



Socio-economic impact of cancer research in Quebec

A partnership



ONCOPOLE
MOBILISER. INNOVER. GUÉRIR.



October 16th, 2018



1. Overview of the latest developments in the cancer field

1.1 Cancer prevalence and cancer care organization in Quebec

1.2 Scientific and medical advances

1.3 Evolution of oncology costs

Summary

1.1 Cancer prevalence and cancer care organization in Quebec

- Cancer was responsible for one third of all deaths in Quebec in 2015, making it the leading cause of death. In 2017, it is estimated that 53,200 people received a cancer diagnosis in Quebec. One out of every two people is expected to develop cancer in their lifetime and half of them will die from it. The number of new cancer cases is on the rise as a result of population aging and demographic growth.
- There are 68 ultra-specialized interdisciplinary teams involved in cancer care in Quebec, affiliated with 11 institutions. Approximately 88% of Quebec cancer patients are under the care of a cancer specialist, one of the highest rates in the country.

1.2 Scientific and medical advances

- Over the past few years, cancer survival rates have increased with respect to several types of cancer. This was made possible thanks to advances in research. Progress will continue to occur rapidly in this field, as several new diagnostic tools and treatments are at various stages of development.
- According to *Food and Drug Administration* approvals, one out of four new treatments targeted the oncology sector (2015-2017). In fact, oncology is the field in which developments from personalized medicine are the most visible and the quickest.

1.3 Evolution of oncology costs

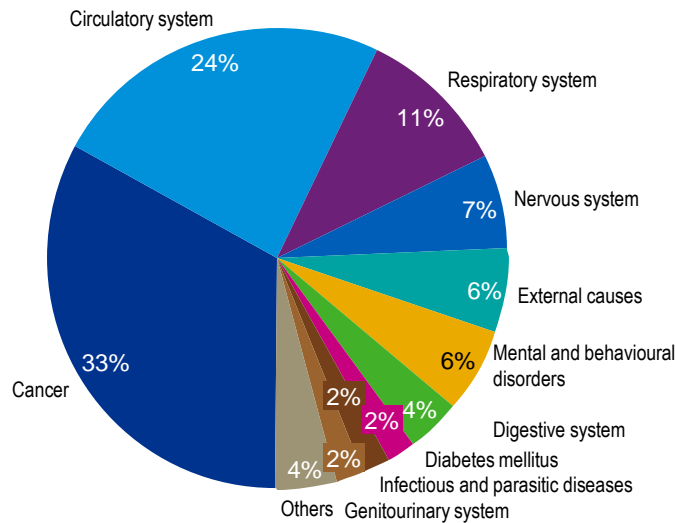
- Oncology costs are highest in the United States, both in absolute terms and per capita. Canada ranks sixth per capita among the major industrialized countries with major growth over the 2010-2014 period (+41%).
- Global costs for cancer-related treatment reached \$113 billion US in 2016, driven by the introduction on the market of several new treatments, as well as an increase in the number of cases. It is estimated that costs may reach between \$147B US and \$177B US in 2021, an annual increase of 6% to 9%.

Cancer is the leading cause of death in Quebec

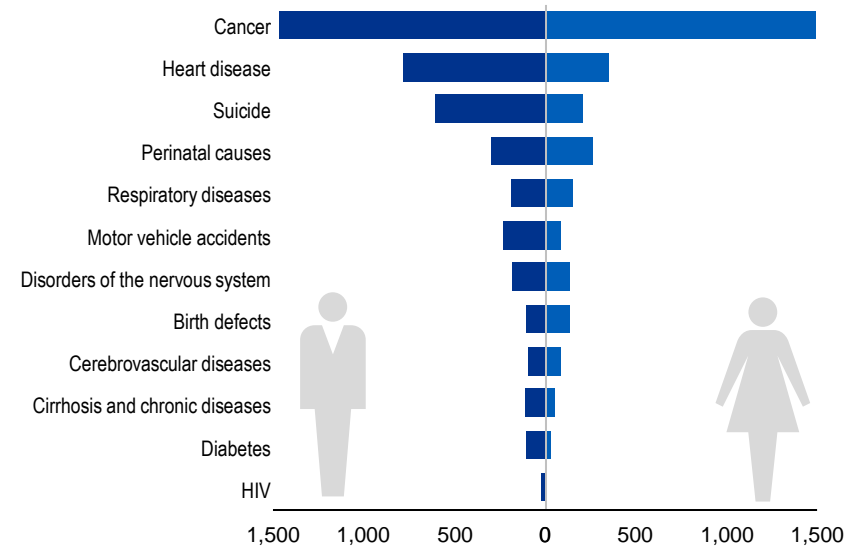
Cancer was responsible for 33% of all deaths in Quebec in 2015.

- Cancer was also, by far, the leading cause of premature death, for both men and women, as evaluated according to Potential years of life lost (PYLL). That same finding is also true for all of Canada.

Deaths according to the main causes, genders combined
Quebec, 2015



Potential years of life lost (PYLL) for certain causes of death
Quebec, 2015, in years, for 100,000 people from 0-74 years of age



Sources: Institut de la statistique du Québec; KPMG Analysis

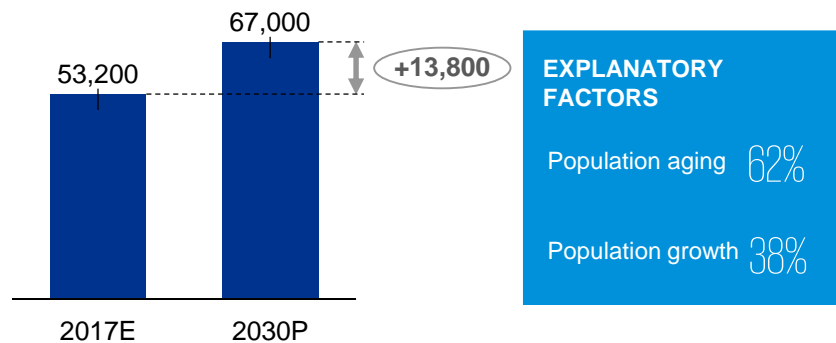
Note: values are presented in decreasing order of total PYLL for both sexes combined and are calculated according to life expectancy based on the mortality rate of all causes combined.

The annual number of new cancer cases is steadily rising

In 2017, it is estimated that 53,200 people received a cancer diagnosis in Quebec, while the number of new cancer cases has increased by an average of 2% per year over the last 10 years.

- That number will continue to increase as a result of demographic growth and population aging. In fact, 89% of cancers occur in people over the age of 50, and 45% in people over the age of 70.

Number of annual new cases of cancer per year
2017E (estimated) and 2030P (projected), Quebec

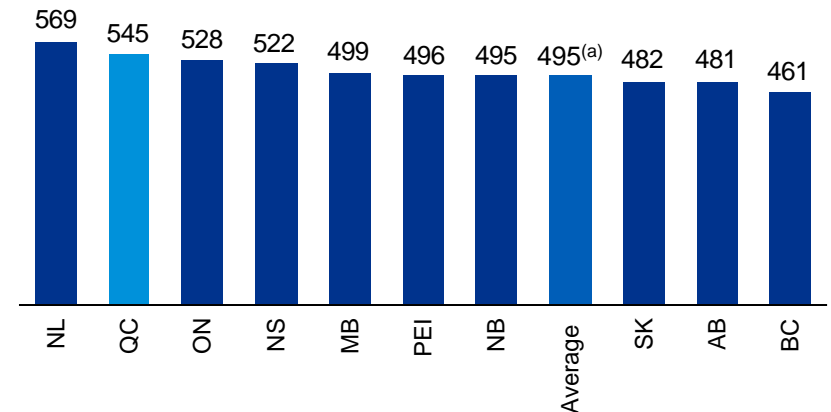


Note: (a) Canadian average excluding Quebec.
Sources: Quebec Cancer Foundation; Canadian Cancer Society; KPMG Analysis

The cancer incidence rate (age-standardized) in the Quebec population is among the highest in the country.

- In 2017, the incidence rate in Quebec was 545 per 100,000 inhabitants, while the Canadian average (excluding Quebec) was 495.

Incidence of cancer rates in the population, age-standardized, by province
2017



Note: Incidence per 100,000 inhabitants

In both Canada and Quebec, 1 in 2 people is expected to develop cancer during their lifetime, and 1 in 4 is expected to die from it.

1.1 Cancer prevalence and cancer care organization in Quebec

The Quebec health care system mobilizes major resources for cancer care

Quebec has 68 ultra-specialized interdisciplinary teams dedicated to cancer care, affiliated with 11 institutions.

Some approximate numbers:

- More than 700 medical specialists;
- 250 oncology pivot nurses;
- 100 social workers; and
- 60 psychologists.

In 2016-2017, care in hemato-oncology departments generated:

- 973,000 visits by 173,000 users; and
- 389,000 chemotherapy treatments.

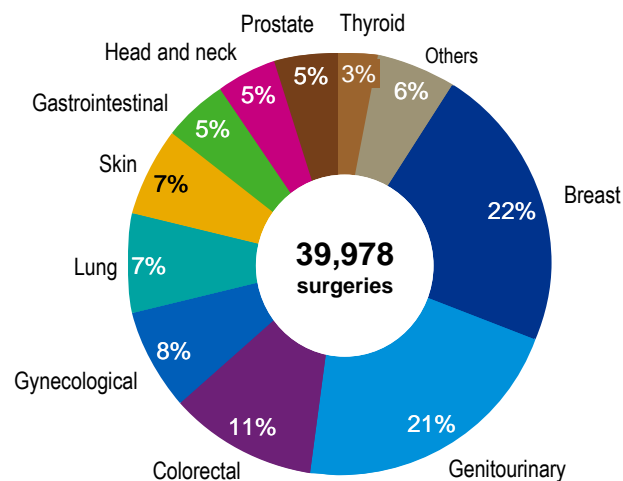
Oncology pivot nurses also carried out follow-ups with 91,000 users, 29,000 of whom were new patients.

Furthermore, at least 40,000 cancer surgeries were performed in Quebec in 2017-2018.

- Number of surgeries is not related to the incidence, notably for kidney cancer where numerous surgeries might be necessary for a patient.

Number of cancer surgeries performed by tumor site

Quebec, 2017-2018



Sources: Direction générale de cancérologie (ministère de la Santé et des Services sociaux); KPMG Analysis

1.1 Cancer prevalence and cancer care organization in Quebec

Patient follow-up that compares favorably with other provinces

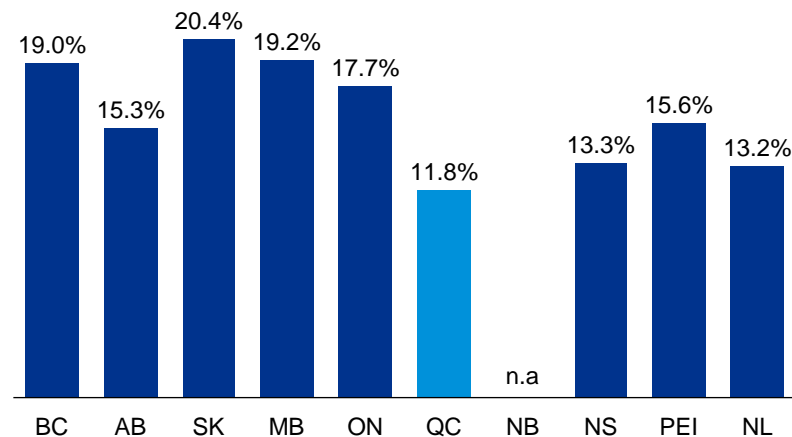
In Quebec, only 11.8% of cancer patients stated that nobody had discussed the various treatments with them.

– That represents the lowest proportion among Canadian provinces.

Furthermore, 88% of cancer patients in Quebec are followed by a cancer specialist, alone or along with the primary care provider, one of the highest proportions in the country.

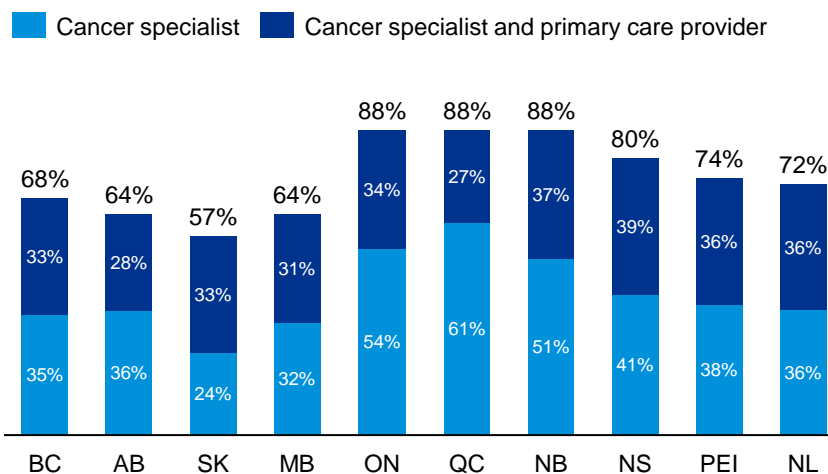
Proportion of cancer patients having stated that nobody had discussed the various treatments available with them

*Last year available**



Proportion of patients whose cancer specialist is responsible for the follow-up (alone or along with the primary care provider), by province

2016



* BC: 2012; SK, PEI: 2013; AB: 2015; MB, NL, NS: 2016; ON, QC: 2015/16.
QC: Weighted data. The survey question referred to a discussion with a health professional rather than with a "person".

Sources : Canadian Partnership Against Cancer, *Living with Cancer – A Report on the Patient Experience*; KPMG Analysis

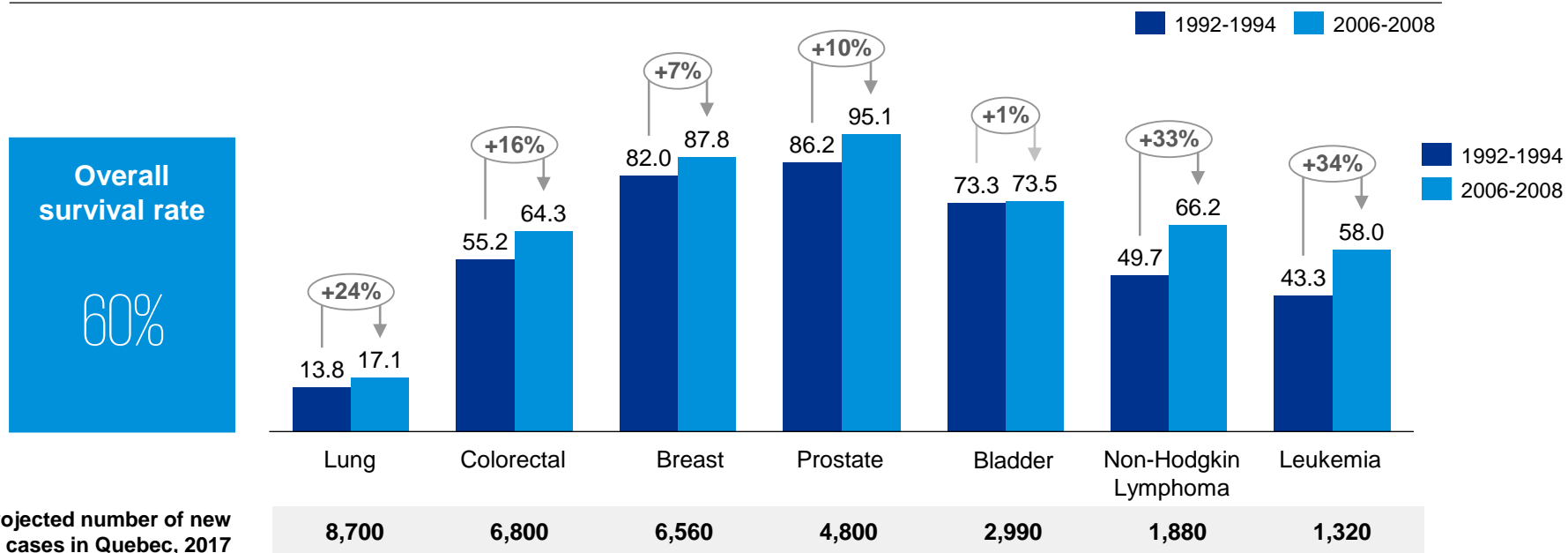
Progress in patient survival...

Over the past few years, patient survival has increased for several types of cancer.

- For example, in the case of leukemia, the likelihood of a person being alive 5 years after their diagnosis, compared to the likelihood of survival in the population of the same age, rose from 43% to 58% between the periods 1992-1994 and 2006-2008, a 34% improvement.

Five-year relative survival report (%) age-standardized for certain cancers

Periods 1992-1994 and 2006-2008*, for the 7 most prevalent cancers, Canada



*Latest statistics available

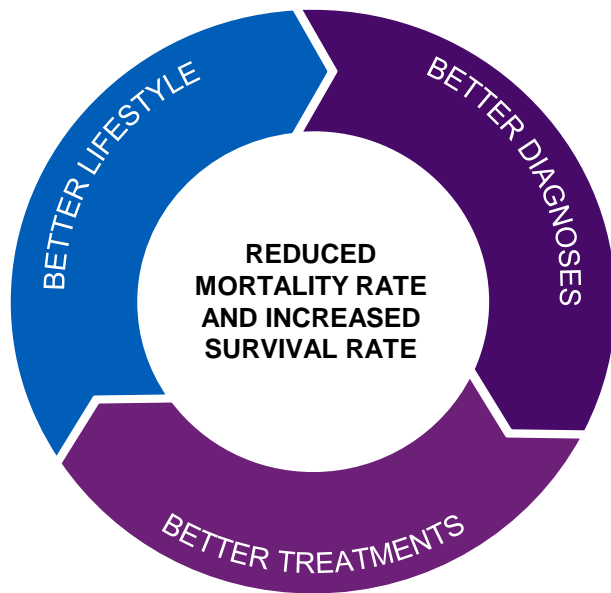
Sources: Canadian Cancer Statistics 2017; Statistics Canada; KPMG Analysis

1.2 Scientific and medical advances

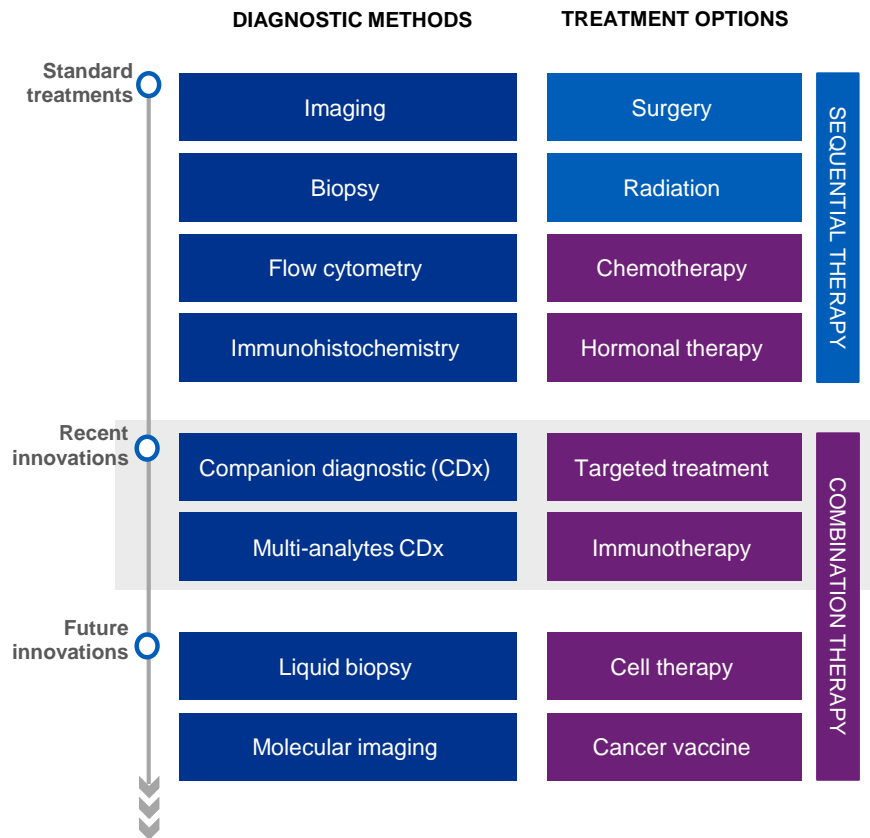
... Thanks to the advancement of knowledge, stemming from research

Cancer causes, the way it develops and the best practices for treating it are now better known...

- The progress made over the last few years is related to improvements made in cancer screening, treatment improvements, and certain lifestyle changes, particularly a decrease in tobacco use.



... as diagnostic methods and treatment options evolve and multiply.

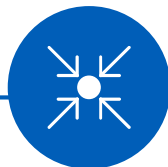


Sources: Graphic on the right adapted from: *In Vivo Pharma intelligence | informa, Oncology Disruption Demands Strategic Transformation, October 2017; KPMG Analysis.*

Several developments are underway (1/2)

Personalized medicine

- Personalized medicine consists of treating each patient according to the genetic and biological specificities of their tumor, while also taking the patient's environment, lifestyle, etc., into account.
- The first treatment developed in personalized medicine was for oncology.
- Targeted therapies based on personalized medicine are already a reality for several types of cancer.
- Current techniques allow to study tumor characteristics more and more specifically in order to specify the diagnosis, identify the anomalies involved and treat them, whenever possible, with a targeted therapy.
- They are also useful in developing markers of treatment efficacy and in predicting disease evolution, such as the emergence of metastases, to adapt patient follow-up.
- Moreover, the development of companion diagnostics to select targeted therapies is a growing industry trend and increases the success rate of clinical trials.



Liquid biopsy

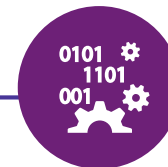
- Still today, the only way to obtain a definitive cancer diagnosis is through a tissue biopsy requiring a surgery or other invasive and painful procedure.
- Over the last few years, research on liquid biopsies has progressed rapidly. A liquid biopsy is a search for signs of cancer in a bodily fluid, most often in blood, the collection of which is quick, non-invasive and may be repeated if necessary.
- Although it is not yet commonly being used to diagnose cancer, liquid biopsy is starting to be useful for i. monitoring disease course and relapses and ii. identifying genetic mutations and emergence of treatment resistance.

Source: Adapted from www.cancer.ca



Artificial intelligence

- Given the increase in the number of cancer new cases, and the proliferation of diagnostic tools, drugs and treatments, artificial intelligence (AI) is one of the avenues currently being explored in order to deal with the growing volume and complexity of information. For example, AI applications could help in:
 - Implementing digital pathology, meaning acquiring, managing, sharing and interpreting pathology information in a digital environment, in a faster and less expensive way than traditional methods, while also reducing the risk of errors.
 - Developing clinical decision support systems, which are software platforms helping clinicians make evidence based decisions by providing comprehensive information about treatment options and expected health results.

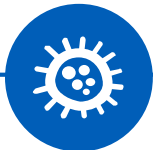


Source: KPMG Analysis.

Several developments are underway (2/2)

Immunotherapy

- According to the scientific and medical community, immunotherapy could be a true revolution in the years to come for treating cancer. These cutting-edge treatments have recently made it to the first line in several cancers.
- Immunotherapy is a type of biological therapy that harnesses the immune system to help destroy cancer cells. Cancer is no longer only seen as a genetic disease, but also as a disease of the organism, the tumor environment and the immune system. Several approaches are being developed including therapeutic vaccines and cell therapies.
- Since 2010, there has been quite a buzz surrounding immunotherapy to fight cancer. Over 200 immunotherapies are currently in clinical trials. The American journal Science placed this discipline at the top of its list of the major advances of 2013.



Cell therapy

- Cell therapy is a recent avenue of immunotherapy that consists of collecting cancer-fighting immune cells, culturing and manipulating them in the laboratory to increase their tumor-fighting potential and reinjecting them into patients.
- CAR-T Cell therapies (for Chimeric Antigen Receptor- T cell) are one of the approaches that has generated very promising results in cases of advanced cancers. This type of immunotherapy relies on a combination of cell therapy and gene therapy.
- Although major efforts are still needed, the development of totally individualized treatments, based on the reprogramming of the patient's own cells, is one of the promising avenues currently under development.

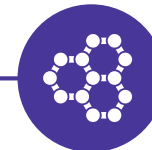
Source: Adapted from
www.cellcan.com



Combination therapies

- Combination therapies consist of simultaneously using treatments that have different mechanisms of action, thus killing more cancer cells and reducing the risk of drug resistance. The overall objective is to improve the patient's response to the therapy without considerably increasing toxicity.
- Over the past few years, identification of new combination therapies has accelerated, with hundreds of clinical trials testing different combinations including chemotherapy, radiation, hormone therapy, cell therapy and immunotherapy.
- However, efforts are still needed in order to identify the most promising combinations among the thousands of possibilities, see them progress in clinical trials and make them available to patients.

Source: Adapted from
www.cancer.gov



Source : KPMG Analysis

One in four new treatments is targeting oncology

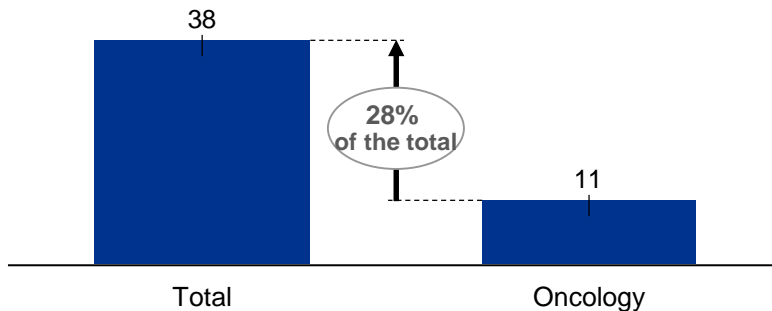
Among the 38 new treatments approved by the Food and Drug Administration (FDA), between 2015 and 2017, 11 (28%) targeted oncology.

- The relative importance of oncology in new treatments is the result of the considerable efforts devoted to research in this therapeutic field as well as the major impact of recent discoveries on the survival rates for several types of cancer.

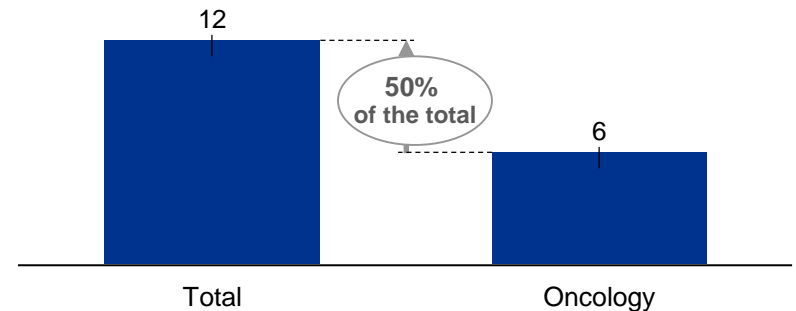
In fact, oncology is the therapeutic field in which developments stemming from personalized medicine are the most visible and the fastest.

- Among the 12 new personalized medicine drugs approved by the FDA, 6 (50%) targeted the oncology field.
- Moreover, these new drugs accounted for 55% of all new cancer drugs approved during that period.

New FDA-approved drugs
3-year average (2015 to 2017)



New FDA-approved drugs stemming from personalized medicine
3-year average (2015 to 2017)



Sources: Food and Drug Administration, 2015-2017 New Drug Therapy Approvals; PMC, 2015-2017 Personalized Medicine at FDA; In Vivo, Oncology Disruption Demands Strategic Transformation, October 2017; Estimation of clinical trial success rates and related parameters, February 2018; KPMG Analysis.

Although trial success rate in oncology was 5% in 2015, it is projected that the 650 Phase II/III candidates studied in 2017 may result in around one hundred new therapies for 30 clinical indications in 5 years

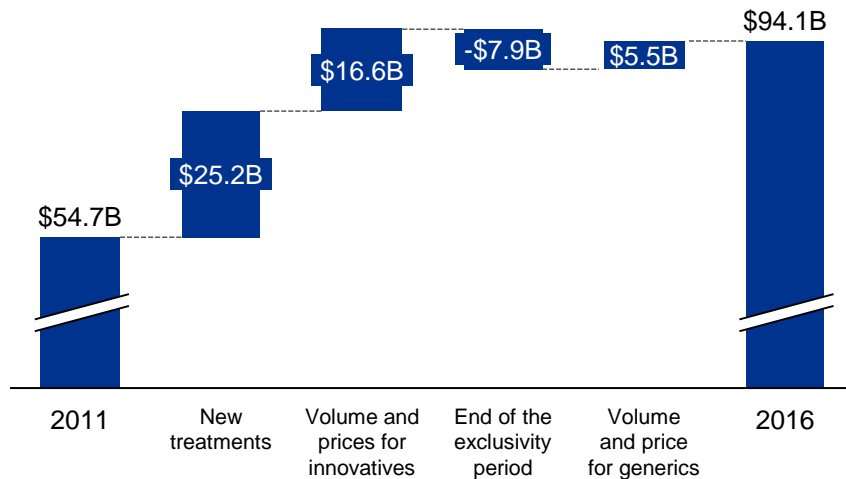
Global oncology costs are fast growing

As a result of several new treatments reaching the market and an increase in the number of cases, global costs for cancer-related treatments reached \$113 billion U.S. in 2016*.

- While global costs increased by 5% in the period between 2011 and 2016, it is estimated that growth may increase 6% to 9% annually between 2016 and 2021, reaching \$147B U.S. to \$177B U.S. in 2021.

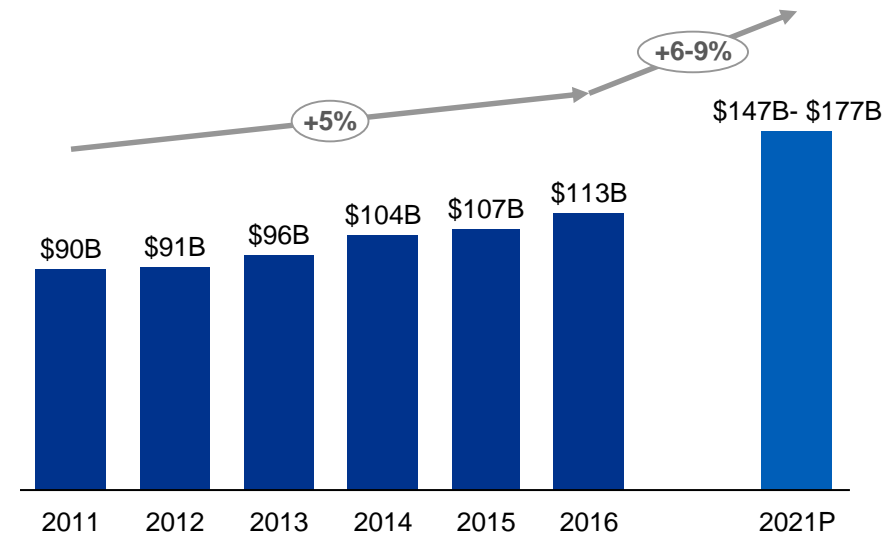
Evolution of global oncology costs (excluding supportive drugs*), according to the main cost factors

2011-2016, in billions of U.S. dollars (constant exchange rate)



Global oncology costs (including supportive drugs*)

2011-2016 and 2021P, in billions of U.S. dollars (variable exchange rate)



* Supportive drugs are not cancer drugs. They protect certain cells or certain organs against the side effects of chemotherapy agents or radiation (source: www.cancer.ca).
Sources: Quintile IMS Institute, Global Oncology Trends 2017, June 2017; KPMG Analysis.

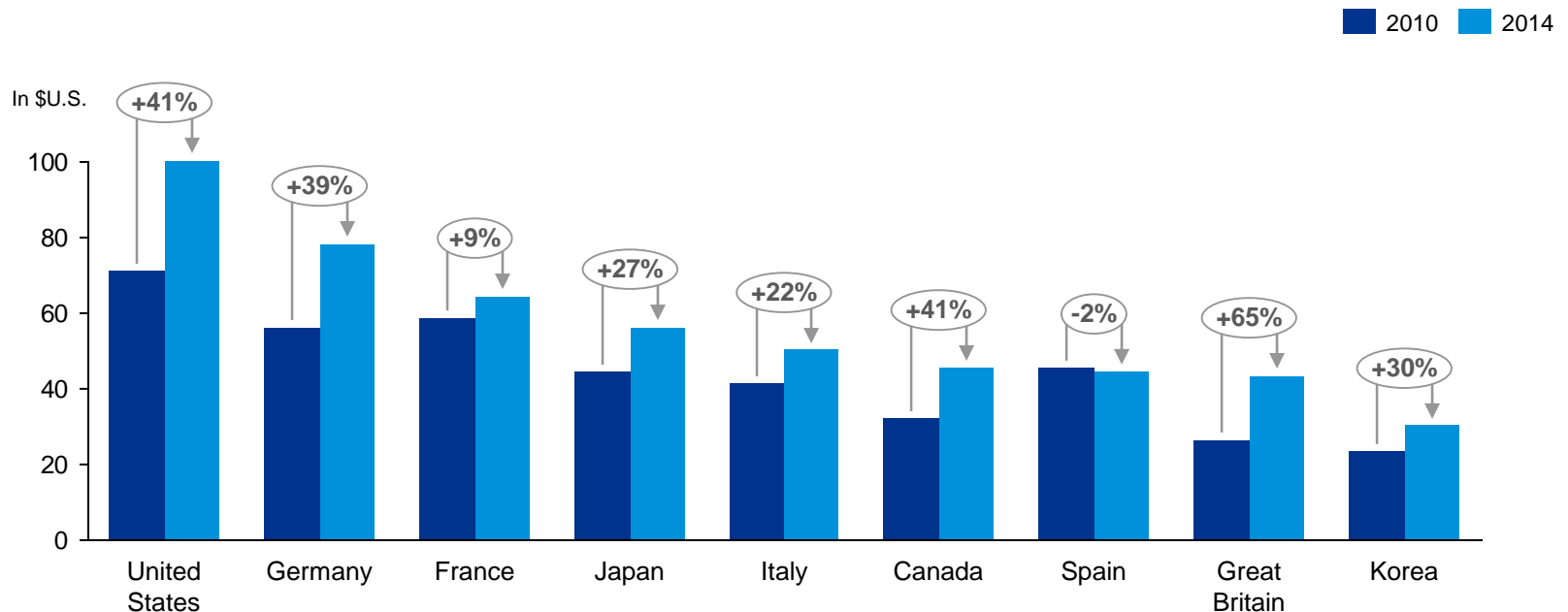
1.3 Evolution of oncology costs

Major differences across industrialized countries

Oncology costs are highest in the United States, in both absolute terms and per capita.

- Canada ranks 6th per capita among the major industrialized countries, with a significant increase over the 2010-2014 period (+41%).

Oncology costs per capita
2010-2014



Sources: IMS as reported in Forbes, *The Cancer Drug Market Just Hit \$100 Billion And Could Jump 50% In Four Years*, May 5, 2015; KPMG Analysis



2. Cancer research in Quebec

- 2.1 Academic research funding
- 2.2 Scientific productivity
- 2.3 Clinical trials
- 2.4 The Quebec cancer research ecosystem

Summary

2.1 Academic research funding

- Cancer research investments in Quebec come mainly from federal funding. Moreover, although Quebec captures a significant part of those funds per capita, provincial funding is greater in Ontario and the province also sets itself apart through its ability to obtain additional funds from other sources (particularly philanthropy).
- In Quebec, 26% of research investments are devoted to breast cancer, while leukemia research accounts for 17% of the total amount, prostate cancer 10%, and colorectal cancer 9%.

2.2 Scientific productivity

- Both Canada and Quebec, rank among the 10 most prolific countries with respect to oncology scientific publications, on a *per capita* basis.
- Quebec researchers have contributed nearly one quarter (23%) of the national scientific productivity in oncology, and 17% of their publications targeted breast cancer. Furthermore, the scientific impact of Quebec publications, measured in terms of average of relative citations, is greater than the Canadian average.
- 56% of Quebec publications were the results of international collaborations, a much higher proportion than the worldwide average (19%) and slightly higher than the Canadian average (53%).

2.3 Clinical trials

- In Quebec, almost one clinical trial out of four targets oncology and that therapeutic field ranks first.
- Since 2014, the number of clinical trials and of patients recruited have been on the rise.
- Although the majority of tumor sites are represented, over 50% of active oncology clinical trials (May 2018) are concentrated on three cancers: hematological cancers (27%), genitourinary cancers (16%) and breast cancer (12%).

2.4 The Quebec cancer research ecosystem

- Quebec has three major university hospital hubs (Montreal, Quebec and Sherbrooke) active in cancer research. Close to 75% of Quebec researchers are located in the Montreal area and produce 80% of the scientific publications.
- Several players are part of the cancer research funding/structuring/commercialization ecosystem in Quebec, some having provincial reach and others a more national scope.

2.1 Academic research funding

Cancer research funding in Quebec come mainly from federal funds

Research grants awarded by members of the Canadian Cancer Research Alliance are higher in Ontario than in Quebec (but higher in Quebec than in British Columbia), both in total and in proportion to the province population.

- *Per capita*, Quebec captures a significant part of the federal funds allocated to cancer, but Ontario compensates by greater provincial funding and its ability to obtain funds from other sources.
- Furthermore, a greater proportion of Quebec's research activities is focused on biology and treatment, while Ontario and British Columbia also set themselves apart with respect to screening and prevention.

Investments breakdown in cancer research according to source of the grants, by provinces

Total 2006-2015, \$ per capita and billions \$

	Quebec	Ontario	British Columbia
Federal funds	\$82.76	\$77.88	\$70.23
Provincial funds	\$27.87	\$52.40	\$18.66
Philanthropy	\$28.27	\$42.78	\$37.56
Others	\$5.16	\$22.62	\$6.37
Total \$ per capita	\$144.06	\$195.68	\$132.83
Total in billions \$	\$1.146B	\$2.6B	\$0.595B

Investments breakdown in cancer research according to the type of research/Common Scientific Outline (CSO)

Total 2006-2015, in % of the total

	Quebec	Ontario	British Columbia
Biology	42.9%	30.6%	25.5%
Etiology	14.8%	12.2%	16.8%
Screening and prevention	13.7%	18.8%	21.0%
Treatment	20.4%	30.6%	26.7%
Survivorship and evaluative research	8.1%	7.8%	10.0%
Total	100.0%	100.0%	100.0%

Note: The Alliance estimates that its study covers 60 to 80% of all cancer research funding sources (excluding industrial research)

Sources: Canadian Cancer Research Alliance; KPMG Analysis.

2.1 Academic research funding

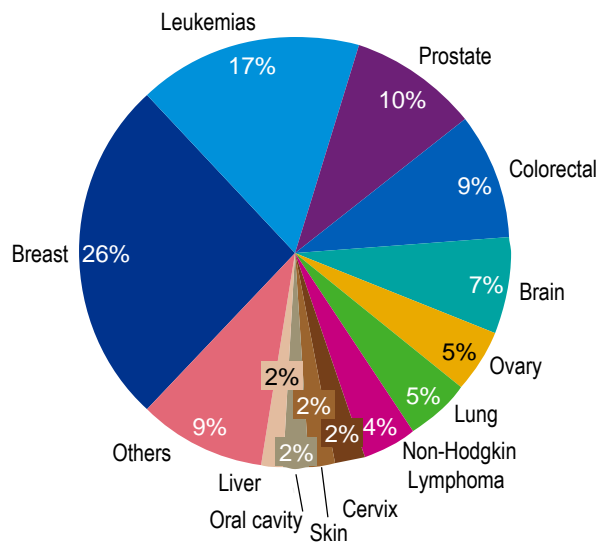
Major research efforts in breast cancer and leukemias

In Quebec, 26% of research investments are devoted to breast cancer, while leukemia research accounts for 17%, prostate cancer 10% and colorectal cancer 9%.

– In Ontario, lung cancer also ranks among the five main sites where the greatest research efforts are being made.

Investments breakdown in cancer research according to tumor site

Quebec, Total 2006-2015, in percentage of total investments



Investments breakdown in cancer research according to the 5 main tumor sites

Quebec, Ontario and British Columbia, Total 2006-2015, in percentage of total investments in the province

	Quebec	Ontario	British Columbia
1	Breast (26%)	Breast (27%)	Prostate (29%)
2	Leukemias (17%)	Prostate (12%)	Breast (14%)
3	Prostate (10%)	Leukemias (11%)	Non-Hodgkin Lymphoma (11%)
4	Colorectal (9%)	Brain (8%)	Leukemias (10%)
5	Brain (7%)	Lung (8%)	Lung (9%)
Others	31%	35%	28%

Note: The Alliance estimates that its study covers 60 to 80% of all cancer research funding sources (excluding industrial research)

Sources: Canadian Cancer Research Alliance; KPMG Analysis.

2.2 Scientific productivity

Canada and Quebec stand out in terms of scientific productivity and impact

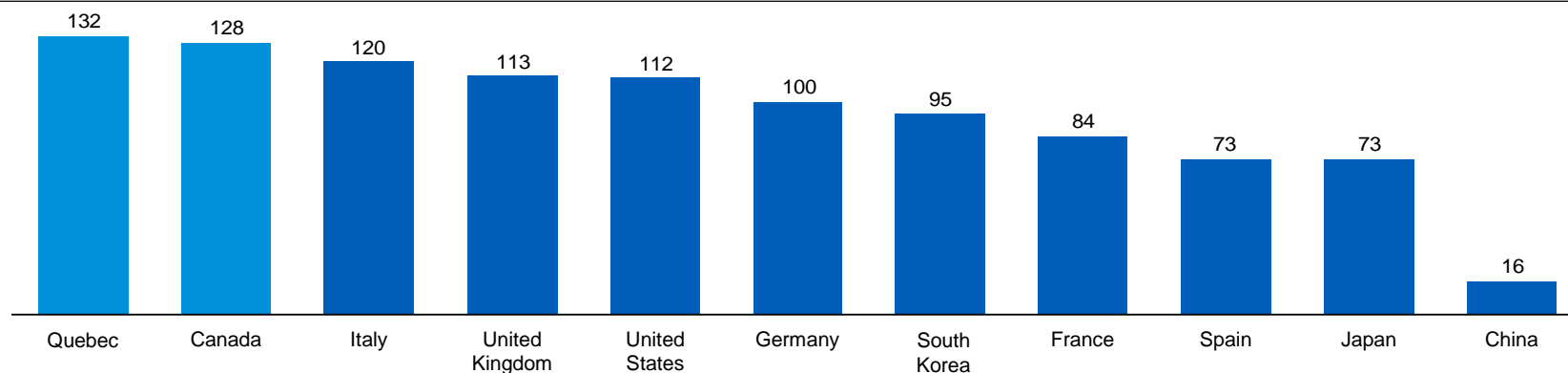
Canada ranks first among the 10 most prolific countries with respect to oncology scientific publications (*per capita*). 2006-2017 worldwide production is 1,153,811 publications.

- Quebec compares favorably with 132 publications per 100,000 inhabitants, compared to 128 for Canada. Quebec researchers have contributed close to one quarter (23%) of the national scientific productivity. Although Quebec ranks 2nd behind Ontario in absolute numbers, it ranks 4th behind Ontario (177), BC (164) and Alberta (146) on a per capita basis.

The scientific impact of publications is at 1.57 for Quebec and 1.49 for Canada, the two highest impacts at the international level.

Number of oncology publications *per capita*, by country and in Quebec

Total from 2006 to 2017, per 100,000 inhabitants



Scientific impact	1.57	1.49	1.25	1.44	1.37	1.25	0.98	1.39	1.38	0.86	0.95
Total number of publications	11,056	47,086	72,664	74,557	365,775	82,967	48,906	56,508	34,017	92,472	215,756

Note: The results per capita were obtained by dividing the number of publications identified from 2006 to 2017 by the total population in 2017. Publications that include several authors are accounted for in each country of authors affiliation as well as in the world total. Scientific impact is measured in terms of average of relative citations, meaning the number of times that a publication is cited compared to publications in the same field for a given year of publication. Sources: Science Metrix; KPMG Analysis

2.2 Scientific productivity

High impact Quebec publications that cover a range of tumor sites

Although the publications are spread out more or less evenly throughout a dozen or so tumor sites, breast cancer is the one with the highest number of publications (17% of the total).

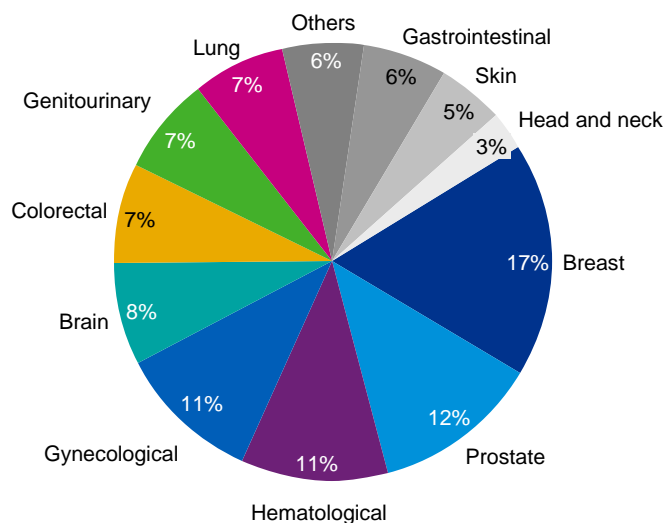
– Please note that the breakdown of the various tumor sites is similar to the one observed in Canada.

The scientific impact* of Quebec publications is 1.57.

Sites with the greatest publication impact are skin (2.24), brain (1.93), and head and neck (1.90).

Number of scientific publications by tumor site (sites with 1,000 publications or more)

Quebec, between 2006 and 2017



Scientific impact by tumor site (sites with 1,000 publications or more)

Quebec, between 2006 and 2017

		Scientific impact index*
Quebec	Skin	2.24
	Brain	1.93
	Head and neck	1.90
	Lung	1.78
	Gynecological	1.77
	Genitourinary	1.68
	Prostate	1.48
	Hematological	1.46
	Colorectal	1.40
	Breast	1.38
	Total-oncology	1.57
Canada	Total-oncology	1.49

Sources: Science Metrix; KPMG Analysis.

*Note: scientific impact is measured in terms of average of relative citations, meaning the number of times that a publication is cited compared to publications in the same field for a given year of publication.

2.2 Scientific productivity

A well developed network of international collaborations

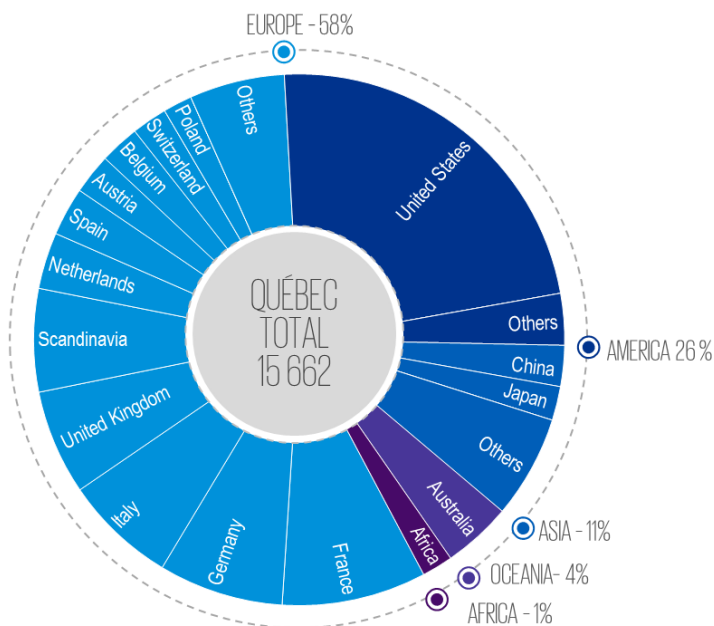
Quebec alone has collaborated with 63 countries with which it has published a total of 15,662 articles.

- Its main collaborators are the United States (3,683 publications), France (1,404), Germany (1,213), Italy (1 090) and the United Kingdom (1,018).

In all, 55.8% of Quebec publications included international collaborations.

- That co-publication rate is much higher than the worldwide average (19.0%) and exceeds the Canadian average (53.4%).

Main collaborating countries according to the number of co-publications
Quebec, between 2006 and 2017



International co-publication rate (IPR) in oncology
Between 2006 and 2017

	IPR
Quebec	55.8%
Canada	53.4%
United Kingdom	51.8%
Spain	46.8%
Germany	46.7%
France	45.2%
Italy	40.2%
United States	32.6%
South Korea	20.0%
China	19.0%
Japan	18.9%
Average - World	19.0%

Sources: Science Metrix; KPMG Analysis.

Note: The Australia segment includes publications from other countries in Oceania. Publications that include several authors are accounted for both in the total of each country of affiliation of the authors and in the world total.

2.2 Scientific productivity

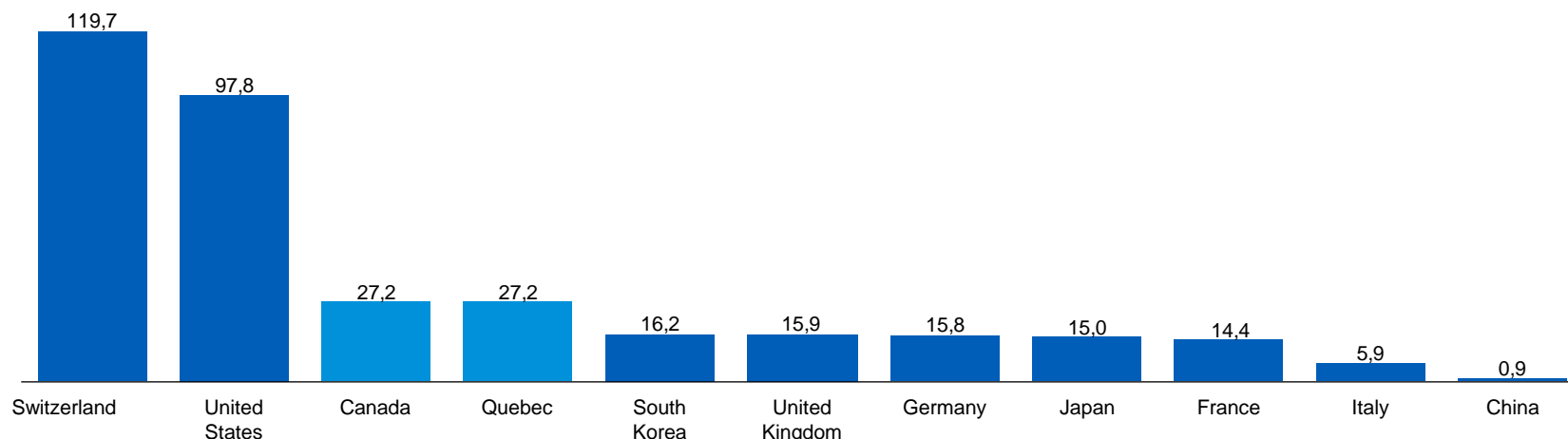
Canada and Quebec among the highest performing jurisdictions in terms of patents filed

Canada ranks 3rd on the international scale with respect to the number of filers *per capita* in oncology.

- Switzerland and the United States largely dominate the rankings with 119.7 and 97.8 filers respectively per million inhabitants between 2006 and 2017.
- With its 27.2 filers per million inhabitants, Quebec's performance compares to that of Canada. At the national level, on a per capita basis, Quebec ranks second to BC (39.2). On the basis of the total number of filers, Quebec ranks second behind Ontario, with 228 filers versus 328 for Ontario.

Number of filers with the United States Patent and Trademark Office *per capita*, by country and in Quebec

From 2006 to 2017, per million inhabitants



Total number of applicants	Switzerland	United States	Canada	Quebec	South Korea	United Kingdom	Germany	Japan	France	Italy	China
	1,013	31,848	999	228	832	1,051	1,306	1,903	968	360	1,216

Notes: The results per capita were obtained by dividing the number of filers identified between 2006 and 2017 by the total population in 2017. Filer means the entity that legally owns the patent's intellectual property and benefits from the monetary spinoffs that it generates. A patent may include one or several filers. In most cases, the filers are companies.

Sources : Science Metrix; KPMG Analysis.

2.3 Clinical trials

In Quebec, close to one in four clinical trials targets oncology

Between 2013 and 2017, 281 clinical trials were completed in Quebec in oncology, which represents 23% of the clinical trials conducted in the province, all therapeutic fields included.

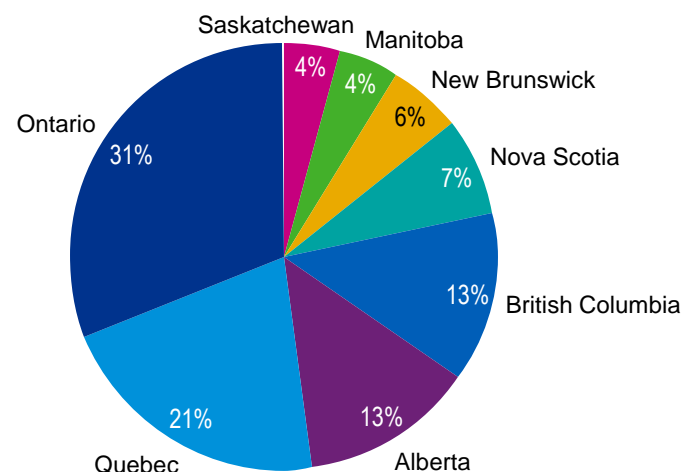
– This ranks oncology first, far ahead of the other therapeutic fields.

Quebec clinical trials represent 21% of all trials conducted in Canada.

Breakdown of clinical trials in Quebec, by therapeutic fields,
2013-2017, Number of studies completed (Phases I to IV)

Rank	Therapeutic fields	Total 2013-2017	% of total
1	Oncology	281	22.9%
2	Endocrinal, nutritional and metabolic diseases	152	12.4%
3	Circulatory system	113	9.2%
4	Infectious and parasitic diseases	99	8.1%
5	Skin and subcutaneous tissue	91	7.4%
6	Respiratory system	83	6.8%
7	Digestive system	57	4.6%
8	Osteoarticular system, muscles and connective tissue	45	3.7%
9	Nervous system	44	3.6%
10	Mental and behavioral disorders	41	3.3%
	Others	222	18.1%

Breakdown of clinical trials in oncology, by province
2013-2017, Number of studies completed (Phases I to IV)



Sources: clinicaltrials.gov; KPMG Analysis

2.3 Clinical trials

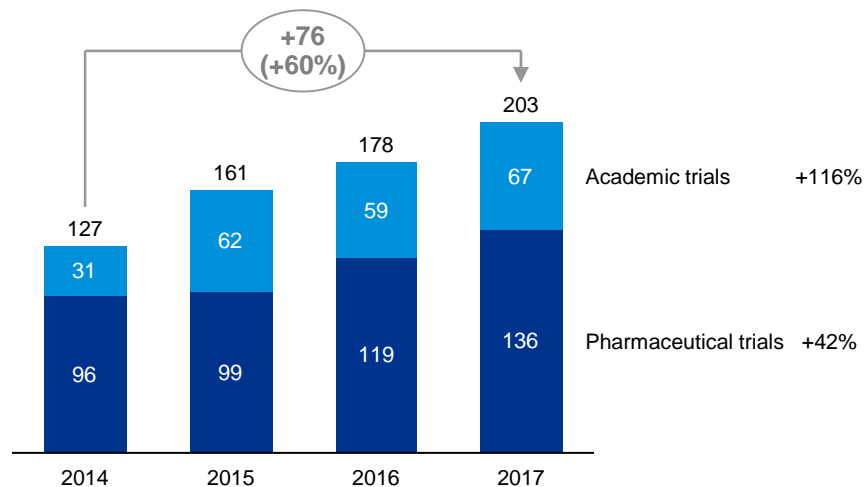
The number of clinical trials and of patients recruited have been on the rise since 2014

Between 2014 and 2017, the number of clinical trials launched in Quebec has gone from 127 to 203, an increase of 60% (+76)^(a).

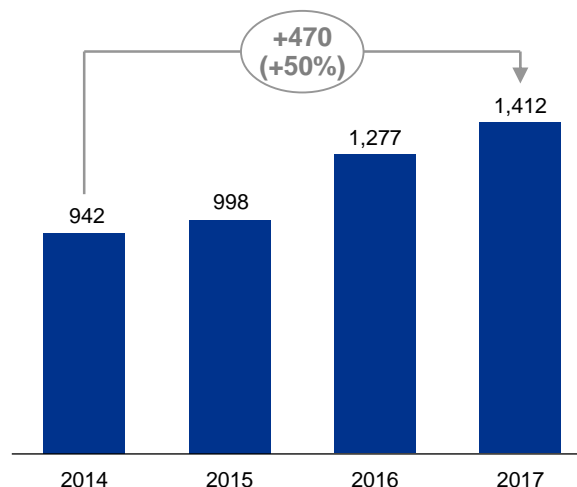
- Academic trials recorded the highest increase (+116% over the period), notably as a result of the Canadian Cancer Clinical Trials Network (3CTN) effort with the scientific community; an initiative coordinated in Quebec by the Quebec – Clinical Research Organization in Cancer (Q-CROC).

At the same time, the number of patients recruited to be part of these trials went from 942 in 2014 to 1,412 in 2017, an increase of 50% (+470)^(a).

Number of clinical trials (Phase I to IV) in oncology launched in Quebec, according to sponsor type 2014-2017



Number of patients recruited in clinical trials in oncology in Quebec 2014-2017



Note: (a) The Q-CROC database covers approximately 80% of Quebec's clinical research activities in oncology (pediatric and adult).

Sources: The Quebec – Clinical Research Organization in Cancer (Q-CROC); KPMG Analysis

2.3 Clinical trials

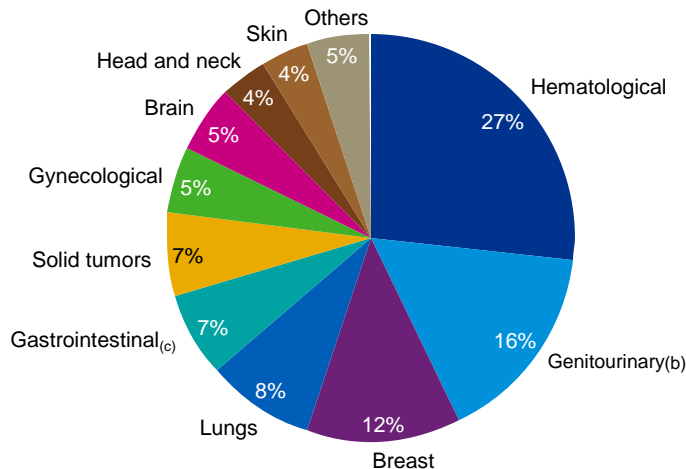
Various tumor sites and an emphasis on Phase III studies

Although most tumor types are represented, over 50% of ongoing clinical trials in oncology as of May, 2018, are concentrated in the following three types: hematological cancers (27%), genitourinary cancers (16%) and breast cancer (12%).

Phase III clinical trials account for 50% of ongoing trials as of May, 2018, while Phase II clinical studies account for 21%, and Phase I for 8%.

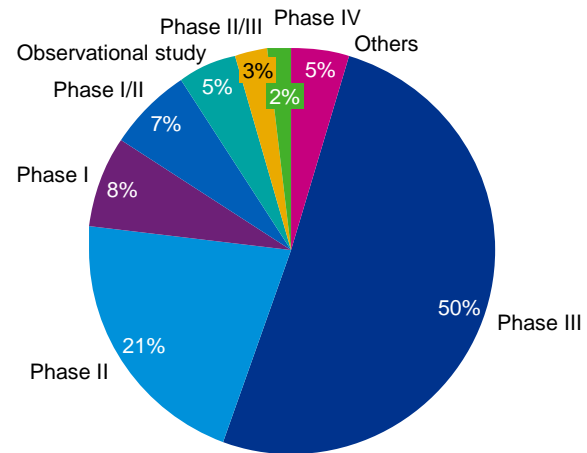
Number of ongoing clinical trials in Quebec, by tumor type

As of May, 2018, all phases included, in percentage of the total number of distinct protocols



Number of ongoing clinical trials in Quebec, by phase

As of May, 2018, in percentage of the total number of distinct protocols



Note: (a) The Q-CROC database covers approximately 80% of Quebec's clinical research activities in oncology (pediatric and adult).

(b) Includes bladder, prostate, kidney, urethral and testicular cancer.

(c) Includes intestinal (colon, colorectal, rectal, etc.), liver, pancreatic, gall bladder and bile duct, stomach, and esophageal cancer.

Sources: The Quebec – Clinical Research Organization in Cancer (Q-CROC); KPMG Analysis

2.4 The Quebec cancer research ecosystem

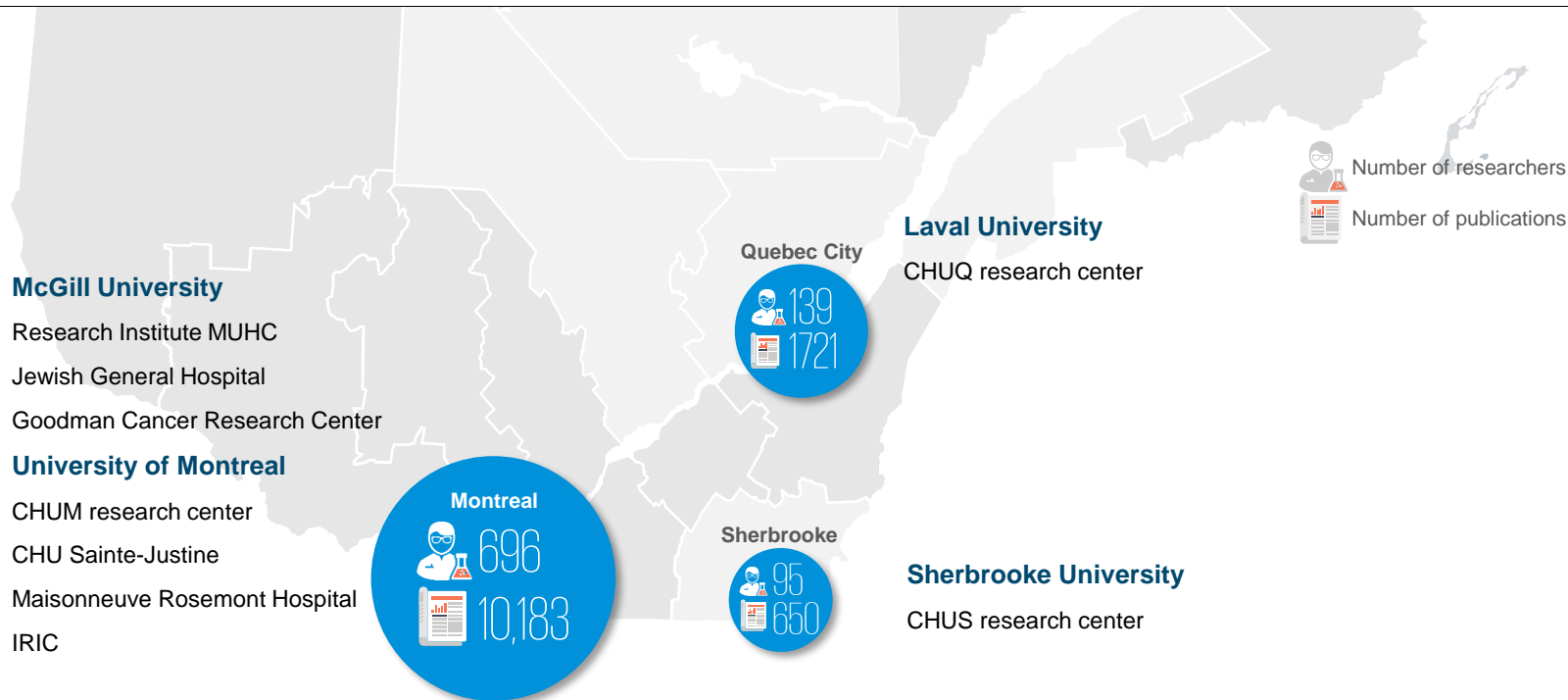
Three major university hospital hubs

In Quebec, close to 1,000 researchers affiliated to more than thirty dedicated universities, university hospitals, research centers and institutes are active in cancer research.

- Almost 75% of those researchers are located in the Greater Montreal region and produce 80% of the publications in Quebec.

Number of active researchers and publications in oncology by major region^(a)

2018



(a) Excluding regions with fewer than 10 researchers. Universities, hospitals and centers with more than 400 publications (2006-2017) are represented.

Sources: Oncopole; KPMG Analysis; Science Metrix

Some key players in the ecosystem (1/2)

Provincial



The Fonds de recherche du Québec – Santé (FRQS) seeks to serve as a catalyst for health research in Québec by planning, coordinating and supporting the development of all public health research sectors; fostering the emergence of research partnerships between the public sector, industry and the charitable community; maximizing health research benefits for citizens, economic development and the province's outreach in Canada and around the world.



Génome Québec is a private not-for-profit organization that funds genomics research in four priority sectors: human health, forestry, agrifood and the environment, and sustainable development. Génome Québec also operates five technology platforms that support fundamental, applied and clinical research.



CQDM is a pre-competitive research consortium driven by the mission to fund the development of breakthrough tools and technologies that enhance biopharmaceutical R&D productivity and accelerate the development of safer and more effective drugs.



The mission of the Consortium for Research and Innovation in Medical Technologies (MEDTEQ), is to accelerate the development of innovative technology for the benefit of clinicians and patients, their validation and integration into the healthcare system, as well as their local and international outreach, by combining the complementary skills of industrial and institutional partners with those of the healthcare system.



The Quebec – Clinical Research Organization in Cancer (Q-CROC) is a not-for-profit organization whose mission is to optimize patient recruitment and the quality of clinical research in oncology. The research community is at the heart of the organization's actions. Q-CROC coordinates a clinical research network bringing together 17 of the most active health care institutions in the oncology field in Quebec.



The CATALIS initiative aims to position Quebec on the world stage of early clinical research (Phase I, II and II/III). Officially launched in 2016-2017, this public-private project basically plans to double the investments and the number of patients recruited for early clinical research (ECR) in Quebec by the private industry. This 5-year initiative more specifically targets the optimization of the institutions operational efficiency, as well as the promotion of Quebec's ECR expertise on an international level.

Sources: Organizations' websites; KPMG Analysis

Some key players in the ecosystem (2/2)

National



As a project maturation cluster in the field of drug discovery, IRICoR is a not-for-profit organization based at the Institute for Research in Immunology and Cancer (IRIC) of the Université de Montréal. Its mandate is to accelerate the discovery, development, and commercialization of novel therapies in cancer, immunotherapy, and related fields. IRICoR provides selected academic and industry projects, from Canada and abroad, with access to its network of experts and cutting-edge infrastructure, including one of the largest academia-based medicinal chemistry groups in Canada.



The Center for Commercialization of Cancer Immunotherapy (C3I) is a Canadian Centre of Excellence supported by the federal government and various partners. C3I operates out of the Maisonneuve-Rosemont Hospital where it has access to a cell production centre that is unique in Canada. C3I specializes in cancer immunotherapy, a rapidly growing field that uses the immune system to fight cancer.



EXACTIS

Exactis Innovation is a pan-Canadian, non-profit organization that provides accelerated access to clinical trials for precision cancer therapies in areas of high unmet need to patients who have their cancer molecularly profiled.



The TransMedTech Institute's mission is to develop next-generation medical technologies aimed at diagnosis, prognosis, procedures and rehabilitation, notably applied to cancers. The keystone of the TransMedTech Institute is its open, transdisciplinary and cross-sectoral innovation ecosystem (living lab), which collectively mobilizes investigators, engineers, students, physicians, health professionals, industries, governmental decision-makers and patients.



IVADO aims to bring together industry stakeholders and academic researchers to develop cutting-edge expertise in data science, operational research and artificial intelligence. With over 1000 affiliated scientists, IVADO is an advanced multidisciplinary centre of knowledge in various sectors.



The NEOMED Institute is a response to the changing R&D business models in the pharmaceutical industry. It seeks to bridge the gap between basic research and bringing new drugs on the market. The Institute provides industrial expertise in drug discovery and development combined with funding and a favorable environment to transform innovations into therapeutic solutions.

Sources: Organizations' websites; KPMG Analysis

Partners for this study

About the Oncopole

The Oncopole is a Quebec hub for research, development and investment to accelerate the fight against cancer. Created in February of 2017, it is the product of a unique co-creation process led by the Fonds de recherche du Québec – Santé (FRQS) and made possible by an initial \$15M investment from Merck Canada. The Oncopole's mission is to act as a catalyst leveraging actions made by the key players in Quebec's oncology and innovation research ecosystem. As a result, it aims to position the province as a leader in the field. Its priorities of action, namely research, entrepreneurship, commercialization and integration of innovation, as well as clinical relevance, are orchestrated in order to foster the mobilization of stakeholders, the discovery of innovative approaches to fight cancer and, ultimately, a positive impact for the benefit of patients. For more information, go to: oncopole.ca

Oncopole founding partners



Montréal InVivo; LHST Cluster

Montréal InVivo is the brand name for the life sciences and health technologies (LSHT) cluster of the Montréal metropolitan area. The cluster comprises almost 600 organizations, including more than 150 research centres, 80 subsidiaries of world-class companies and more than 40,000 people employed in the sector. A wellspring of great ideas, the cluster includes four universities and ranks first in Canada for the number of research centres. Montréal InVivo is a non-profit economic development organization dedicated to the creation of wealth. Its activities are supported by funding from the Ministère de l'Économie, de la Science et de l'Innovation (MESI), the Secrétariat à la région métropolitaine reporting to the Ministère des Affaires municipales et de l'Occupation du territoire, the Communauté métropolitaine de Montréal (CMM), Canada Economic Development (CED) for the region of Québec and private and institutional sectors. – www.montreal-invivo.com



kpmg.ca



© 2018 KPMG LLP, a Canadian limited liability partnership and a member firm of the KPMG network of independent member firms affiliated with KPMG International Cooperative (“KPMG International”), a Swiss entity. All rights reserved. The KPMG name and logo are registered trademarks or trademarks of KPMG International.

The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. Although we endeavour to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.