14th International Conference of Social Security Actuaries and Statisticians
Office of the Chief Actuary, OSFI
September 23, 2003

By way of introduction, I am Jean-Claude Ménard, Chief Actuary of the Canada Pension Plan and public sector pension plans. Thank you for inviting me here today to talk about the mortality of Canada Pension Plan and Old Age Security Beneficiaries and the implications for Public Pensions. Before I go any further, let me say a few words about the organization to which I belong.

(Slide 2) The Office of the Superintendent of Financial Institutions (OSFI) is the primary regulator of federally regulated financial institutions and pension plans in Canada. To fulfil its mission to safeguard policyholders, depositors and pension plan members from undue loss, OSFI administers a regulatory framework that contributes to the public's confidence in the financial system. The Office of the Chief Actuary (OCA) is responsible for providing actuarial services for the Canada Pension Plan (CPP), the Old Age Security (OAS), the Canada Student Loans Program, and pension and benefit plans provided to public sector employees.

Today, I will talk about the Canadian mortality trends and projections as well as the specific mortality of the Canada Pension Plan Retirement and Survivor beneficiaries. I will also present an international comparison of life expectancies and survival curves.

(Slide 3) Like the rest of the industrialized countries around the world, Canada has seen significant improvements in life expectancy over the last century. Improvements in the standard of living and in working conditions, implementation of good health care programs and tremendous gains in the medical domain have all contributed to an increase in life expectancy. The following chart shows the evolution of Canadian life expectancy at birth from 1921 to 1996 using the Life Tables for Canada, as published by Statistics Canada.

Since the early 1970s life expectancy at birth has increased by 6 years, which is much less than the estimated 21-year increase experienced from 1900 to 1970. Since 1981, male longevity has been catching up to female longevity. ***(Slide 4)*** Since the early 1970s, male and female life expectancy at age 65 has increased by about two and a half years to 16 and 20 years for males and females respectively.

(Slide 5) The following graph shows the probability of survival for a male newborn in 1921, in 1996 and in 2050. Even though life expectancy increased considerably over the last century, the maximum age to which we can live has not improved much for centuries. The "squaring" of the survival curve can be explained by the increase in life expectancy while the maximum age to which we can live is assumed to remain constant at 110 years. One consequence of the squaring of the survival curve is that more people are now surviving to older ages. While there were only slightly more than 50% of the people living at 65 years in the 1921 cohort, this percentage climbs to 80% for the 1996 cohort and to 90% for the 2050 cohort. A notable difference in the curves is the proportion of people living at 65 years. The life expectancies for each of the cohorts are shown on the graph. Despite a major increase in life expectancy at birth, the age at death did not increase significantly. Few people live to be 110 years. A headline in the *Globe and Mail* stated that 70% of men are expected to die between 74 and 94. The same illustration for the 1921 cohort would have produced ages between 1 and 85 years. When we remove the 15% of the people in a cohort at the two extremities, that is, those who die prematurely and those who are the strongest, we get a better assessment of the costs associated with financing retirement. If we look at past changes, it is reasonable to assume that mortality rates will continue to fall for the younger ages, but the challenge is quite different for people over 80 years.

(Slide 6) The next chart presents the same information for Canadian women. In the future, 70% of women are expected to die between 77 and 96 years of age, which is quite close to the figures for men.

(Slide 7) The following chart provides an overview of the average annual population-weighted mortality improvement rates in Canada for various subperiods over the 70 years ended in 1996. Average annual mortality improvement rates for females were always higher than for males until the beginning of the 80s. Mortality improvement rates of females are now lower than for males.

(Slide 8) The combination of improved mortality, genetic research and advances made in medical science raise a question as to whether a life expectancy of 100 years is possible in the near future. To which extent, do the current mortality rates need to be reduced to obtain a life expectancy at birth of 100 years, meaning that half of the population would reach this age?

To answer the question of living to age 100 years, we used simple mathematical models based on the Life Tables for Canada combined with general mortality improvements. A general improvement of, say, 10% means that all of the base mortality rates are reduced by 10%. If we want to have an expected average age at death of 100 for a newborn, the mortality rates at all ages must decrease by over 90% for males (black line on the graph). The corresponding figure for females is over 85%. To put these figures in perspective, to achieve a 90% mortality improvement over the next 50 years, we would need an average annual mortality improvement rate of 4.5%. The observed average annual mortality improvement rate in Canada between 1986 and 1996 was about 1.5%.

Thus, to achieve this level of improvement would require mortality to improve at three times the current rate, across all ages over the next 50 years. This test implies that to significantly increase life expectancy at birth, mortality improvements must be significant, especially at later ages.

It is worth noting that our mathematical models have so far assumed a maximum life span of 110. So let us examine what effect an increase in the maximum life span has on the life expectancy at birth. The following survival curve for males shows that if we keep the shape of the current mortality curve using an age mapping, males would need a maximum life span of 146 years to have a life expectancy at birth of 100 years. The increase in maximum life span (red line) is compared to a general mortality improvement of 90% (black line).

(Slide 9) The comparable figure for females is 135 years. To achieve this result, the chart shows that it is necessary to eliminate virtually all mortality before age 65, and furthermore, that 90% of the cohort must still be alive at age 80 (presently this percentage is about 65% for women). To attain a life expectancy at birth of 100 years needs two ingredients: Annual mortality improvements much higher than in the past, and a significant increase in the maximum life span.

(Slide 10) One of the principal components of the CPP Actuarial Report is the population projection, which is used to determine the contributors, beneficiaries and total expenditures in each future year. To obtain the projected population, assumptions on migration, fertility and mortality rates must be made. To project mortality rates, our methodology requires the use of mortality improvement factors.

The methodology used to project mortality rates is based on an approach that uses two sets of mortality improvement rates. The first set defines the initial annual mortality improvement rates based on the most recent experience, and is used to improve mortality rates for the first projection year. The second set is based on a study by cause of death and corresponds to the ultimate annual mortality improvement rates for years 2020 and thereafter. Intermediate annual improvement rates between the initial year and 2020 are determined by linear interpolation.

Beyond 2020, annual mortality improvement rates in the CPP Actuarial Report were determined from the latest United States Social Security Administration (SSA) mortality study. The U.S. study was used because of its exhaustive research on mortality improvement rates by cause of death and by age group. Historically, death rates for the two countries have shown similar patterns. However, to recognize the Canadian mortality experience, the U.S. rates were further adjusted.

(Slide 11) As can be seen from this chart, the current differences in life expectancies at age 65 between the two countries decrease over the projection period. By 2075 the difference is less than a year for each sex, both at birth and at age 65. The life expectancies shown are based on the mortality rates for that year (it means no subsequent mortality improvements).

(Slide 12) In the context of the CPP, what are the consequences of contributors and beneficiaries living longer? The answer is of primary importance for the future financial health of the Plan. CPP contributory service begins at age 18 and ends at the age of retirement benefit uptake. The retirement benefit is then paid until death.

One of the important elements of the Plan is the number of contributors, which forms the basis for the financing of the Plan together with investment income. The future number of contributors relies on both fertility and immigration. With respect to fertility a newborn must reach age 18 to become a contributor. Looking at past statistics and using the mortality projections of the CPP Actuarial Report, the evolution of the probability of becoming a contributor (meaning surviving from birth to age 18) can be traced. The probability of a newborn reaching age 18 has increased significantly over the past 40 years and is projected to continue increasing but at a much lower rate. This chart shows that great progress was made in the 20^{th} century in reducing childhood mortality in Canada.

(Slide 13) CPP contributory service begins at age 18, from which time contributions on employment earnings become revenue to the Plan. The following chart shows the probability of surviving from age 18 to the normal retirement age of 65. The probability of surviving the contributory period has increased over time for males (from 72% in 1966 to 84% in 2000) and is projected to reach 91% by 2075. The increases have been only half as large for females, (from 85% in 1966 to 90% in 2000), with 94% projected for 2075.

(Slide 14) This chart differs from the previous one because future mortality improvements are introduced in the values shown. For example, the official statistic based on the Life Tables for Canada presents a probability of 90% for females in 2000 while our actuarial model uses a probability of 93% to take into account the future mortality improvements that will be experienced by a female aged 18 in 2000. Note that the official probability for a female aged 18 in 1966 to survive to 65 in 2013 (using the Life Tables at that time) was 85% while it is expected to be around 92% when this person will reach 65 in 2013.

(Slide 15) The following charts show the probability of receiving a CPP retirement benefit up to selected ages from 70 to 100. It also shows that the average length of time beneficiaries receive their benefits has substantially increased since the inception of the plan. In 1966 male beneficiaries were most likely to receive a retirement benefit for 10 to 15 years and females for 15 to 20 years. ***(Slide 16)*** In the future males will most likely receive retirement benefits for approximately 20 years while females will most likely receive benefits for 20 to 25 years.

(Slide 17) This chart highlights the differences between the probability of surviving between age 65 and 80 without future mortality improvements and with future mortality improvements. For example, the official statistic presents a male survival probability of 58% from age 65 to age 80 in 2002 while our actuarial model is using 72% based on expected future mortality improvements.

(Slide 18) While one could assume that the mortality of CPP beneficiaries should be close to the mortality of the general population, there are some interesting trends and results peculiar to CPP beneficiaries. We did a study on the mortality of retirement beneficiaries by level of pension. The study included 761,000 deaths and 21.5 million life-years of exposure covering the nine-year period from 1992 to 2000.

The pattern by level of pension is clearly recognizable; the higher the level of pension, the lower the mortality rate. The reason that individuals with high pensions have lower mortality is likely that their socio-economic background and education makes them less exposed to some mortality risks. With universal access to medical care in Canada, lack of medical care can be ruled out as a significant factor.

(Slide 19) For all levels of pension combined, female retirement beneficiaries generally have slightly lower mortality rates than the general population. The overall light mortality is attributable to the light mortality of females with at least 25% of the maximum pension only partially offset by the excess mortality of those with the lowest pensions.

(Slide 20) The following table shows life expectancies for males by level of pension obtained for 1996. Male CPP life expectancies do not differ much from the general population life expectancies; they are slightly lower for each level of pension except the 75-100% level. ***(Slide 21)*** In contrast, CPP females have higher life expectancies than the general population for levels of pension except for the 0-25% level.

(Slide 22) Just as for retirement beneficiary mortality, survivor beneficiary mortality trends diverge somewhat from the general population. Our study included 328,000 deaths and 10,773,923 life-years of exposure covering a sixteen-year period from 1985 to 2000. The term “general population” is used to refer to the population of Canada less Québec as this is the population covered by the CPP.

The following chart shows the CPP survivor mortality rates relative to the rates for the general population. CPP survivor beneficiary mortality is seen to be significantly higher than that of the general population. One reason must be that survivors have mortality similar to single persons that are known to have a higher mortality than the general population. One other reason may be that survivors are deeply affected by the loss of their spouse, especially at the older ages where the survivor may already be in a weakened condition. Also in some cases one could assume that losing part of the primary source of income adds stress to the survivors.

(Slide 23) The following table shows the life expectancy of survivor beneficiaries obtained for 1996. Male CPP survivor beneficiary life expectancies are materially lower than the corresponding figures for the general population; for female survivor beneficiaries, they are slightly lower until about age 80, after which they are the same as for the general population.

(Slide 24) The OAS basic pension is a monthly benefit available, on application, to anyone age 65 or over who meets the residence requirements specified in the *Old Age Security Act*. Historically, mortality at older ages has always been difficult to measure accurately. A good source of data for measuring mortality at ages 80 and over in the future would be the administrative database of Old Age Security (OAS) beneficiaries. A new database with seriatim data will enable us in the future to do a complete study of the mortality of Old Age Security beneficiaries. In the most recent actuarial report, the proportion of the OAS beneficiaries age 80 and over is expected to increase from 24% to 35% of the total OAS beneficiaries by 2050.

(Slide 25) The maximum age to which we can live (maximum life span) has not significantly increased over the years. One reason is that most of the observed mortality improvements have occurred at ages 90 and below. A life expectancy at birth of 100 years is practically impossible in the next half century unless there are dramatic medical and scientific breakthroughs. It would require sustained mortality improvements at a level about three times what has been observed over the last 10 years. Alternatively, assuming a maximum human life span of about 145 years could result in a life expectancy at birth of 100 years.

Future mortality improvements are expected to come more slowly and at older ages, as mortality rates at younger ages are already very low. As shown by the probabilities of survival, more and more contributors are expected to reach the retirement age of 65. As well, CPP beneficiaries are expected to receive their benefit for a longer period.

(Slide 26) The next chart presents the survival curves for three groups, the least developed countries with a life expectancy of 50 years, the less developed countries with a life expectancy of 66 years and the more developed countries with a life expectancy of 76 years. Note the incredible and somewhat disturbing difference in the percentage of people still alive at age 65, ranging from 40% to 80%.

(Slide 27) The survival curve of Canadian males 1921 was added to the chart. While it is similar to the current survival curves for the least developed countries between ages 0 and 1, it is unfortunate and sad that the least developed countries currently have much higher mortality after age 30 than was the case in Canada some 80 years ago. ***(Slide 28)*** The current survival curve of Mexico with a life expectancy of 73 was also added for a comparison with other countries in the world. According to the data, the probability of being alive at age 65 for a Mexican is 75%.

(Slide 29) I will conclude with this table that shows good and sad news. Japan is the country with the highest life expectancy at birth while Zambia is the one with the lowest. Since 1980, the difference in the life expectancy at birth between the best and the worst country has actually increased from around 40 years to 50 years. According to the United Nations, it is expected that by 2050 the highest life expectancy will be experienced by Japan with 88 years and the lowest by Botswana at 44 years.

Thank you.