

SYNTHESIS

THE MAGAZINE OF UC DAVIS COMPREHENSIVE CANCER CENTER

VOL 19 | NO 2 | FALL/WINTER 2016



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Dear Reader,

I am delighted to share this newly updated issue of *Synthesis* with you. As you know, our long-time director, Ralph de Vere White, retired in June. I have assumed the role of acting director while recruitment is under way for Dr. de Vere White's permanent replacement.

At the UC Davis Comprehensive Cancer Center, we are committed to doing the hard, scientific work of untangling the molecular underpinnings of cancers so that our patients are treated with the most precise and least toxic treatments available.

We want to make sure our patients are cared for in other ways, too. That's why we provide an array of specialty clinics and other services such as nutrition counseling, pain management and supportive oncology care, among others.

This issue of *Synthesis* explores both the science and art of cancer healing with an introduction to some of our early-career cancer researchers and our molecular tumor board, as well as our sexual health clinics for men and women undergoing cancer treatment and our chemotherapy class — all designed to support patients through their cancer journey.

In delving into this issue, you may notice that the look of the magazine is different from past issues. We have updated the design with our patients in mind, so they have more easy-to-access information as they navigate their care here, as well as a resource to learn about the basic and translational science that drives the oncology field forward.

We hope you enjoy the magazine. If you have any suggestions for future editions, please contact our editor, Dorsey Griffith, at dgriffith@ucdavis.edu.



Primo “Lucky” Lara, Jr. | ACTING DIRECTOR, UC DAVIS COMPREHENSIVE CANCER CENTER

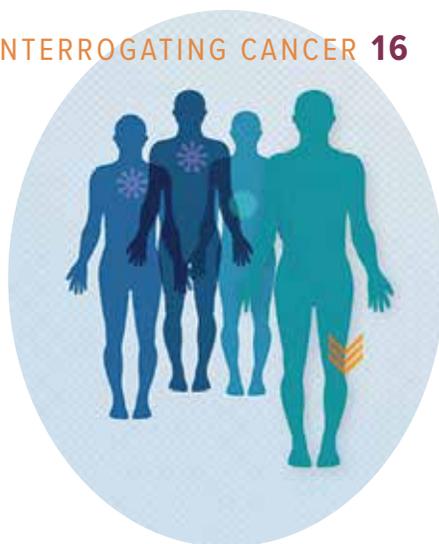
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Breaking Barriers to Beat CancerSM

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ON THE COVER Lung cancer driven by the Kras gene in a genetically engineered mouse model; photo courtesy of the National Cancer Institute.

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New technologies rolled out for prostate, bladder cancer surgeries

The UC Davis Department of Urology is the first in the region to use two new technologies to improve care and outcomes for prostate and bladder cancer patients.

The technologies are fluorescence cystoscopy, also called blue light cystoscopy, to enhance surgery for bladder tumor removal, and fusion-guided biopsy to more precisely target treatment areas for prostate cancer patients.

Marc Dall’Era, associate professor and vice chair of the Department of Urology, said the fluorescence cystoscopy “helps us better visualize small tumors that may not be identified under white light. **The blue light**



also helps the surgeon see the edges of the tumor to enable a more complete surgical removal of the tumor.”

The thorough view and removal of bladder tumors mean there is a decreased risk of cancer recurrence. The American Urological Association has added fluorescence cystoscopy

to their recommended guidelines for treating bladder cancer.

The fusion-guided biopsies blend MRI and ultrasound for better prostate cancer detection. After an MRI, a radiologist circles suspicious areas before the image is uploaded to a biopsy machine. The urologist then performs an ultrasound and biopsy. The MRI image is overlaid on the ultrasound image, which is done in real time, to help the urologist target a specific area for biopsy.

“It’s drastically changed the way we are diagnosing and treating localized prostate cancer,” said Dall’Era, adding that the approach is especially beneficial to patients under active surveillance who have lower-risk tumors.

HEPATITIS B AND LIVER CANCER

The cancer center’s Population Science and Health Disparities Program is working to reduce the burden of liver cancer among Asian Americans by **GETTING MORE PEOPLE SCREENED FOR HEPATITIS B VIRUS** — the leading cause of liver cancer in this group — and linking them to care.



1 in 3

2 BILLION, OR 1 IN 3

Number of people affected by hep B; 400 million are chronically affected



FIRST

“ANTI-CANCER” VACCINE

The hepatitis B vaccine is the world’s first “anti-cancer” vaccine



SECOND DEADLIEST

Liver cancer is the world’s second deadliest cancer, after lung cancer

SECOND LEADING CAUSE

Following tobacco use, hep B is the second leading cause of preventable cancer

Liver cancer **INCIDENCE AND MORTALITY IN BOTH MEN AND WOMEN IS RISING IN THE U.S.**, especially among populations of color

De Vere White endowment to help young science students

Ralph de Vere White, who stepped down in June after serving 20 years as the cancer center's director, has been honored with an educational endowment in his name.

The Ralph de Vere White Endowed Education Fund was created by his wife, Antoinette, for the purpose of training the next generation of medical professionals who will continue the fight against cancer. She hopes to reach a target of \$200,000.

The fund will be used to support undergraduate and high school students who plan to participate in cancer research training programs or need funds to conduct summer research, attend conferences or take admissions exams.

The fund will be available only to students who have demonstrated a special aptitude for the study of cancer science, and it will give special preference to individuals with personal perspectives on issues facing marginalized communities.

To learn more or to donate visit ucdmc.ucdavis.edu/cancer/DVW.endowment

BREAST CANCER

Long-term, heavy **SMOKING** **MAY INCREASE BREAST CANCER RISK**, particularly among women who start smoking before pregnancy.



White women have a higher incidence of breast cancer than African American women, but **AFRICAN AMERICAN WOMEN ARE MORE LIKELY TO DIE FROM THE DISEASE.**

3.1

MILLION SURVIVORS

of breast cancer in the U.S. today



1 in 8

The overall lifetime risk for developing breast cancer

AT AGE...	BREAST CANCER RISK IS...
20	» 1 in 1,674
30	» 1 in 225
40	» 1 in 69
50	» 1 in 44
60	» 1 in 29
70	» 1 in 26

61

MEAN AGE

of breast cancer diagnosis

Women diagnosed with breast cancer have a **LESS THAN ONE PERCENT CHANCE** of developing cancer in the other breast.

So, unless she has the BRCA genetic mutation, her overall survival is not improved by having a double mastectomy, research has shown.

Sources: American Cancer Society, American Society of Breast Surgeons website – breastsurgeons.org, Breast Cancer Facts and Figures 2015-2016 – breastcancer.org, Smigal C, Jemal A, Ward E, et al. Trends in breast cancer by race and ethnicity: update 2006. CA Cancer J Clin. May-Jun 2006;56(3):168-183.

Lay educators help boost colorectal screening rates in Hmong

A study by **Elisa Tong**, associate professor of internal medicine, found that Hmong Americans are more likely to understand the importance of colorectal cancer screening and get screened when they get information from specially trained Hmong lay health educators.



The study, published in the journal *Cancer*, was conducted in collaboration with the Hmong Women's Heritage

Association in Sacramento, home to the third largest Hmong population in the U.S. **This group is disproportionately affected by high rates of poverty and other socio-economic challenges that affect preventive health screening rates.**

"Hmong Americans in the age group for colorectal cancer screening are especially vulnerable because of low levels of education and limited literacy, even in

the Hmong written language," said Tong. "Added to that are the cultural barriers that can come with receiving Western medical care."

Penny Lo, project coordinator with the Hmong Women's Heritage Association and a study co-author, said the study opened doors to introducing cancer prevention education to the Hmong community.

"Lay health educators have access to the community because of family or church relations that even nonprofit organizations can't normally reach," she said.

Hybrid treatment hunts down and kills leukemia cells

UC Davis pediatric cancer researcher **Noriko Satake**, in collaboration with Ionis Pharmaceuticals, has developed a hybrid treatment for B-cell type acute lymphoblastic leukemia (ALL) that shows promise in mice.

The treatment, which harnesses a monoclonal antibody to deliver single-strand (antisense) DNA to ALL cells, reduces levels of a certain protein that helps cancer cells survive. Importantly, the treatment also limits damage to other tissues.

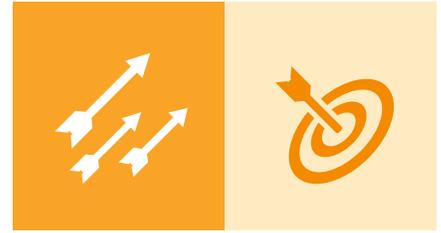
“This could be a new type of treatment that kills leukemia cells with few side effects,” said Satake,



associate professor in the Department of Pediatrics.

ALL is a disease of the bone marrow and the most common type of childhood cancer. While most children survive ALL, many suffer late or long-term side effects from treatment, which may include heart problems, growth and development delays, secondary cancers and infertility.

The hybrid treatment was effective against ALL cell lines grown in the laboratory and in a mouse model. Animals that received the hybrid therapy



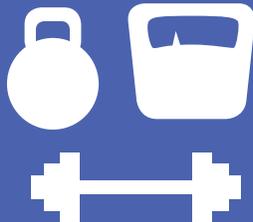
survived significantly longer than those in the control group.

Satake’s work was supported by The Hartwell Foundation, Keaton Raphael Memorial Foundation, National Center for Advancing Translational Sciences, the California Institute for Regenerative Medicine, National Institutes of Health and a UC Davis Comprehensive Cancer Center Support Grant.

KEY TIPS from our oncology dieticians

EATING WELL after a cancer diagnosis helps you feel better, keep your strength and energy up, tolerate treatment better, lower risk of infection and support healing and recovery

ADD a colorful mixture of fresh fruits and vegetables to your diet



BALANCE your healthy diet with favorite activities that minimize stress and support a positive outlook

INCLUDE healthy fats like avocado, olives, nuts and seeds

MINIMIZE your intake of alcohol

LIMIT your fried food and simple sugar consumption

ASK to meet with an oncology dietitian if you are confused or overwhelmed by conflicting nutritional advice

Precious time for the great-grandchildren: Lymphoma patient celebrates 100th chemo treatment

When Barbara Mooney was diagnosed with non-Hodgkin's lymphoma in 1999, she didn't think she would see her grandkids grow up. She was wrong.

The journey has been one of great triumph for the 75-year-old native New Yorker, thanks to the innovative care she receives at the UC Davis Comprehensive Cancer Center.

After finishing her chemotherapy regimen in 2001 she moved to Elk Grove, Calif. to be closer to her family and came under the care of Joseph Tuscano, a hematologist-oncologist at UC Davis, who determined that her cancer was slow growing, but resilient. He put her on several different drug regimens, but her cancer kept resurfacing.

"Generally, people who relapse after initial chemotherapy have a very poor prognosis," Tuscano said. "It's usually an indicator of a very resistant disease."

In 2008 Tuscano enrolled her in a clinical trial combining rituximab, with Revlimid. The hope was that the immunomodulatory activity of



Barbara Mooney, center, and cancer center staff celebrate her 100th chemotherapy dose.

Revlimid would combine with the B-cell antibody activity of the rituximab to more effectively fight the cancer. Mooney was one of the first in the world to have the combination therapy.

Mooney experienced a dramatic remission.

Eight years and more than 100 cycles of treatment later, there is no evidence of disease. Although

declared cancer-free, Mooney has elected to stay on her therapy as an insurance policy against recurrence. Now that she doesn't have to worry about cancer, Mooney spends most of her time babysitting her great grandchildren.

"I would never have dreamed of it," Mooney said. "Let me tell you, it is a blessing."

UC Davis scientists awarded \$1 million grant for prostate cancer research

The Prostate Cancer Foundation and Movember, the movement that has raised hundreds of millions of dollars for men's health research and programs and best known for encouraging mustache growth in November, have delivered \$1 million to UC Davis prostate cancer researchers.

The funding will allow UC Davis



basic scientist **Hongwu Chen** of the Department of Biochemistry and Molecular Medicine and his colleagues to further develop a novel approach to overcome treatment-resistant prostate cancer.

The project builds on the researchers' recent finding that a receptor protein



called RORgamma can be an important prostate cancer driver, and that small molecules targeting the ROR protein can effectively block tumor growth and circumvent drug resistance in pre-clinical models such as cell lines and in human tumors in mice.



K12 SCHOLARS:

A focus on translational research

Six UC Davis junior research and faculty members have been selected this year for a Paul Calabresi Career Development Award for Clinical Oncology (K12).

Carvajal-Carmona, assistant professor of biochemistry and molecular medicine, is at the forefront of the emerging field of single-cell genome sequencing. His research takes advantage of recent advances in high-throughput technology, allowing characterization of the heterogeneous genomic content of bladder tumors.



Preliminary data enabled him to obtain a grant from the National Cancer Institute to apply his approach to gastric cancer. Mentors: Ralph de Vere White and Wolf Heyer

Luís Carvajal-Carmona | Single-cell sequencing of bladder cancer

Daly, assistant professor of clinical radiation oncology, studies the use of radiation for patients with metastatic non-small lung cancer being treated with immune checkpoint inhibitors — drugs that activate the immune system to fight cancer. Used alone, the effects of these drugs are often short-lived. But radiation aimed at a



tumor can pump up the immune response and may work synergistically with checkpoint inhibitors to shrink distant metastases. Mentors: Karen Kelly and Joseph Tuscano

Megan Daly | Combining radiation with immune checkpoint inhibition

Barisone, an assistant researcher in the Department of Internal Medicine, is studying a fermented wheat germ powder as an adjunct to standard therapy for non-Hodgkin's lymphoma. Early research indicates that it is highly active against cancer cells. In his second year as a K12 scholar, Barisone collaborates with the UC Davis



School of Veterinary Medicine to study its effect on dogs with cancer in anticipation of human clinical trials. Mentors: Joseph Tuscano and William Murphy

Gustavo Barisone | Evaluating wheat germ extract to fight cancer

Funded by the National Institutes of Health and the National Cancer Institute, the awards support the research career development of young clinically focused scientists. The grants provide up to three years of protected time for research, as well as intensive training in the design and testing of clinical cancer research

protocols. Each scholar works closely with both a senior basic scientist mentor and a clinician researcher mentor.

During training, scholars aim to develop a Phase I, Phase II or Phase III clinical trial and secure funding to support it.

“The research funded by the K12 program is predicted to have imminent

human applications,” says Primo “Lucky” Lara, Jr., principal investigator of the grant and acting director of the UC Davis Comprehensive Center. “I have no doubt that the results of our scholars’ research will someday touch a cancer patient.”

Doxorubicin is effective against non-Hodgkin’s lymphoma, but its use can be limited by toxic side effects. Burton, assistant professor of clinical oncology in the UC Davis School of Veterinary Medicine, aims to increase its efficacy and reduce its toxicity by delivering tiny amounts of it directly to the tumor with a novel nanomicelle delivery

system. Burton will offer therapy to canine cancer patients, the results of which will provide valuable information for eventual human use. Mentors: Kathy Ferrara and Primo Lara, Jr.



Jenna Burton | Developing a nano-particle for cancer drug delivery

Treating patients with standard drugs for the aggressive bone marrow cancer, acute myeloid leukemia, may help them, or harm them. Jonas, assistant professor of internal medicine, is exposing leukemia cells from patient blood samples to radioactive-labeled cancer drugs. If a drug binds well to the cancer’s DNA, it may

be effective. Jonas hopes his research will lead to a biomarker assay to help doctors make better prescription decisions. Mentors: Chong-xian Pan and Paul Henderson



Brian Jonas | Predicting treatment response in acute myeloid leukemia

How do you know when a mole is deadly? According to Kiuru, assistant professor of clinical dermatology, diagnosing malignant melanoma is not always clear-cut, even when looking at biopsy samples under a microscope. Her research compares genetic mutations found in cancer cells to those in benign cells

to identify objective cancer markers and make diagnosis more reliable. Mentors: William Murphy and Maxwell Fung



Maija Kiuru | Defining markers of melanoma

T32 SCHOLARS:

Creating breakthrough opportunities

The National Institutes of Health's NRSA Institutional Predoctoral Training Grants (T32) provide young scientists with extensive training opportunities in basic and translational research.

Hexamethylene amiloride (HMA), a derivative of a commonly used diuretic to treat high blood pressure, has a surprising effect: it kills breast cancer cells without harming normal



cells. Rowson-Hodel, a postdoctoral fellow, uses HMA as a tool to better understand the therapeutic susceptibilities of cancer.

Ashley Rowson-Hodel | Evaluating HMA as a cancer therapeutic

The link between mutations in the BRCA1 gene and breast cancer is well known. But why the link? Appling intends to find out. Using biophysics approaches, he is attaching tiny magnetic beads —



about 1,000 times smaller than a pinhead — to individual DNA strands to study the mutation and its effects. Understanding this may be key to developing new drugs against breast cancer.

Frank Appling | Biophysical analysis of DNA repair

Six scholars at UC Davis were awarded grants through the T32 Postdoctoral Fellowship Program in Oncogenic Signals and Chromosome Biology. They will work closely with experienced scientist mentors on research projects of their own design, and participate in monthly meetings that expose them to the richness of the wider UC Davis research community.

All projects have in common a search for a detailed understanding of cellular and molecular processes with relevance to cancer diagnosis, treatment and prevention. But the studies themselves, says Wolf-Dietrich Heyer, professor of microbiology and molecular genetics who oversees the National Cancer Institute-funded program, are as diverse as the field of molecular oncology itself and

represent a multiplicity of leading-edge approaches.

“The T32 program is an important cornerstone for the UC Davis Comprehensive Cancer Center,” Heyer says. “These projects in basic cancer research — and, most importantly, the training the program provides to ensure the next generation of scientists — offer the best chance for future breakthroughs in cancer medicine.”

The cellular protein known as p53 has been termed the “guardian of the genome” because of its protective functions. More than half of human cancers involve inactivation of p53.



Lucchesi works to introduce a peptide into cancer cells to get p53 up and running again to fight cancer.

Christopher Lucchesi | Regulating p53 production in cancer cells

Gliomas are brain cancers that can occur at any age, but are particularly aggressive in children. Chen works to analyze mutated genes encoding for epigenetic factors — such as histones and



regulatory proteins that interact with the genome — in pediatric glioma cells, where evidence shows that important cellular pathways have gone awry.

Michael Chen | Characterizing epigenetic factors in pediatric glioma

Yokdang works to elucidate the effects of the LRIG1 gene, which encodes for a protein on cell membranes. The protein has been implicated as a negative regulator for oncogenic receptors, and its loss may contribute



to a cancer’s ability to grow and metastasize. Yokdang’s earlier work found that LRIG1 expression inhibits breast cancer cell growth, migration and tumor growth in an animal model.

Nucharee Yokdang | The role of LRIG1 in tumor metastasis

SEXUAL HEALTH after cancer

IT'S NOT ALWAYS A COMFORTABLE TOPIC for either patient or provider, but many patients who undergo cancer treatment also experience difficulties with sexual function, which can hamper partner intimacy and harm relationships. Providers at UC Davis Comprehensive Cancer Center say these issues should be addressed at the outset of a diagnosis so that patients and their partners have the information they need to minimize the potential effects of cancer treatment even before treatment begins.

Synthesis spoke to two leaders in this effort: Paula Wagner, a certified family nurse practitioner in the Department of Urology who sees patients with prostate, bladder and rectal cancer; and Vanessa Kennedy, a surgical oncologist who treats women with cancers of the cervix, anus, ovary, vagina and endometrium, among others.

VANESSA KENNEDY, M.D.



What are the most common side effects of cancer treatment that affect female sexual function?

A. Surgery, radiation therapy and chemotherapy affect female sexual function in a variety of ways. All may lead to premature menopause, which can cause thinning, dryness and sensitivity of the vulvar and vaginal tissues, and result in pain with penetration during sex or pelvic exams. Over time, this can lead to spasm and dysfunction of the pelvic floor muscles. Cancer treatments can also cause infertility, shortening and narrowing of the vagina. Physical changes are often accompanied by changes in body image and libido. Relationship strain and loss of intimacy are also common in romantic partnerships.



What are some of the things patients can do to avoid or deal with side effects?

A. A common misperception is that nothing can be done for sexual function concerns after cancer. In fact, many of the side effects can be addressed. Menopausal dryness can be treated with lubricants if the symptoms are primarily during penetration (I recommend coconut oil), and vaginal





PAULA WAGNER, C-FNP



What are the most common side effects of prostate and bladder cancer treatment that affect male sexual function?

A. The most common sexual side effect of prostate cancer treatment is erectile dysfunction (the inability to achieve or maintain an erection), also known as impotence, which can result after surgery, radiation, cryotherapy and hormone therapy. Hormone manipulation, such as androgen deprivation therapy, also can affect libido (sexual desire). These potential side effects can lead to partner intimacy and relationship problems. Cystectomy, the surgery to remove a cancerous bladder, also can result in erectile dysfunction. We really want to talk openly and clearly with patients and their partners about their needs, and how things might change in terms of sexual function.



What kinds of things can be done to address erectile dysfunction related to cancer treatment?

A. I begin with a pre-treatment questionnaire to determine the patient's sexual function prior to cancer treatment, and to collect information about other conditions that can affect sexual function, such as high blood pressure. At that stage we may also recommend penile rehabilitation therapy, which may shorten the recovery time of spontaneous erections after prostatectomy. This involves regular use of an oral therapy, such as Cialis, Viagra or Levitra before and after surgery. There are a number of other treatments for erectile dysfunction, each with their own pros and cons, including vacuum pumps, intraurethral suppositories, injection therapy and penile prostheses — all of which I can discuss with you and your partner before and after surgery.



How does a patient get an appointment with you?

A. Call the Urology Clinic in the Department of Urology at 916-734-2222.

moisturizers if symptoms persist. Local hormone treatment is also an option for some women, depending on their individual cancer history. Vaginal dilators can help to regain vaginal length and girth after radiation therapy, and these come in a variety of materials, shapes and sizes. For patients with spasm and tenderness of the pelvic floor muscles, a course of pelvic floor physical therapy can be life-changing. I have a list of sexual health resources for patients. This includes information for finding a local sex therapist and/or pelvic floor physical therapist.



How does a patient get an appointment with you?

A. I have a special clinic every other Friday morning for women with sexual health concerns who have had any type of cancer. To make an appointment, call the cancer center at 916-734-5959 and request an appointment with Dr. Vanessa Kennedy in the Gynecologic Oncology Sexual Health Clinic. Many patients have had pain with exams in the past, so the first appointment can focus on medical history and symptoms without an exam. While crucial to formulating the treatment plan going forward, the exam can be performed at the second visit. I want women to know that they are not alone in their symptoms, and that sexual health is just as important as the rest of their care.

Chemo class eases anxiety

IN NEWLY DIAGNOSED CANCER PATIENTS

DALE JOHNSON FLIPS THROUGH the slides that tackle the many possible side effects of chemotherapy: fatigue, nausea, neuropathy, mouth sores, appetite changes.

And hair loss.

“Probably not going to be too big of an issue for you,” Johnson jokes with newly diagnosed oral cancer patient Jason Mitchell, who is bald.

“Well, maybe it will be different,” Mitchell responds with a laugh. “Maybe it will grow *more*.”

The class, offered to all chemotherapy patients and always presented by a registered nurse who specializes in medical oncology, provides a primer on chemotherapy, how it works in the body, and what side effects may occur during and after treatment.

...

The exchange between the nurse-educator and patient is typical of the UC Davis Comprehensive Cancer’s “chemo class,” created two years ago

to address the good, the bad and the ugly of what many people just diagnosed with cancer fear most: chemotherapy treatment.

“The class came about because patients wanted to know what they were going to go through,” says Heidi Wieser, cancer center clinic nurse manager, who oversees the program. “It relieves anxiety. The more educated they are, the more empowered they are.”



“The class came about because patients wanted to know what they were going to go through. It relieves anxiety. The more educated they are, the more empowered they are.”

— HEIDI WIESER

The class, offered to all chemotherapy patients and always presented by a registered nurse who specializes in medical oncology, provides a primer on chemotherapy, how it works in the body, and what side effects may occur during and after treatment. Patients are given tours of both the infusion areas and

the Department of Radiation Oncology, where many chemotherapy patients also receive radiation treatment.

Barbara Riggs, a 76-year-old lung cancer patient, says the chemo class helped her formulate and then get answers to questions she wouldn't have thought of otherwise.

When Johnson explained how chemotherapy can deplete white blood cell counts and increase infection risk, for example, Riggs wondered if it would be safe to cut her toenails during treatment, since she sometimes nicks her toes with the clipper.

“I told him I'd cut them before I started treatment,” she says.

Social workers and dieticians also stop by with information to help patients adjust to treatment, cope with the possible emotional toll of a diagnosis, and how to adapt their diet while undergoing chemotherapy.

“We bring in supportive oncology experts to broaden the scope of education for our oncology patients,” says Wieser. “We approach oncology care as a team, and there is no better time to initiate these team members into our patient's treatment plan than when they are first diagnosed.”

Riggs had been worried how treatment might affect her energy, and the dietician's information convinced her to bring some drinks with electrolytes and an energy bar or two to each chemotherapy session.

Mitchell, diagnosed with tumors in his throat and right tonsil, and expecting

OUTREACH

to undergo an aggressive chemotherapy and radiation therapy regimen, welcomed the opportunity to learn as much as he could through the class.

“It really came out of the blue like some surreal nightmare,” Mitchell says of his diagnosis.

Mitchell, who remains upbeat about his future, admitted that before taking the class he didn’t know much about chemotherapy in general, let alone what he would endure as a patient. Afterward, he

says he felt better prepared to tackle the challenges in front of him because knowing how sick he’ll get is better than being in the dark and wondering if something’s wrong.

“I’m glad I went, because now I have a better view on what’s going to happen,” he says. “I know it will put me where I need to be.”

Mitchell, who remains upbeat about his future, admitted that **before taking the class he didn’t know much about chemotherapy in general, let alone what he would endure as a patient.**



Dale Johnson teaches Jason Mitchell about what to expect during chemotherapy treatment.

FEELING YOUR BEST DURING CHEMO

Cancer and cancer treatment can affect many aspects of life, both physical and emotional. The cancer center's chemo class gives newly diagnosed patients the information they need to address potential side effects, which may include changes in mood and increased stress, as well as physical changes related to chemotherapy toxicity. Each class is taught by a specially trained registered nurse in oncology.

Emotional and Social Side Effects

YOU MAY NOTICE CHANGES IN:

- ◆ Mood
- ◆ Roles and relationships
- ◆ Body image
- ◆ Intimacy and sexuality
- ◆ Work or financial stressors
- ◆ Ability to manage stress

HOW YOU CAN COPE

- ◆ Mobilize available social support
- ◆ Accept help from others
- ◆ Rely on skills that have worked in the past
- ◆ Maintain open communication
- ◆ Be patient with self and others
- ◆ Stay as active as you can

“Chemo Brain”

WHAT IS IT?

- ◆ Temporary memory loss or forgetfulness
- ◆ Difficulty finding words
- ◆ Mental fog

CAUSES

- ◆ Stress, depression, anxiety
- ◆ Fatigue
- ◆ Medications
- ◆ Hormonal Changes

WHAT YOU CAN DO

- ◆ Keep a planner
- ◆ Make an ongoing list of questions for your doctor
- ◆ Exercise your brain
- ◆ Maintain good nutrition
- ◆ Track memory problems

Fatigue

HOW YOU CAN COPE

- ◆ Get enough calories
- ◆ Get enough sleep
- ◆ Manage your stress

- ◆ Be active, get regular light exercise
- ◆ Plan your day to save energy
- ◆ Delegate responsibilities
- ◆ Tell your oncologist/RN about fatigue at next appointment



INTERROGATING CANCER:

Molecular Tumor Board looks for answers in tumor genomes

The group meets regularly around a large rectangular table: hematologists, oncologists, researchers, pathologists, geneticists.

Joining the meeting by phone is a scientist from Foundation Medicine, the company that handles tumor sequencing for the cancer center and produces detailed reports about each patient's cancer genome. It's the basis for these discussions.

But knowing the mutations isn't enough. The Molecular Tumor Board must transform that data into individual treatment plans, identifying the ideal combinations of drugs that will dial back a patient's cancer. This is where

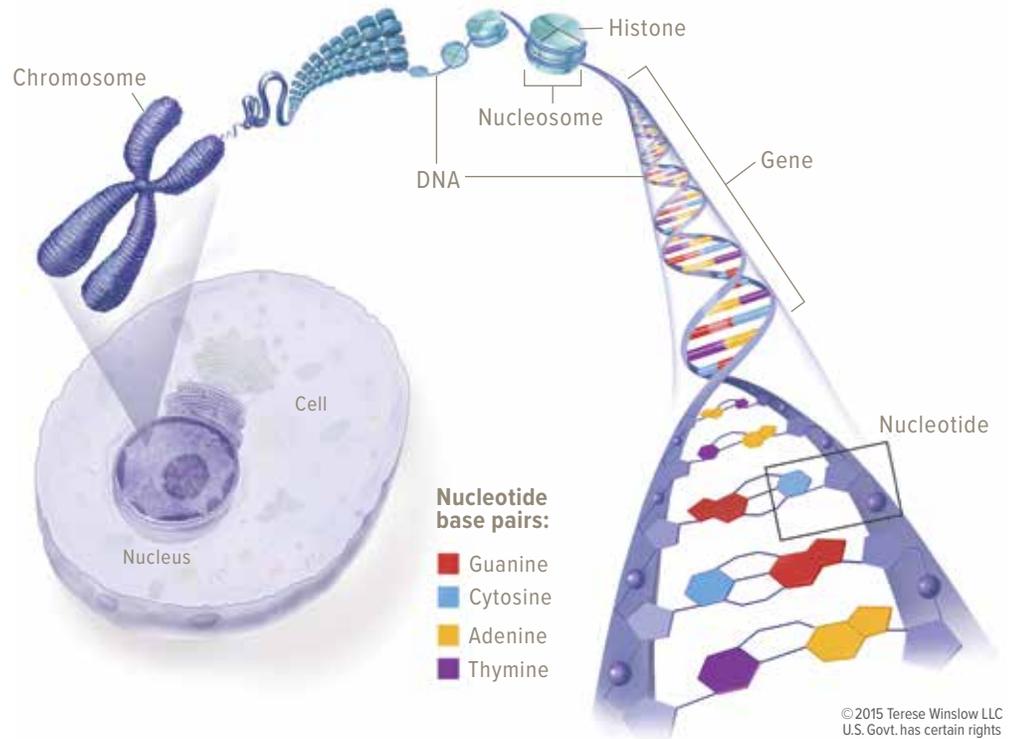
leading-edge science meets patient care. They have a difficult job, assessing data from tumor genomes and choosing actionable mutations. The key word is actionable — genetic variations they can treat with targeted therapies.

The challenge of personalizing care

Tumor boards are nothing new. For decades these groups have met to select the best therapies for cancer patients. But with the emergence of next-generation sequencing, UC Davis and other cancer centers have added molecular tumor boards to the mix.



DNA Structure



The Foundation Medicine report starts the process.

“We look at almost all known cancer genes, analyze them and report the alterations and all the molecular information that’s pertinent to the alterations,” says Andreas Heilmann, biomedical informatics scientist at Foundation Medicine. “The clinical report describes the mutations, their role in that specific tumor type and, most importantly, the potential therapeutic options.”

The report produces an alphabet soup of genetic culprits: EGFR, ALK, RAS1, MET, BRAF, RET, ERBB2, mutated genes that have targeted therapies. If there are no FDA-approved drugs, the report will suggest clinical trials of drugs in development or a novel use or combination of existing drugs. Along with the mutations, board members discuss tumor type, location, stage, metastasis, patient history, family history and other factors.

But it’s not just connecting the dots between mutations and therapies. Genomes are complicated and cancer genomes doubly so. As tumors progress they become mutation machines, making it difficult to determine which variations are responsible for fueling cancer growth.

“We have to ask, is that mutation driving the cancer or is it just associated with the cancer?” says Karen Kelly, associate director for clinical research at the UC Davis

Comprehensive Cancer Center.

This is the core issue in any molecular tumor board discussion. Targeting a driver mutation could slow the cancer, while hitting an associated variation — basically an artifact of tumor progression — might have no impact at all.

“Many of these patients have late-stage cancer,” says Kelly. “We have to do everything we can to make the right choices.”

A different angle on cancer

For centuries, tumors have been grouped by organ of origin: breast, lung, prostate, kidney. But lately

scientists have discovered that mutations aren’t so particular.

“This is all about the molecular profile,” says Kelly. “Whether there’s a BRAF mutation in melanoma or a BRAF mutation in lung cancer, it’s still all about BRAF.”

Despite this emerging understanding of how mutations transcend tumor type, however, drugs are still approved the old-fashioned way. The BRAF inhibitor being used to fight melanoma may not be available for lung cancer, even if it does have the same mutation.

“That’s a frequent barrier,” notes Kelly. “We may have an FDA-approved

drug for one cancer, but not for the one we're trying to treat. We do everything we can to find a clinical trial."

Patients in Northern California are particularly fortunate, as UC Davis, Stanford and UCSF are constantly conducting trials — and collaborating closely — to provide unique access to new treatments.

Molecular testing also can clarify the cancer of origin in ways traditional pathology cannot.

Molecular testing also can clarify the cancer of origin in ways traditional pathology cannot.

Under a microscope, a tumor may look ambiguous, making it difficult to solidify a treatment plan.

"When we see a case where we're not sure about the underlying cancer,

we can sometimes use the molecular profile," says Kelly. "One tumor we

thought was skin cancer was clinically odd. But then we saw it had this specific mutational profile, which supported the initial diagnosis."

A lot to learn

The Molecular Tumor Board has been meeting for over a year, and the effort seems to be paying off for patients. However, Kelly warns that more research must be done to fully gauge its effectiveness.

And other issues remain for investigation. Sometimes, even

How next generation sequencing can drive cancer treatment

Cancer is a genetic disease. Over a period of years, or even decades, genes can mutate. Some mutations take the brakes off cell growth. Genes that should only tell cells to divide when they receive certain signals get turned on permanently, spurring rampant growth. To complicate matters, genes that should tell damaged cells to die get turned off completely.

Many genes can be mutated in cancer, and we are beginning to understand how these changes drive the disease. In some cases, pharmaceutical and biotech companies have designed therapies that target specific mutations. For example, several drugs have

been developed that quiet the damaged genes that make cancer cells divide continuously.

These therapies only work on cancers that contain the targeted mutations, which is why next generation sequencing (NGS) is becoming so important. NGS is a new DNA sequencing technology that sequences millions of small fragments of DNA concurrently.

NGS can provide a blueprint for each cancer patient's unique disease by reading their tumor's genome, exome (the small part of the genome that codes for proteins) or select genes — the usual suspects. This information can help oncologists and other clinicians develop a treatment

plan, outlining which mutations they should target to personalize care.

This personalization can continue throughout the treatment process. NGS can help determine if treatments are working, track cancer mutations as the disease evolves and continue to pinpoint a tumor's vulnerabilities. In addition, by identifying which patients are more likely to respond to a particular therapy, sequencing can accelerate clinical trials, providing new treatment options sooner.

when given the appropriate inhibitors, patients do not respond to treatment.

“We know a lot about EGFR deletion 19,” Kelly offers as an example, “but there are still patients who don’t respond to EGFR inhibitors. We need to understand why some patients respond and others don’t. There’s still a lot to learn.”

Still, gathering tumor information is helpful. Foundation Medicine has

created FoundationCORE, a database with tumor information from about 80,000 patients. The company has produced more than 135 peer-reviewed publications, gradually moving the science forward.

“Molecular tumor boards are an excellent opportunity for physicians to understand and apply this genomic information to their patients,” Kelly says. “We encourage all physicians to participate.”

UC Davis joins California, national precision medicine initiative

UC Davis is now part of the California Precision Medicine Consortium which, along with other California medical centers, has joined the National Institutes of Health Precision Medicine Initiative (PMI) Cohort Program.

The PMI Cohort Program is a landmark longitudinal research effort that aims to engage one million or more U.S. participants to enable research that over time helps to prevent and treat disease based on individual differences in lifestyle, environment and genetics. Participants will contribute a range of data about themselves, provide blood and urine samples, undergo physical evaluations and share real-time information via smartphones or wearable devices. The PMI Cohort Program aims to create a national resource for researchers, including citizen scientists, to help answer important questions about a variety of health conditions.

“We were recognized as having the infrastructure to meet the ambitious recruitment goals and the leadership to contribute to the California consortium and the national consortium,” said Frederick J. Meyers, UC Davis associate dean, precision medicine. **“The information will be collected with the greatest respect for individual privacy and a commitment to community participation.”**

Bioinformatics expert Michael Hogarth, professor in the UC Davis Departments of Internal Medicine and Pathology and Laboratory Medicine, will serve as the site principal investigator. Also on the UC Davis team are assistant professor Katherine Kim of the Betty Irene Moore School of Nursing, who specializes in using information technology to improve health, care coordination and clinical research, and associate professor Alexander Borowsky of the Department of Pathology and Laboratory Medicine, who will oversee study accrual.

“This will greatly benefit two areas: high-impact diseases that we have difficulty treating such as cancer, Parkinson’s and Alzheimer’s diseases, and on the other end, rare disorders for which we need very large numbers of participants so we can have the statistical power to justify clinical trials,” Hogarth said.

Discovering unique therapies that treat an individual’s cancer based on the specific genetic abnormalities of that person’s tumor.



Courtesy of the National Cancer Institute

LEUKEMIA SURVIVOR

turns disease, science passion into cancer research career

In the summer before his second year at UC Davis, Melvin Florencio Lorenzo was diagnosed with acute lymphoblastic leukemia.

The 20-year-old was terrified.

“The first thing that popped into my head was ‘I have to finish school, I have to get my Ph.D.’ ”

Now 23, Lorenzo not only finished school, but flourished, and can anticipate a promising future as a scientist.

When he was diagnosed, Lorenzo was in the middle of completing not one, but two very difficult degrees: mechanical and aerospace engineering. UC Davis offered a dual degree program so, he thought, why not try rocket science?

The son of Guatemalan immigrants, Lorenzo said his parents inspired him to work hard as a student, and that drive sparked his interest in engineering.

“They never held jobs that were high paying or even stable,” Lorenzo says. “I knew going into college that

I wanted to pursue something I was passionate about and make the most of all the opportunities they made available to me.”

But cancer put that in jeopardy. The pediatric team of oncologists and specially trained nurses at the UC Davis Comprehensive Cancer Center doggedly managed his case to help him defeat the disease so he could graduate from college and reach his goals.

Lorenzo’s oncologist Jonathan Ducore said because of his older age at diagnosis, Lorenzo was at higher risk of relapse, so he was put on an aggressive chemotherapy regimen. His intensive, 9-month course of treatment was complicated by liver failure, nerve problems, drug reactions, medication-related diabetes and various infections, Ducore says. Lorenzo was in and out of the hospital.

“One has to wonder how he could get through an engineering program while all the rest of this was going on,” Ducore says. “We periodically had to remind him that he had cancer.”

Indeed, treatment and the competing academic pursuits took their toll.

“I felt hopeless — absolutely hopeless,” Lorenzo recalls. “There were so



Melvin Florencio and mother, Ofelia, in the UC Davis Comprehensive Cancer Center's pediatric infusion center.

many assignments and tests, I had no idea what was going on in any of my classes. I wanted to give up, I shed tears just thinking 'I can't do it. This is physically impossible.' "

Now 23, Lorenzo not only finished school, but flourished, and can anticipate a promising future as a scientist.

Lorenzo cited the added difficulty of distance from loved ones who lived in Los Angeles. Friends and fellow cancer survivors coached him throughout his treatment. Then his mother moved to Davis for six months as he poured himself into his studies.

"She told me that it was okay to take a break, but that if I really wanted to do

it, I could," Lorenzo says. "My mom would drive me to chemo and I would study in the car, and the nurses would give me quiet time to work. That's the most focused I've ever been in my entire life."

Little by little,

Lorenzo squared away his assignments. He didn't just pass his classes, he made the dean's list.

"I just knew that since I made it through the chemo and the studying, I could make it through anything," he says.

Lorenzo is nearly finished with his more than three years of cancer therapy, and recently started a Ph.D. program

at Virginia Tech in the Bioelectromechanical Systems Laboratory under Rafael Davalos, where he is at work developing new cancer therapies.

Specifically, the research team is devising a method in which tumors are pulsed by electric fields to create holes in the cell's membrane and induce cell death.

Lorenzo's motivation to help others beat cancer comes naturally.

"Cancer is very near to my heart," Lorenzo says. "I've seen a few friends pass away because the technology isn't developed as much as it could be. I hope to make a difference."



**FROM SPAGHETTI DINNER TO FUNDRAISING POWERHOUSE:
Amador Cancer Research Foundation
sets \$5.5 million goal**

Since its start in 2007, the Amador Cancer Research Foundation (ACRF) has been providing important research support for the UC Davis Comprehensive Cancer Center through their tremendous generosity, hard work, dedication and spaghetti — lots and lots of spaghetti.

Cathy Landgraf, who heads the foundation, is the daughter of Helen

and John Landgraf, a couple who started a cancer research endowment in 1973 in memory of their daughter Christine.

Today, Landgraf is dedicated to bringing the small Amador County community together to help fight cancer as a continuation of her family's research endowment.

The focal point of this community-based fundraising has been the foundation's Spaghetti Western, a big party held every year at Cooper Vineyards in Plymouth, California. It's a night full of music, dancing, food and drink. The party brings in money through ticket sales, sponsors, live and silent auctions, and donations. The funds raised at the Spaghetti Western have made up the bulk of

the foundation's recent support.

"It all came out of Cathy's brain — she knows the people in the county," says ACRF treasurer Jim Schnepf. "Amador has somewhere between 30,000 and 40,000 people. The individuals who support our work support us year after year. She just keeps drawing these people back."

Jim and his wife, Teri (a board member who serves as the foundation's secretary), first got involved with the program when Cathy asked them to volunteer at the Spaghetti Western. Four hundred-plus servings of salad later, they were hooked.

David Logan, a longtime ACRF supporter along with his wife, Diane, said the reason the ACRF is so dedicated to UC Davis is that it has touched so many Amador County residents' lives.

"There are only 47 comprehensive cancer centers recognized by the NCI (National Cancer Institute)," notes Logan. "It's a real blessing for the area. Not many people in Amador County realize what we have."

Teri Schnepf agrees.

"We're a rural county where there aren't many options," Schnepf says. "There have been a lot of people who

The foundation's grants have been integral to the cancer center's development of research and faculty.

have directly benefitted from UC Davis. It builds a loyal following because we can directly see what we're doing."

The foundation's grants have been integral to the cancer center's development of research and faculty. Primo "Lucky" Lara, Jr., acting cancer center director, received the grant in 1999 and again in 2007.

This year's recipient is UC Davis Assistant Professor of Radiation Oncology Megan Daly. Her \$20,000 grant will support a clinical trial that enrolls patients with metastatic non-small cell lung cancer.

The new chair will create a permanent and significant tie between the Amador Cancer Research Foundation, the Landgraf Family and the UC Davis Health System.

"The money from the Landgraf award will be incredibly helpful in allowing us to open a pilot study evaluating radiation in lung cancer patients who have not responded to immunotherapy," Daly says. "We hope this approach will allow more patients to benefit from these promising new drugs."

The foundation recently began to diversify their funding sources by promoting legacy donations through estate giving. Several Amador County residents decided to commit money to the ACRF through their estate plans, and today the foundation's total committed funds exceed \$3.5 million.

The committee also has set a new goal of \$5.5 million. This allows for the future establishment of an endowed chair within the cancer center to ensure the pursuit of new knowledge in cancer research. The new chair will create a permanent and significant tie between the Amador Cancer Research Foundation, the Landgraf Family and the UC Davis Health System.

As for the future, Landgraf is confident that the ACRF's expected growth in resources will allow them to play a larger, more meaningful role in the fight against cancer.

"I am very grateful for the board's hard work and grateful for our community's generosity and support," she says. **"We are all affected by cancer, and ACRF is dedicated to prevention, better treatments and better outcomes to this disease. We must push on."**



Amador Cancer Research Foundation members from left to right are Jago Landgraf, Jen Mason, Jim Schnepf, Cathy Landgraf, Gary Little, John Mills and Teri Schnepf.



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Taylor Hurst was one of several cancer patients who received an American Girl doll in her likeness that she brings with her to her chemotherapy and other medical appointments. The dolls, courtesy of the Children's Miracle Network Hospitals, are part of an effort to normalize the treatment and resulting hair loss experience. Taylor named her doll "Lucy Davis" in recognition of her cancer care at UC Davis.

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Synthesis – the art of bringing together distinct elements

in a way that makes them whole – is a particularly

relevant name for the magazine of UC Davis Comprehensive Cancer Center, which is distinct in its commitment to team science.

Our research program unites clinical physicians, laboratory scientists, population specialists and public-health experts from

throughout UC Davis and Lawrence Livermore National Laboratory with the goals of making cancer discoveries and delivering

these advances to patients as quickly as possible. We are also dedicated to sharing our expertise throughout the region,

eliminating cancer disparities and ensuring all Californians have access to high-quality cancer care. *Synthesis* – linking the best in

cancer science toward the united goal of improving lives – is the name of our magazine, and our promise as your National Cancer

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