



## JUST THE FACTS

MORE THAN

**1.7 M**

ESTIMATED NEW CASES OF CANCER  
IN 2018 IN THE UNITED STATES

MORE THAN

**609,000**

U.S. CANCER DEATHS  
ARE EXPECTED IN 2018

SINCE PEAKING IN THE 1990s,  
CANCER DEATH RATE  
HAS DECLINED

**26%**

MORE THAN

**15.5 M**

AMERICANS ARE CANCER  
SURVIVORS (AS OF JANUARY 2016)

APPROXIMATELY

**73%**

OF SURVIVAL GAINS IN CANCER  
ARE ATTRIBUTABLE TO NEW  
MEDICINES<sup>2</sup>

# MEDICINES IN DEVELOPMENT FOR CANCER

## More Than 1,100 Cancer Treatments in Clinical Testing Offer Hope to Patients

In recent decades, substantial progress has been made in the fight against cancer. Since peaking in the 1990s, cancer death rates have declined 26 percent, leading to more than 2.3 million cancer deaths avoided.<sup>1</sup> Accordingly, rates of cancer survivorship continue to rise. The number of cancer survivors living in the United States has increased from three million in 1971 to 15.5 million as of January 1, 2016.<sup>1</sup> Approximately 73 percent of survival gains in cancer are attributable to new medicines.<sup>2</sup> Between 1988 and 2000, treatment advances in cancer have saved 23 million years of life and added \$1.9 trillion to society based on improved productivity, extended life and other factors.<sup>2</sup> And, since 1975, the chances that a cancer patient will live five years or more have increased by 41 percent across all cancers.<sup>2</sup>

Much of this progress is due, in part, to advances in molecular and genomic research that have revealed the unique complexities of cancer and changed our understanding of the disease. Today, scientists recognize that no two cancers are alike; cancer is far more complex and varied. Just as each person's genetic material is unique to them, every patient's cancer is impacted and driven by a variety of unique factors. The condition broadly referred to as cancer is in fact a group of hundreds of different diseases.

These advances have expanded our knowledge of how cancer develops and how to target medicines for specific cancer types, which has resulted in new, more effective therapies for patients.

In fact, *an average of 85 percent of medicines in the oncology pipeline are likely to be first-in-class medicines*, meaning they use a new and unique mechanism for treating a disease.<sup>2</sup>

While great progress has been and continues to be made against cancer, it remains a large unmet need. It is the second leading cause of death in the United States, accounting for 22 percent of all deaths. It is estimated that in 2018, more than 1.7 million new cancer cases will be diagnosed and more than 609,000 Americans will die from cancer (more than 1,600 people per day).<sup>1,3</sup>

America's biopharmaceutical research companies are responding to the needs of cancer patients, working to develop more effective and better tolerated treatments. Researchers are now exploring game-changing methods and technologies to fight cancer as well as innovative ways to use existing medicines, either alone or in combination with other therapies. This rapid pace of scientific advances ushered in a new era of medicine for cancer patients over the last decade. Biopharmaceutical researchers' understanding of the underlying biological mechanisms that lead to cancer cell growth create promising avenues for treatment advances. Research into the role of the body's immune system in fighting cancer has yielded some of the most exciting advances, resulting in a new wave of immunotherapies that specifically target cancers.

Today, **1,120 medicines and vaccines**<sup>4</sup> for cancer are currently in development by America's biopharmaceutical companies, all of which are in clinical trials or awaiting review by the U.S. Food and Drug Administration (FDA). The medicines in development include:

- **137** for several types of leukemia, which accounts for more than three percent of all new cases of cancer.<sup>1</sup>
- **135** for lymphoma, including non-Hodgkin lymphoma, which accounts for nearly five percent of all new cancer diagnoses.<sup>1</sup>
- **132** for lung cancer, the leading cause of cancer death in the United States, with more than 154,000 deaths and 234,030 new cases expected in 2018.<sup>1</sup>
- **108** for breast cancer, the leading cancer diagnosed in women in the United States with more than 266,000 new cases expected in 2018.<sup>1</sup>
- **90** for brain tumors, including gliomas, which represent nearly 25 percent of all primary brain tumors.<sup>5</sup>
- **46** for skin cancer, including melanoma, which accounts for 69 percent of all skin cancer deaths (excluding basal and squamous cell).<sup>1</sup>

Other medicines in development target colorectal cancer, prostate cancer, ovarian cancer, childhood cancers and solid tumors, among others.

## Novel Approaches to Tackle Cancer

While we are at a time of remarkable change in cancer care, and new drug approvals over the past several years represent significant advances for many patients across many types of cancer, we are just beginning to understand the true power of new cancer treatments, including immuno-oncology and personalized medicines, to help patients. There is still a need for new cancer treatments and potential cures. Many of the 1,120 medicines in the pipeline today are using novel approaches to attack cancer. Some examples of the exciting science behind potential new cancer treatments include:

### Adoptive Cell Therapy (CAR-T)

By genetically altering and boosting special immune cells of patients suffering from certain forms of cancer, those cells – often referred to as a “living drug” – may serve to eliminate the disease. White blood cells, called T-cells, play a role in many cancer immunotherapy approaches. In healthy individuals, T-cells identify and kill infected or abnormal cells, including cancer cells. Two promising technologies in

development that activate a patient's own T-cells to attack cancer cells are genetically modified chimeric antigen receptor T-cell therapy (CAR-T) and T-cell receptors (TCR) therapy. Other types include tumor infiltrating-lymphocytes (TILs) and natural killer cells.

CAR-T therapy utilizes a patient's own T-cells to uniquely recognize and kill cancerous tumor cells. To receive the treatment, a patient's blood is filtered to remove T-cells, which are then altered in the lab by inserting a gene that codes for a receptor that targets a protein unique to cancer cells. The T-cells are then returned to the patient intravenously, where they can then bind to and kill the cancer cells. In 2017, the first CAR-T treatment was approved for certain pediatric and young adult patients with a form of acute lymphoblastic leukemia.

### **Antibody-Drug Conjugates**

Antibody-drug conjugates (ADCs) are monoclonal antibodies linked to a therapeutic cytotoxic drug. Monoclonal antibodies are highly-selective for tumor-associated antigens, allowing them to target specific cancer cells without harming normal or healthy cells. Because improved targeting leaves more healthy cells unharmed, ADCs have the potential to cause fewer side effects than traditional chemotherapy, providing patients with a higher quality of life. When combined with a cytotoxic drug, the antibody binds to specific cancer cells and this antibody-drug combination is taken up by the cancer cells, releasing the cytotoxic drug and causing cancer cell death. There are four ADCs approved for use in the United States.

### **Immune Checkpoint Modulators**

The body's immune system must include many checks and balances to protect the body from invading pathogens while preventing itself from inadvertently attacking normal cells. The immune system uses "checkpoint" proteins in order to activate and prevent immune responses. Years of research revealed some tumors have high levels of proteins that put the brakes on the immune system, preventing it from attacking cancer cells.

Since discovering this, researchers have worked to understand the role of these checkpoint proteins and to target them in order to "release the brakes" on the immune system. Current checkpoint modulators commonly target three proteins - CTLA-4, OX40 and PD-1/PD-L1.

Long-term data reveals tremendous survival outcomes in many forms of cancer. In a recent study, 40 percent of advanced melanoma patients receiving a checkpoint modulator were alive three years after starting treatment.<sup>6</sup> Before the arrival of the first immunotherapy in 2011, survival for these patients was measured in months. Since that first approval, the FDA has approved five more checkpoint inhibitors.

### **Metabolic Immunotherapy**

Immuno-oncology therapies use many different pathways to activate the body's immune system to attack cancer cells. Metabolic immuno-oncology involves using metabolic pathways to improve the immune system's ability to attack cancerous tumors. It is believed that cellular metabolism plays an important role in moderating parts of the immune system. In cancer, tumor cells can deplete nutrients the immune system needs to work correctly and support the development of immunosuppressive metabolites, making it difficult for the immune system to recognize and attack the tumors. Metabolic immuno-oncology hopes to modulate the activity of immune system and enhance its ability to activate an anti-tumor response by targeting key metabolic enzymes. The first metabolic immuno-oncology medicine was approved last year.

## Oncolytic Virus Therapy

In 2015, FDA approved the first in an entirely new class of medicines called oncolytic virus therapies for the treatment of melanoma lesions that cannot be removed by surgery or have recurred after surgery. This treatment is a genetically modified virus that, when injected directly into a cancerous lesion, replicates inside cancer cells and causes them to rupture.

## Vaccines

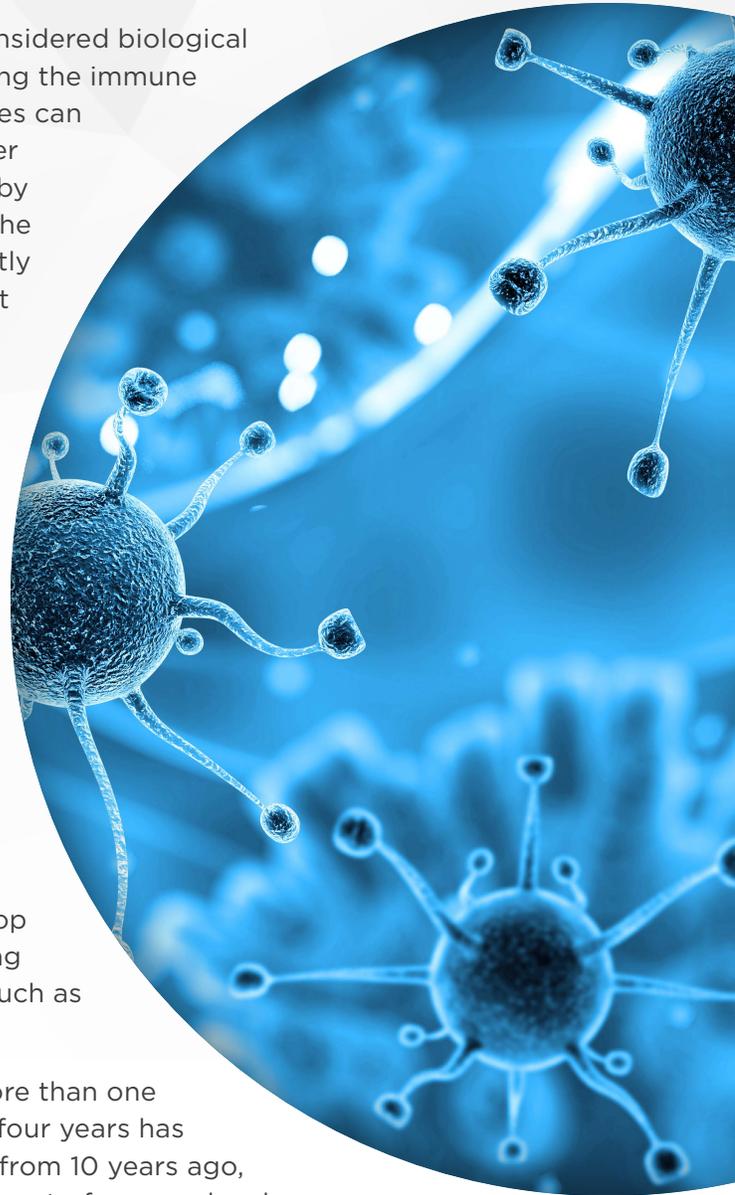
Cancer vaccines – a form of cancer immunotherapy – are considered biological response modifiers and work by either stimulating or restoring the immune system’s ability to fight infection and disease. Cancer vaccines can be either be preventive, which are intended to prevent cancer from developing in healthy people or meant to treat cancer by strengthening the body’s natural immune response against the cancer, these are referred to as therapeutic vaccines. Currently available preventive vaccines for cervical cancer help protect against strains of the human papillomavirus (an infectious agent which is known to cause the disease). Additionally, one therapeutic vaccine (for prostate cancer) is approved in the United States.

## The Growth of Personalized Medicine

Personalized medicine, or precision medicine, is a growing medical field where health care providers use diagnostic tests to determine which treatments will work for the right patient at the right time. In cancer, tumor types can differ from one patient to another, even within the same form of cancer. For personalized medicines to treat cancer effectively, scientists need an understanding of the genetic variables present in the cancer and they need to develop a therapy that targets those genetic variables. Personalized medicine allows health care providers to develop a targeted treatment plan by combining the data from testing with an individual’s medical history and life circumstances, such as exposure to cancer-causing toxins.

According to the Personalized Medicine Coalition (PMC), more than one of every four medicines approved by the FDA over the past four years has been a personalized treatment. This is a significant increase from 10 years ago, when personalized medicines accounted for less than 10 percent of new molecular entities annually. Beginning in 2014, personalized medicines have accounted for more than 20 percent of all new molecular entity approvals each year.

2017 was a milestone year for personalized medicine and patients. PMC’s “2017 Progress Report: Personalized Medicine at FDA,” found that 34 percent (16 of 46) of all NMEs approved by FDA last year were personalized medicines, and of those, nine were cancer treatments. In addition, 2017 saw the first approvals of gene therapies (personalized treatments that involve transplanting healthy cells into missing or defective cells), two of which were approved for blood cancers; the first ever personalized biosimilar medicine was approved for HER2-positive breast cancer, and the first approval for a medicine based on a present biomarker (tissue-agnostic indication), regardless of where the tumor is located.



## Research in Immuno-Oncology Treatments Ushering in New Era

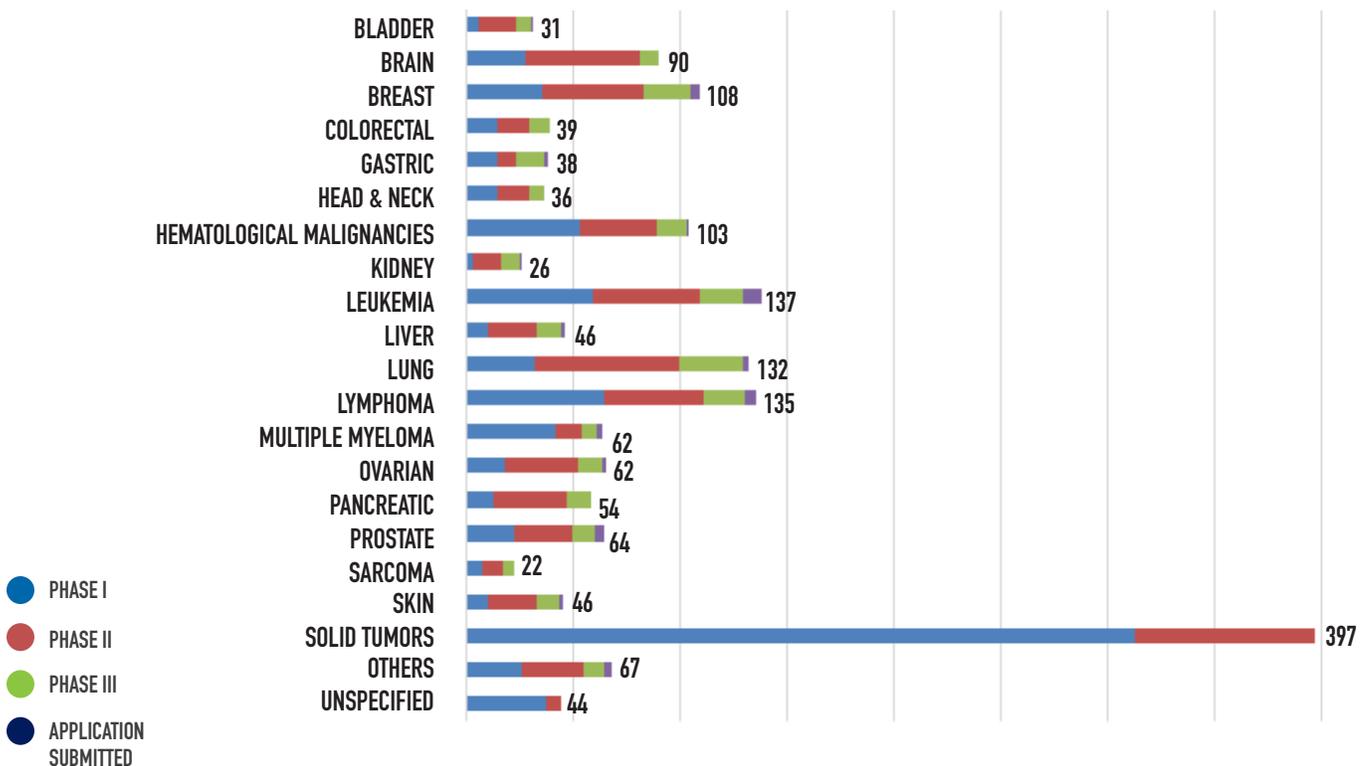
Cancer immunotherapies, also known as immuno-oncology, enable the patient's own immune system to fight cancer similarly to the way it fights disease-causing viruses and bacteria. These treatments can help unleash a patient's own immune system against cancer, with the promise of lasting results. Different cancer immunotherapies work on the immune system in different ways. For example, some immunotherapies facilitate a stronger immune response to cancer, while others show the immune system what cancer looks like so that it can better identify, target and kill the cancer cells. While immunotherapies broadly have been around for years, innovation has ushered in a new era of science which has opened the door to the next generation of discovery. In fact, in some forms of cancer, chemotherapy is no longer

considered standard of care as a new wave of immuno-oncology treatments transform the treatment paradigm.

A 2017 PhRMA report on immuno-oncology treatments in the pipeline found that biopharmaceutical companies were developing 248 immuno-oncology medicines and vaccines in the most recognized classes of cancer immunotherapy. While there is no single accepted definition of immuno-oncology, the report included many of the most recognized classes: adoptive cell therapies (including CAR-T therapy), bi-specific antibodies, cytokine therapy, immune checkpoint modulators, oncolytic virus therapies and vaccines.

Since that report, there has been an increase in cancer immunotherapy research with 295 immuno-oncology medicines and vaccines development in the pipeline today.

## Medicines and Vaccines in Development for Cancer by Tissue of Origin



**Note:** Some medicines may be in more than one category.



## GOING BOLDLY: BEATING THE ODDS

At 24 years old, Matt's life changed forever. Halfway through medical school, he was diagnosed with stage IV lung cancer – as a nonsmoker. With a diagnosis that marked his fate uncertain, he chose to battle the disease with everything he had.

During his treatment, Matt discovered he had a specific gene mutation which made him eligible to access a two-week-old medicine released in a phase I clinical trial. Through a progressive cancer treatment (with virtually no side effects), Matt has successfully put his cancer into remission. He beat the odds, he likes to say. Currently at the age of 29, Matt is 100 percent disease-free. This new, healthy life is one characterized by his own work as a researcher.

Enter Ted. Ted is one of hundreds of scientists who has devoted his life to fighting cancer through research and development of new medicines. This dedication stems from losing his 62-year-old mother to cancer. He says, “At the time [my mother] had cancer, treatments just weren't effective.” So, Ted set out to develop ones that were. Ultimately, this work led him to developing a life-saving treatment for a specific genetic mutation of lung cancer. The very same targeted-therapy that saved Matt's life.

These men have seen cancer from both sides, and their stories are a testament to the importance of fighting against a disease as hard as one can, whether as a patient or as a researcher. The army of researchers like Ted, who discover the breakthrough treatments that ultimately save millions of lives, directly impact patients like Matt.

Today, there are **nearly 300** immunotherapy medicines in development, alongside the 1,000+ cancer medicines in development for a multitude of cancers. The future is bright for patients like Matt, and thanks to researchers like Ted, newer innovations are just around the corner.

### Sources:

1. Cancer Facts and Figures 2018, American Cancer Society
2. 2018 Cancer Chart Pack, PhRMA
3. Deaths: Final Data for 2015, National Vital Statistics Reports, National Center for Health Statistics (NCHS)
4. Number of medicines obtained through public government, and industry sources, and the Adis “R&D Insight” database; current as of May 6, 2018.
5. American Brain Tumor Association
6. American Society of Clinical Oncology, “PD-1 Inhibitor Pembrolizumab Provides Long-Term Survival Benefit for Patients with Advanced Melanoma: First report of 36-month Overall Survival Data from Patients in Early-Stage Study.” May 30, 2016.

