

How Pharmaceutical Innovation Has Revolutionized Health Care

by Yanick Labrie



Never before in the history of humanity has there been as rapid an increase in longevity as there was during the 20th century. In industrialized countries, life expectancy at birth has risen from an average of about 50 years in 1900 to a little over 80 years today.¹ A growing number of people can now live not only longer but also healthier than ever before. Indeed, substantial gains in terms of quality-adjusted life expectancy have been recorded for decades in many countries.²

The causes of this progress are complex and varied. Certainly, the improvement of hygiene conditions, the development of water sanitation systems and the changing of dietary habits, as well as the increasing wealth of the population, have all contributed to reducing mortality and markedly improving health conditions.

The field of medicine has also made enormous progress over the course of the past century. The evolution of biomedical knowledge gave rise to a new branch of medicine, namely pharmacology. The discovery of new drugs and vaccines led to more effective treatments for many diseases, and even to outright cures for many others that were long considered incurable. This *Economic Note* revisits a few of the most important contributions of the pharmaceutical field over the past century.

The Elimination of Numerous Infectious Diseases

It would be hard to think of an innovation in the field of health care that has saved more lives than vaccines.³ Before mass immunization, populations lived under the

constant threat of being hit by various infectious disease epidemics.

At the start of the 20th century, the main causes of death were diseases like tuberculosis, pneumonia, smallpox, diphtheria, polio, influenza and bronchitis. Polio, for example, was responsible for the paralysis, disability and death of thousands of Canadians during the first half of the century.⁴ After the arrival of the vaccine in 1955, polio cases plummeted within a few years and the disease was subsequently eradicated (see Table 1), not only in Canada but also in most regions of the world.

Sulfa drugs, those belonging to the class of sulfonamides discovered in the 1930s, as well as the first antibiotics like penicillin developed in the 1940s, also greatly reduced the number of deaths due to infectious diseases, starting with pneumonia and scarlet fever.⁵ In Canada, the mortality rate related to the main contagious diseases fell by more than 80% between the start of the 1920s and the year 1960.⁶

Of course, contagious diseases can appear very suddenly and spread rapidly,⁷ the



AIDS epidemic that began in the early 1980s being the perfect example.

Nonetheless, researchers have estimated that the combination of antiretroviral treatments (tritherapy) for patients with HIV/AIDS have saved the equivalent of three million years of life between 1989 and 2003 in the United States.⁸ Just in the three years following the introduction of the innovative drug Efavir in 1995, the mortality rate fell by 70%.⁹ Thanks to these therapeutic advances, a young 20-year-old adult with HIV/AIDS living in Canada or the United States today can expect to live to the age of 70 and beyond, nearly as long as the rest of the population.¹⁰

The Prevention and Treatment of Cardiovascular Disease

During the first half of the 20th century, bed rest was the standard treatment for people suffering from heart disease.¹¹ Today, several treatment options are available that save lives and allow these people to remain active.

Drugs like aspirin help dissolve blood clots and re-establish the flow of blood to the heart. Beta-blockers, developed starting in the 1960s, can be prescribed to reduce blood pressure, which in turn reduces the workload of the heart. As for drugs in the statin class like Lipitor, which began appearing in the late 1980s, they help to lower blood cholesterol levels.

Before mass immunization, populations lived under the constant threat of being hit by various infectious disease epidemics.

In serious cases like heart attacks and strokes, patients are treated with thrombolytic drugs that, when administered quickly, can prevent or greatly limit any long-term damage.¹²

All of these drugs have led to significant reductions in patient mortality and morbidity, as numerous studies confirm.¹³ Since 1970, the mortality rate from heart disease has fallen by nearly half in the United States (see Figure 1), and a similar trend can be observed in industrialized countries as a whole.¹⁴

Increased Efforts to Fight Cancer

Before the 1950s, the treatment of cancer was essentially in the hands of surgeons, and the hopes of long-term cancer

Table 1 — Incidence of Select Vaccine-Preventable Diseases in Canada, Pre-vaccine Era Compared with the Years 2007-2011

Disease	Year vaccine was introduced	5-year average annual incidence per 100,000	
		Pre-vaccine era*	2007-2011
Pertussis (whooping cough)	1943	156.0	3.88
Diphtheria	1930	84.2	0.006
<i>Haemophilus influenzae</i> type b (Hib)**	1991	30.1	0.49
Mumps	1969	251.2	1.84
Paralytic poliomyelitis	1955 (Salk) 1962 (Sabin)	17.5	0
Measles	1963	372.7	0.6
Rubella	1969	106.3	0.01

*Five years prior to the introduction of the vaccine, except for the following diseases: mumps, measles and rubella (1950-1954).

**Children 5 years of age or younger.

Source: Public Health Agency of Canada, *Canadian Immunization Guide*, Part 1, Government of Canada, 2014, pp. 2-4.

survival were basically nil. As documented by historian and oncologist Siddhartha Mukherjee in his Pulitzer Prize-winning work, the advent of chemotherapy and the pharmacological progress that took place during the second half of the 20th century gradually led to substantial gains in the battle against cancer.¹⁵

Cancer drugs are the ones that now most attract the attention of pharmaceutical companies. Nearly three times as many innovative oncological drugs were developed between 1990 and 2009 as were launched between 1970 and 1989.¹⁶ Within a period of a few years, a modest initiative primarily financed with public funds became a veritable armada involving thousands of companies and hundreds of billions of dollars of private investment.¹⁷

These efforts are starting to bear fruit. Since the early 1990s, the age-adjusted cancer mortality rate has been falling in industrialized countries¹⁸ and in much of the rest of the world as well. Economist Frank Lichtenberg of Columbia University recently looked into the connection between

pharmaceutical innovation and mortality rates for some 60 types of cancer. For the 2000-2009 period, he found that the use of new drugs was responsible for nearly 60% of observed reductions in cancer-related mortality rates.¹⁹

It is without a doubt in the treatment of cancers afflicting children that the most remarkable advances have been made. Since the early 1970s, the mortality rate for these types of cancer have fallen by 3% a year on average in Canada, the United States, Australia and Japan, in large part thanks to pharmacological treatments that were developed and made accessible during this period. Today, over 70% of childhood cancer cases that occur in industrialized countries are cured.²⁰

One of the most striking events in recent decades has been the development of targeted therapies, which are medical treatments targeting certain genes or proteins that contribute to tumour growth. By attacking cancerous cells more directly, these treatments significantly improve patients' chances of survival, all while reducing the side effects usually associated with chemotherapy.²¹

Since 1970, the mortality rate from heart disease has fallen by nearly half in the United States.

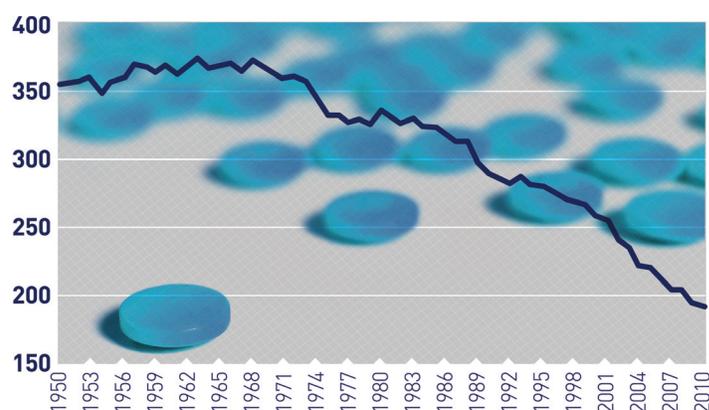
For instance, the arrival on the market of the drug Gleevec in 2001 revolutionized the battle against leukemia (CML). This disease used to be highly lethal and the number of years of survival for a leukemia survivor rarely extended beyond 3 to 6 years. Today, a patient can expect to live over 25 years. Given that the median age at which leukemia is detected is 60, the life expectancy of these patients is comparable to that of the rest of the population.²²

Challenges

Falling mortality rates and higher life expectancy, while remarkable accomplishments, have been accompanied in recent decades by increases in chronic conditions like arthritis and diabetes. Some two million Canadians currently suffer from one form or another of diabetes, and this number is growing.²³

Even though it is not a cure, insulin, discovered in the 1920s by Frederick Banting and subsequently developed by Eli Lilly and Company,²⁴ continues to improve the quality of life of

Figure 1 — Number of Deaths Due to Heart Disease per 100,000 Population, United States



Source: Center for Disease Control and Prevention, quoted in David S. Jones, Scott H. Podolsky and Jeremy A. Greene, "The Burden of Disease and the Changing Task of Medicine," *New England Journal of Medicine*, Vol. 366, 2012, p. 2336.

diabetics. Before insulin, the standard treatment consisted in reducing the food intake of sufferers. This treatment replaced a quick death from diabetes with a slow death from starvation.²⁵

Since the discovery of insulin, numerous innovations in the treatment of diabetes have followed. Patients' options have grown over the past two decades with the discovery of eight new classes of drugs to better treat the disease. There are currently over 180 drugs in the development stage whose purpose is to slow or stop the progression of diabetes, or to reduce the risk of complications.²⁶

Conclusion

For over 100 years, pharmaceutical innovation has literally revolutionized health care, and has given rise to treatments that we could no longer do without.

The progress we have enjoyed over the years is the result of a close collaboration between university and industry researchers. Private, for-profit R&D funding in the biomedical field began to grow at an unprecedented pace in the 1980s, however, and now exceeds funding from the public and non-profit sectors combined.²⁷

With advances in pharmacogenetics and personalized medicine, doctors in the future will increasingly be able to prescribe made-to-measure drugs that take patients' genetic profiles into account. These innovations will likely further

improve the health of patients while also reducing the risks of toxicity and side effects related to the use of medicines.

Doctors in the future will increasingly be able to prescribe made-to-measure drugs that take patients' genetic profiles into account.

Without pretending that every condition can be treated with drugs or that prevention and other factors are not also important, we must recognize that pharmaceutical research and the therapeutic progress it has entailed continue to be of enormous service to patients.

References

- Karen N. Eggleston and Victor R. Fuchs, "The New Demographic Transition: Most Gains in Life Expectancy Now Realized Late in Life," *Journal of Economic Perspectives*, Vol. 26, No. 3, 2012, p. 140.
- Robert F. Schoeni, Vicky A. Freedman and Linda G. Martin, "Why Is Late-Life Disability Declining?" *Milbank Quarterly*, Vol. 86, No. 1, 2008, p. 50; Susan T. Stewart, David M. Cutler and Allison B. Rosen, "US Trends in Quality-Adjusted Life Expectancy from 1987 to 2008: Combining National Surveys to More Broadly Track the Health of the Nation," *American Journal of Public Health*, Vol. 103, No. 11, 2013, p. e80; Eric B. Larson *et al.* "New Insights Into the Dementia Epidemic," *New England Journal of Medicine*, Vol. 369, 2013, pp. 2275-2277.
- Sandra W. Roush *et al.*, "Historical Comparisons of Morbidity and Mortality for Vaccine-Preventable Diseases in the United States," *Journal of the American Medical Association*, Vol. 298, No. 18, 2007, pp. 2155-2163; F. E. André *et al.*, "Vaccination greatly reduces disease, disability, death and inequity worldwide," *Bulletin of the World Health Organization*, Vol. 86, No. 2, 2008, pp. 140-146.
- Luis Barreto, Rob Van Exan and Christopher J. Rutty, "Polio Vaccine Development in Canada: Contributions to Global Polio Eradication," *Biologicals*, Vol. 34, Issue 2, 2006, pp. 91-101.
- Seema Jayachandran, Adriana Lleras-Muney and Kimberly V. Smith, "Modern Medicine and the Twentieth Century Decline in Mortality: Evidence on the Impact of Sulfa Drugs," *American Economic Journal: Applied Economics*, Vol. 2, No. 2, 2010, p. 119.
- R. D. Fraser, *Historical Statistics of Canada, Section B: Vital Statistics and Health*, Series B35-50, Statistics Canada, July 1999. This refers to tuberculosis, pneumonia, influenza, bronchitis, diphtheria, whooping cough, measles, scarlet fever and typhoid fever.
- Anthony S. Fauci and David M. Morens, "The Perpetual Challenge of Infectious Disease," *New England Journal of Medicine*, Vol. 366, 2012, pp. 454-461.
- Rochelle P. Walenski *et al.*, "The Survival Benefits of AIDS Treatment in the United States," *Journal of Infectious Disease*, Vol. 194, 2006, pp. 11-19.
- Mark G. Duggan and William N. Evans, "Estimating the Impact of Medical Innovation: A Case Study of HIV Antiretroviral Treatments," *Forum of Health Economics & Policy*, Vol. 11, No. 2, 2008, p. 5.
- Hasina Samji *et al.*, "Closing the Gap: Increases in Life Expectancy among Treated HIV-Positive Individuals in the United States and Canada," *PLoS ONE*, Vol. 8, No. 12, 2013.
- Tinsley R. Harrison, "Abuse of Rest as a Therapeutic Measure for Patients with Cardiovascular Disease," *Journal of the American Medical Association*, Vol. 125, No. 16, 1944, pp. 1075-1077.
- Vijayalakshmi Kunadian and C. Michael Gibson, "Thrombolytics and Myocardial Infarction," *Cardiovascular Therapeutics*, Vol. 30, 2012, pp. e81-e88.
- David M. Cutler *et al.*, "The Value of Antihypertensive Drugs: A Perspective on Medical Innovation," *Health Affairs*, Vol. 26, No. 1, 2007, pp. 97-110; Earl S. Ford *et al.*, "Explaining the Decrease in U.S. Deaths in Coronary Disease, 1980-2000," *New England Journal of Medicine*, Vol. 356, No. 23, 2007, pp. 2388-2398; David C. Grabowski *et al.*, "The Large Social Value Resulting from Use of Statins Warrants Steps to Improve Adherence and Broaden Treatment," *Health Affairs*, Vol. 31, No. 10, 2012, pp. 2276-2285.
- See among others Angus Deaton, *The Great Escape: Health, Wealth, and the Origins of Inequality*, Princeton University Press, 2013, p. 136.
- Siddhartha Mukherjee, *The Emperor of All Maladies: A Biography of Cancer*, Scribner, 2010.
- Frank Lichtenberg, "Has Medical Innovation Reduced Cancer Mortality?" *CESifo Economics Studies*, Vol. 60, No. 1, 2014, p. 139.
- Bruce A. Chabner and Thomas G. Roberts Jr., "Chemotherapy and the War on Cancer," *Nature Reviews: Cancer*, Vol. 5, 2005, p. 70.
- Organisation for Economic Co-operation and Development, *Health at a Glance 2013*, p. 31.
- Frank Lichtenberg, *op. cit.*, footnote 16, pp. 31-32.
- Liliane Chatenoud *et al.*, "Childhood Cancer Mortality in America, Asia, and Oceania, 1970 through 2007," *Cancer*, Vol. 116, 2010, p. 5073.
- See for example Jean-Louis Santini, "Cancers agressifs : de nouvelles thérapies ciblées prometteuses," *La Presse*, May 31, 2014.
- M. J. Duffy, "The War on Cancer: Are We Winning?" *Tumor Biology*, Vol. 34, 2013, p. 1278.
- Public Health Agency of Canada, *Health-Adjusted Life Expectancy in Canada*, Government of Canada, 2012, p. 2.
- Michael Bliss, "The History of Insulin," *Diabetes Care*, Vol. 16, Supplement 3, 1993, pp. 4-7.
- Richard Epstein, "The Tale of How Insulin Came to Market," *Defining Ideas: A Hoover Institution Journal*, January 2011.
- Phrma, "Biopharmaceutical Research Companies Are Developing 180 Medicines to Treat Diabetes and Related Conditions," *Medicines in Development — Diabetes*, 2014 Report, p. 1.
- E. Ray Dorsey, "Funding of US Biomedical Research, 2003-2008," *Journal of the American Medical Association*, Vol. 303, No. 2, 2010, p. 139.

910 Peel Street, Suite 600
Montreal (Quebec) H3C 2H8, Canada
Telephone: 514-273-0969
Fax: 514-273-2581
Website: www.iedm.org

The Montreal Economic Institute is an independent, non-partisan, not-for-profit research and educational organization. Through its publications, media appearances and conferences, the MEI stimulates debate on public policies in Quebec and across Canada by proposing wealth-creating reforms based on market mechanisms. It does not accept any government funding.

The opinions expressed in this study do not necessarily represent those of the Montreal Economic Institute or of the members of its board of directors.

The publication of this study in no way implies that the Montreal Economic Institute or the members of its board of directors are in favour of or oppose the passage of any bill.

Reproduction is authorized for non-commercial educational purposes provided the source is mentioned.

Montreal Economic Institute © 2014

Illustration: Ygreck