms of serious or terminal cancer.[8]

In contrast, precision cancer prevention can include tumor genetic testing, vaccination for certain cancers, population genomics, health care navigation, imaging and liquid biopsies, real-time biosampling and monitoring, and health data system integration.[9] Precision therapies can include small molecules (often orally administered), injectable treatments (including radioactive molecules or immune system stimulants) and genetically engineered immune cells.[10] The patient's goals are also an important aspect of this approach to tailor treatments that balance the effects of treatments on their quality of life.[11]

No one tumor or patient is exactly the same, and cancer treatment often requires a diverse precision therapeutic approach. Generally, tumors are identified via imaging or characterizing the tumor before specific genetic analysis occurs that can determine which genes are mutated and what treatments are available. Common precision tools treat cancers by blocking the functions that are mutated in a patient, such as hormones, DNA repair, tumor growth, metabolism, and cell survival, as well as genetic information to match tumors to the right tools.[12]

Challenges Facing Precision Cancer Care and Research

Precision medicine has the potential to improve the lives of millions. While major advancements have been made, there is a disconnect between research findings and practical application. In cancer care, there are three major barriers between the research-to-public pipeline: 1) Lack of research with diverse communities, 2) disconnected medical records and databases, and 3) incomplete understandings of social determinants of health for cancer.[13,14]

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6 UC Davis Comprehensive Cancer Center: The Burden of Cancer Among Hispanic/Latinos in California, 2010-2019.

7 Hoeben, A., Joosten, E. A., & van den Beuken-van Everdingen, M. H. (2021). Personalized medicine: recent progress in cancer therapy. *Cancers*, *13*(2), 242.

8 National Cancer Institute: Types of Cancer Treatment (2024).

9 Masina, R., & Caldas, C. (2024). Precision Cancer Medicine 2.0—Oncology in the postgenomic era. *Molecular Oncology*, *18*(9), 2065-2069.

10 Han, C., & Zhan, Q. (2023). Precision medicine revolutionizes cancer diagnosis and treatment. *Medical Review*, *2*(6), 541-543.

11 Papalexis, P., Georgakopoulou, V. E., Drossos, P. V., Thymara, E., Nonni, A., Lazaris, A. C., Zografos, G. C., Spandidos, D. A., Kavantzas, N., & Thomopoulou, G. E. (2024). Precision medicine in breast cancer (Review). *Molecular and clinical oncology*, *21*(5), 78.

12 Sarhangi, N., Hajjari, S., Heydari, S. F., Ganjizadeh, M., Rouhollah, F., & Hasanzad, M. (2022). Breast cancer in the era of precision medicine. *Molecular biology reports*, *49*(10), 10023–10037.

13 Randall A. Oyer et al. Increasing Racial and Ethnic Diversity in Cancer Clinical Trials: An American Society of Clinical Oncology and Association of Community Cancer Centers Joint Research Statement. JCO 40, 2163-2171(2022). DOI:10.1200/JCO.22.00754

Much of the research being done on cancer studies groups of people who are well integrated in the medical system and people who have the time and resources to participate in research studies. Research data and treatments then only represent those who have the time and resources to access medical services. People from underrepresented and minoritized communities cannot access treatment due to affordability, lack of insurance, or lack of primary care knowledge and become excluded from novel medical advancements. This affects research in that diverse genetic factors contributing to cancer may be overlooked if certain community's genetics are not studied.[14]

Large datasets of medical records are crucial for understanding the underlying mechanisms of cancer to develop new treatments; yet there is a lack of accessible, diverse medical records, clinical samples, and a lack of integrated data systems, which limits insights on specific treatments and information for patients that could save lives.[13]

Lastly, a main issue in precision cancer research is a general lack of understanding of environmental, structural, interpersonal, racial/ethnic, and economic factors that influence health trajectories and outcomes, also known as 'social determinants of health', and how they can lead to barriers for treatment and diagnosis. For minoritized Californians, these social determinants (such as race, ethnicity, urbanicity, rurality) can create disparities in access to treatment, and in particular precision medical care for critical health conditions, like cancer. Researchers who are able to develop novel treatments for a specific minoritized population may find themselves unable to implement their findings in the population studied. Barriers, such as language and literacy, can hinder individuals from learning about novel treatments or new research on how and when to use diagnostics tools for disease. Limited public health resources can influence the accessibility and reach of health information from the medical community to the public.[15]

Challenges Facing Cancer Patients in Accessing Precision Cancer Care

A cancer diagnosis enters a patient into specialized care, which unlike primary care, is a setting in which clinicians can identify the specifics of a patient's illness and begin discussing tailored treatment options. The continuum from primary care to specialized cancer care is not universal and the waiting period before a patient begins receiving specialized care is dependent on various factors, like referrals and provider availability. Primary care practices that have relationships with specific oncologists can accelerate referrals of patients to specialized care. However, social determinants of health shape the experience of the primary-to-specialized care continuum and ultimately shape the health trajectories for patients. For example, living in rural (versus urban) areas can be associated with fewer options for nearby oncologists and treatment facilities.[15]

To receive cancer care, individuals must traverse through available services, covered providers, and a complex insurance system, further complicated if there are cultural, language or systemic barriers to understand the healthcare system.[16] Health insurance literacy is critical in cancer care and navigating this complex medical financial system may be difficult for many, especially if an informed and timely decision-making process requires English proficiency and an understanding of the US healthcare system. Upon admittance into specialized cancer care, substantial costs begin accruing for cancer patients.[16] High cost and insurance coverage are barriers for accessing cancer care and more specifically precision cancer care.[17]

Cancer Disparities Research Program

To address some of the challenges described above, CIAPM released a Request for Proposals (RFP) entitled *Reducing Cancer Disparities through Collaborative Precision Medicine Care* [18] in 2018. The goal of the RFP was to fund demonstration research projects that "aim to improve access to precision medicine cancer care approaches, for patient populations that suffer from cancer health disparities, through collaborations between academic, community, and nonprofit and private partners." Projects should aim to improve cancer outcomes and reduce disparities in the county or

14 Mateo, J., Steuten, L., Aftimos, P., André, F., Davies, M., Garralda, E., ... & Voest, E. (2022). Delivering precision oncology to patients with cancer. *Nature medicine*, *28*(4), 658-665.

15 Baird, A. M., Westphalen, C. B., Blum, S., Nafria, B., Knott, T., Sargeant, I., ... & Wong-Rieger, D. (2023). How can we deliver on the promise of precision medicine in oncology and beyond? A practical roadmap for action. *Health Science Reports*, *6*(6), e1349.

16 Let's Get Healthy California: Social Determinants of Health (August 2016).

17 American Cancer Society. (October 2020).

18 CIAPM Request for Proposals 2018.

community setting(s) and increase understanding of how to apply precision medicine approaches in commonly diagnosed, high prevalence, or high mortality cancers (e.g., breast, colorectal, lung, prostate, pancreatic cancer). Projects should be able to obtain molecular measurements, remotely collect behavioral or other data, subtype the disease, link genomic data to electronic health records, access existing biobanks, databases, medical records, engage participant communities, and/or establish mechanisms for responsible data sharing. Projects also were required to be co-led by at least one California community organization that provides cancer treatment for patient populations that experience cancer health disparities.

The demonstration projects were selected through a competitive, peer-reviewed process with a group of out-of-state precision medicine experts. Reviewers used criteria for selection based on the National Institutes of Health process. Reviewers were asked to evaluate proposals based on a number of factors including: 1) Significance; 2) Investigators; 3) Innovation; 4) Approach; and 5) Environment. Each proposal was also assigned an overall impact score. As per CIAPM's statute and the Request for Proposals, at least one awarded project had to be located at a public institution in northern California and another in southern California. Additionally, individual institutions could only receive one award.

The awarded projects were selected (see list below) because they proposed promising use of data and computing tools to improve health outcomes and health care and followed the themes of the National Academies of Science Report on Precision Medicine, including identifying barriers to effective cancer care, defining effective cancer care practices, and developing early successes in the implementation of novel research and care techniques.[19] Given the above-mentioned disparities and burden of cancer in California, the three projects awarded focused on research and interventions of this disease because of their comprehensive use of community engagement, 'big data,' genetic/genomic informatics, and healthcare navigators. Additionally, the projects advanced several themes described in the Background, including focusing exclusively on underrepresented and minoritized communities in California (predominately Latinas with or at risk of developing breast cancer) increasing the amount of available data to assess cancer risk and identify common genetic mutations in tumors from Latinas, leveraging genetic analyses of tumors to inform treatments, enhancing patient knowledge and care coordination to improve outcomes, and engaging communities about cancer and the challenges patients face.

The projects aimed to improve access, care, and outcomes for patient populations that experience cancer health disparities through collaboration between academic, community, nonprofit, and private partners. Each project received $3 million to recruit participants, conduct precision medicine research, and foster novel partnerships to address cancer disparities in California over three years. Due to challenges faced by researchers and communities during the COVID-19 pandemic, one-year no cost extensions were provided for each project, for a total project term of four years.

Awarded demonstration projects for the Cancer Disparities Research Program:

1. Improving Breast Cancer in Latinas: A Multi-Tiered Approach; UC San Francisco. Lead PI: Elad Ziv, PhD
2. Integrated Machine-Learning Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project); UC San Diego. Lead PIs: William Kim, PhD and Pablo Tamayo, PhD
3. Reducing Cancer Disparities Through Innovative Community-Academic Partnerships - Addressing Latinx CANcer Care Equity (ALCANCE) Project; Stanford University. Lead PI: Manali Patel, MD, MS, MPH.

PROCESS OF EVALUATION

As required by state law, expert evaluations followed the completion of the cancer disparities research program. For this purpose, CIAPM recruited out-of-state subject matter experts to assess each project's scientific, clinical, and technical accomplishments objectively within the context of cancer, health disparities, and precision medicine. In addition, evaluations gauged how the work has addressed the goals of the program to advance precision medicine and benefit diverse communities across California. The specific goals of the program, as it exists in the California Health and Human Services Agency (CalHHS), are listed in statute and were initiated through the competitive Requests

19 National Research Council (US) Committee on A Framework for Developing a New Taxonomy of Disease. (2011). *Toward Precision Medicine: Building a Knowledge Network for Biomedical Research and a New Taxonomy of Disease*. National Academies Press (US).

for Proposals (RFP). Each awarded project was not expected, nor designed, to address each point, and only goals relevant to each project were considered by the evaluators. CIAPM received a total of 23 cancer research proposals, of which 11 finalists were invited to submit full research plans before funded awardees were selected.

RFP Goals

1. Improve patient outcomes in the short- (36 months) and long-term.
2. Reduce health disparities.
3. Increase understanding of how to apply precision medicine approaches to cancer care among populations that are affected by cancer health disparities.
4. Guide the development and/or utility of a shared data platform.
5. Use "omics" data to improve preventative, diagnostic, and/or treatment approaches.
6. Improve precision medicine capabilities, such as through infrastructure and tools, including new consortia, collaborations, personnel competencies, databases, datasets, applications, software, computational development, intellectual property, patient cohorts, participant communities and networks, and models for responsible data sharing.
7. Engage patients in guiding and contributing to research and clinical practice, such as by providing opportunities to build trust, frameworks to ensure informed consent, and approaches to data sharing, privacy, and security.
8. Allow patients access to their medical data and/or provide opportunities for patients to contribute data from this project to other research studies.
9. Scale and leverage multiple electronic health records systems.
10. Develop the use of tools, measurements, and data, including publicly generated and available data.
11. Engage researchers and collaborative partners from underrepresented backgrounds.

Out-of-State Expert Evaluators

Six out-of-state evaluators were selected and recruited based on their expertise in the genetics of cancer, health disparities in cancer, and community engagement in the context of cancer. Three evaluators previously served on the cancer disparities RFP selection committee. Each evaluator was subject to a conflict-of-interest screening, adapted from the standard process of the National Institutes of Health (NIH).[20] Following agreement to nondisclosure and confidentiality, each evaluator was assigned to one project, and each project was evaluated by two evaluators. All evaluators are listed in Appendix A.

Evaluation Materials

The following materials were provided to evaluators at the onset of the evaluation process:

- Request for Proposals
- Original Proposal
- Final reports, prepared by project teams using a template
- Instructions for evaluators

Evaluation Process

Evaluators drafted evaluative comments. CIAPM then virtually convened evaluators assigned to each project for the purpose of gathering further details and addressing specific aspects of the evaluative comments. For those evaluators who indicated the need for additional information from research teams for a comprehensive evaluation, CIAPM facilitated the exchange of evaluators' follow-up questions and research teams' responses. In addition to evaluating how the projects met the RFP goals, evaluators assessed the items below:

1. Evaluate the scientific, clinical, and/or technical quality of the work.
2. Assess whether the team accomplished its overall goals and to what degree milestones were achieved.
3. Evaluate the extent to which the following accomplishments by the team may have an impact

20 NIH Conflict of Interest rules for initial peer review for grant applications, and technical evaluation of R&D contract proposals, based on federal regulations (42 CFR Part 52h) and presented in detail in NIH Guide Notices NOT-OD-13010 and NOT-OD-14-069.

on precision medicine and on the State of California:

a. The project as a whole
b. The insights regarding institutional, state, and federal regulatory processes and policies that were obtained
c. The processes, best practices, and partnerships that were established
d. The training, education, and professional development opportunities
e. Impact on the economy
f. Impact on the community
g. The "lessons learned"
h. Other contributions relating to advancing precision medicine

4. Evaluate the likelihood that the future goals for the project can be achieved, both in terms of feasibility and ability to attract funding, and the potential for impact on precision medicine and on the State of California.
5. Additional questions for the team that, if answered, would significantly improve their ability to evaluate this project.

Evaluation Report

CIAPM staff prepared this Evaluation Report, which is based on the research teams' final reports, original proposals, expert evaluations, evaluation discussions, and research teams' responses to evaluators' follow-up questions. Feedback on drafts of the report was solicited from the expert evaluators, research teams, and CalHHS. Appendix A features bios of the expert evaluators, and Appendix B lists all publications, press releases, and presentations generated as a result of CIAPM-funded research.

Improving Breast Cancer in Latinas: A Multi-Tiered Approach

Principal Investigator: Elad Ziv, PhD
University of California, San Francisco

California Initiative to Advance Precision Medicine

Project Goals

1 Collect new biological samples to understand genetic variation and refine breast cancer **PRS** in Latinas

2 Implement a bilingual, promotora-led education program on **hereditary** breast cancer

3 Conduct semi-structured interviews to understand expense barriers to genetic testing for breast & ovarian cancer in Latinas

4 Pinpoint new **mutations** in tumor genes unique to Latinas with breast cancer of diverse ancestries

Key words:

polygenic risk score (PRS) - a person's individual risk for a certain disease compared to others with a different genetic makeup
hereditary - traits passed through genes to children
mutation - change in the sequence of DNA
acquired mutation - change in DNA resulting from environment or lifestyle influences
promotora - lay community health worker who provides culturally and linguistically tailored health education

Traineeships

24 **promotoras** - who provided education to Latina women about hereditary breast cancer risk

2 post-doctoral research fellows

Community Contributions

Community Partners:

Patient Education & Referrals
- Promoters for Better Health
- Vision y Compromiso

Community Advisory Board
- Latina Breast Cancer Agency
- Latino Cancer Institute

(Los Angeles, Riverside, Orange, Santa Clara, San Bernadino, San Francisco, Stanislaus counties)

1620 women in the community received bilingual education program on **hereditary** breast cancer

1300 women received a cancer family history screening

102 met the criteria for genetic counseling referral

50 received clinical genetic testing

5 tested positive for cancer risk

Improving Breast Cancer in Latinas: A Multi-Tiered Approach

New Assets

Clinical Collaboration to Build Dataset

Collaborated with City of Hope to build a database of tumor samples from Northern and Southern Californians with breast cancer

1,695 newly collected Latina breast cancer samples analyzed

734 tissue pairs comparing cancerous and non-cancerous samples from each patient to identify **hereditary** vs. **acquired** components to cancer

4,264 genetic samples from collaborative genomics research network throughout CA & Mexico were analyzed to determine which genes suspected to contribute to cancer were frequently present in Latina cancer samples.

Genes with Population-Specific Associations in Latinas with Breast Cancer

Mutations in cancer genes were identified more commonly in Native American/East Asian women with estrogen receptor-negative tumors and less commonly among African ancestry

Novel Genes Identified with Unique Risk for Breast Cancers in Latina Women

New Databases Generated for the California Breast Cancer Genetics in Latina Women Study

https://bit.ly/3FZSmDI
https://bit.ly/4jRGGB5

Refined PRS in Latinas

Genomic data from ~5700 Latina breast cancer samples expanded the groundwork for refining cancer risk assessments

The team found that the newly identified genetic **mutations** were additive to previously discovered **mutations** and inform on a more accurate and applicable **PRS** for breast cancer in Latinas.

Scientific Contributions

8 manuscripts

9 presentations

Takeaways

1. By focusing exclusively on Latina breast cancer patients, the team fine-tuned genetic testing for breast cancer risk, providing more accurate tools for diverse and underrepresented populations.
2. Precision cancer education leads to utilization of family history screens and genetic tests to identify unique cancer risks, potentially diagnosing cancer earlier and improving patient outcomes.

EVALUATIONS OF DEMONSTRATION PROJECTS

1. Improving Breast Cancer in Latinas: A Multi-Tiered Approach

Lead Principal Investigator: Elad Ziv, PhD

Project Period: October 1, 2019 – September 30, 2023

Research Team, Community Partners, and Collaborators

UC San Francisco (UCSF) /Zuckerberg San Francisco General Hospital (Research Team)

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Vision y Compromiso (Community Partner)

- Miriam Hernandez

City of Hope (Collaborator)

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Luis Carvajal-Carmona, PhD, Principal Investigator

Paul Lott, PhD

Stanford University (Partner Institution)

Suzanne Tamang, PhD

Scientific Background and Context

Importance of hereditary cancer screening and genetic testing

Hereditary cancer screening via a family history questionnaire can help improve the understanding of inherited cancer risk. Genetic testing further aims to determine cancer risk and, ultimately, aids in the detection of cancer. By identifying people who are at particularly high inherited risk, those patients can start screening at an earlier age, can be screened more often, and be assessed with advanced, high-resolution technologies like MRI. Improved screening allows for early detection, leading to earlier interventions and a decrease in cancer mortality.[21]

Measures to understand genetic cancer risk

Polygenic risk score (PRS): A calculation, using genome-wide genetic information, to assess a person's chances of having or developing cancer based on a collection of known cancerous genes or mutations.

Variants of uncertain significance (VUS): A genetic difference, identified through analysis (or sequencing) of a patient's genome, for which there is unclear evidence of the variant's connection to cancer, due to a lack of collected data on that variant.

Single nucleotide polymorphism (SNP): A genetic variant at a single base position in the genome, present in a significant fraction of the population. Scientists study if and how SNPs in a genome influence the functionality of proteins, affecting health, cancer, drug response, and other traits.

Hereditary mutations: Changes in the DNA, yielding traits that are passed through genes from parent to child.

Acquired mutations: Changes in the DNA resulting from environmental or lifestyle influences.

Genetic and tumor testing and their limitations

Genetic tests can be part of a wide range of molecular tests used to determine the contribution that DNA plays in cancer and whether other factors, such as overall health conditions, lifestyle, or the environment, affect the progression of a tumor.

Other molecular tests look at the role proteins, metabolism, bacteria, or other factors have in the progression of disease. Genetic tests are one of a suite of tools that look at internal factors affecting cancer but can also be limited in scope.[22]

For example, many genetic tests are biased towards existing genes that are known to cause cancer and are not informed by diverse population genetics. Genetic tests also are limited due to a lack of standards across the industry, leading to varied reliability and limiting the assessment of cancer-associated genes to a small pool of candidate genes. Tumor testing, which assesses the physical or genetic characteristics of a tumor, typically does not consider genetic differences of the same cancer

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from patient-to-patient.

Furthermore, testing services may limit what genes to test for because of the cost associated with looking at select areas versus 'genome-wide' stretches of DNA, creating different recommendations for routine clinical-use. The confidence in such tests is worsened when only certain population groups contribute their DNA for genetic analysis and are worsened by limitations in care access or research recruitment of underrepresented groups.[23,24]

Breast cancer prevalence and inequities in research and care in Latina communities

Breast cancer is the most common cancer among Latinas and is the leading cause of cancer death among Latinas in California.[21] However, the scientific understanding of which genetic variants cause Latinas to develop breast cancer is limited because Hispanic/Latina women are substantially under-represented in studies of genetic risks for breast cancer and the genomics of breast cancers through tumor testing.[25] Latinas are less likely to receive and be referred to genetic and tumor testing, leading to less data and, as a result, more genetic variants in Latinas being classified as VUS.[26] Latinas are often excluded in obtaining PRSs, which increase accuracy of breast cancer prediction, from commercial testing labs.[27] Precision medicine treatment of breast cancer is guided by genetic and tumor testing, but data shows that breast cancer tumor testing is more common among non-Latina White women.[28] Thus, genetic mutations more common in Latinas and other underrepresented minoritized communities may go undetected through tumor testing. Additional barriers, such as lack of insurance, lack of access to primary care, and fears of family health history discrimination, result in lower community awareness of hereditary cancer, limited genetic testing, and limited knowledge of other precision medicine approaches among Hispanic/Latina communities.[29]

Project goal

The goal of this project was to address these critical issues in precision cancer care by: 1) determining which genetic variants may predispose Latinas to breast cancer, 2) which tumor mutations are more common in Latinas, and 3) by training community health workers (known as 'promotoras') to conduct outreach and education among Latina communities about breast cancer risk. Together, the UCSF team seeks to improve breast cancer outcomes in Latina populations.

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Project Summary

The goal of the project led by Dr. Elad Ziv at UCSF was to leverage large-sample size genetic sequencing and analysis to address hereditary breast cancer in Latina women through the following objectives:

1. To understand the relevance of genetic variants in breast cancer risk in Latinas, the team analyzed VUS within known breast cancer risk genes. To achieve this, the team collected samples from 1695 Latinas with breast cancer. The team then combined data from these samples with additional samples and datasets to sequence and analyze samples from 4264 breast cancer patients and 4350 patients without breast cancer (non-cancerous controls). While the team is still adding samples and data from additional sources, this approach is allowing the team to identify trends and candidate genes most closely associated with breast cancer in Latinas.

The UCSF team refined PRSs for hereditary breast cancer in Latinas, using a large data set of ~5700 breast cancer cases and ~12,750 controls. The team found that the PRS with previously identified SNPs, combined with the SNPs the team found in Latinas, performed best in providing a high-quality PRS, improving assessment of cancer risk. Additionally, the additive information from the SNPs discovered in Latinas is most informative among Latinas with Indigenous American ancestry.

2. In collaboration with community partners Promoters for Better Health in Southern California and Vision y Compromiso in Northern California, the UCSF team implemented a bilingual education program on hereditary breast cancer, enrolling 1,620 women. A subset of 1,300 women responded to a cancer family history screening survey with 102 (7.8%) of them meeting the criteria for genetic counseling referral.

3. To understand payer reimbursement and out of pocket expenses for genetic testing for hereditary breast and ovarian cancer in Latina communities, the team performed semi-structured interviews with providers in the San Francisco Bay Area. They found that laboratory patient assistance programs help patients mitigate financial barriers, but potential challenges emerge for sustainability of low-cost testing and further access to testing for at-risk family members, which is crucial for hereditary cancer diagnoses.

4. To identify novel mutations in genes that may be more frequently or uniquely altered in tumors from Latinas with breast cancer, the team collaborated with City of Hope to build a dataset of 734 new tumor/normal (cancerous and noncancerous) pairs of samples for further research that is currently in progress. Based on initial findings from a subset of these samples, the team found common single variants in known, often mutated breast cancer genes. With this initial sample, they also analyzed tumor mutational patterns and identified common signatures, finding a signature not previously identified to be associated with breast cancer and also present in a series of tumors specifically from Mexican women.

To understand the association between genetic ancestry and breast cancer mutations, the team analyzed data from >35,000 breast tumors with the ancestry-based genetic variation database, Foundation Medicine, and found high correlations between specific genes and specific ancestry.

Project Achievements

Improving hereditary breast cancer risk scores in Latinas

To understand the relevance of genetic variants in breast cancer risk in Latinas, the UCSF team obtained genetic samples from Latina breast cancer patients through various sources, including enrolling 1695 Latinas in California themselves and obtaining samples from the Peruvian Genetics and Genomics of Breast Cancer Study. Together, the team sequenced and analyzed samples from 4264 breast cancer cases and 4350 controls. They found an association between a subtype of breast cancer (ER-negative) and variants in the gene *FANCM*, which has been reported previously in non-Hispanic/Latina White populations, but has not been found to be significant across the genomes of other ethnicities. This finding suggests that *FANCM* should be considered as a gene associated with increased risk of ER-negative breast cancer in clinical practice, and women with breast cancer and a mutation in this gene may be responsive to particular medications (poly-ADP ribose polymerase (PARP) inhibitors). The team also identified two additional genes with associations for breast cancer in Latinas that have not been reported in other populations and warrant additional follow-up.

To improve the utility of PRS for Latinas, the team developed a refined PRS for hereditary breast cancer in Latinas using a large data set of ~5700 breast cancer cases and ~12,750 controls. The team tested a variety of methods to generate this refined PRS, including the addition of common SNPs found in Asian and Latina populations. Ultimately, the team found that PRSs that include both the 313 SNPs published by the Breast Cancer Association Consortium with the SNPs newly discovered in Latinas are most effective at predicting breast cancer risk in this population. Additionally, they found that the additive information from the SNPs discovered in Latinas is most informative among those with Indigenous American ancestry. Thus, this project demonstrates the power of 'big data' analytics to refine a measurement that assesses a person's risk for cancer, based on known cancerous genes or mutations.

The UCSF team intends to combine their data with data from the NIH *All of Us* Research Program to increase the power of their final analyses.

Community partnerships to educate and refer patients

To provide education and navigation on hereditary cancer risk and care, the team implemented a bilingual education program on hereditary breast cancer for 1,620 women from the Los Angeles, Sacramento, and San Francisco areas, in partnership with 24 health navigators or '*promotoras*' from the community partners Promoters for Better Health and Vision y Compromiso, leaving a lasting footprint of trained, culturally-astute healthcare professionals in the community.

A subset of 1,300 women responded to a cancer family history screening survey, with 102 (7.8%) of them meeting the criteria for genetic counseling referral. Of the 102, 50 (~50%) consented to be tested, 34 (~30%) declined or were lost to follow up, and 18 already had clinical genetic testing, with five reporting a positive cancer-risk, eight negative tests, and one patient with a VUS (four did not remember their results). Of the 50 who consented, the team received results for 26, with one positive result for cancer-risk, one VUS, and 24 with negative results. The team is still following up with the 24 women that consented but have not yet received test results. This project therefore demonstrated that having culturally-appropriate health navigators can lead to improved knowledge and pursuit of precision medicine tools (screenings).

Identifying genetic mutations in breast tumors in Latina women

To identify genetic mutations in tumors from Latinas with breast cancer, the team collaborated with City of Hope to build a dataset of 734 new tumor/normal (cancerous and noncancerous) pairs of samples from the same patient using both cancerous and noncancerous tissue. While comprehensive analyses of these data are still in progress, the team has identified initial findings from a subset of these samples. Based on these initial data, the team found common SNPs in known breast cancer genes and identified common signatures known to be present in breast cancer, as well as one signature that has not been previously associated with breast cancer but was present in tumors from Mexican women.

The team also completed analyses of data from 35,000 breast cancer tumors from Foundation Medicine to assess the association between genetic ancestry and breast cancer mutations. The team

found that ancestry correlates with mutations in specific genes, identifying mutations in specific breast cancer tumor genes that correlate with African, East Asian, and Indigenous American ancestry, respectively. These data suggest specific mutations for a given ancestry that could be targeted with current or future medications, and the power of tying small pools of clinical data with an expanded 'big' dataset.

Economic impact analysis

To understand financial barriers for genetic testing, the team performed semi-structured interviews with providers in the San Francisco Bay Area. The team found the use of laboratories with payment assistance programs reduces barriers to testing, but challenges can emerge for sustainability of low-cost testing and access to cascade testing for family members, which is crucial for hereditary cancer assessment. The team thus found barriers and potential solutions to effective care access. Solutions offered in these interviews included 1) education of providers to ensure the most appropriate test is ordered and 2) patient-centered education materials that address the concerns of specific Hispanic/Latino subpopulations.

Challenges facing the team

The UCSF team experienced challenges in recruitment due to the COVID-19 pandemic, as initially breast cancer patients were not coming to the clinic in person. The team pivoted to remote recruitment and consent, but found that their recruitment efforts were more effective once in-person visits resumed. Additionally, the team could not complete one of their milestones during the funding period, a genome-wide association study, because it depended on the National Cancer Institute (NCI) Confluence project, which has only recently started processing samples. The team has provided samples and data to NCI and anticipates receiving data back from NCI within 6-12 months. Additionally, due to the onset of the COVID-19 pandemic, patient recruitment decreased. Following a return to in-person recruitment later during the pandemic, the team was able to recruit efficiently at both UCSF and City of Hope.

Training and education

The UCSF team trained two postdocs and supported their attendance at multiple national and international conferences. Additionally, the team trained 24 bilingual, bicultural *promotoras* to educate Latina women in their community about hereditary breast cancer risk. As part of the project, the *promotoras* have educated 1300 Latina women from their community about their own hereditary breast cancer risk across Northern and Southern California.

Collaborations and partnerships

The UCSF team formed several collaborations and partnerships during the study. City of Hope participated in the recruitment and coordinated all the clinical data collection and interactions with the California Cancer Registry. City of Hope also performed the DNA sequencing and the informatics for the tumor genomics, as well as the analyses for the tumor genomics. UC Davis led the educational work on hereditary breast cancer risk, the research on polygenic risk of breast cancer, and collaborated on the rare variant analyses and tumor genomics. Notably, the UCSF team formed new partnerships with Promoters for Better Health and Vision y Compromiso. Promoters for Better Health led the educational sessions in Southern California and Vision y Compromiso led the educational sessions in Northern California and in the Central Valley. The collaboration between UC Davis and Vision y Compromiso is continuing beyond this CIAPM study. Additionally, representatives from the Latina Breast Cancer Agency and the Latino Cancer Institute served on the project's community advisory board.

Future research and funding

The team is actively seeking additional funding based on their CIAPM-funded work to further understand genetic susceptibility of breast cancer in Latinas, polygenic risk score improvement, further sequencing of breast cancer tumors from Latinas, fine mapping studies, and community education. Notably, the team has received a grant from NCI for $2 million to study genetic susceptibility of breast cancer in Latinas, a grant from NCI for $2.5 million to build an international consortium to study breast cancer risk in U.S. Hispanic/Latina women and in Latin American women, and a grant from Gilead for $750,000 for community education in collaboration with Vision y Compromiso. Additionally, the team developed a new study of 1659 Latina women with breast cancer from California (UCSF, Zuckerberg San Francisco General Hospital and City of Hope), called the California Breast Cancer in Latinas Study (CBLS). This successful awarding of additional grants demonstrates the power of a multi-stake-

holder project in building a research network and infrastructure and attracting further funds.

Advantage of CIAPM's funding opportunity

According to the UCSF team, CIAPM's funding allowed the team to recruit a large number of women who are not currently well-represented in existing cancer datasets, which is not necessarily incentivized by other funders. This recruitment is critical because cancer research has not included enough Latinas and women from other non-European ancestries to have the large sample sizes that are needed for genetic studies in specific populations. Additionally, CIAPM's emphasis on community partnerships allowed the team to build new relationships between scientists and the communities they serve and incorporate an extensive community educational component to return the benefits of research to the community.

Expert Evaluation

By Dr. Jennifer Mack and Dr. Elaine Mardis

The UCSF Multitier Breast Cancer study set an overarching goal of improving on the lack of knowledge of genomic factors impacting Latinas with breast cancer. The main aims of the project were to 1) define genetic risk factors, such as variants of uncertain significance (VUS) among Latinas, 2) generate refined polygenic risk scores (PRS) and engage Latinas with these elevated risks via community education promoting risk assessment and testing, and 3) characterize targetable mutations among Latinas with breast cancer.

The project had a number of novel achievements, including 1) identifying previously un-associated variants in a gene called *FANCM* as likely responsible for a genetic risk to develop ER-negative breast cancer in Latinas, 2) developing a PRS model with two mutations specific to Latinas and/or those with Indigenous American ancestry, 3) implementing a hereditary cancer education and screening program, reaching over 1300 women who completed family history screens (while a modest 102 women qualified for genetic testing and 68 sought out or already received testing, the team nevertheless demonstrated the many obstacles to obtaining a genetic screen), 4) created a data set of 734 paired patient samples of cancerous and non-cancer tissues (tumor-normal analysis) allowing for comparison of mutations that are due to heredity versus acquired, and 5) identified differences in important genes from an ancestry-based genetic variation database, Foundation Medicine, using over 35,000 breast cancer samples.

Evaluators felt that the overall scope and quality of the work was impressive and outstanding, having incorporated clinical information appropriately and when available. The sheer number of samples in the study (well over 4000 patient tumors and 4000 non-cancerous controls) were quite powerful in helping the field to understand and address the genetics of underserved populations. Given the large number, evaluators felt that additional retrospective analysis of the geographic ancestry of diverse Latina ethnicities within the sample provided nuance, particularly to those profiles of high Indigenous American ancestry versus European, African, or mixed heritage.

Regarding project milestones, the evaluators felt the team made significant progress towards quite ambitious goals that inform future work, including generating large datasets representing Latina breast cancer genomics, VUS, and developing a PRS for each breast cancer patient.

Importantly, some milestones were delayed due to external partners and resources that were unavailable during the COVID-19 pandemic. This included Genome Wide Association Studies of 5000 samples sent to the National Cancer Institute Confluence project and the linking of genomic data to clinical outcomes from patients at the City of Hope.

However, important milestones achieved included: 1) partial completion of classifying VUS based on the metastatic state of a tumor (high- versus intermediate- penetrating tumors), 2) finding variants in several genes and trends associated with overall, ER-positive or ER-negative, breast cancer incidence (such as *FANCM, EGFR*, and *PIK3CA* genes), 3) collecting a total of 2500 new Latina breast cancer samples (in addition to those from a Peruvian study), 4) adding new mutations to the existing PRS program, with added specificity for Indigenous Latinas, 5) developing a bilingual education program on hereditary breast cancer reaching over 1600 women via *promotoras* (community health workers), 6) identifying mutations and their prevalence in the 734 paired patient samples, including comparing to a screen of 50 commonly mutated cancer genes (PAM50), and 7) analyzing data from Foundation Medicine to cross-correlate ethnicity with tumor driving mutations.

Improvements on patient outcomes and reducing health disparities

The project provided genetic cancer risk information to women who desired such data for themselves and their physicians, an important near-term aid and project goal. Over the long term, the project also showed potential for treating cancers with acquired mutations or genes specific to Latinas.

Application and understanding of precision medicine to address cancer health disparities

As one of the most important contributions, this project went a long way in establishing how testing both hereditary and acquired mutations can be a pathway to eliminate health disparities. The large number of patients and samples allowed the generation of cancer risk scores for both hereditary and acquired mutations. The team then educated 1300 Latinas on those genetic differences and the necessity for genetic and tumor screening.

As a proof of concept, this project contextualized how to apply precision medicine approaches and public datasets to cancer care and is primed for further dissemination to other communities, such as Latina-rich regions of the country like Texas, New Mexico, and Arizona. Further, the gene *FANCM*, thought to contribute to cancer risk, may provide a target for further clinical trials, especially if combining conventional cancer treatments with FDA-approved therapies (such as PARP inhibitors).

The project also advances understanding of the prevalence of specific mutations and new treatment approaches with larger sample numbers to investigate novel genes suitable for treatment.

Develop new precision medicine assets, capabilities, and infrastructure

The team was able to recruit a representative cohort of Latina breast cancer patients, establishing the framework and infrastructure for further studying this subpopulation with a 'multi-omics' approach.

Engage patients and underrepresented researchers in clinical practice and investigation

The UCSF team established a solid educational model on how to work, educate, and engage with Latinas on breast cancer risk and the necessity for screening. Similarly, the team included a significant number of Latino/Latina investigators and staff within the *promotora* network and established a unique infrastructure to promote precision medicine in this underserved population.

Impact of the project on precision medicine in California

The expert evaluators felt that the impact and innovation of the project was outstanding. The project went a long way in establishing best practices for the State of California, which were informed by new and genuine partnerships with community organizations, academic, and medical partners, such as an ongoing partnership between UC Davis and the Vision y Compromiso community organization, and more partners at both the national and international level. Further, the training and professional development opportunities were significant for the state, having built a network of 24 *promotoras* and two postdoctoral scholars who ran annual gatherings and educational sessions to carry the work past CIAPM funding.

The results are also compelling for the State of California, having found a potential clinically-relevant cancer risk variant (*FANCM*), comparing inherited versus acquired cancer mutations, and finding two mutations common in Latinas with breast cancer in a population well represented in the state.

Regarding the economic and community impacts of the program for the state, analysis of semi-structured provider interviews suggests barriers to sustainable low-cost testing and follow-up testing. Evaluators were interested in learning more about the overall health economic equations used, which would likely indicate a high net economic benefit given that better diagnosis leads to better treatment and outcomes. The large community set of 1300 Latinas who received a family screen and the 100+ who pursued genetic risk testing also provided significant positive return for this community through 1) learned knowledge about cancer risk, 2) ongoing dissemination of this work and knowledge, and 3) the potential for improved health outcomes with appropriate genetic testing.

The project also provided certain lessons for the precision medicine field at large, including how to obtain remote consent and recruitment amidst a global pandemic. Many of those obstacles were overcome by the power of trusted community engagement. The project also demonstrated the

value of pooled samples and data across various sources, as well as the importance of precision diagnosis, treatment, and unique contributions of ancestry within a diverse state population. Finally, the project established the potential for using PRS to enhance the evaluation of genetic screening for diverse patients as an early success of a research recruitment strategy.

Likelihood of achieving future goals and obtaining additional funding

The project is continuing to expand the analyses of the genetic samples and are expected to obtain data in the near term, which will enhance the value of the project and further impact this subpopulation. Many of the results will likely be patient-centric and may include testing PARP inhibitors with Latinas with *FANCM* mutation. This team has also attracted additional funding from the National Institutes of Health.

Conclusion

Overall, the UCSF project aimed to address critical issues for Latinas with breast cancer through genetic analyses of large data sets. The team made significant progress in determining which genetic variants may predispose Latinas to breast cancer, which tumor mutations are more common in Latinas, and by training *promotoras* to conduct outreach and education among Latina communities about hereditary breast cancer risk. Together, the UCSF team combines genetic research and community education to improve breast cancer outcomes for Latinas. Their CIAPM-funded project formed the basis of additional grant applications on which to build on their state-funded work.

Integrated Machine-Learning Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project)

Principal Investigators: William Kim, PhD and Pablo Tamayo, PhD
University of California, San Diego

California Initiative to Advance Precision Medicine

Project Goals

1. Develop prototype **AI** model to predict therapeutic options based on a tumor's genes
2. Conduct preclinical evaluation of drug combinations predicted by AI to target specific **TNBC** subtypes
3. Collect clinical samples to refine the **AI** model
4. Engage with community for optimal study implementation, interpretation & dissemination

Key words for the Celsus Project

triple-negative breast cancer (TNBC) - aggressive form of breast cancer common among Latinas
Artificial Intelligence (AI) - is a computer analysis that can process big datasets and run algorithms to come to conclusions about the data.
promotora - lay community worker who provides culturally & linguistically tailored health education

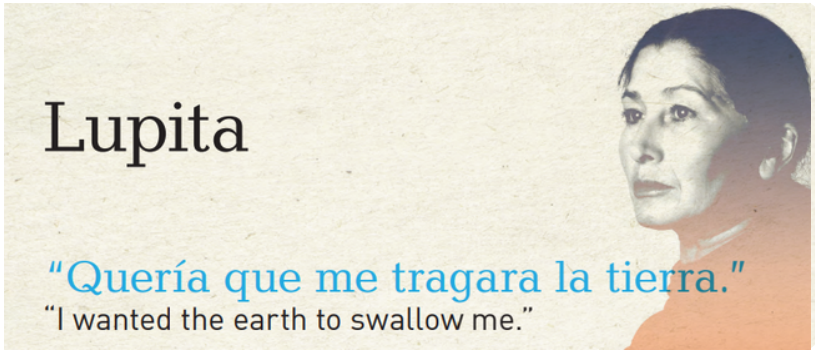
Traineeships

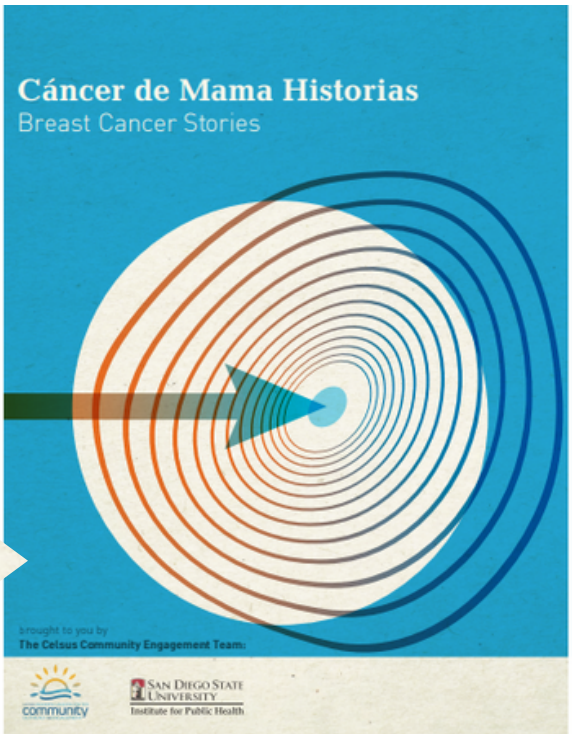
11 Trainees who spanned a variety of career stages including: undergraduate, Master's, and doctoral students, and industry researchers

Community Contributions

Community Report
Reflections of real-world barriers and experiences of Latinas with breast cancer

48 patients and stakeholders engaged in a drafting of a community report interviewing Latinas with breast cancer





Integrated Machine-Learning Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project)

Community Contributions (cont'd.)

Community Partners:

Community Engagement & Data Analysis

- El Centro Regional Medical Center
- Moores Cancer Center

Community Patient Education via Promotoras & Team Advising on Patient Engagement

- Tri-City Medical Center
- Cancer Resource Center of the Desert (San Diego and Imperial counties)

Dr. Kim was featured in a community presentation at the UCSD Moores Cancer Center entitled *Behind the Science: A Cancer Research Forum* (https://bit.ly/3Nwmsza)

New Assets

Celsus Artificial Intelligence (AI) Model with the potential to predict treatment efficacy in both experimental and patient derived tumor tissues and be deployed clinically if refined with additional patient samples

New Master's Program in Precision Medicine Therapeutics in Oncology at UCSD (https://bit.ly/45cKRDS)

Scientific Contributions

79 blood and tissue samples were used to refine the **AI** model

29 manuscripts

10 presentations

New drug candidates:

Systematically tested **more than 50 individual agents** and **47 drug combinations** across **24 breast cancer cell lines**

Takeaways

1. Celsus Model has potential to identify effective therapeutic combinations in **TNBC** patients with more data input.
2. Community stakeholders report that navigating healthcare is challenging. **Promotoras** are critical in recruiting community members into cancer care.

2. Integrated Machine-Learning (AI) Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project)

Lead Principal Investigators: William Kim, PhD and Pablo Tamayo, PhD

Project Period: August 15, 2019 – August 14, 2023

Research Team, Community Partners, and Collaborators

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- Barbara Parker, MD (Co-Principal Investigator)
- Elena Martinez, PhD
- Jesse Nodora, DrPH
- Oluwole Fadare, MD
- Rebecca Shatsky, MD (Co-Principal Investigator)

El Centro Medical Center (Community Partner)
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Moores Cancer Center (Community Partner)
- Adam Burgoyne, MD
- Jason Sicklick, MD
- Rana McKay, MD
- Shweta Joshi, PhD
- Thomas Kipps, MD

Cancer Resource Center of the Desert (Community Partner)

Tri-City Medical Center (Community Partner)

SDSU Institute for Public Health (IPH) (Partner Institution)
- Ana Alvarez Mendoza, MPH
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- Kanako Sturgis, MPH
- Martha Crowe, MA, MPH
- Nasreen Nabizadeh, MPH
- Shadeh Rassoulkhani, MPH

In Memoriam: *The team honors the memory of Bryce Olson, a friend and patient advocate, who passed away in 2023. Bryce was a cancer patient and a tireless patient advocate who spent many years raising awareness for the need of precision medicine approaches like the one developed as part of this project.*

Scientific Background and Context

Advancing precision medicine cancer treatment

Precision medicine cancer treatment usually involves testing cancer cells for certain gene or protein changes, a process known as tumor testing. With this approach, clinicians and health care providers can determine which treatments are likely to work best for an individual patient, based on the characteristics of the specific tumor from that patient. However, the current approach often involves testing a few commonly identified cancer-promoting genes or proteins, which can be insufficient for informing optimal treatment decisions. Understanding the characteristics of how individual cancer cells respond to different therapeutic interventions is critical for advancing precision medicine cancer treatments.

Inequities in breast cancer outcomes in patients from Hispanic communities

Triple-Negative Breast Cancers (TNBC), which account for about 20% of breast cancers, are highly prevalent in patients from Hispanic/Latina communities (29% more prevalent than non-Hispanic/Latina Whites), representing a major health inequity in cancer diagnosis and treatment.[30] Despite recent progress in the development of new cancer medications, TNBCs remain largely untreatable. TNBC tumors grow faster and are more likely to metastasize than other breast cancers, leading to higher mortality rates. Additionally, Latina women with TNBC generally represent small percentages of the available genomic database, often because of a lack of access to primary care, insufficient recruitment in clinical trials, and cultural and linguistic barriers to biomedical information and healthcare navigation.

Artificial Intelligence as a tool for precision medicine

Artificial Intelligence (AI) is a type of computer analysis that can process big datasets and run algorithms, a process known as machine learning, which allows conclusions to be drawn from the data. This approach can often find and extract hidden patterns in large datasets that, in practice, most humans cannot discern quickly, if at all.[31]

In the context of cancer, this provides a tremendous assist to clinicians who see many patients and process large amounts of patient data. Many of the types of clinical applications of AI can include remote health monitoring and data collection, recommending preventative screenings based on risk and lifestyle, accurate diagnoses of tumor types, customizing treatment regimens and prediction of treatment efficacy, recommending new drugs based on their genetic and environmental factors, and assisting patients in treatment adherence.

AI is largely dependent on the parameters by which computer programs are written, as well as the type of health data these programs have access to, which can be limited, restricted, or siloed. For example, many electronic health records are not uniformly accessible to scientists and clinicians between institutions, and some advanced diagnostic tests may be deemed costly or untrustworthy by clinicians or insurance for patient access, leaving gaps in the type of data AI can analyze.

Despite these barriers, AI shows promise on improving the precision application of treatment and care using an individual's data on genomics, biomarkers, radiology and imaging, and treatment response/outcomes. When this health data is unified with external factors like genetic changes and exposures over time, available trial therapeutics, access to technology to monitor outcomes, and social determinants of health (like stress or access to food and housing), more precise treatments can be applied to the right patients.

AI can save time and resources by preemptively determining patients who should be recommended for drug trials based on their genetics. AI is also able to help identify new targets and candidate treatments with multiple forms of data, reducing the use of costly or ineffective therapies, while performing cost/benefit analysis on the use of invasive therapies, or identifying the factors that can cause disease or affect health outcomes.

30 Martínez, M.E., Gomez, S.L., Tao, L. *et al.* Contribution of clinical and socioeconomic factors to differences in breast cancer subtype and mortality between Hispanic and non-Hispanic white women. *Breast Cancer Res Treat* **166**, 185–193 (2017).

31 Liao, J., Li, X., Gan, Y., Han, S., Rong, P., Wang, W., ... & Zhou, L. (2023). Artificial intelligence assists precision medicine in cancer treatment. *Frontiers in oncology*, *12*, 998222.

Project inspiration and goal

The team named the project "Celsus" in recognition of Aulus Cornelius Celsus, an early trailblazer of cancer medicine in the 1st century A.D. who described four stages of breast cancer and distinguished superficial tumors from those arising in internal organs. An advocate for surgical therapy, he also compiled a comprehensive catalog of treatments and their properties while explaining their proper use in patients.[32]

The goal of this project was to create a powerful, flexible and fully-integrated AI platform for exploring new therapeutic opportunities and precision medicine capabilities for TNBC patients from Hispanic communities. To achieve this, the team conceptualized and developed a prototype AI model that integrates data across modalities and databases, summarizes data, and provides predictions of individual patient response to candidate therapies.

32 Greive, J. A Cornelius Celsus of Medicine. (Lightning Source Incorporated, 2010).

Project Summary

The goal of the Celsus Project, led by Drs. William Kim and Pablo Tamayo at UC San Diego, was to build an effective precision medicine system to identify treatments and medications for patients with TNBC, which are highly prevalent among Latina women. To do this, the team utilized genomic data from tumors and an AI model to predict how effective treatments are in treating TNBC, based on different genetic markers in their tumors. The team had the following objectives:

(1) The UCSD team expanded on their previous methodology to identify key tumor and cellular states to build a predictive, prototype AI model based on publicly available data from The Cancer Genome Atlas [33] (representing over 10,010 tumor samples from 30 cancer types from the National Institutes of Health). The Celsus AI model provides predictions for the most and least effective therapeutic options based on the state of the tumor and other cellular and genetic tumor characteristics. Additionally, the model predicts the potential efficacy of drug combinations and assesses which tumors or patients are likely patients to respond to a given treatment across many samples.

(2) To identify novel therapeutic candidates for TNBC, the UCSD team selected 50 individual drugs based on predictions from their Celsus AI model and tested these drugs individually and in combinations across TNBC cell samples and patient-derived organoids (a collection of tumor cells derived from TNBC patients and grown 3-Dimensionally).

(3) In collaboration with community partner El Centro Medical Center, an acute-care center providing healthcare needs to the Imperial Valley, the UCSD team began and continues to collect TNBC samples from patients to refine their Celsus AI model and eventually execute a precision medicine treatment.

(4) In collaboration with the community partner, Moores Cancer Center, and San Diego State University, the UCSD team hosted meetings with researchers, community clinicians, community outreach collaborators, and industry collaborators to engage stakeholders in study design, implementation, interpretation, and dissemination of the study. The UCSD team also interviewed participants and stakeholders to generate a report on the lived experiences of Latina women living with breast cancer, which will be translated to Spanish and disseminated to the community.

33 National Cancer Institute: The Cancer Genome Atlas Program.

Project Achievements

Project Celsus made great strides in developing and advancing a precision medicine-based AI approach that can be used to predict treatment response based on tumor characteristics from individual patients. To address a critical need in cancer research and treatment, as well as health inequities, the UCSD team is refining their prototype model for AI-recommended treatments of TNBC, a type of cancer common in Latina communities, where the conventional standard of care for most patients is still invasive treatments (such as surgery or chemotherapy).

Cancer States and Immune Archetypes (CSIA) framework model development

The UCSD team used publicly available datasets, such as The Cancer Genome Atlas Program, Cancer Dependency Map, and the Cancer Target Discovery and Development Network, to develop and refine their Cancer States and Immune Archetypes (CSIA) framework. The prototype Celsus AI model builds upon prior models developed by the team. By categorizing different types of cancers by their genomic (across the entire genome) characteristics, the UCSD team compared common mutations and genetic patterns in over 30 types of cancer to find the most common breast cancer hallmarks. The intention of this model is to provide accurate predictions about which treatment will be the most effective for a particular tumor and ranked categorizations of treatments that can be easily interpreted in clinical settings. Using the Celsus model, clinicians will be able to easily identify which treatments are predicted to be the most and least effective, based on the genomic characteristics of a tumor from an individual patient. The UCSD team refined and validated their Celsus model with TNBC tumors as a proof of concept.

Testing Triple-Negative Breast Cancer cells against various treatments

Using their prototype Celsus model, the UCSD team selected the top 50 most likely effective treatments for TNBC and tested these treatments in TNBC cell samples and patient-derived organoids (a collection of tumor cells derived from TNBC patients and grown 3-Dimensionally). The UCSD team found that the candidate drugs, when tested individually or in combination, did not cause cancer cell death to the magnitude they expected, likely due to increased drug resistance. These findings highlighted the need for the UCSD team to supplement the Celsus model with additional clinical data and expand the toolkit of available TNBC cell lines and models for further validation. This fine tuning improves the predictions of the AI model by providing the most optimal strategies to kill specific cancer cell types. The results also showed that using a 'big data' AI model with many samples could draw conclusions faster on drugs before committing costly clinical resources. The AI model also shows potential for patient impact by quickly identifying specific drug combinations that may be effective for an individual tumor.

Along with the community partners El Centro Medical Center and Moores Cancer Center, the team collected a total of over 70+ samples from blood and tissue from TNBC patients before and after treatment. When the team obtains enough TNBC samples from patients before and after treatment response, they can further refine the Celsus AI model to more accurately predict responses based on past patient data. The UCSD team is currently examining the data for differences in tumor characteristics of Latina vs. non-Latina patients with TNBC to identify specific genetic targets and potential treatments.

Engaging community members

During the initial stages of development, the team collaborated with the Moores Cancer Center Community Outreach and Engagement (COE) team and San Diego State University (SDSU) to organize a workshop to discuss the project and request feedback from the community. The workshop included community clinicians and researchers from COE, UCSD, SDSU, Tri-City Medical Center, Cancer Resource Center of the Desert, and Pfizer. Together, they discussed the aims of the upcoming Celsus project and brainstormed the best way to engage the community and patients as well as how to educate the public on concepts of precision medicine.

In order to better understand the lived experiences of Latina women with breast cancer, researchers at the Institute for Public Health at SDSU completed 48 interviews in San Diego and Imperial Counties representing patients from Kaiser Permanente, UCSD, San Ysidro Health, City of Hope, Scripps Healthcare, Sharp Healthcare, Family Health Centers of San Diego, the Cancer Research Center of Imperial County, and the Every Woman Counts program. Based on these interviews, the SDSU team prepared a 26-page report of community feedback and study interpretation, as well as recommendations about the specific needs of Latina breast cancer patients. Common themes of lived experiences of Latina women with breast cancer include: 1) language barriers that interfere with effective care, 2) mistrust in the medical system, 3) economic barriers, and 4) the need for support groups that play a key role in education and care navigation. Thus, the project helped to identify barriers to effective care.

The report has been professionally formatted and is being translated into Spanish, allowing for additional community dissemination.

Economic impact analysis

The team constructed a microsimulation model to evaluate outcomes among a hypothetical cohort of Latina and non-Latina patients with newly diagnosed breast cancer to help understand economic impacts of patients receiving either precision oncology care or standard care. The model simulated the clinical course of patients from diagnosis, incorporating cost data, drug toxicity and side effects, quality of life, disease progression, and survival. This model is currently being validated, but initial findings suggest that health costs do not depend on patient ethnicity. Future plans will incorporate other social determinants of health into the microsimulation model to help better understand how a patient's education, employment, and access to care influence the cost of care.

Challenges facing the team

The team faced several challenges during the funding period. As the funding period overlapped with the onset of the COVID-19 pandemic, the team faced challenges in staff turnover and the consenting and sample collections process. Additionally, technical challenges included the lack of adequate technologies in the clinical setting, data generation and collection, storage and management, data standardization, data ownership, privacy, and security. Organizational challenges included cost, ethics, infrastructure, implementation, and regulatory and system validation challenges. Additionally, the team posited that technological innovations in AI can quickly outpace laws and regulations, suggesting that organizations who aim to integrate precision medicine into their healthcare systems must find a way of overcoming an array of technological, organizational, ethical, and legal challenges.

The UCSD CIAPM project served as an invaluable opportunity for the project team, as basic researchers, to interact with community oncologists to learn about their challenges and needs. Community physicians shared enthusiasm for prioritizing patients' well-being and willingness to seek out the most innovative and effective treatments. Prior to CIAPM funding, community physicians were historically under-resourced and despite their needs, could not always take advantage of the latest research findings in the larger oncology field. The physicians and community clinics also were often under-staffed because of clinical commitments or could not always afford to attend meetings. Finally, the hospital system that physicians were part of lacked infrastructure to work with academic hospitals; CIAPM's funding provided an opportunity to bridge this gap and help build the infrastructure for this multi-stakeholder project.

Training and education

The Celsus project supported eleven trainees across the career spectrum, including undergraduate, Master's, doctoral students, and postdoctoral fellows in the fields of cancer, computational, and experimental biology, genomics, precision oncology, and pharmacology. Additionally, the team is developing a new course, entitled "Analytical Approaches to Precision Medicine in Cancer: Data, Models and Paradigms," for a new Masters in Precision Medicine program.

Collaborations and partnerships

The Celsus team formed new partnerships in the development and implementation of their project. Community partners El Centro Medical Center and Moores Cancer Center supported the team in community engagement and data analysis. Additional community partners Tri-City Medical Center and Cancer Resource Center of the Desert supported engagement of community patients and ad-

vised the Celsus team on how to educate patients on the concepts of precision medicine in a community-friendly way, including language accessibility for patient populations. Additionally, the SDSU Institute for Public Health has been central in community engagement activities as well as providing support for the community report. The team also formed collaborations with other researchers at UCSD, SDSU, and the Salk Institute.

Future research and funding

The UCSD team obtained funding from the NIH for the methodology that led to the development of the Celsus model prior to and during the project period (2017-2023, $5 million). The UCSD team is committed to further developing and deploying their Celsus model beyond this CIAPM-funded project and continues to submit grant proposals to further develop the model in the context of different cancer types, such as liver and prostate cancers. In order to fully test the accuracy of the model, the team is planning on collecting more clinical data and integrating actual patient responses to their model to provide the most accurate predictions. The team is refining the output of the Celsus model to streamline interpretation by clinicians and biologists for smooth integration into research and clinical settings. Additionally, the UCSD team is collaborating with SDSU to study the role of 'obesogens,' chemicals that disrupt biological processes and contribute to negative health outcomes, in aggressive TNBC in Hispanic women.

The Celsus team is further evaluating the economic impact of the precision medicine treatments suggested by the algorithm, specifically focusing on the overall cost to patients, payers, and society using computer simulations.

Advantage of CIAPM's funding opportunity

The project team noted that this CIAPM project has served as a one-of-a-kind opportunity to bring together a large number of investigators (including 11 trainees), clinicians, cancer patients and survivors, and others, across various disciplines, institutions, and backgrounds. The common goal of addressing persistent cancer disparities within local communities left a lasting training impact in the biomedical field and demonstrates the power of multiple stakeholders in the precision medicine pipeline. CIAPM's approach to support precision medicine projects in a problem-centric way allowed the team to explore and identify a number of real-life research challenges that could not have been anticipated, thus teaching academic researchers about effective community engagement strategies.

The project team now appreciates the enormous complexities underlying cancer as a disease and the major challenges in developing an effective and practical precision medicine system. While realization of such complexities can be discouraging and appear to thwart immediate progress, projects like those supported by CIAPM allow the team to revisit and re-assess established scientific knowledge and generate novel paradigms to tackle this terrible disease. CIAPM support uniquely made possible the collection of data, lessons, computer resources, and collaboration paradigms generated from these investigations. This support will bring the field closer to realizing the potential of precision cancer medicine and advancing health equity in underrepresented patients, progressing the process of matching tumors and therapeutic interventions overall.

Expert Evaluation

By Dr. Rulla Tamimi and Dr. Elizabeth Cohn

The main goal of this project was to build an AI platform that predicts potential treatments for patients with TNBC, which is more common in Hispanic communities, based on different genetic markers in patient tumors.

The evaluators felt that, overall, the UCSD-CELSUS project was ambitious, made significant contributions in innovation and discovery, and the progress toward their goals was exceptional. Given that the program took place during the COVID-19 pandemic, which led to pauses in consent and sample collection, the evaluators felt that some of the incomplete milestones were reasonable and required more time to complete post-CIAPM support.

Significant achievements of this project included: 1) the successful development of the Celsus AI platform with multiple functions, 2) creating nine 3-Dimensional (3D) TNBC tumor cell models from 12 TNBC tumor samples, 3) conducting more than 50 single agent drug screens and 47 drug combinations of lead treatment candidates and cancer cells based on different states of cancer, and 4)

extensive work engaging and understanding breast cancer community needs, including moderate success at recruiting and enrolling larger numbers of Hispanic TNBC patients.

Given the regulatory delays and building an infrastructure from initial inception, the evaluators felt the project significantly advanced the field, such as, remote consenting of trial participation, building a sophisticated AI model, and developing a guide on how to overcome barriers in the healthcare space for minoritized communities.

Evaluators also felt that the project partnership with El Centro Medical Center and Moores Cancer Center, and their co-authored community report, informed how to address barriers to treatment in Southern California Hispanic communities, and how to expand, intervene, and increase accessibility to precision medicine options. The interviews were conducted to understand the care Latina breast cancer patients receive and provided useful information highlighting several barriers to the accessibility of precision medicine to all, particularly highlighting greater barriers within the Hispanic/Latino community. However, the community report could be strengthened by conducting a literature review that focuses on the details of the methodology used for qualitative analysis and drawing conclusions.

In addition, the evaluators felt that while studying the economic burden of cancer care by ethnicity is an important question that complements the project, the team should consider additional factors that can affect economic burden beyond ethnicity. The community report highlights financial concerns related to insurance coverage and concerns related to being able to take time off from work and financial anxiety, all potential areas for economic analyses to focus on.

Overall, the team made significant contributions in innovation and discovery, and the progress toward their goals was exceptional. Given the overall impacts both from COVID-19 and the need to build an infrastructure from the ground up, the evaluators felt that this project achieved a great deal, was innovative, and would benefit from more time and support to meet the goals set out by CIAPM and the State of California. The study identified key areas for future work to achieve equity goals and performed an impressive amount of foundational setup to continue the program.

Assessment of How the Project Addressed Programmatic Goals

Improvements on patient outcomes and reducing health disparities

Given the long-term work necessary to build the Celsus model, datasets, and trusting community partnerships, the evaluators felt that the most tangible short-term outcomes for reducing health disparities lie in the new collaborations and coalitions that were successful in laying the framework for patient recruitment from minoritized communities. Through improving patient education and prevention, diagnoses, and treatment via a consolidated precision medicine pipeline from the Celsus model, database building, and healthcare partner collaborations, the project is well-positioned to improve patient outcomes and address health disparities in the long-term.

Application and understanding of precision medicine to address cancer health disparities

The evaluators felt that the project effectively brought together several stakeholders in the precision medicine space that were crucial to the application of equitable precision medicine. The team learned from and worked with the community to develop trust, which will allow them to design new interventions that meet the needs of Latina TNBC patient communities and move this type of work forward in the future.

Develop tools, data, and genomics data to use in prevention, diagnosis, and treatment

The Celsus team incorporated 'multi-omic' data from both genomic tumor samples and publicly available data, such as from The Cancer Genome Atlas Program from the National Institutes of Health, to develop the Celsus AI model that predicts effective treatments for a particular tumor.

Develop new precision medicine assets, capabilities, and infrastructure

The main precision medicine asset developed was the Celsus AI model. The team also partnered with the SDSU Institute for Public Health to develop a publicly available community report based on perspectives from 48 Latina TNBC patients and their advocates from San Diego and Imperial Counties. The English and upcoming Spanish bilingual report qualitatively summarizes community feedback of the project, study interpretation from the participants, and expert recommendations for healthcare access. The report found that TNBC diagnosis is particularly overwhelming for those with low English

proficiency and health literacy.

Engage patients in research and clinical practice

The evaluators felt that the project had a strong patient advocacy focus, which included conducting the community interviews with Spanish-speaking communities to better understand the patient and community perspectives from Latina TNBC patients and their advocates.

Engage researchers and collaborators from underrepresented backgrounds

The UCSD-CELSUS team partnered with the El Centro Regional Medical Center, an acute-care center providing healthcare needs to the Imperial Valley, a historically dense Hispanic/Latino and Spanish-speaking population. This partnership established a streamlined Internal Review Board (IRB) process for all patient trials in concert with the UCSD Moores Cancer Center and their Biorepository. Several of the research investigators were individuals who were underrepresented in the biomedical workforce. The program also employed a heavy diversity component in their traineeship, including engaging junior faculty, high school, and summer college research interns, many of whom are underrepresented in the biomedical community.

Impact of the project on precision medicine in California

The evaluators anticipate that this project will have a positive and extended impact for precision medicine, including identifying several barriers to clinical and translational research that, while not unique or novel to California, are very well present within the state.

Conclusion

Overall, Project Celsus built a prototype AI platform that predicts potential treatments for cancer patients based on the genetic characteristics of their individual tumor. The team made great strides in refining their prototype AI platform to demonstrate a use case for patients with TNBC, which is largely untreatable and more common in Latina communities. The team also interviewed patients and stakeholders to generate a report on the lived experiences of Latina women living with breast cancer. The team is collecting more clinical data and integrating actual patient responses to provide the most accurate predictions, with the goal of deploying their AI model for clinical use and smooth integration into research and clinical settings.

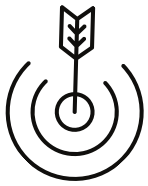
Reducing Cancer Disparities Through Innovative Community-Academic Partnerships (ALCANCE Project)

Principal Investigator: Manali Patel, MD, MS, MPH
Stanford University

California Initiative to Advance Precision Medicine

Project Goals

1. Establish and engage a **CAB** in discussing research study activities
2. Develop bilingual cancer screening and prevention education for **community health workers (CHWs)**
3. **CHW-led Intervention** to compare precision medicine cancer care with usual care
4. Analysis of financial impact of care intervention



Key words for the ALCANCE Project:

community health worker (CHW) - trained, nonclinical community members that facilitate access to, and navigation of, healthcare services and education
intervention - a program aimed to improve health conditions
Community Advisory Board (CAB) - a panel of professionals, patients, and advocates that help guide the research project and health outcomes

Traineeships (all types)

9 community health workers

11 additional research trainees: a medical student, Master's degree student, medical fellow

Community Contributions

Community Partners:

Recruitment Site & CHW Employment
- Clinica de Salud del Valle de Salinas & Pacific Cancer Care

CAB, Community Education, & CHW Training
- Latino Cancer Institute

CHW Onboarding
- Cancer Patients Alliance (Monterey & Santa Clara Counties)

Built website of local cancer care resources: https://trello.com/b/X22sL18p

Pivoted efforts to support the community during the COVID-19 pandemic:

21 COVID testing events

18 vaccination clinics

20 other community events (such as food distribution events from 10/2020 to 1/2022)

Community Advisory Board (CAB)

9 meetings

40 members (stakeholders representing industry, government, public and private health care or clinic systems, advocates, survivors)

Reducing Cancer Disparities Through Innovative Community-Academic Partnerships (ALCANCE Project)

Assets & Scientific Contributions

107 presentations

18 manu-scripts

15 press releases

CHW integration into clinical care provides the support below:

- Connecting to cancer screenings
- Assessing cancer risk & family history
- Logistical & emotional support
- Answering questions
- Teaching prevention behaviors

Interventions and Services to Patients

Screening and Prevention Intervention

153 primary care patients received a personal and **family history screen** assessing eligibility for a **genetic test** for cancer risk

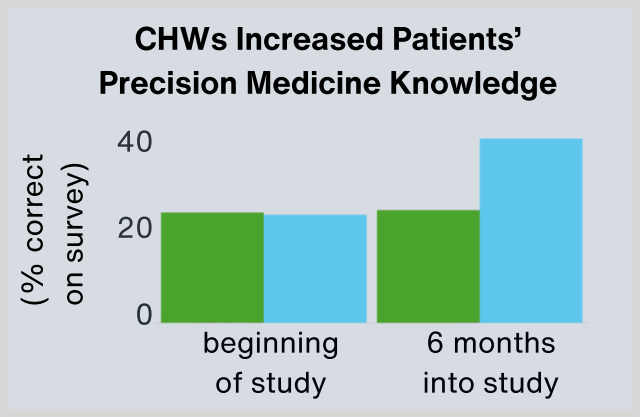
7 individuals had screen results warranting further testing and received **genetic testing**

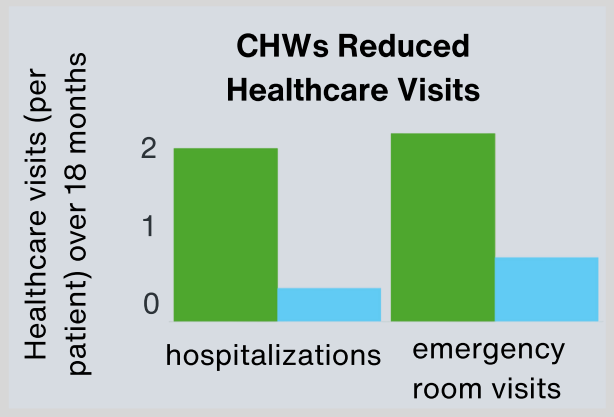
Diagnosis and Beyond Intervention

57 patients received **CHW-supported education & navigation** through precision cancer care

51 or 89% of patients **completed tumor genetic profile tests** compared to 13% in the non-intervention group

~$35,000 saved for unnecessary acute care by private insurers per patient in 'Diagnosis' intervention





Takeaways

1. A CHW education and intervention model improved cancer care in Latinx communities within Monterey County.
2. The CHW model is scalable to delivering culturally-sensitive precision medicine interventions to underserved communities.
3. Suggested modifications to enhance the delivery of precision cancer care in the future:
   1) expand the inclusion criteria for patients and methods of delivering care,
   2) integrate activities in Spanish in collaboration with the CBOs for those with low-literacy levels, and
   3) ensure that the goals of the care reflect the patient's and community's priorities.

3. Reducing Cancer Disparities Through Innovative Community-Academic Partnerships - **A**ddressing **L**atinx **CAN**cer **C**are **E**quity (ALCANCE) Project

Lead Principal Investigator: Manali Patel, MD, MS, MPH

Project Period: October 8, 2019 – October 31, 2023

Research Team and Community Partners

Stanford University (Research Team)

- Ariana Murillo, BS
- Cynthia Perez, BA
- Emily Wood, MPH
- Gladys Rodriguez, MD
- Hector Saul Medrano, BS
- Jeffery Edwards
- John Layton, BS
- Keely Fuller, BS
- Lisa Goldman-Rosas, PhD, MPH (Co-Principal Investigator)

Cancer Patients Alliance (Community Partner)

- Dale O'Brien, MD, MPH (Co-PI)

Latino Cancer Institute (Community Partner)

- Ysabel Duron, BS (Co-PI)

Pacific Cancer Care (Community Partner)

- Gerardo Villicana
- Jajaira Reynaga, BA
- Jenni Osorio, BA, BS
- Lesly Lopez Guzman
- Maria Leach
- Susann Lua, BS
- Zach Koontz, MD

Clinica de Salud del Valle de Salinas (Community Partner)

- Kasandra Escobar
- Maria Reina Garcia
- Miriam Juarez Vargas

Scientific Background and Context

Inequities in clinical outcomes among Hispanic/Latino cancer patients

Despite advances in cancer diagnosis and treatment, cancer remains a top cause of death among Hispanic/Latino populations.[34] These inequities can be attributed to institutional barriers, such as delays in diagnoses (and therefore treatment) and under-representation in clinical trials, which are even greater among low-income Hispanic/Latino populations.[35-36] Identifying the factors that contribute to these cancer inequities is necessary to develop effective and appropriate interventions. A qualitative study on barriers encountered by low-income Hispanic/Latino cancer patients revealed the prevalence of low health and healthcare literacy and language barriers, and their adverse effects on these patients' clinical outcomes and experiences.[37] Health literacy is critical for caregivers and patients who receive cancer diagnoses to mutually understand the prognosis, treatment options, and anticipated changes in quality of life. Language barriers can be detrimental as well; without the assistance of bilingual and bicultural personnel, patients may be unable to fully participate in treatment discussions, support groups, and clinical research.

A community health worker (CHW)-based intervention

Receiving basic education in precision medicine concepts, such as genetic testing and targeted therapies, can increase patients' research participation and engagement in treatment discussions, ultimately leading to improved patient outcomes.[37,38] Therefore, it is important to ensure that patients can learn and discuss complex precision medicine concepts regardless of cultural backgrounds, socioeconomic status, and proficiency in English.

This project explores the role of precision medicine literacy in improving patient outcomes for Hispanic/Latino primary care and cancer patients by centering community health workers (CHWs, also known as *promotoras*) as an intervention. CHWs are trained, nonclinical community members that facilitate access to, and navigation of, healthcare services and education for diverse and minoritized patient populations. CHW involvement has demonstrably improved cancer care screening and treatment adherence, as well as the patient's motivation and ability to seek care (patient activation) and improve their quality of life.[38] Preliminary data suggests that CHWs can effectively encourage patients to discuss advance care planning and symptom burden with their cancer care teams.

Project goal

The goal of this project was to integrate CHWs into primary care and cancer care delivery to address existing inequities in cancer diagnosis, treatment, and outcomes for Latinx patients (Note: The project team used the term Latinx). The team also aimed to educate and embed CHWs into clinical practice to increase patient knowledge of precision medicine cancer care.

34 Health of Hispanic or Latino population (2021) CDC Web site. Updated 2021.

35 Wojcik GL, Graff M, Nishimura KK, et al (2019) Genetic analyses of diverse populations improves discovery for complex traits. Nature (London) 570(7762):514-518.

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37 Rodriguez GM, Leach M, Osorio J, Villicana G, Koontz Z, Wood EH, Duron Y, O'Brien D, Rosas LG, Patel MI. Exploring cancer care needs for Latinx adults: a qualitative evaluation. Support Care Cancer. 2022 Dec 22;31(1):76. doi: 10.1007/s00520-022-07518-0.

38 Patel MI, Kapphahn K, Wood E, Coker T, Salava D, Riley A, Krajcinovic I. Effect of a Community Health Worker-Led Intervention Among Low-Income and Minoritized Patients With Cancer: A Randomized Clinical Trial. J Clin Oncol. 2024 Feb 10;42(5):518-528. doi: 10.1200/JCO.23.00309. Epub 2023 Aug 25.; 42(12):1457. doi: 10.1200/JCO.24.00286.

The goal of the **A**ddressing **L**atinx **CAN**cer **C**are **E**quity (ALCANCE) Project led by Dr. Manali Patel at Stanford University was to apply a precision medicine approach to address cancer care inequity in Monterey County. Through a community engagement approach, they enlisted community members and incorporated an innovative CHW model in collaboration with a Federally Qualified Health Center and a cancer care clinic in Salinas Valley and Monterey County. The Stanford team accomplished this through four objectives:

(1) The Stanford team formed a 40-member community advisory board (CAB), comprised of professionals, patients, and advocates across the spectrum of cancer care, and met quarterly in-person and remotely on Zoom during the COVID-19 pandemic. During CAB meetings, the Stanford team presented early study results for each clinic site and CHWs presented anecdotal highlights of intervention impacts. The CAB discussed feedback on challenges faced during the study, as well as planned and sustained project activities and integration of the project into standard care.

(2) In preparation for two CHW-facilitated interventions, the Stanford team developed a training curriculum on cancer screening, prevention, and precision medicine cancer care. Nine CHWs in Monterey County were trained and then educated patients about precision cancer care. The team also developed English and Spanish language education resources for patients. Remarkably, during the onset of the COVID-19 pandemic, the team pivoted to contributing CHW services to support testing and vaccination events in the Monterey County community, while also providing precision cancer education.

(3) The Stanford team implemented a CHW-facilitated *Screening and Prevention* intervention to assess intervention viability and participants' knowledge on the potential benefits of genetic testing for cancer-related risk genes through a personal and family history cancer screening in a primary care setting. CHWs attended over 60 outreach events, enrolling 158 Latinx initial participants and speaking to over 570 individuals about cancer and enrollment in the *Screening and Prevention* study.

To assess the effectiveness of the CHW-facilitated *Diagnosis and Beyond* intervention *following* a patient cancer diagnosis, the Stanford team launched a randomized controlled trial and enrolled 110 Latinx participants with cancer (from 1390 who were screened for eligibility). A total of 57 participants were randomly assigned to the intervention group (which involved usual care, CHW support, and education on precision medicine for cancer care) while 53 participants were assigned to the usual care control group (no CHW support or additional information on precision medicine for cancer care). Each participant completed a baseline survey at the time of enrollment, with follow-up surveys occurring at 3-, 6-, and 12-months post-enrollment. Surveys evaluated the primary outcome, knowledge of precision medicine, as well as secondary outcomes including satisfaction with care and care decisions, aligning and documenting goals of care, patient motivation and activation, quality of life, and healthcare utilization and cost.[39]

The two CHW-facilitated interventions were developed in collaboration with the sites at which they were delivered, *Screening and Prevention* at Clinica de Salud del Valle de Salinas (CSVS) and *Diagnosis and Beyond* at Pacific Cancer Care (PCC).

(4) A preliminary financial impact analysis showed that patients in the *Diagnosis and Beyond* intervention were five times less likely to be hospitalized, and three times less likely to have an emergency room visit than those in the usual care group; with savings for each patient roughly $35,000 and saving private insurers roughly $2.13 million (for the entire intervention group) in unnecessary acute medical care.

39 Rodriguez GM, Wood EH, Xiao L, Duron Y, O'Brien D, Koontz Z, Rosas LG, Patel MI. Community health workers and precision medicine: A randomized controlled trial. Contemp Clin Trials. 2022 Oct;121:106906. doi: 10.1016/j.cct.2022.106906. Epub 2022 Sep 6.

Project Achievements

Throughout the course of the ALCANCE project, the newly created CAB supported the focus of the research by providing guidance and advice on how to make precision medicine knowledge and care available to the whole community. With this community-led direction, the team developed educational materials to aid CHWs in improving outcomes for cancer treatment and screening in Latinx communities.

Capacity building for clinics and CHWs

Through this project, the team established the first CHW roles at CSVS and PCC clinics through the development of job descriptions and filling CHW positions primarily through word-of-mouth in the community. Both CSVS and PCC were unfamiliar with the role of CHWs at first, but after six months, CHWs became an integral part of the medical team, with five CHWs at CSVS in the primary care setting and four CHWs at PCC in the cancer clinic setting. The team trained CHWs through a mix of live and recorded trainings and self-paced online courses. CHWs also provided feedback during onboarding/training, which the team incorporated into training materials. The team also incorporated CHW feedback during completion of the project, which the team incorporated into the training materials and help identify barriers and opportunities for sustainability. CHWs learned about genetic testing and counseling, financial assistance options for genetic testing, and how and what types of testing panels are ordered by the clinic. These trainings left a lasting footprint of trained health professionals in the community, in that CHWs developed additional subject matter expertise and improved their capacity for care navigation for patients.

The ALCANCE team interviewed patients to identify barriers to accessing routine cancer treatment and screenings; barriers included language, low cancer-health literacy, stress and anxiety due to insurance, and potential costs. The team also found a need for supportive bilingual and bicultural personnel to assist in overcoming barriers to cancer treatment and informing academic researchers of obstacles that prevent patients from accessing routine patient care and participating in clinical trials. Despite those obstacles, CHWs built relationships with patients, attuned to patient schedules by calling on evenings and weekend, and learned cancer-specific terminology to better explain treatments and options to patients and reduce the likelihood for participant withdrawal. CHWs attended and provided patient interpretation, translation, and support at pre-genetic testing counseling visits while also assisting with sample collection.

The ALCANCE team also made recommendations for effective researcher-community engagement and partnership, including ensuring appropriate staff resources are provided such as project managers, documentation of partnership agreements, researchers assisting community-based organizations (CBOs) with administrative tasks, working groups to divide the research, community partners disseminating CHW job openings, and ensuring trainings are recorded and departments involved in the project have their tasks mapped out. CHWs from CSVS also presented their project experiences as course material to medical students at Stanford University in November 2021. Through this, the team was able to identify barriers to effective care and defined effective research recruitment strategies that are now available for future community and researcher dissemination.

Improvement of patient outcomes

In the short-term, the ALCANCE team helped 153 women at CSVS receive a personal and family history screen to assess potential benefits of genetic testing and identify women for screenings of cancer-related genes in the *Screening and Prevention* intervention. Importantly, without the CHW intervention, many patients in this study would have never learned about their genetic risk for cancer or even considered and/or received genetic testing for cancer risk-related genes. Before the *Screening and Prevention* intervention, there was no usual care pathway for patients to learn about or receive genetic testing with their primary care providers at CSVS. Only two providers out of a total of 27 reported ordering genetic testing for high-risk patients as part of usual practice prior to the ALCANCE Project.

One hundred and ten patients with a cancer diagnosis enrolled in the *Diagnosis and Beyond* study at PCC. The fifty-seven patients receiving community health worker support in the intervention group became more engaged in their care, showed an increase in knowledge of precision medicine, and obtained evidence-based cancer care, including targeted therapeutics and recommended tumor

testing. The CHW-facilitated intervention group patients were nearly **3 times** as likely to receive guideline recommended tumor testing compared to the control group.

Fifty-one participants in the intervention group completed tumor testing (89%) compared to seven participants (13%) in the control group. The team's findings also suggested the following modifications to the intervention to enhance the delivery of precision cancer care in the future: 1) expand the inclusion criteria for patients and methods of delivering care, 2) integrate activities in Spanish in collaboration with CBOs for those community members with low-literacy levels, and 3) ensure that the goals of the care reflect the patient's and community's priorities.[40]

Ultimately, by consolidating patients into the intervention workflow, patients were aware of tumor-specific treatments with potentially fewer side-effects than the guideline-based chemotherapy standards. Importantly, the team demonstrated a method for implementing and paying for precision cancer care, where there are very few health-industry standards or workflows for implementing evidence-based therapeutics, care, or payment structures.

The ALCANCE project is improving patient outcomes through a sustainable and scalable CHW model by providing support to all patients as part of usual care. The ALCANCE project reduced delays from the time of diagnosis to treatment from a county-wide average of 82.7 days to 42.5 days.

Community outreach and connections during COVID-19

Because the first year of the ALCANCE project coincided with the onset of the COVID-19 pandemic in 2020, the team pivoted to contributing CHW services to support COVID-19 testing and vaccine events hosted by CSVS in the Monterey County community. CHWs were trained about the transmission and prevention of COVID-19 and attended a total of 21 COVID-19 testing events in eight different cities. At these events, CHWs subsequently and opportunely provided health education about cancer screening and distributed 2,500 flyers about the importance of early cancer screenings and information about the ALCANCE study.

Along with collaborators, the research team created resources and infographics in both Spanish and English for patients about different types of cancers, screening options, and resources. The research team is preparing a plain language one-pager with key takeaways about each study that will be provided to the CAB to share with their networks. Additionally, the research team developed a web-based toolkit publicly available to share resources developed through the study, leaving a lasting footprint of educational, financial, genetic, transportation, food, housing, legal, home care, mental health, and care planning services and how to access them.

Preliminary economic impact analysis

Further preliminary financial analyses were performed for acute care, with longer-term cost efficacy studies still pending. For the patients who received the *Diagnosis and Beyond* CHW intervention, less than one-quarter (24%) of participants used the emergency room (ER) at any point, versus nearly two-thirds of patients (62%) who sought ER care in the usual care group.

Further, less than one-in-five (18%) participants in the intervention group were hospitalized for any extent of time versus two-thirds of patients (62%) in the usual care group.

Patients in the intervention group were five times less likely to be hospitalized (0.34 vs. 1.75 hospitalizations per patient), and three times less likely to visit the ER (0.65 vs. 1.9 ER visits per patient) than patients in the usual care group.

Using 2018 monetary values, median list costs for patients in Monterey County ranged about $1,127 for emergency room visits, and $22,100 for extended hospitalizations. This equates to a roughly $35,000 savings per patient (when combining all care visits, on average), or roughly $2.13 million for the entire intervention group (of 57 patients) in costs averted from private insurers for unnecessary acute care. The patient navigation and advance care planning provided in the intervention group may have contributed to those averted acute care costs. Thus, the team was able to define a streamlined pipeline process for effective care by identifying a reimbursement scheme that successfully reduced hospital and ER visits, in part via the use of culturally-appropriate health navigators.

40 Wood EH, Leach M, Villicana G, Goldman Rosas L, Duron Y, O'Brien DG, Koontz Z, Patel MI. A Community-Engaged Process for Adapting a Proven Community Health Worker Model to Integrate Precision Cancer Care Delivery for Low-income Latinx Adults With Cancer. Health Promot Pract. 2023 May;24(3):491-501. doi:10.1177/15248399221096415. Epub 2022 Jun 4

Sustainability and scalability of the ALCANCE project

During the course of this project, PCC began billing CHW services to Medi-Cal for reimbursement, enhancing the financial sustainability of the CHW model. As a result of this project and Medi-Cal reimbursement, PCC providers can now refer any patient for CHW services as part of usual care, and at present, CHWs are serving about 200 cancer patients. As such, the team was able to successfully develop and implement a streamlined pipeline to cancer care by reducing the time to correct diagnosis and demonstrated early success in care implementation.

Additionally, the ALCANCE team is expanding implementation of their CHW model to the San Joaquin Valley and identifying opportunities to improve evidence-based care delivery in close collaboration with a new local CAB. The ALCANCE project has demonstrated that implementation of their CHW approach for improved cancer care can be sustainable and effective, providing a model for other counties and states to successfully implement CHWs in primary and specialty care to reduce health inequities.

Challenges facing the team

The ALCANCE team faced several challenges during the project. The COVID-19 pandemic led to a complete halt in non-essential research activities and work had to be delayed due to an inability to visit community clinic sites at CSVS or PCC during the early period of the pandemic. The team demonstrated flexibility in transitioning to a remote and hybrid delivery model to continue the study and pivoted to existing COVID-19 testing and vaccination sites to reach the community. Additionally, the timeline for IRB approval was a logistical challenge for the team and took longer than anticipated. Institutional barriers delayed the finalization of subawards for community partners and the team experienced initial challenges in hiring CHWs that were overcome by word-of-mouth. The team also experienced delays in CHWs' integration in the primary care pipeline at the clinics, and experienced issues in establishing a standard protocol to escalate the capacity for genetic testing at clinical sites.

Training and education

The ALCANCE project supported 11 trainees across the career span from undergraduate trainees through career researchers. Several trainees achieved significant milestones in their careers, including a Stanford University Internal Medicine Residency, an Assistant Professorship in Hematology and Oncology at Northwestern University, and a Chief Residency in Pediatrics at Boston Medical Center. Additionally, the ALCANCE team hired and trained nine CHWs. All of these CHWs remain involved in community health, and many are advancing their career through higher education, such as graduate school for physical therapy or for a master's in public health. The ALCANCE team provided many professional enhancement opportunities for staff and community partners, including conference attendance, authorship opportunities for staff at all levels, shadowing opportunities, and specialized training. The team also presented the project's accomplishments at community clinics and events and hosted provider trainings for clinicians as well.

Collaborations and partnerships

The ALCANCE project led to partnerships with the Latino Cancer Institute, the Cancer Patients Alliance, CSVS and PCC. The Latino Cancer Institute was responsible for forming and running the CAB, produced a newsletter quarterly with project updates, and leveraged their network to assist with hiring and training CHWs. The Cancer Patient's Alliance enabled the creation of the CHW role at PCC, guided the preparation of job descriptions, scope of practice, hiring, and training of all CHWs serving at PCC and CSVS, and advised on the IRB process. PCC and CSVS each served as study sites and provided significant support from senior leadership that facilitated project initiation, including the hiring of the CHW roles as part of the project. Leadership from each site participated in monthly research meetings with the full team, in addition to CAB board meetings. Notably, the partnership with CSVS was new and members of the ALCANCE team will continue this partnership for future studies. The ALCANCE team also formed connections with the Food Bank of Monterey and the Monterey County Department of Public Health.

Future funding and research

The ALCANCE project secured additional external funding to continue and expand upon its current CIAPM-supported research on reducing cancer health disparities in Monterey County. To explore food insecurity and test a medically-tailored supplemental nutritional program for patients with cancer and their families, the team received $46,000 from the Stanford Cancer Center Innovation Fund.

Through this work, the ALCANCE team is providing six months of supplemental nutrition assistance to 30 patients and their families through a voucher card for fresh fruits and vegetables. The ALCANCE team was awarded $300,000 from the American Cancer Society Navigation Capacity-Building Initiative Grant Program to continue and expand CHW activities at PCC. The ALCANCE team, in collaboration with the Veterans Affairs (VA) Palo Alto Health Care System, also received $100,000 from the LUNGevity Foundation to further the implementation of a similar CHW-led approach among 40 Veterans in the VA Palo Alto Health Care System. Currently, the team has plans to implement the use of digital technology, including patient-centered and community co-designed video,s to improve patient understanding of precision medicine. Thus, the team was able to successfully implement a multistakeholder framework that was key in attracting further funding of this work.

Advantage of CIAPM's funding opportunity

CIAPM's focus on underrepresented populations is a unique opportunity to leverage precision medicine research that improves clinical outcomes for communities with cancer and differs from cancer-related precision medicine grant programs from other funders. Additionally, CIAPM's requirement to engage community partners leads to more effective, acceptable, and sustainable approaches for cancer research and care.

Expert Evaluation

By Dr. Gloria Coronado and Meg Gaines

The project's goals were to increase knowledge of precision medicine and encourage participation of underrepresented groups in the precision care pipeline.

Given that low-income and minoritized populations often experience disproportionately high rates of cancer incidence and mortality, often going untreated or having no access to evidence-based care, the team sought an intervention that takes patients' linguistic, cultural, and socioeconomic factors into account to increase access and knowledge of precision cancer care.

The evaluators felt positively about the scientific merits and technical quality of the CHW approach to improve access to care for low-income and minoritized populations. This includes positive review of the novelty of the project, given that few studies have looked at the efficacy of using CHWs to deliver cancer care and increase precision medicine access in minoritized communities.

Clinically, the team also rigorously screened patients at a Federally Qualified Health Center for prevention, testing, and cancer diagnoses. By selectively recruiting and risk-testing patients who were overdue for routine cancer screens, scheduling their clinical visits, offering education about cancer screens and family/individual medical histories, CHWs were able to identify eligible candidates and empower them to talk about and request genetic cancer tests.

The study broke patients down into control and treatment groups, where treated patients received education on 1) precision genetic and tumor testing and targeted therapies, 2) general cancer topics, 3) advanced care planning, and 4) community resources relevant to their current predicament and social determinants of health.

The evaluators were satisfied with the completion of all milestones in the project, including the fact that both the study and the CAB continued regular virtual meetings throughout the COVID-19 pandemic. The Stanford team made the most of the pandemic, by volunteering at COVID-related health fairs and vaccination sites as a nexus to distribute general precision and cancer care information, despite logistical pauses of the study caused by COVID-19.

The evaluators felt that the project advanced the understanding of how to embed CHWs within communities and clinical care to educate and support medically underserved communities, empowering patients to make personalized and informed decisions about cancer care.

The intervention group demonstrated improved knowledge about precision cancer medicine (nearly **two-fold** improvement), and those diagnosed with cancer were **three-times** more likely to receive recommended tumor testing than the control group. One evaluator noted that this finding represents a 'gateway to targeted therapies…and increased tumor testing' for improved outcomes in Latinx and other minoritized populations, demonstrating that precision medicine tools can be taught and advocated for by patients.

The study also established a framework for how CHWs can be an integral part of the care pipeline,

having received instruction on interactive cultural and cancer care training. The CHWs were then embedded in the primary care system with dedicated positions and streamlined insurance reimbursement.

Overall, the evaluators were impressed by the ultimate project outcome of improving precision cancer care for the largely Latinx and low-income populations of Monterey County and felt that the research model was applicable statewide. The Stanford team also demonstrated impact in training CHWs throughout Monterey County and the eventual release of a publicly available cancer navigation toolkit (including training, protocols, and workflows).

Further, the evaluators felt the study could be adapted modularly depending on the goals of other programs, in that CHWs engage with patients at distinct points in the cancer diagnosis pipeline. From screening to genetic testing and coaching, education and care, and recruitment to clinical trials, the study has several points of applicability to other providers and patients. The evaluators felt that the project would largely succeed in an expanded model and anxiously anticipate the publication of the full budget and impact assessment.

Further, evaluators felt that the research model has high potential to attract additional public or philanthropic dollars to increase precision care access given its successes. This includes disentangling insurance barriers to accessing care for minoritized populations and considering these barriers as part of future research grant objectives and successful proposals.

Assessment of How the Project Addressed Programmatic Goals

Improvements on patient outcomes and reducing health disparities

The research program resulted in 153 primary care patients receiving personal and family medical history screening and genetic testing information in the *Screening and Prevention* intervention. CHWs also provided in-person interpretation services at pre-genetic counseling visits and saliva sample collection, helping to ensure up-to-date screenings or re-continuity of care.

CHWs also guided 57 patients through their cancer diagnosis and care. These patients demonstrated significant increases in their knowledge about precision medicine and seeking out and receiving advanced care, such as targeted therapeutics and molecular testing. While both control and intervention patient groups had low knowledge of precision medicine at the beginning of the study, at 6-months the intervention group demonstrated increased pursuit of care and were **three-times** more likely to receive tumor testing.

Ultimately, the evaluators were convinced that the CHW intervention group benefited and may be better situated in the long-term to address and advocate for their improved cancer care or risks, creating a permanent benefit to Monterey County and Latinx communities. They also felt confident that significant increases in high-risk patient genetic testing would encourage integration and implementation of the model in the care continuum, allowing clinicians to be more in line with medically recommended screening guidelines.

Application and understanding of precision medicine to address cancer health disparities

To inform the development of their interventions, the team conducted interviews with patients to understand the specific barriers to cancer care and treatment faced at each clinic site. Key findings from these interviews included barriers such as (1) low cancer health literacy, (2) challenges in communicating and receiving supportive services due to language barriers, (3) stress and anxiety regarding financial hardships related to job loss, insurance barriers, and the COVID-19 pandemic, and (4) the need for supportive, bilingual, and bicultural personnel to assist in overcoming these challenges. The team developed tailored CHW-based interventions based on these findings.

The CHW model in this study moved the field of care forward by increasing the understanding and efficacy in treating minoritized cancer patients. CHWs helped improve the use of, or seeking of, genetic screening with medical providers, as well as improved outreach to engage and educate community members in precision care that they normally did not have.

As a result of the CHW efforts, patients in the care intervention group experienced a nearly **two-fold** reduction in delayed diagnoses, which evaluators felt was likely to continue as CHWs permanently integrated into the care continuum.

Develop tools, data, and genomics data to use in prevention, diagnosis, and treatment

The research team developed a cancer patient resource website,[41] allowing Monterey County residents to find cancer care resources. The team also increased the use of genetics and genomics data directly into patient cancer care via genetic testing for cancer-related risk genes and tumor testing at each respective health care organization, as well as detailed family histories and how to discuss test results and genetic information with clinicians.

Administratively, the team also developed CHW training curricula in cancer care, screening, prevention, new job descriptions, and bilingual educational materials in English and Spanish, allowing for larger application and scale in other counties and states.

Develop new precision medicine assets, capabilities, and infrastructure

The research team established the utility of a CAB and greatly improved on the care infrastructure, with new collaborations between providers, insurers, and community organizations.

Academically, the team also disseminated their research findings in 18 peer-reviewed manuscripts in high-impact journals and presented over 100 oral and poster presentations at national and international symposia. The team also raised the profile of CHWs to recruit participants in precision medicine interventions by being highlighted in 15 press pieces and disseminating precision cancer care educational materials broadly.

Additionally, during the course of this project, PCC was able to begin billing CHW services to Medi-Cal for reimbursement, which greatly enhanced the sustainability of the CHW model. As a result of this project and Medi-Cal reimbursement, PCC providers can now refer any patient for CHW services as part of usual care. At present, CHWs are serving about 200 cancer patients.

Engage patients in research and clinical practice

The researchers heavily respected the level of trust that CHWs foster with patients and the community in engaging in cancer screens, treatments, and the larger research and precision medicine enterprise. Both evaluators were impressed by the ability to deliver patients into a research and care framework via trusted messaging, including reinforcement of patient privacy and security, and 100% participant completion of informed consent and willingness to partake in the study. Assuming that clinicians remain committed and patient populations become engaged and value genetic testing, the evaluators believe this research model will continue and is scalable to other clinics.

Engage researchers and collaborators from underrepresented backgrounds

From project inception, community members Ysabel Duron of The Latino Cancer Institute and Dr. Dale O'Brien of the Cancer Patients Alliance, were engaged in the role of community Co-Investigators. Ms. Duron is both a cancer survivor and Latina who has served as a strong guiding voice throughout the ALCANCE Project to ensure appropriate community outreach. Ms. Duron led the CAB, and along with Drs. Goldman Rosas and Patel, was instrumental in recruiting diverse stakeholders including patients, advocates, policymakers, payers, and clinicians to serve on the CAB.

The CAB was 'the primary engine' of the project, allowing large and diverse grassroot representation by minoritized communities from the start of the project. This forum also served as a nexus for researchers and collaborators to gather in one space and determine project goals together. Spanning 40+ members, the group met quarterly and received evaluations from the research team on effectiveness and sustainment.

The program also built training capacity for CHWs in the cancer screening, prevention, and education space, requiring over 30+ hours of instruction and interactive training, and embedding nine CHWs in Monterey County via the CSVS and PCC clinics. This was a crucial structural addition to the project, given that both clinics serve a heavily Latinx population of patients and 25 states, including California, provide cost reimbursements to CHWs for services.[42] Thus, the project demonstrated that culturally tailored curricula can go a long way in providing those services, and that a multi-stakeholder approach can achieve a precision medicine program.

Conclusion

Overall, the Stanford team implemented a CHW model to improve cancer care and treatment in

41 Monterey County Cancer Patient Resources.

42 State Policies for Expanding Medicaid Coverage of Community Health Worker (CHW) Services (2023). Kaiser Family Foundation.

Latinx communities within Monterey County. They used a community-centered research model, in partnership with Clinica de Salud del Valle de Salinas, Pacific Cancer Care, and the Community Advisory Board to develop and implement tailored CHW-based interventions for Latinx and low-income cancer patients. This project advances the understanding of the role of CHWs in delivering precision medicine interventions to underserved communities. The project can serve as a scalable model for delivering culturally-tailored precision medicine to medically underserved communities and the products created through this program can be used by other programs across the state and nationally.

CONCLUSIONS OF THE CANCER DISPARITIES RESEARCH PROGRAM

The CIAPM Cancer Disparities Research Program left lasting impacts in the field of precision cancer care in the State of California by identifying barriers to effective cancer care, defining effective cancer care practices, and developing early successes in the implementation of novel research and care techniques.

Collectively, the program trained over 21 trainees and 33 community health workers whose impacts in their California communities will be long felt.

Additionally, the programs demonstrated that community health workers (or *promotoras)* can improve the cancer care of minoritized cancer patients and modifications to the cancer care continuum can improve outcomes. This includes teaching and empowering patients with low-health literacy about their familial risk to cancer and the precision tools available in healthcare.

Two of the projects demonstrated the modern capabilities of 'big data,' in that including more underrepresented patients can refine the accuracy of genetic risk assessments and potentially correlate those data with new therapeutic targets and candidate therapeutic options.

The program also provided lasting services and knowledge in the communities they served, educating nearly 2000 participants about how cancer genetics work and their individual risks and barriers to care. The program also provided over 1400 participants in-depth family history screens and/or direct preventative genetic testing services to over 200 patients. The program further obtained over 1700 California tumor samples to study and compare across national and international databases of tens-of-thousands of tumor samples.

Further, these projects helped many of the academic-based researchers engage more intimately with community-based research, including understanding many of the barriers behind participant recruitment and structural barriers within the healthcare system. It also provided an opportunity for the researchers to offer solutions that can improve on community engaged research from their first-hand experiences.

Lastly, the program demonstrated that precision medicine health outcomes require a multi-stakeholder approach, in that cancer patients benefit from an accessible and culturally-competent, front-facing healthcare system that is directly intertwined with researchers who have capable computational infrastructure to analyze patient data. This infrastructure can lead to the implementation of precision medicine in which each patient receives the right treatment at the right time, based on personalized preventative, diagnostic, and treatment strategies.

APPENDIX A: EXPERT EVALUATORS

Gloria Coronado, PhD

Professor

University of Arizona

Dr. Gloria Coronado is the Associate Director of Population Science at the University of Arizona Cancer Center and the Maynard Chair in Prevention Research. Dr. Coronado is an epidemiologist who champions affordable, long-term solutions to health disparity issues. She leads a well-funded research portfolio that inspires health system leaders to make sensible, evidence-informed choices to engage hard-to-reach populations in life-saving preventive behaviors. Dr. Coronado's research uses existing health system data and population segmentation approaches to proactively deliver outreach to patients who need it the most. Her research strives to promote health care efficiency while advancing equity. Dr. Coronado's team specializes in applying patient-engagement strategies to develop culturally relevant health education material. Materials developed by her team (both English- and Spanish-language patient-facing materials) have been disseminated to hundreds of health systems and community organizations across the United States. Dr. Coronado has developed several innovative, cost-effective interventions to improve the rates of participation in cancer screening of patients served by community health centers. Her work has led to successful partnerships with large health plans, state institutions, and community clinics. Dr. Coronado received her PhD in epidemiology from the University of Washington and then was a Research Associate Professor in the university's Department of Epidemiology. She also received training at Stanford University.

Martha "Meg" Gaines, JD, LLM

Distinguished Clinical Professor Emerita

University of Wisconsin

Meg Gaines founded the interdisciplinary Center for Patient Partnerships at the University of Wisconsin, served as Director for 20 years, and is currently the Director Emerita. The Center's mission is to disrupt dysfunctional health care by restoring people to the core of care. Professor Gaines' work

focuses on consumer engagement and empowerment in health care reform, health professionals' education, and access to high quality, effective health care. She has collaborated with the Robert Wood Johnson Foundation (RWJF), the Kaiser Family Foundation (KFF), the American Board of Internal Medicine Foundation (ABIMF), the Josiah Macy Jr Foundation, and the National Cancer Institute (NCI) among others. She currently serves on the Board of the Academy of American Medical Colleges (AAMC) and previously on the Boards of the National Quality Forum (NQF), the Academy on Communication in Healthcare (ACH), and the National Cancer Research Advocates of the NCI (NCRA). She co-chaired the Josiah Macy Jr Foundation annual conference "*Partnering with Patients, Families, and Communities to Link Interprofessional Practice and Education.*" Recent publications include the National Academies of Sciences, Engineering, and Medicine's Committee report on the *Vital Directions for Health and Healthcare* and *Making Medicines Affordable: A National Imperative*, the Association of American Medical Colleges paper on the *Charter on Organizational Professionalism for Healthcare Organizations* as a companion to the *Charter on Medical Professionalism* of the Choosing Wisely Campaign, and the American Medical Association publications on *How HIPAA Harms Care, and How to Stop It* and *Changing the Game of Prior Authorization: The Patient Perspective* with Dr. Don Berwick, MD. She is a graduate of Vassar College (A.B.) and the University of Wisconsin Law School (JD, LLM) and a "durable survivor" of metastatic ovarian cancer.

She previously served on CIAPM's Cancer Disparities Selection Committee.

Elizabeth Gross Cohn, RN, PhD, FAAN

Vice President for Health Equity Research

Northwell Health

Dr. Elizabeth Gross Cohn is the Vice President for Health Equity Research at Northwell Health and Professor at the Institute for Health System Science at the Feinstein Institute for Medical Research in the Zucker School of Medicine at Hofstra University. Her research focuses on the ethical and social issues at the intersection of precision medicine and health disparities through the engagement of underrepresented communities, community-engaged research, and the ethical, legal, social, and scientific issues of emerging technologies and public health. Her model for translating the lab to the living room promotes interactions between scientists and the communities they serve. Through this work, she has developed an interactive graphic novel, a community education program on precision medicine, and a decision tool for community faith-leaders who are advising congregants on research participation. She is part of the leadership of the Communities of Harlem Health Revival, a member of the New York State Health Equity Council, a Fellow in the New York Academy of Medicine, and she mentors investigators in community-based and community-engaged research. Dr. Gross Cohn was named a 2016 White House Champion of Change in Precision Medicine for her work at the intersection of precision medicine, public health, and health equity. Dr. Cohn received her associate degree from Nassau Community College, her bachelor's Degree from the State University of New York at Purchase, her master's degree and Nurse Practitioner training from the State University of New York at Stony Brook, and her Doctorate from Columbia University.

She previously served on CIAPM's Cancer Disparities Selection Committee.

Jennifer Mack, MD, MPH

Associate Professor

Harvard University

Dr. Jennifer Mack is a Senior Physician, the Associate Chief of the Division of Population Sciences, and an Associate Professor in Pediatrics at Harvard Medical School. As a pediatric oncologist, she has a particular interest in cancer-related communications as a model for all difficult medical conversations. Her work focuses on communication about the cancer diagnosis, cancer treatment decision-making, and the transition to palliative care, where communication can have a major impact on the way care unfolds at the end of life. The overarching objective of her work is to build patient-clinician relationships and improve patient outcomes through effective communication. She has developed clinical expertise in communication through dedicated inpatient and outpatient care of childhood cancer patients, created a body of research that defines specific attributes and outcomes of high-quality communication, and trained pediatric hematology/oncology fellows and other physicians to communicate effectively with patients and families. Ultimately, Dr. Mack hopes that this work will enable valid assessment of care quality, and rigorous evaluation of interventions that improve the delivery of adolescent and young adult end-of-life care. Dr. Mack received her MD from Harvard Medical School, completed a residency in Pediatrics, and a fellowship in Pediatric Hematology Oncology and Pediatric Palliative Care between Children's Hospital Boston and Dana-Farber Cancer Institute. Dr. Mack also received a Master's in Public Health from the Harvard School of Public Health.

Elaine Mardis, PhD

Professor

Ohio State University

Dr. Elaine Mardis is Co-Executive Director of the Steve and Cindy Rasmussen Institute for Genomic Medicine at Nationwide Children's Hospital and holds the Rasmussen Nationwide Foundation Endowed Chair in Genomic Medicine. She is also a Professor of Pediatrics at The Ohio State University College of Medicine. Dr. Mardis is an internationally recognized expert in cancer genomics, with ongoing interests in the 1) integrated characterization of cancer genomes, 2) defining DNA-based somatic and germline interactions and RNA-based pathways, and 3) immune microenvironments that lead to cancer onset and progression, specifically involving pediatric cancers. Most recently, her research has been oriented toward translational aspects of cancer genomics, such as 1) identifying

how the cancer genome changes with treatment, including acquired resistance, 2) the use of genomics in understanding immune therapy response, and 3) the clinical benefit of cancer molecular profiling in the pediatric setting. Dr. Mardis served as president of the American Association for Cancer Research (AACR) from 2019-2020. In 2019, she was elected a fellow of the AACR Academy and a member in the prestigious National Academy of Medicine. Educated at the University of Oklahoma with a B.S. in Zoology and a PhD in Chemistry and Biochemistry, Dr. Mardis conducted postgraduate work in industry at BioRad Laboratories. She was on the faculty of Washington University School of Medicine from 1993-2016, where she served as co-director of the McDonnell Genome Institute at Washington University.

Dr. Mardis previously served on CIAPM's Cancer Disparities Selection Committee and the 2018 CIAPM Evaluation Committee.

Rulla Tamimi, SciD, MS

Professor

Cornell University

Dr. Rulla Tamimi is a Professor of Population Health Sciences, Division Chief of Epidemiology, and Professor of Epidemiology in Pathology and Laboratory Medicine at Cornell University. As the Associate Director for Population Science at the Sandra and Edward Meyer Cancer Center, she works closely with an interdisciplinary group of investigators to study cancer risk and survival, with the goal of reducing morbidity and mortality in the New York City area. Her research goal is to better understand breast cancer risk and prognosis by designing epidemiological studies that integrate biomarkers, imaging, and lifestyle factors. Specifically, her research has focused on intermediate markers of breast cancer risk including mammographic density and benign breast diseases. As a principal investigator on numerous NIH-funded grants and author of over 200 peer-reviewed publications, she has identified a number of genetic, molecular and lifestyle predictors of breast cancer risk. Her foundational work includes studies on early life and environmental exposures' link to breast disease, molecular characterization of breast tumors, and mammographic density as a predictor of breast cancer. Dr. Tamimi received her bachelor's degree from Tufts University and her master's degree and doctorate in epidemiology from the Harvard T. H. Chan School of Public Health. Previously, she was an associate professor in epidemiology at the Harvard T.H. Chan School of Public Health, associate professor of medicine at Harvard Medical School, and the co-lead of the Breast Cancer Program at the Dana Farber/Harvard Cancer Center.

APPENDIX B: PUBLICATIONS, PRESS RELEASES, AND PRESENTATIONS GENERATED AS A RESULT OF CIAPM-FUNDED RESEARCH

Improving Breast Cancer in Latinas: A Multi-Tiered Approach – UC San Francisco

Publications

1) Shieh, Y., et al. (2020). A Polygenic Risk Score for Breast Cancer in US Latinas and Latin American Women. J Natl Cancer Inst 112(6): 590-598.
2) Zavala, V. A., et al. (2021). Cancer health disparities in racial/ethnic minorities in the United States. Br J Cancer 124(2): 315-332.
3) MP Douglas, GA Lin, JR Trosman, KA Phillips, Hereditary cancer panel testing challenges and solutions for the latinx community: costs, access, and variants J Community Genet 2022 Feb;13(1):75-80. doi: 10.1007/s12687-021-00563-y. Epub 2021 Nov 6.
4) Reyna M, Almeida R, Lopez-Macha A, Fuller S, Duron Y, Fejerman L. Training promotores to lead virtual hereditary breast cancer education sessions for Spanish-speaking individuals of Latin American heritage in California. BMC Womens Health. 2022 Aug 8;22(1):336. doi: 10.1186/s12905-022-01902-y. PMID: 35941639
5) Lizeth I Tamayo, Fabian Perez, Angelica Perez, Miriam Hernandez, Alejandra Martinez, Xiaosong Huang, Valentina Zavala, Elad Ziv, Susan L. Neuhausen, Luis Carvajal- Carmona, Ysabel Duron, Laura Fejerman. Cancer screening and breast cancer family history in Spanish-speaking Hispanic/Latina women in California. Front. Oncol., 26 October 2022 Sec. Cancer Epidemiology and Prevention.
6) Yuan C Ding*, Hanbing Song*, Aaron Adamson*, Daniel Schmolze, Donglei Hu, Scott Huntsman, Linda Steele, Carmina Patrick, Shu TaoNatalie Hernandez, Charleen D Adams, Laura Fejerman, Kevin L. Gardner, Anna María Nápoles, Eliseo J. Pérez-Stable, Jeffrey N. Weitzel, Henrik. Bengtsson, Franklin W. Huang, Susan L. Neuhausen+, Elad Ziv+ Profile of the somatic mutational landscape in breast tumors from Hispanic/Latina women, Cancer Research PMID: 37145128; PMCID: PMC10390863. *Joint first authors, +Joint senior authors
7) Fabian Perez, Miriam Hernandez, Alejandra Martinez, Patricia Castaneda, Raquel Ponce, Maria Gonzalez, Cindia Martinez, Angelica Perez, Juanita Elizabeth Quino, Eric Robles Garibay, Valentina A. Zavala, Xiaosong Huang, Susan L Neuhausen, Elad Ziv, Luis Carvajal- Carmona, Ysabel Duron, Laura Fejerman. Promotores' perspectives on the virtual adaptation of a hereditary breast cancer education program. J Genet Counseling; 2023 Dec;32(6):1226-1231, PMID: 37747056.
8) Nierenberg JL, Adamson AW, Hu D, Huntsman S, Patrick C, Li M, Steele L, Tong B, Shieh Y, Fejerman L, Gruber SB, Haiman CA, John EM, Kushi LH, Torres-Mejia G, Ricker C, Weitzel JN, Ziv E*, Neuhausen SL*. Whole exome sequencing and replication for breast cancer among Hispanic/Latino women identifies FANCM as a susceptibility gene for estrogen-receptor- negative breast cancer. medRxiv. 2023 Jan 28. PMID: 36747679; PMCID: PMC9901069. * Joint senior and co-corresponding authors.

Presentations

1) Nierenberg JL, Adamson A, Zavala V, Lott P, John E, Hu D, Huntsman S, Weitzel J, Torres-Mejia G, Haiman C, Kushi L, Fejerman L, Carvajal-Carmona L, Neuhausen S, and Ziv E. Common RAD52 variants are associated with decreased breast cancer risk among US Latinas and Latin American women. Oral presentation at the Breast Oncology Program Scientific Retreat, Best Abstract Award. March 2021.
2) Nierenberg JL, Adamson A, Ding YC, Shieh Y, Hu D, Huntsman S, John EM, Torres-Mejia G, Haiman CA, Kushi LH, Ricker CN, Steele L, Lee R, Weitzel JN, Fejerman L, Neuhausen SL, and Ziv E. Breast cancer polygenic risk scores and rare variants in Latinas. Oral poster talk and poster presentation at the American Society for Human Genetics Annual Meeting, Reviewers' Choice poster award. October, 2021.
3) Nierenberg JL, Adamson A, Ding YC, Shieh Y, Hu D, Huntsman S, John EM, Torres-Mejia G, Haiman CA, Kushi LH, Ricker CN, Steele L, Lee R, Weitzel JN, Fejerman L, Ziv E, and Neuhausen SL. Pathogenic Variants in Breast Cancer Risk Genes in Latinas. Poster presentation at the American Association for Cancer Research Disparities Conference. October, 2021.
4) Nierenberg JL, Adamson A, Ding YC, Shieh Y, Hu D, Huntsman S, John EM, Torres-Mejia G, Haiman CA, Kushi LH, Ricker CN, Steele L, Lee R, Weitzel JN, Fejerman L, Neuhausen SL, and Ziv

E. Breast Cancer Risk Genes and Common Variant Risk Scores in Latinas. Poster presentation at the Breast Oncology Program Scientific Retreat. March, 2022.

5) Pooja Middha Kapoor, Angel C.Y. Mak, Linda Kachuri, Donglei Hu, Scott Huntsman, Lawrence H. Kushi, Christopher Haiman, Esther M. John, Gabriela Torres-Mejia, Esteban G. Burchard, Susan L. Neuhausen, Laura Fejerman, Elad Ziv. Transcriptome-wide association study identifies novel genes associated with breast cancer susceptibility in Latinas. Oral presentation at the American Association of Cancer Research 2022. Award: AACR Scholar- in-training
6) Pooja Middha, Angel C.Y. Mak, Linda Kachuri, Donglei Hu, Scott Huntsman, Lawrence H. Kushi, Christopher Haiman, Esther M. John, Gabriela Torres-Mejia, Esteban G. Burchard, Susan L. Neuhausen, Laura Fejerman, Elad Ziv. Transcriptome-wide association study of breast cancer risk in Latinas. Oral presentation and poster presentation at the UCSF Breast Oncology Program 2022Award: BOP Best poster award
7) Nierenberg JL, John EM, Torres-Mejia G, Haiman CA, Kushi LH, Gruber S, Weitzel JN, Fejerman L, Ziv E, Neuhausen SL. Pathogenic Variants in Breast Cancer Susceptibility Genes and Polygenic Risk among US Latinas and Mexican Women. Submitted to the International Genetic Epidemiology Society Annual Meeting. Paris, France, Presented, September 2022.
8) Pooja Middha, Linda Kachuri, Angel C.Y. Mak, Donglei Hu, Scott Huntsman, Lawrence H. Kushi, Christopher Haiman, Esther M. John, Gabriela Torres-Mejia, Esteban G. Burchard, Susan L. Neuhausen, Laura Fejerman, Elad Ziv Transcriptome-wide association study identifies new breast cancer susceptibility genes in Latinas. American Society of Human Genetics Oct 2022
9) Jovia L. Nierenberg, Aaron Adamson, Yuan Chun Ding, Yiwey Shieh, Donglei Hu, Scott Huntsman, Esther M. John , Gabriela Torres-Mejia, Christopher A. Haiman, Lawrence H. Kushi, Charite N. Ricker, Linda Steele, Robin Lee, Jeffrey N. Weitzel, Laura Fejerman , Susan L. Neuhausen, and Elad Ziv FANCM and ZNF404 identified as risk genes for breast cancer in Latinas. Presented at the American Society of Human Genetics Oct 2022

Integrated Machine-Learning Platform to Inform Precision Therapy in Breast Cancer Patients (Celsus Project) – UC San Diego

Publications

1) Joshi S, Liu KX, Zulcic M, Singh AR, Skola D, Glass CK, Sanders PD, Sharabi AB, Pham TV, Tamayo P, Shiang D, Dinh HQ, Hedrick CC, Morales GA, Garlich JR, Durden DL. Macrophage Syk-PI3Kγ Inhibits Antitumor Immunity: SRX3207, a Novel Dual Syk-PI3K Inhibitory Chemotype Relieves Tumor Immunosuppression. Mol Cancer Ther. 2020 Mar;19(3):755-764. doi: 10.1158/1535-7163. MCT-19-0947. Epub 2020 Jan 23. PubMed PMID: 31974273; NIHMSID:NIHMS1550106.
2) Liu C, Sadat SH, Ebisumoto K, Sakai A, Panuganti BA, Ren S, Goto Y, Haft S, Fukusumi T, Ando M, Saito Y, Guo T, Tamayo P, Yeerna H, Kim W, Hubbard J, Sharabi AB, Gutkind JS, Califano JA. Cannabinoids Promote Progression of HPV-Positive Head and Neck Squamous Cell Carcinoma via p38 MAPK Activation. Clin Cancer Res. 2020 Jun 1;26(11):2693-2703. doi:10.1158/1078-0432. CCR-18-3301. Epub 2020 Jan 13. PubMed PMID: 31932491.
3) Pham TV, Boichard A, Goodman A Riviere P, Yeerna H, Tamayo P, Kurzrock R. Role of ultraviolet mutational signature versus tumor mutation burden in predicting response to immunotherapy [published online ahead of print, 2020 Jun 12]. Mol Oncol. 2020;10.1002/1878-0261.12748. doi:10.1002/1878-0261.12748.
4) Panda A, Yadav A, Yeerna H, Singh A, Biehl M, Lux M, Schulz A, Klecha T, Doniach S, Khiabanian H, Ganesan S, Tamayo P, Bhanot G. Tissue- and development-stage-specific mRNA and heterogeneous CNV signatures of human ribosomal proteins in normal and cancer samples. Nucleic Acids Res. 2020 Jul 27;48(13):7079-7098. doi: 10.1093/nar/gkaa485. PubMed PMID: 32525984.
5) Stern JL, Hibshman G, Hu K, et al. Mesenchymal and MAPK Expression Signatures Associate with Telomerase Promoter Mutations in Multiple Cancers. Mol Cancer Res. 2020;18(7):1050-1062. doi:10.1158/1541-7786.MCR-19-1244.
6) Rusert JM, Juarez EF, Brabetz S, Jensen J, Garancher A, Chau LQ, Tacheva-Grigorova SK, Wahab S, Udaka YT, Finlay D, Seker-Cin H, Reardon B, Gröbner S, Serrano J, Ecker J, Qi L, Kogiso M, Du Y, Baxter PA, Henderson JJ, Berens ME, Vuori K, Milde T, Cho YJ, Li XN, Olson JM, Reyes I, Snuderl M, Wong TC, Dimmock DP, Nahas SA, Malicki D, Crawford JR, Levy ML, Van Allen EM, Pfister SM, Tamayo P, Kool M, Mesirov JP, Wechsler-Reya RJ. Functional Precision Medicine Identifies New Therapeutic Candidates for Medulloblastoma. Cancer Res. 2020 Dec 1;80(23):5393-5407. doi: 10.1158/0008-5472.CAN-20-1655. Epub 2020 Oct 12. PMID: 33046443; PMCID: PMC7718387.

7) Lee S, Jun J, Kim WJ, Tamayo P, Howell SB. WNT Signaling Driven by R-spondin 1 and LGR6 in High-grade Serous Ovarian Cancer. Anticancer Res. 2020 Nov;40(11):6017-6028. doi: 10.21873/anticanres.14623. PMID: 33109540.
8) Li J, Tiwari M, Xu X, Chen Y, Tamayo P, Sen GL. TEAD1 and TEAD3 Play Redundant Roles in the Regulation of Human Epidermal Proliferation. J Invest Dermatol. 2020 Oct;140(10):2081-2084.e4. doi: 10.1016/j.jid.2020.01.029. Epub 2020 Mar 3. PMID: 32142794; PMCID: PMC7483246.
9) Ren S, Gaykalova DA, Guo T, Favorov AV, Fertig EJ, Tamayo P, Callejas-Valera JL, Allevato M, Gilardi M, Santos J, Fukusumi T, Sakai A, Ando M, Sadat S, Liu C, Xu G, Fisch KM, Wang Z, Molinolo AA, Gutkind JS, Ideker T, Koch WM, Califano JA. HPV E2, E4, E5 drive alternative carcinogenic pathways in HPV positive cancers. Oncogene. 2020 Oct;39(40):6327-6339. doi: 10.1038/s41388-020-01431-8. Epub 2020 Aug 26. PMID: 32848210; PMCID: PMC7529583.
10) Li, J., Xu, X., Tiwari, M. et al. SPT6 promotes epidermal differentiation and blockade of an intestinal-like phenotype through control of transcriptional elongation. Nat Commun 12, 784 (2021).
11) Maynard RE, Poore B, Hanaford AR, Pham K, James M, Alt J, Park Y, Slusher BS, Tamayo P, Mesirov J, Archer TC, Pomeroy SL, Eberhart CG, Raabe EH. TORC1/2 kinase inhibition depletes glutathione and synergizes with carboplatin to suppress the growth of MYC-driven medulloblastoma. Cancer Lett. 2021 Apr 28;504:137-145. doi: 10.1016/j.canlet.2021.02.001. Epub 2021 Feb 8. PMID: 33571541.
12) Hahn WC, Bader JS, Braun TP, Califano A, Clemons PA, Druker BJ, Ewald AJ, Fu H, Jagu S, Kemp CJ, Kim W, Kuo CJ, McManus M, B Mills G, Mo X, Sahni N, Schreiber SL, Talamas JA, Tamayo P, Tyner JW, Wagner BK, Weiss WA, Gerhard DS; Cancer Target Discovery and Development Network. An expanded universe of cancer targets. Cell. 2021 Mar 4;184(5):1142-1155. doi: 10.1016/j.cell.2021.02.020. PMID: 33667368.
13) Pouyanfard S, Meshgin N, Cruz LS, Diggle K, Hashemi H, Pham TV, Fierro M, Tamayo P, Fanjul A, Kisseleva T, Kaufman DS. Human induced pluripotent stem cell-derived macrophages ameliorate liver fibrosis. Stem Cells. 2021 Dec;39(12):1701-1717. doi: 10.1002/stem.3449. Epub 2021 Oct 1.
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23) Ford K, Munson BP, Fong SH, Panwala R, Chu WK, Rainaldi J, Plongthongkum N, Arunachalam V, Kostrowicki J, Meluzzi D, Kreisberg JF, Jensen-Pergakes K, VanArsdale T, Paul T, Tamayo P, Zhang K, Bienkowska J, Mali P, Ideker T. Multimodal perturbation analyses of cyclin-dependent kinases reveal a network of synthetic lethalities associated with cell-cycle regulation and transcriptional regulation. Sci Rep. 2023 May 11;13(1):7678. doi: 10.1038/s41598-023-33329-2. PMID: 37169829; PMCID: PMC10175263.
24) Rohila D, Park IH, Pham TV, Jones R, Tapia E, Liu KX, Tamayo P, Yu A, Sharabi AB, Joshi S. Targeting macrophage Syk enhances responses to immune checkpoint blockade and radiotherapy in high-risk neuroblastoma. Front Immunol. 2023 Jun 7;14:1148317. doi: 10.3389/fimmu.2023.1148317. PMID: 37350973; PMCID: PMC10283071.
25) Rohila D, Park IH, Pham TV, Weitz J, Hurtado de Mendoza T, Madheswaran S, Ishfaq M, Beaman C, Tapia E, Sun S, Patel J, Tamayo P, Lowy AM, Joshi S. Syk Inhibition Reprograms Tumor-Associated Macrophages and Overcomes Gemcitabine-Induced Immunosuppression in Pancreatic Ductal Adenocarcinoma. Cancer Res. 2023 Aug 15;83(16):2675-2689. doi: 10.1158/0008-5472.CAN-22-3645. PMID: 37306759; PMCID: PMC10416758.
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27) Panuganti BA, Carico C, Jeyarajan H, Flagg M, Tamayo P. Transcriptional subtypes of glottic cancer characterized by differential activation of canonical oncogenic programming. Head Neck. 2023 Nov;45(11):2851-2861. doi: 10.1002/hed.27514. Epub 2023 Sep 8. PMID: 37682073.
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Presentations and Talks

1) Jill Mesirov, Computational Genomic Approaches to the Understanding and Treatment of Cancer, Institute for Pure and Applied Mathematics, UCLA, January 28, 2020
2) P. Tamayo, Cellular and Tumor Archetypes: A Functional Taxonomy of Cancers, Monash University, Australia, Nov 17, 2020.
3) P. Tamayo, Cancer Archetypes: a Framework to Functionally Classify and Model Oncogenic Cellular and Tumor States. Cell-NCI Symposium: Beyond Cancer Genomics Toward Precision Oncology October 4-6, 2021 (Online).
4) P. Tamayo, Cancer Archetypes: a Framework to Functionally Classify and Model Oncogenic Cellular and Tumor States. Delivering Discoveries: Updates in Oncology October 29-30, 2021, Hyatt Regency La Jolla at Aventine, San Diego.
5) Kim, W. Integrated Machine-Learning Platform to Inform Precision Therapy in Hispanic Triple-Negative Breast Cancer Patients." (2022) 2022 Precision Medicine World Conference, June 28-30. Santa Clara, CA, USA.
6) P. Tamayo, Studying Cancer Cell States at the Single-Cell Level, Genomics and Precision medicine Division presentation. Center for Neural Circuits and Behaviour (CNBC) UCSD, July 29, 2022.
7) Kim, W. Navigating multi-level complexities of cancer cellular and molecular landscape."

(2022) 2nd Annual Delivering Discoveries: Updates in Oncology Conference, October 27– 28. San Diego, CA, USA.

8) Kim, W. Behind the Science: A Cancer Research Forum from Moores Cancer Center. May 25th (2023). UCSD MCC Community Outreach Engagement. Online
9) P. Tamayo, A tumor state model and prototype AI system to predict individual patient response to cancer therapies (Nov 3rd 2023). Designing Hope: Engineering Solutions to Cancer, Atkinson Hall UCSD.

Posters

1) Takahashi, Hideyuki., Shepard, Ryan M., Paradise, Marc A., Lee, Sang Min., Shih, Ann., Flores-Arenas Cristina., Kim, William., Varner, Judith A. "Macrophage PI3Kγ controls T cell activation and T cell memory generation through the production of IL-12." Proceedings: AACR Annual Meeting 2020; April 27-28, 2020 and June 22-24, 2020; Philadelphia, PA.

Press

1) Fikes, Bradley. 2019. "UCSD gets $3 million to fight triple-negative breast cancer." San Diego Union Tribune, February 15.
2) Fikes, Bradley. 2019. "UCSD gets $3 million to fight triple-negative breast cancer." Baltimore Sun, February 15.

Reducing Cancer Disparities Through Innovative Community-Academic Partnerships – Stanford University

Publications

1) Rodriguez, Gladys M., Leach, Maria, Osorio, Jennifer, Wood, Emily H., Duron, Ysabel, O'Brien, Dale, Koontz, Zachary, Goldman Rosas, Lisa, Patel, Manali I. (2021). "Addressing Cancer Care Needs for Latinx Adults: A Formative Qualitative Evaluation." Journal of Health Care for the Poor and Underserved.
2) Rodriguez, Gladys M., Ferguson, Jacqueline, Kurian, Allison, Bondy, Melissa, Patel, Manali I. "The impact of COVID19 on cancer: A qualitative study." American Journal of Clinical Oncology, November 2021.
3) Wood, Emily H., Leach, Maria, Villicana, Gerardo, Rosas, Lisa G., Duron, Ysabel, O'Brien, Dale G., Koontz, Zachary, & Patel, Manali I. (2022). A Community-Engaged Process for Adapting a Proven Community Health Worker Model to Integrate Precision Cancer Care Delivery for Low-income Latinx Adults With Cancer. Health Promotion Practice, 15248399221096415.
4) Patel, M. I., Wood, E. H., Charlot, M., Florez, N., Duron, Y., James, S. E., ... & Jain, S. (2022). Do no harm: A call to action on COVID-19 and mask requirements. Cancer, 128(19), 3438-3440.
5) Rodriguez, G. M., Wood, E. H., Xiao, L., Duron, Y., O'Brien, D., Koontz, Z., ... & Patel, M. I. (2022). Community health workers and precision medicine: A randomized controlled trial. Contemporary Clinical Trials, 121, 106906.
6) Wood, E. H., Leach, M., Villicana, G., Rosas, L. G., Duron, Y., O'Brien, D. G., ... & Patel, M.I. (2022). A Community-Engaged Process for Adapting a Proven Community Health Worker Model to Integrate Precision Cancer Care Delivery for Low-income Latinx Adults With Cancer. Health Promotion Practice, 15248399221096415.
7) Wood, Emily H., Patel, Manali I. McFarland, Daniel, Editor. Springer. In press 2022. Chapter 5: The role of trust in oncology across populations and cultures: implications for inequities and social justice. The Complex Role of Patient Trust in Oncology.
8) Patel, Manali I., Duron, Ysabel, O'Brien, Dale G., Koontz, Zachary. Perspectives of Low Income and Minority Populations with Lung Cancer: An Evaluation of Unmet Needs. In press, May 2022.
9) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to Clinica de Salud del Valle de Salinas Clinic Managers, Salinas, California, July 7, 2022.
10) Villicana, G., Wood, E.H., Layton, J., Rodriguez, G.M., Murillo, A., Leach, M., Osorio, J., Duron, Y., O'Brien, D.G., Koontz, Z., Patel, M.I. Community Health Worker Perspectives on Challenges and Solutions for Integrating Precision Medicine Education at Community Oncology Practices. Abstract accepted to The Academy of Oncology Nurse & Patient Navigators (AONN+) 13th Annual Navigation and Survivorship Conference, New Orleans, Louisiana, November 2022.
11) Patel, M. I., Wood, E. H., Charlot, M., Florez, N., Duron, Y., James, S. E., ... & Jain, S. (2022). Do no harm: A call to action on COVID-19 and mask requirements. Cancer, 128(19), 3438-3440.
12) Villicana, G., Wood, E.H., Layton, J., Rodriguez, G.M., Murillo, A., Leach, M., Osorio, J., Duron, Y., O'Brien, D.G., Koontz, Z., Patel, M.I. "Community Health Worker Perspectives on Challenges

and Solutions for Integrating Precision Medicine Education at Community Oncology Practices. "Abstract accepted to The Academy of Oncology Nurse & Patient Navigators (AONN+) 13th Annual Navigation and Survivorship Conference, New Orleans, Louisiana, November 2022.

13) Rodriguez G., Leach M., Osorio J., Wood E.H., Duron Y., O'Brien D., Koontz Z.M., Rosas L.G., Patel M.I. Exploring Cancer Care Needs for Latinx Adults: A Qualitative Evaluation. Supportive Cancer Care," December 2022. PubMedID: 36544063
14) Wood, Emily H., Leach, Maria, Villicana, Gerardo., Rosas, Lisa G., Duron, Ysabel, O'Brien, Dale G., Koontz, Zachary, & Patel, Manali I. (2023). A Community-Engaged Process for Adapting a Proven Community Health Worker Model to Integrate Precision Cancer Care Delivery for Low-income Latinx Adults with Cancer. Health Promotion Practice.
15) Rodriguez G., Kumar D., Patel M.I. "I have constant fear." A national qualitative study on the impact of COVID-19 on cancer care and potential solutions to improve the cancer care experience during the pandemic, Journal of Clinical Oncology Practice May 2023.
16) Wood, E. H., Rodriguez, G. M., Villicana, G., Lopez Guzman, L., Reynaga, J., Medrano, H. S., ... & Patel, M. I. (2023). The effect of a multilevel community health worker–led intervention on patient knowledge of precision medicine: A randomized clinical trial. ASCO Quality
17) Hanna, M. T., Wood, E. H., Medrano, H. S., Perez, C., Noyola, A., Villicana, G., ... & Patel, M. I. (2023). ALCANCE Food for Health Equity: Community-driven development of a food insecurity intervention for patients with cancer.
18) Kamran, R., Wood, E. H., Perez, C., Medrano, H. S., Villicana, G., Lopez Guzman, L., ... & Patel, M. I. (2023). Advancing equity in cancer care through community-academic partnerships: Results from the addressing Latinx cancer care equity—Program for long- term united skills building (ALCANCE-PLUS).

Posters

1) Gyurdzhyan, Samvel. Edwards, Jeffrey G, Duron, Ysabel, O'Brien, Dale G., Patel, Manali I, Goldman Rosas, Lisa. Reducing Cancer Disparities in Monterey County Through an Innovative Community-Academic Partnership to Advance Precision Medicine Access and Delivery. 2021 Community Health Symposium, Stanford, March 31, 2021.
2) Wood, E. H., Rodriguez, G. M., Villicana, G., Lopez Guzman, L., Reynaga, J., Medrano, H. S., ... & Patel, M. I. The effect of a multilevel community health worker–led intervention on patient knowledge of precision medicine: A randomized clinical trial. Oncology/Hematology/BMT Research Retreat at Asilomar Conference Center, Monterey, CA, September 2023.
3) Hanna, M. T., Wood, E. H., Medrano, H. S., Perez, C., Noyola, A., Villicana, G., ... & Patel, M. I. ALCANCE Food for Health Equity: Community-driven development of a food insecurity intervention for patients with cancer. Oncology/Hematology/BMT Research Retreat at Asilomar Conference Center, Monterey, CA, September 2023.
4) Wood, E. H., Rodriguez, G. M., Villicana, G., Lopez Guzman, L., Reynaga, J., Medrano, H. S., ... & Patel, M. I. The effect of a multilevel community health worker–led intervention on patient knowledge of precision medicine: A randomized clinical trial. 2023 ASCO Quality Care Symposium, Boston, MA, October 27, 2023.
5) Hanna, M. T., Wood, E. H., Medrano, H. S., Perez, C., Noyola, A., Villicana, G., ... & Patel, M. I. ALCANCE Food for Health Equity: Community-driven development of a food insecurity intervention for patients with cancer. 2023 ASCO Quality Care Symposium, Boston, MA, October 27, 2023.
6) Wood, E. H., Rodriguez, G. M., Villicana, G., Lopez Guzman, L., Reynaga, J., Medrano, H. S., ... & Patel, M. I. The effect of a multilevel community health worker–led intervention on patient knowledge of precision medicine: A randomized clinical trial. 2023 American Public Health Association Conference, November 13, 2023.

Presentations and Talks

1) Patel, Manali I. "Precision Medicine in Monterey County." Manali I Patel. 1st Annual National Latino Cancer Institute Forum hosted by The Latino Cancer Institute, San Francisco, CA, October, 2019.
2) O'Brien, Dale G., Nkwocha, Oguchi, Agustin-Garcia, Romy. "Genetic Testing and Applications of the GIA Chatbot with Invitae." Clínica de Salud del Valle de Salinas Provider Meeting, Salinas, CA, February 6, 2020.
3) Koontz, Zach. "Precision Medicine in Monterey County Project: expanding access for underserved communities." Community Hospital of the Monterey Peninsula, Monterey, CA, informal oral presentations February 12 and February 26, 2020.

4) Koontz, Zach. "Introducing the Precision Medicine in Monterey County Project in Collaboration with Stanford." Pacific Cancer Care Journal Club, Monterey, CA, March 1, 2020.
5) Duarte, Valeria, Garcia, Yesica. "Prostate Cancer Detection and Prevention." Presented at Clínica de Salud del Valle de Salinas, Salinas, CA, August 20 & 31, 2020.
6) Duarte, Valeria, Garcia, Yesica. "Colorectal Cancer Detection and Prevention." Presented at Clínica de Salud del Valle de Salinas, Salinas, CA, August 20 & 31, 2020
7) Duarte, Valeria, Garcia, Yesica. "Breast Cancer Screening and Prevention." Presented to patients at Clínica de Salud del Valle de Salinas, Salinas, CA, August 20, 31, and October 13-14, 2020.
8) Duarte, Valeria, Garcia, Yesica. "Cervical Cancer Detection and Prevention." Presented to patients at Clínica de Salud del Valle de Salinas, Salinas, CA, August 31, 2020.
9) Duarte, Valeria, Garcia, Yesica. "Lung Cancer Detection and Prevention." Presented at Clínica de Salud del Valle de Salinas, Salinas, CA, August 31, 2020.
10) Duarte, Valeria, Garcia, Yesica. "Cancer Prevention in the Time of COVID-19." Presented to patients at Clínica de Salud del Valle de Salinas, Salinas, CA, September 9, 2020.
11) Duarte, Valeria, Garcia, Yesica. "Prevención de Cáncer en Tiempo del COVID-19." Breast Cancer Presentation hosted by Migrant Education, Virtual, October 20, 2020.
12) Brooks, Victor, Duarte, Valeria, Garcia, Yesica. "Cáncer de Pecho: detección y prevención." Clínica de Salud del Valle de Salinas Community Meeting, Salinas, CA, October 21, 2020
13) Duarte, Valeria, Garcia, Yesica. "Breast Cancer Screening and Prevention." Presented to patients at Clínica de Salud del Valle de Salinas, Salinas, CA, October 31, 2020.
14) Koontz, Zach. "Introducing the Precision Medicine in Monterey County Project in Collaboration with Stanford." Pacific Cancer Care Committee Meeting, Monterey, CA, December 2020.
15) Duron, Ysabel. "The Value Added of Community Health Workers." Stanford Internal Medicine Resident Educational Conference for Stanford University, Stanford, CA (virtual), December 9, 2020.
16) Duarte, Valeria, Garcia, Yesica. "Migrant Farmworker Health Issues and Barriers to Care." Stanford Internal Medicine Resident Educational Conference for Stanford University, Stanford, CA (virtual), December 9, 2020.
17) Duarte, Valeria, Garcia, Yesica. "Factores de riesgo de enfermedades crónicas." Parent Health Workshop hosted by Migrant Education, Virtual, March 2, 2021
18) Patel, Manali I. "Value Based Care Delivery – The Influence of Data-Driven Community- Based Approaches to Improve Cancer Outcomes Equitably," invited speaker, Northern California Kaiser Permanente Grand Rounds. Virtual Presentation. May 17, 2021
19) Patel, Manali I. "Ensuring Equity in Precision Cancer Care," invited speaker, American Society of Clinical Oncology Virtual Roundtable. Virtual Presentation. May 24, 2021
20) Nkwocha, Oguchi, Goldman Rosas, Lisa. "SPHERE Precision Health Equity in Primary Care Seminar." Stanford University (virtual). June 2021.
21) Koontz, Zach, Patel, Manali I. "Precision Medicine in Monterey County Update." Cancer Care Meeting at Pacific Cancer Care, Monterey, CA. June 11, 2021.
22) O'Brien, Dale G., Nkwocha, Oguchi, Agustin-Garcia, Romy, Wood, Emily H. "Genetic Testing for Cancer Risk for Primary Care Providers: Common questions and practical applications." Clinica de Salud del Valle de Salinas. July 2021.
23) Rodriguez Espinosa, Patricia, Goldman Rosas, Lisa, Wood, Emily. "Qualitative Interviewing Training." Stanford University (virtual), July 2021.
24) Garcia, Maria R., Garcia, Yesica. "Cancer Prevention and Screening." Breastfeeding Awareness Health Fair/Walk. Soledad, CA. August 2021.
25) Garcia, Maria R., Garcia, Yesica. "Cancer Prevention and Screening." Ciclovia. Soledad, CA. August 2021.
26) Patel, Manali I. "Equity: Every Patient, Every Day, Everywhere," invited plenary speaker at the Association of Northern California Oncologists and the American Society of Clinical Oncology Meeting Highlights Annual Session. August 21, 2021.
27) Koontz, Zach. "The ALCANCE Project at Pacific Cancer Care." Annual Board Meeting for the National Cancer Care Alliance. Scottsdale, AZ. February 2022.
28) Tenney, Dorothy, Villicana, Gerardo. "PINE (Plant-based Instant Pot Nutrition Education) Program, ALCANCE Announcement." Pacific Cancer Care. September and October 2021.
29) Rodriguez, Gladys M., Leach, Maria, Osorio, Jenni, Wood, Emily H., Duron, Ysabel, O'Brian, Dale, Koontz, Zach, Rosas, Lisa G., Patel, Manali I. "Addressing Cancer Care Needs for Latinx Adults: A Formative Qualitative Evaluation," Poster Presentation, American Society of Clinical Oncology Quality Symposium September 24, 2021 (hybrid meeting).

30) Magaly Rodriguez, Gladys. "Addressing Latinx Cancer Care Equity (ALCANCE) Study." Oncology/Hematology/BMT Research Retreat at Asilomar Conference Center. Virtual. September 23, 2021.
31) Garcia, Maria R., Garcia, Yesica. "Cancer Prevention and Screening." CSVS Child/Adolescent Vaccine Clinic. Salinas, CA. October 2021.
32) Patel, Manali I. Reimagining a More Equitable Future Together," invited expert panel moderator at the BMS Foundation Virtual Grantee Summit, October 8, 2021.
33) Duron, Ysabel. "3rd Annual National Latino Cancer Institute Forum - COVID, Cancer and Systemic Barriers to Latino Health." Virtual. October 29, 2021.
34) Patel, Manali I. "Achieving Equity in Cancer Care through Quality Improvement," invited speaker at the Cancer & Blood Center of Arizona Grand Rounds, November 2021.
35) Patel, Manali I. "Addressing Racial Disparities to Provide Quality Care for Adults with Acute Leukemia" invited speaker at the Cook County Health System Grand Rounds, November 2021.
36) Rodriguez, Gladys M., Patel, Manali I. "Is Community Health Equity Within Reach? The ALCANCE Study." Presentation at the Frontiers in Cancer Clinical Translation Series at Stanford Cancer Center. Stanford, CA. November 2021.
37) Patel, Manali I. The Price We Pay: Bringing Value to Cancer Care," Stanford Cancer Institute Frontiers in Oncology Webinar Series, November 2021.
38) Goldman Rosas, Lisa. Panel presentation in a panel entitled: "What is at Stake? Ethical, Legal, and Social Implications (ELSI) of Community Engagement to Diversify the Human Reference Genome." TAGRI-II Conference: Reducing Health Disparities: Actively Engaging the Community, Researchers, and Community Health Workers, Representatives, and Guides. November 6, 2021.
39) Magaly Rodriguez, Gladys. Is Community Health Equity Within Reach? The ALCANCE Study. Frontiers in Cancer Clinical Translation Series at Stanford Cancer Center. November 9, 2021.
40) Patel, Manali I. "Achieving Equity in Cancer Clinical Trials: Partnerships with Communities" invited lecturer and coordinator for the Harvard Medical School's Addressing Health Disparities: Clinical Insights on Race and Social Justice Virtual Web Series. November 10, 2021.
41) Patel, Manali I. "Cancer Health Disparities and Cancer Health Equity: A policy problem." Invited Keynote Speaker at the Florida Society of Clinical Oncology Cancer Disparities and Health Equity Summit. November 12-13th, 2021.
42) Villicana, Gerardo, Koontz, Zachary. "Introducing the Precision Medicine in Monterey County Project in Collaboration with Stanford." Tumor Board Meeting at the Community Hospital of the Monterey Peninsula. November 19, 2021.
43) Patel, Manali I. Disparities to Equity: Moving the Needle on Lung Cancer," invited Keynote Conversation Virtual Panel Speaker, 5th Annual Meeting of the National Lung Cancer Roundtable, December 7, 2021
44) Garcia, Maria R., Garcia, Yesica. "Cancer Prevention and Screening." Stanford Office of Community Engagement Facebook. Virtual Facebook Live Event. January 2022.
45) Garcia, Maria R. "Cancer Prevention and Screening." Presentation for the Migrant Education Program on Breast Cancer and Risk Factors for Chronic Diseases. January 2022.
46) Patel, Manali I. "Bridging Gaps in Quality Care for Hematologic Malignancies in Federal and Public Health Settings," invited Keynote Address Speaker at the Live Keynote Webinar for PRIME 7th Annual Seminar Series, January 2022.
47) Koontz, Zach. "The ALCANCE Project at Pacific Cancer Care." Annual Board Meeting for the National Cancer Care Alliance. Scottsdale, AZ. February, 2022.
48) Patel, Manali I. Lung Cancer Screening and Prevention," School of Medicine Community Health and Prevention Research (CHPR) 250 Course, Virtual Lecture, February 17, 2022.
49) Patel, Manali I. Building Equitable Lung Cancer Control and Care for All," invited speaker and panelist, National Lung Cancer Roundtable Webinar, February 17, 2022
50) Juarez Vargas, Miriam, Garcia, Maria R. "Cancer Prevention and Screening." Salinas Adult School Virtual Fair. Salinas, CA. February 24, 2022.
51) Juarez Vargas, Miriam, Garcia, Maria R. Health Tabling Event at the Mexican Consulate (Móvil). February 26, 2022. Movil, CA.
52) Patel, Manali I. "Lung Cancer Disparities – A Policy Problem," Stanford University School of Medicine Community Health and Prevention Research (CHPR) 250 Course, Virtual Lecture, Thursday February 25, 2022 Patel, Manali I. Multilevel interventions to achieve equity in end of life cancer care delivery," Stanford Cancer Institute Population Sciences Members Meeting, February 28, 2022.
53) Juarez Vargas, Miriam, Garcia, Escobar, Kasandra. "Cancer Prevention and Screening." Sali-

nas City Elementary School District Soccer Event. Salinas, CA. March 12, 2022.
54) Juarez Vargas, Miriam, Escobar, Kasandra. "Cancer Prevention and Screening." Ciclovia. Salinas, CA. March 20, 2022.
55) Patel, Manali I. Cancer Care Delivery," invited speaker University of Alabama Cancer Institute Cancer Control and Population Sciences Meeting, March 23, 2022.
56) Juarez Vargas, Miriam, Garcia, Escobar, Kasandra. "Cancer Prevention and Screening." Watsonville Farmers Market. Watsonville, CA. April 1, 2022.
57) Juarez Vargas, Miriam, Garcia, Escobar, Kasandra. "Cancer Prevention and Screening." Watsonville Farmers Market. Watsonville, CA. April 15, 2022.
58) Juarez Vargas, Miriam, Garcia, Escobar, Kasandra. "Cancer Prevention and Screening." Amor Salinas Earth Day Festival. Salinas, CA. April 23, 2022.
59) Juarez Vargas, Miriam, Garcia, Escobar, Kasandra. "Cancer Prevention and Screening." Dia del Nino Event. Salinas, CA. April 24, 2022.
60) Rodriguez, Gladys M., Wood, Emily H., Leach, Maria, Villicana, Gerardo, Rosas, Lisa G., Duron, Ysabel, O'Brien, Dale G., Koontz, Zachary, Patel, Manali I. "Addressing Latinx CANcer Care Equity (ALCANCE) Randomized Controlled Trial: baseline findings from a community health worker led intervention." Poster presentation at the Binaytara Foundation 2022 Summit on Cancer Health Disparities: Moving from Challenges to Solutions. Seattle, WA. April 29 – May 1, 2022.
61) Patel, Manali I. Cancer Care Disparities: training the next generation," invited speaker and panelist at the 2022 Summit on Cancer Health Disparities, April 29, 2022.
62) Rosas, Lisa G., Wood, Emily H., Patel, Manali P. "Introducing the ALCANCE Study." May 2022 CSVS Provider Meeting. Salinas, CA. May 5, 2022.
63) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to Clinica de Salud del Valle de Salinas Clinic Managers, Salinas, California, June 2, 2022.
64) Patel, M.I. "Closing the Gap: Removing Barriers to Equitable Care Delivery," invited speaker at the 2022 Association of Clinical Oncology Annual Meeting Care Delivery and Policy Poster Discussion Session, Chicago, Illinois, June 3, 2022.
65) Rodriguez, Gladys M., Wood, Emily H., Leach, Maria, Villicana, Gerardo, Rosas, Lisa G., Duron, Ysabel, O'Brien, Dale G., Koontz, Zachary, Patel, Manali I. "Addressing Latinx CANcer Care Equity (ALCANCE) randomized controlled trial: Precision medicine and community health workers." Accepted for Poster Presentation at June 2022 American Society of Clinical Oncology (ASCO) Annual Meeting. Chicago, IL. June 3-7, 2022.
66) Juarez Vargas, M., Escobar, K. "Cancer Screening and Prevention" at Everyone's Harvest Salinas Farmers Market, Salinas, California. June 21, 2022.
67) Juarez Vargas, M., Escobar, K. "Cancer Screening and Prevention" at MCOE x Ag Growers Event, Salinas, California. June 22, 2022.
68) Patel, M.I. "Patient-Centered Care and Decision-Making: How integration of communities can improve care delivery," invited speaker at the Innovative Patient- Centered Decision-Making Consortium, Durham, North Carolina, July 11, 2022.
69) Patel, M.I. "Precision Cancer Care – Partnering with Communities to Ensure Equity," invited speaker at the inaugural Cedars-Sinai Cancer Health System: Precision Medicine in Oncology Virtual Retreat, July 16, 2022.
70) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to Clinica de Salud del Valle de Salinas Clinic Managers, Salinas, California, August 11, 2022.
71) Koontz, Z. "The ALCANCE Project" invited presentation at Friday Case Conference. Community Hospital of the Monterey Peninsula (CHOMP), Monterey, California, August 19, 2022.
72) Patel, M.I. "Cancer Health Equity Through Innovations," invited panel member at the American Northern California Oncology Association Annual Meeting, San Francisco, California, August 27, 2022.
73) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to Clinica de Salud del Valle de Salinas Clinic Managers, Salinas, California, September 01, 2022.
74) Juarez Vargas, M., Escobar, K. "Cancer Screening and Prevention" at End of Summer Celebration at Clinica de Salud del Valle de Salinas, Salinas, California. September 3, 2022.
75) Koontz, Z. "The ALCANCE Project: Updates" presentation to Medical Executive Committee. Pacific Cancer Care, Monterey, California, September 13, 2022.
76) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to new hires, Clinica de Slaud del Valle de Salinas, Salinas, California, September 22,

2022.

77) Patel, M.I. "Multimodal and multicomponent interventions to improve symptom management," invited speaker at the ASCO 2022 Quality Symposium, Chicago, Illinois, September 30, 2022.
78) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to new hires, Clinica de Slaud del Valle de Salinas, Salinas, California, October 6, 2022.
79) Juarez Vargas, M., Escobar, K. "ALCANCE Project: Cancer Screening and Prevention." Presentation to new hires, Clinica de Slaud del Valle de Salinas, Salinas, California, October 20, 2022.
80) Wood, E.H., Rodriguez, G.M., Layton, J., Villicana, G., Lua, S., O'Brien, D.G., Xiao, L., Koontz, Z., Patel, M.I. "Baseline Characteristics and Patient Perspectives of a Community Health Worker Model for Integrating Precision Medicine Education at Pacific Cancer Care." Abstract and presentation at the 2022 Stanford University School of Medicine Annual Oncology and Hematology Division Retreat. Asilomar, California, October 21, 2022.
81) Koontz, Z. "The ALCANCE Project" invited presentation at Friday Case Conference. Community Hospital of the Monterey Peninsula (CHOMP), Monterey, California, October 28, 2022.
82) Patel, M.I., Villicana G. "Exploring Community Health Worker Models for Serious Illness," invited speaker and panelist at the Massachusetts Coalition for Serious Illness Care 7th Annual Summit, Virtual Presentation, November 3, 2022.
83) Juarez Vargas, M., Escobar, K. "Cancer Screening and Prevention" at Resource Fair at Clinica de Salud del Valle de Salinas, Salinas, California. November 5, 2022.
84) Patel, M.I. "Cancer Health and Health Disparities," invited speaker, panel moderator, and faculty at the Florida Society of Clinical Oncology Cancer Disparities and Health Equity Summit, Hollywood, Florida, November 11, 2022.
85) Patel, M.I. "Reducing Disparities in Palliative and End of Life" invited speaker and panelist at the 2022 Florida Association of Cancer Oncologists Cancer Disparities and Health Equity Summit, Hollywood, Florida, November 11, 2022.
86) Patel, M.I. "Addressing Health Related Social Needs," invited presenter and panelist at the virtual National Cancer Institute Care Delivery Research Steering Group Meeting, Virtual Presentation, November 17, 2022.
87) Patel, M.I. "Conquering the Digital Divide – Strategies and Approaches that Can Achieve Equity," Center for Digital Health Advisory Board Meeting, Stanford, CA, January 20, 2023.
88) Patel, M.I. "Equity in the Delivery of Precision Cancer Care Through Community- Academic Partnerships," invited speaker at the Precision Medicine World Conference, Santa Clara, CA, January 24, 2023.
89) Patel, M.I. "Lessons learned in the conduct of multilevel community-based research to improve value-based cancer care delivery," invited speaker at the UNC Chapel Hill Lineberger Comprehensive Cancer Center Cancer Outcomes Research Program, Chapel Hill, North Carolina, February 7, 2023
90) Patel, M.I., Wood E.H. "Wildfires and Health," invited speaker with Emily Wood at the ACTIVATE23 AgSafe Annual Conference, Monterey, California, February 9, 2023.
91) Patel, M.I. "Barriers and Facilitators in the Conduct of Multilevel Community-based research," Stanford-Surgery Policy Improvement Research and Education Center," Stanford University, February 13, 2023.
92) Patel, M.I. "Cancer Health Equity," School of Medicine Cancer Biology Course, Stanford University February 21, 2023
93) Patel, M.I. "Lung Cancer – Policies to Reduce Burden," Stanford University School of Medicine Community Health and Prevention Research (CHPR) 250 Course, Stanford University February 23, 2023
94) Patel, M.I. Invited to present as the recipient of the Iris Fischer Memorial Lectureship Yale Cancer Center Grand Rounds, New Haven, New Jersey, March 28, 2023.
95) Patel, M.I. "Community Based Organizations and Fireside Chats" invited speaker and panelist at the 2023 Bristol Myers Squibb Foundation Grantee Summit, Austin, Texas, April 19, 2023.
96) Patel, M.I. "Symptom Management" invited speaker at the 2023 Global Breast Cancer Conference, Seoul Korea, April 27, 2023.
97) Patel, M.I. "Novel therapeutics and cancer disparities" speaker and panelist at the 2023 Summit on Cancer Health Disparities, Seattle, Washington, April 29, 2023.
98) Patel, M.I. "Advocating for policies and practices to advance cancer health equity," invited speaker and panelist and named Advocacy Champion - President's Circle at the American Society of Clinical Oncology Advocacy Summit, Washington DC, May 1, 2023.
99) Patel, M.I. "It's not the biology--Advancing Cancer Health Equity," Stanford University Cancer

Biology 242 Course, Stanford University May 10, 2023

100) Kamran, R., Wood, E. H., Perez, C., Medrano, H. S., Villicana, G., Lopez Guzman, L., ... & Patel, M. I. Advancing equity in cancer care through community-academic partnerships: Results from the addressing Latinx cancer care equity—Program for long- term united skills building (ALCANCE-PLUS). American Society of Clinical Oncology Quality Care Symposium 2023, Boston, MA, October 27, 2023.

101) Patel, M.I., Wood, E.H., Agrawal, M., Kamran, R., Rodriguez, G.M., ...& Galvez, D.R. "Partnerships to Advance Cancer Care (PACC): Advancing cancer care delivery from Trenches to Benches to Bedsides and Wrenches." Oncology/Hematology/BMT Research Retreat at Asilomar Conference Center, Monterey, CA, September, 2023.

Press

1) Governor's Office of Planning and Research. 2019. "Announcement: OPR Announces Awardees for the California Initiative to Advance Precision Medicine." Governor's Office of Planning and Research Website, February 12.
2) Latino Cancer Institute. 2019. "Stanford University and The Latino Cancer Institute Awarded Precision Medicine Grant." The Latino Cancer Institute Website, February 13.
3) The Latino Cancer Institute. 2019. "Stanford researchers partner with The Latino Cancer Institute in a winning proposal." The Latino Cancer Institute Website, October 10.
4) Community Advisory Board. 2020. "February 2020 Community Advisory Board Newsletter."
5) Community Advisory Board. 2020. "May 2020 Community Advisory Board Newsletter." Community Advisory Board. 2020. "August 2020 Community Advisory Board Newsletter."
6) Community Advisory Board. 2020. "September 2020 Community Advisory Board Newsletter."
7) Community Advisory Board. 2021. "February 2021 Community Advisory Board Newsletter."
8) Stanford University. "Patel Receives California Award." Stanford University Department of Medicine News. No Date. Accessed April 7, 2021.
9) Office of Community Engagement. No Date. "Research Projects. Supporting & Conducting Research in Communities." Accessed April 7, 2021.
10) Community Advisory Board. 2021. "May 2021 Community Advisory Board Newsletter."
11) Office of Community Engagement. July 22, 2021. "ALCANCE PROJECT: Monterey County Addressing Latinx CANcer Care Equity."
12) Community Advisory Board. 2022. "January 2022 Community Advisory Board Newsletter."
13) Office of Community Engagement. February 28, 2022. "ALCANCE PROJECT: Monterey County Addressing Latinx CANcer Care Equity."
14) Community Advisory Board. 2022. "August 2022 Community Advisory Board Newsletter."
15) Community Advisory Board. 2022. "November 2022 Community Advisory Board Newsletter."