Public health surveillance of cancer survival in the US and world-wide: the contribution of the CONCORD programme

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Public health surveillance of cancer survival in the US and world-wide: the contribution of the CONCORD programme

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Abstract

CONCORD is a program for the global surveillance of cancer survival. In 2015, the second cycle of the program (CONCORD-2) established long-term surveillance of cancer survival world-wide, for the first time, in the largest cancer survival study published to date.

CONCORD-2 provided cancer survival trends for 25,676,887 patients diagnosed during the 15-year period 1995-2009 with one of 10 common cancers that collectively represented 63% of the global cancer burden in 2009.[5]

In this article, we summarise the past, describe the present and outline the future of the CONCORD program. We discuss the difference between population based studies and clinical trials, and we review the importance of international comparisons of population-based cancer survival. We focus on the US. We explain why population-based survival estimates are crucial for driving effective cancer control strategies to reduce the wide and persistent disparities in cancer survival between whites and blacks, which are likely to be attributable to differences in access to early diagnosis and optimal treatment.

Introduction

The CONCORD programme started in the late 1990s, with the aim of monitoring population-based cancer survival world-wide.

The first CONCORD study[1] produced five-year survival estimates for almost 2 million patients diagnosed with breast, colorectal or prostate cancer during 1990-1994 and followed up to 1999. The data were provided by 101 cancer registries in 31 countries, 16 with national coverage. Global variation in survival was very wide. Survival was generally higher in North America, Australia and Japan, and in northern, western, and southern Europe, and lower in Algeria, Brazil, and eastern Europe. The CONCORD study covered 42% of the US population, and it provided the first population-based cancer survival estimates for 11 US states covered by the National Program of Cancer Registries (NPCR).

Two high-resolution studies were carried out[2,3] to explain the differences in survival for breast and colorectal cancers between Europe and the US. Detailed data on stage at diagnosis, investigation and treatment were collected directly from the original medical records for about 19,000 women with breast cancer and 12,500 adults with colorectal cancer. Differences in breast cancer survival between Europe and the US were mainly explained by lower survival in Eastern Europe, where low healthcare expenditure may have constrained the quality of treatment.[4] Differences in colorectal cancer survival between Europe and the US persisted into the late 1990s. They were probably attributable to earlier stage and more extensive surgery and adjuvant treatment in the US than in Europe.

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As a result, health ministers in 67 countries, home to two-thirds (4.8 billion) of the world's population, finally obtained cancer survival estimates that are methodologically rigorous and internationally comparable, to help them prioritise and formulate cancer control strategies.[6] For some countries, this was the first time such data had been available.

The US Centers for Disease Control (CDC) described CONCORD-2 as the start of global surveillance of cancer survival,[a] with survival estimates *"that can be compared, so scientists can begin to determine why survival differs among countries. This could lead to improvements in cancer control programs."* In the US, the analyses included individual data for 9,815,173 cancer patients, provided by 44 population-based cancer registries in 37 states with a total population of 257 million, doubling the population coverage of the US in the CONCORD programme to 83%.

The world-wide results were striking. Age-standardised five-year net survival from colon, rectal and breast cancers had increased steadily in most developed countries up to 2009, reaching 60% or more in 22 countries for colon and rectal cancers, and up to 85% or more in 17 countries for breast cancer in women. For cancers of the liver and lung, however, 5-year survival was still below 20% everywhere. Striking rises in prostate cancer survival were seen

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in many countries, but survival still varied from less than 60% in Bulgaria and Thailand to 95% or more in Brazil, Puerto Rico and the USA. Survival from cervical cancer also ranged widely, from below 50% to over 70%, and improvements since the late 1990s were generally small. For women with ovarian cancer, 5-year survival was above 40% in only 20 of the 67 countries, including the USA. For stomach cancer, 5-year survival was very high in Japan and South Korea (54–58%), compared with less than 40% in all other countries. Oddly, 5-year survival from adult leukaemia in Japan and South Korea (18–23%) was lower than in most other countries. For acute lymphoblastic leukaemia in children, survival was less than 60% in several countries, but close to 90% in Canada, the US and four European countries, suggesting major deficiencies in many countries in the management of what is now considered a largely curable disease.

Alexander Langmuir, who founded CDC's epidemic intelligence service for communicable diseases more than 50 years ago, commented that "*good surveillance does not necessarily ensure the making of the right decisions, but it reduces the chances of wrong ones*".[7] Chronic diseases such as cancer have long since become the predominant causes of morbidity and mortality in the US. Alongside incidence and mortality, population-based cancer survival has become one of the key metrics of overall progress in cancer control.[8]

For most of the ten malignancies examined in CONCORD-2, five-year net survival among patients diagnosed in the US up to 2009 was very high on a global scale. These figures are encouraging, but detailed examination of the data reveals wide differences in survival between blacks and whites, and to a lesser extent between US states and regions.

This *Cancer Supplement* presents the results of further analyses of the US data from CONCORD-2. In particular, it provides survival estimates by race (black, white) and stage at diagnosis for nine solid tumours in adults, and for acute lymphoblastic leukaemia in children, in each of the 37 participating states, for patients diagnosed 2001-2009. Separate results for the main types of leukaemia in adults will be presented in other publications.

Clinical trials or population-based survival?

It is worth spending a moment to consider the contrast between the survival estimates derived from population-based cancer registries and those derived from randomised clinical trials, with which most clinicians will be more familiar. Randomised trials and population-based studies of cancer survival are both immensely useful, but they have very different purposes. As a consequence, they differ in design, execution and interpretation.

Randomised clinical trials test the ***efficacy*** of a new surgical approach, radiotherapy regimen, systemic drug or drug combination. They are the gold standard method to assess whether a new treatment is better than the best treatment available to date. However, trials typically include ***fewer than 10% of patients*** with a specific cancer in a given country. They often exclude patients older than (say) 70 years of age, or with specific comorbidities, or with advanced disease. The clinicians conducting the trials are the most research-oriented, with access to the best available facilities. Treatment protocols are rigidly enforced. The outcomes most often measured are short-term differences in the median duration of disease-free survival, rather than longer-term estimates of overall survival.

A report from the Institute of Medicine in 2010 commented that the system for conducting cancer clinical trials in the US was approaching a state of crisis.[9] More than 25,000 patients were being recruited into clinical trials each year, but that still represented less than 3% of all cancer patients. The report noted that substantial progress in clinical management of various cancers had been produced by NCI-sponsored trials, but also that only about 60% were

actually completed and published. More recently, the Cancer Moonshot[b] initiative set out to improve participation in clinical trials. This may lead to improvement in population-based outcomes if personalized cancer care and targeted therapies become available to a much higher proportion of cancer patients.

By contrast, population-based cancer survival studies are the gold standard approach to assess the overall ***effectiveness*** of the entire health system in dealing with cancer.[8] Cancer survival estimates derived from population-based cancer registries include ***all patients diagnosed with cancer*** in a country or region, young and old, rich and poor, with or without serious comorbidity, and whether diagnosed at an early stage or with disease that is too advanced for any treatment of curative intent. They are diagnosed and managed in the entire range of healthcare facilities, with a wide range of treatment regimens, some of which may be unavailable to some patients contraindicated in others. Some patients will not adhere tightly to the treatment they are prescribed. Others may withdraw from treatment altogether if out-of-pocket payments are too expensive, or travelling or taking time off work is too difficult, or the side-effects of treatment are too severe.

Differences in survival between study groups in a clinical trial are easily interpreted as being attributable to differences in the efficacy of the treatment regimens being compared, to the skill of the medical staff who designed the trial, and the rigour with which they delivered the protocol. By contrast, results from population-based studies are often profoundly misinterpreted.

International differences in population-based cancer survival may be criticised by doctors in a country or region with lower survival, on grounds such as bad data, bias or incompetent analysis, or simply dismissed out of hand as flawed or unacceptable. The unspoken fear behind some of these criticisms is the implication that the doctors in the country with lower survival are somehow being judged as less competent. This concern is misplaced.

No physician, surgeon or radiotherapist sees a representative sample of all cancer patients. The survival of patients seen by a single doctor, cancer team or hospital will thus rarely reflect the overall national picture. Patients whose disease is too advanced at diagnosis for surgery are more likely to be referred for radiotherapy. Survival estimates derived from a single hospital are subject to referral bias. For all except the most common cancers and in the largest hospitals, they are also affected by statistical instability.[10]

Population-based cancer survival estimates differ in both purpose and scope from the survival estimates derived from clinical trials, or from the patients seen by an individual clinician, clinical team, or hospital. Population-based survival estimates are designed for public health surveillance, and to inform strategic policy-making on how to improve cancer management.

Life expectancy at birth provides a useful analogy. It encapsulates the likely longevity of recently born baby, and it incorporates many factors that have affected recent mortality in children and young people, but also the current mortality patterns of people who were born as long as 80 or 90 years ago. Despite this complexity, trends and international comparisons in life expectancy are readily interpreted. Life expectancy is generally increasing, but sharp reductions have been seen as a result of war, the AIDS epidemic in Lesotho and South Africa,[11] and the relaxation of alcohol control policy in the former Soviet Union.[12] Similarly, population-based cancer survival trends encapsulate a wide range of factors, including the speed with which patients seek help when they have symptoms suggestive of malignancy, as well as the efficiency of primary care, the speed of referral to secondary care, access to health insurance, and the availability of staff and equipment to deliver a thorough

[b] https://www.whitehouse.gov/CancerMoonshot

investigation and prompt, optimal treatment. They also reflect the human and financial resources available in the health system, and the efficiency with which it is organised.

A simple thought experiment should suffice to prove this point. Even the most experienced oncological team would be unable to deliver the standard of care and the level of survival they can achieve in a developed country if they were transposed to a country where patients are seen in a hospital with no pathologist and no access to radiotherapy, where they may have had to travel for days to seek attention, and they cannot afford to return after the first surgical intervention, perhaps for vital follow-up care or chemotherapy. Seen in that context, the skills and competence of any one doctor or cancer team are part of a much wider system, in which many other elements contribute to the overall outcome for all cancer patients.

That is why the CONCORD programme for the global surveillance of population-based cancer survival is useful. It provides internationally comparable data on cancer survival trends in many countries, and for most of the common cancers. It contributes vital information to public health programmes designed to improve cancer outcomes. This *Cancer Supplement* offers more detailed results for the US, by race and stage at diagnosis. The results are relevant for cancer patients and public health strategy for cancer control in each state.

Studying how best to implement laboratory findings into clinical practice - "from the bench to the bedside" – may be characterised as early translational research. However, it is also important that effective new interventions identified in clinical trials become available to all patients for whom they are clinically appropriate. Public health research focusses on how best to deliver those gains as quickly as possible. This may be described as "late translational research": from the paper to the people.

The impact of the CONCORD programme

The US National Cancer Institute recognised the impact of CONCORD-2 in an invited commentary for *The Lancet*, noting that global analyses of cancer survival provide an opportunity for lessons from countries with successful cancer control initiatives to be applied to other regions.[6] The commentary added that the availability of better data *"provides a clearer picture of the effect of cancer control programmes on the ultimate goal of improving survival and reducing the effect of cancer on the social and economic development of countries."*

In September 2015, the International Atomic Energy Agency's Programme for Action on Cancer Therapy (PACT) used CONCORD-2 results to launch an ambitious world-wide campaign to highlight the global divide in survival, and to raise awareness of persistent inequalities in access to life-saving cancer services.[13]

From 2017, the Organisation for Economic Co-operation and Development will include survival estimates from the CONCORD programme for 48 countries in its biennial publication *Health at a Glance*.[14] CONCORD will thus become the *de facto* standard for international cancer survival comparisons. This provides formal recognition by an international agency of the global coverage, methodological rigour and international comparability of the CONCORD survival estimates, which will become crucial for the evaluation of health systems performance in all OECD Member States and many associated countries.

Updating the global surveillance of cancer survival

CONCORD-3 is now in progress. It will update world-wide surveillance of cancer survival trends from 1990-94[1] and 1995-2009[5] to include patients diagnosed as recently as 2014. It

will include 15 malignancies that collectively represent 75% of the global cancer burden: oesophagus, stomach, colon, rectum, liver, pancreas, lung, melanoma, breast (women), cervix, ovary and prostate in adults (15-99 years), and brain tumours, lymphomas and leukaemias in both adults and children (0-14 years).

CONCORD-3 will compare geographic variation and time trends in cancer survival in 70 or more countries. Where adequate data are available, we will examine survival by stage at diagnosis, morphology, and race/ethnicity. We will also include information on the first course of treatment for each patient.

The data call was issued in May 2016, and we expect to begin producing up-to-date survival estimates from the first half of 2017. The US contribution is expected to cover up to 90% of the national population.

In a global study of this scale, good communication is vital. The data specification for CONCORD-3 has been translated from English into eight other languages: Arabic, Chinese, French, Italian, Japanese, Portuguese, Russian and Spanish. Face-to-face discussions on the protocol have been held with Canada, China, the Russian Federation, Malaysia, the UK, the US and at international meetings. The CONCORD team communicates with colleagues in six languages.

The results of CONCORD-3 are likely to have a substantial impact on the public, in the media and in the scientific and public health community. CONCORD-2 was covered by TV, radio, press and wire services world-wide. The Altmetric score of 780, reflecting social media impact, is higher than 99.98% of 6.5 million articles evaluated to date. Results have been incorporated into the American Cancer Society's Cancer Atlas.[15] The article[5] has been cited 590 times since 2015 (Google Scholar).

The results of CONCORD-3 will help monitor progress toward the overarching goal of the 2013 World Cancer Declaration, to achieve major improvements in cancer survival by 2020.

Improving cancer survival in the US

The analyses reported in this *Supplement* show that by 2010, the longstanding differences in cancer survival between blacks and whites in the US had not diminished, at least up to the time when implementation of the Patient Protection and Affordable Care Act (ACA) began to improve access to health insurance, screening and cancer treatment.[16,17] CDC reported in 2016 that the proportion of the US population without health insurance had dropped from 16% in 2010 to 9% by 2015, representing some 20 million people who had gained access to health insurance since introduction of the ACA.[18] The drop was especially marked for those living below the federal poverty line, among whom the proportion uninsured fell from 29.5% to 17.2%.[19]

One motive for producing the detailed analyses in this *Supplement* of cancer survival trends in the US by race, stage at diagnosis and state was to provide a baseline set of survival patterns, against which any impact of the Affordable Care Act could later be observed. As Weir and colleagues point out elsewhere in this *Supplement*: “the challenge [of implementation of the ACA] will be to ensure that everyone diagnosed with cancer in the United States benefits equally from advancements in medical care”.[20]

The survival estimates from CONCORD-3 and the distributions of stage and treatment for patients diagnosed 2010-2014 will offer a preliminary evaluation of the impact of the ACA on cancer patient survival. We do not know yet how the legislation proposed to replace the ACA from 2017 will change access to health insurance, diagnostic investigation, and treatment. It

will therefore be particularly important to maintain national surveillance of cancer survival in the US beyond 2014.

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A report from the Institute of Medicine in 2010 commented that the system for conducting cancer clinical trials in the US was approaching a state of crisis.[9] More than 25,000 patients were being recruited into clinical trials each year, but that still represented less than 3% of all cancer patients. The report noted that substantial progress in clinical management of various cancers had been produced by NCI-sponsored trials, but also that only about 60% were

actually completed and published. More recently, the Cancer Moonshot[b] initiative set out to improve participation in clinical trials. This may lead to improvement in population-based outcomes if personalized cancer care and targeted therapies become available to a much higher proportion of cancer patients.

By contrast, population-based cancer survival studies are the gold standard approach to assess the overall ***effectiveness*** of the entire health system in dealing with cancer.[8] Cancer survival estimates derived from population-based cancer registries include ***all patients diagnosed with cancer*** in a country or region, young and old, rich and poor, with or without serious comorbidity, and whether diagnosed at an early stage or with disease that is too advanced for any treatment of curative intent. They are diagnosed and managed in the entire range of healthcare facilities, with a wide range of treatment regimens, some of which may be unavailable to some patients contraindicated in others. Some patients will not adhere tightly to the treatment they are prescribed. Others may withdraw from treatment altogether if out-of-pocket payments are too expensive, or travelling or taking time off work is too difficult, or the side-effects of treatment are too severe.

Differences in survival between study groups in a clinical trial are easily interpreted as being attributable to differences in the efficacy of the treatment regimens being compared, to the skill of the medical staff who designed the trial, and the rigour with which they delivered the protocol. By contrast, results from population-based studies are often profoundly misinterpreted.

International differences in population-based cancer survival may be criticised by doctors in a country or region with lower survival, on grounds such as bad data, bias or incompetent analysis, or simply dismissed out of hand as flawed or unacceptable. The unspoken fear behind some of these criticisms is the implication that the doctors in the country with lower survival are somehow being judged as less competent. This concern is misplaced.

No physician, surgeon or radiotherapist sees a representative sample of all cancer patients. The survival of patients seen by a single doctor, cancer team or hospital will thus rarely reflect the overall national picture. Patients whose disease is too advanced at diagnosis for surgery are more likely to be referred for radiotherapy. Survival estimates derived from a single hospital are subject to referral bias. For all except the most common cancers and in the largest hospitals, they are also affected by statistical instability.[10]

Population-based cancer survival estimates differ in both purpose and scope from the survival estimates derived from clinical trials, or from the patients seen by an individual clinician, clinical team, or hospital. Population-based survival estimates are designed for public health surveillance, and to inform strategic policy-making on how to improve cancer management.

Life expectancy at birth provides a useful analogy. It encapsulates the likely longevity of recently born baby, and it incorporates many factors that have affected recent mortality in children and young people, but also the current mortality patterns of people who were born as long as 80 or 90 years ago. Despite this complexity, trends and international comparisons in life expectancy are readily interpreted. Life expectancy is generally increasing, but sharp reductions have been seen as a result of war, the AIDS epidemic in Lesotho and South Africa,[11] and the relaxation of alcohol control policy in the former Soviet Union.[12] Similarly, population-based cancer survival trends encapsulate a wide range of factors, including the speed with which patients seek help when they have symptoms suggestive of malignancy, as well as the efficiency of primary care, the speed of referral to secondary care, access to health insurance, and the availability of staff and equipment to deliver a thorough

[b] https://www.whitehouse.gov/CancerMoonshot

investigation and prompt, optimal treatment. They also reflect the human and financial resources available in the health system, and the efficiency with which it is organised.

A simple thought experiment should suffice to prove this point. Even the most experienced oncological team would be unable to deliver the standard of care and the level of survival they can achieve in a developed country if they were transposed to a country where patients are seen in a hospital with no pathologist and no access to radiotherapy, where they may have had to travel for days to seek attention, and they cannot afford to return after the first surgical intervention, perhaps for vital follow-up care or chemotherapy. Seen in that context, the skills and competence of any one doctor or cancer team are part of a much wider system, in which many other elements contribute to the overall outcome for all cancer patients.

That is why the CONCORD programme for the global surveillance of population-based cancer survival is useful. It provides internationally comparable data on cancer survival trends in many countries, and for most of the common cancers. It contributes vital information to public health programmes designed to improve cancer outcomes. This *Cancer Supplement* offers more detailed results for the US, by race and stage at diagnosis. The results are relevant for cancer patients and public health strategy for cancer control in each state.

Studying how best to implement laboratory findings into clinical practice - "from the bench to the bedside" – may be characterised as early translational research. However, it is also important that effective new interventions identified in clinical trials become available to all patients for whom they are clinically appropriate. Public health research focusses on how best to deliver those gains as quickly as possible. This may be described as "late translational research": from the paper to the people.

The impact of the CONCORD programme

The US National Cancer Institute recognised the impact of CONCORD-2 in an invited commentary for *The Lancet*, noting that global analyses of cancer survival provide an opportunity for lessons from countries with successful cancer control initiatives to be applied to other regions.[6] The commentary added that the availability of better data *"provides a clearer picture of the effect of cancer control programmes on the ultimate goal of improving survival and reducing the effect of cancer on the social and economic development of countries."*

In September 2015, the International Atomic Energy Agency's Programme for Action on Cancer Therapy (PACT) used CONCORD-2 results to launch an ambitious world-wide campaign to highlight the global divide in survival, and to raise awareness of persistent inequalities in access to life-saving cancer services.[13]

From 2017, the Organisation for Economic Co-operation and Development will include survival estimates from the CONCORD programme for 48 countries in its biennial publication *Health at a Glance*.[14] CONCORD will thus become the *de facto* standard for international cancer survival comparisons. This provides formal recognition by an international agency of the global coverage, methodological rigour and international comparability of the CONCORD survival estimates, which will become crucial for the evaluation of health systems performance in all OECD Member States and many associated countries.

Updating the global surveillance of cancer survival

CONCORD-3 is now in progress. It will update world-wide surveillance of cancer survival trends from 1990-94[1] and 1995-2009[5] to include patients diagnosed as recently as 2014. It

will include 15 malignancies that collectively represent 75% of the global cancer burden: oesophagus, stomach, colon, rectum, liver, pancreas, lung, melanoma, breast (women), cervix, ovary and prostate in adults (15-99 years), and brain tumours, lymphomas and leukaemias in both adults and children (0-14 years).

CONCORD-3 will compare geographic variation and time trends in cancer survival in 70 or more countries. Where adequate data are available, we will examine survival by stage at diagnosis, morphology, and race/ethnicity. We will also include information on the first course of treatment for each patient.

The data call was issued in May 2016, and we expect to begin producing up-to-date survival estimates from the first half of 2017. The US contribution is expected to cover up to 90% of the national population.

In a global study of this scale, good communication is vital. The data specification for CONCORD-3 has been translated from English into eight other languages: Arabic, Chinese, French, Italian, Japanese, Portuguese, Russian and Spanish. Face-to-face discussions on the protocol have been held with Canada, China, the Russian Federation, Malaysia, the UK, the US and at international meetings. The CONCORD team communicates with colleagues in six languages.

The results of CONCORD-3 are likely to have a substantial impact on the public, in the media and in the scientific and public health community. CONCORD-2 was covered by TV, radio, press and wire services world-wide. The Altmetric score of 780, reflecting social media impact, is higher than 99.98% of 6.5 million articles evaluated to date. Results have been incorporated into the American Cancer Society's Cancer Atlas.[15] The article[5] has been cited 590 times since 2015 (Google Scholar).

The results of CONCORD-3 will help monitor progress toward the overarching goal of the 2013 World Cancer Declaration, to achieve major improvements in cancer survival by 2020.

Improving cancer survival in the US

The analyses reported in this *Supplement* show that by 2010, the longstanding differences in cancer survival between blacks and whites in the US had not diminished, at least up to the time when implementation of the Patient Protection and Affordable Care Act (ACA) began to improve access to health insurance, screening and cancer treatment.[16,17] CDC reported in 2016 that the proportion of the US population without health insurance had dropped from 16% in 2010 to 9% by 2015, representing some 20 million people who had gained access to health insurance since introduction of the ACA.[18] The drop was especially marked for those living below the federal poverty line, among whom the proportion uninsured fell from 29.5% to 17.2%.[19]

One motive for producing the detailed analyses in this *Supplement* of cancer survival trends in the US by race, stage at diagnosis and state was to provide a baseline set of survival patterns, against which any impact of the Affordable Care Act could later be observed. As Weir and colleagues point out elsewhere in this *Supplement*: “the challenge [of implementation of the ACA] will be to ensure that everyone diagnosed with cancer in the United States benefits equally from advancements in medical care”.[20]

The survival estimates from CONCORD-3 and the distributions of stage and treatment for patients diagnosed 2010-2014 will offer a preliminary evaluation of the impact of the ACA on cancer patient survival. We do not know yet how the legislation proposed to replace the ACA from 2017 will change access to health insurance, diagnostic investigation, and treatment. It

will therefore be particularly important to maintain national surveillance of cancer survival in the US beyond 2014.

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