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Good afternoon. By way of introduction, I am Jean-Claude Ménard, Chief Actuary of the Canada Pension Plan, the Old Age Security Program and federal public sector pension plans in Canada. Thank you for inviting me here today to talk about the mortality projections for Social Security Programs in Canada.

(Slide 2) Let me begin by saying a few words about the organization to which I belong. The Office of the Superintendent of Financial Institutions (OSFI) is the primary regulator of federally regulated financial institutions and pension plans in Canada. Although the OCA is housed within the Office of the Superintendent of Financial Institutions (OSFI), it operates independently and with a different mandate. Our primary role is to provide actuarial services to the federal and provincial governments who are Canada Pension Plan (CPP) stakeholders. The Office also conducts actuarial valuations of the Old Age Security Program, the Canada Student Loans Program and pension and benefit plans covering the federal public sector employees. While I report to the Superintendent, I am solely responsible for the content and actuarial opinions in reports prepared by my office. Today, I will talk about Canadian mortality trends and the mortality projections for Social Security Programs in Canada. I will explore the applicability of stochastic processes in our deterministic valuation model and conclude with future challenges.

(Slide 3) Over the last century, life expectancy at birth has increased by an estimated 28 years in Canada with most of the change occurring before 1950. The rate at which life expectancy at birth has increased is slowing down mainly due to the fact that infant mortality rates have declined significantly. As a result, younger ages have already experienced most of the increase in life expectancy they are likely to see. Since mortality in the early years of life is very low, it is more difficult to raise life expectancy at birth. Since 1981, life expectancy at birth has increased by approximately 4 years from 76 to 80 years, which is much less than the estimated 24-year increase experienced from 1901 to 1981. The gap between female and male life expectancies at birth increased to reach more than seven years by the mid-1970s. Since then, male longevity has been catching up to female longevity.

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(Slide 4) Most experts agree that the rapid increase in life expectancy at birth that occurred during the 20th century will not continue and that future increases in life expectancy will have to take place at older ages as opposed to younger ages. Since the early 1970s, male and female life expectancy at age 65 has increased by about two and a half years to 18 and 21 years for males and females, respectively. The gap between female and male life expectancies at age 65 has also narrowed but only more recently.

(Slide 5) The following chart provides an overview of the average annual population-weighted mortality improvement rates in Canada for various 15-year subperiods over the 75 year period ended in 2001. Average annual mortality improvement rates have always been higher for females than for males except during the past 15 years. Although the female mortality improvement rates are still positive, the pace has slowed down in the past 15 years compared to the preceding 15 years. For the age group 65 to 89, the average annual mortality improvement rates have decelerated from 1.7% in the period 1971-1986 to 0.9% in the period 1986-2001. For males, the phenomenon is the reverse. Average annual mortality improvement rates have accelerated from 1.1% to 1.5%.

(Slide 6) As shown in the previous chart, past annual rates of mortality improvement have varied significantly by age and sex. Thus, future mortality rates are projected using annual rates of mortality improvement that vary by age and sex.

(Slide 7) Due to the uncertainty with respect to future mortality improvements, it was assumed that annual rates of mortality improvement for the first five years of the projection period would be similar to those experienced recently. For years 2002 to 2006, annual rates of mortality improvement are assumed to vary by age and sex and are set equal to the average annual rates experienced over the period 1991 to 2001.

Annual rates of mortality improvement after the first five years of the projection period reflect both long-term historical trends and an eventual reduction in the rates of improvement at older ages since it may become more difficult to eradicate the causes of death at those ages. The slowdown in annual rates of mortality improvement after 2006 is assumed to occur linearly over a period of 20 years. The ultimate rates for years 2026 and thereafter are assumed to vary by age and sex only and not by calendar year. The ultimate rates were derived from an analysis of the experience in Canada and the U.S. over the last century. The ultimate annual mortality improvement rates are based on the assumption that causes of death and general medical treatment in North America should not differ much in the future between the two countries and that the gap between U.S. and Canadian mortality should reduce over the projection period.

(Slide 8) Canadian mortality is lower than U.S. mortality for the first year of life. Under the assumption that Canadian and U.S. mortality will converge over time, it is assumed that the ultimate annual rate of mortality improvement is 1.35% for males and 1.25% for females. These rates are lower than the ultimate rates used in the U.S. report. Thus, the gap between Canadian and U.S. mortality is projected to narrow over time.

(Slide 9) In Canada, cancer is the leading cause of death for in the age group 45 to 64. Therefore, improvements will come mainly from medical breakthroughs. There is more room for male mortality to improve compared to female mortality because male mortality rates are higher. Assuming convergence in Canadian and U.S. mortality, the ultimate improvement rates are set at 0.65% for males and 0.55% for females. These rates are lower than the ultimate rates of 0.8% for males and 0.7% for females assumed in the U.S. Report, and so the gap between Canadian and U.S. mortality is projected to narrow over time.

(Slide 10) For the age group 65 to 84, heart disease is the leading cause of death. Thus, improvements will come mainly from medical breakthroughs and lifestyle changes. Assuming convergence in Canadian and U.S. mortality, the ultimate improvement rates are assumed to be 0.5% for both males and females. These rates are lower than, but consistent with, the U.S. Report assumption where male and female ultimate rates are set equal at 0.7%. As with the younger age groups, the gap between Canadian and U.S. mortality in this age group is projected to narrow over time.

(Slide 11) The following graph shows the probability of survival for a male newborn from 1925 to 2075 based on period life tables. The “squaring” of the survival curve is the result of expected lifetimes increasing and the maximum age that can be attained being about 120 years. As indicated on the graph by the intersection of the vertical line at age 65 with the survival curves, the probability of reaching age 65 increased substantially in the past. Based on period life tables of 1925, males had a 58% probability of reaching age 65. This figure increased to 85% by 2000 and is projected to reach 93% by 2075.

(Slide 12) Despite a major increase in life expectancy at birth, the maximum lifespan did not increase significantly in the past century. Few people live to 110 years. Based on period life tables of 1925, about 70% of females could expect to die between the ages of 24 and 84; that is 15% of females died prematurely before age 24 while 15% died after age 84. When we remove the 15% of the people in a cohort at the two extremities, we get a better assessment of the costs associated with financing retirement. By 2000, this range has moved forward and narrowed to an age range of 71 to 94 years. This trend is expected to continue in the future but at a much slower pace compared to the past. In 2050, it is expected that 70% of females will die between the ages of 74 and 96.

While the probability of reaching age 65 has significantly increased in the past (from 60% to 91%), it is expected to only increase marginally in the future, reaching 95% by 2075. In my view, it is much more important to look at the probability of reaching age 85 in the future. For females, the probability is expected to increase from 50% in 2000 to 65% in 2075.

(Slide 13) A new methodology has been developed for determining the evolution, as well as volatility, of mortality rates. Historical mortality rates have been analyzed using a stochastic time series model. In a stochastic process, random variation is present, which is generally based on fluctuations observed in historical data compared to a fitted model. The distribution of potential outcomes comes from a large number of simulations, each with random variation in the variables. Variable states at a particular point in time are not described by unique values, but rather by probability distributions, increasing the information available relative to the deterministic model.

(Slide 14) This chart shows the historical and projected mortality rates for males in the age range 65 to 69. The middle line represents the median mortality rates of the 1000 scenarios run, while the lines above and below represent the bounds of the 95% confidence interval. Once 1000 scenarios of mortality rates are projected for each age-sex group, those rates are converted into mortality improvement factors. During the twentieth century, structural changes in mortality patterns have lessened the validity of historical experience compared to the recent past and emerging patterns. Thus, judgment is used to finalize the best-estimate mortality improvement factors to be used in the projections.

(Slide 15) Next, the best-estimate mortality improvement factors are applied to the 2001 Canada Life Table (CLT) in order to establish the best-estimate mortality rates for the future. Finally, a stochastic process is used to project 1000 future mortality rate paths that are centered around this best-estimate. The life expectancy for each of the 1000 paths is then calculated and the best-estimate life expectancy is set equal to the median of the 1000 life expectancies. This table shows the best-estimate life expectancy at birth and age 65 as compared to the values from CPP 21, as well as the 95% confidence interval of these life expectancies.

(Slide 17) The last chart presents the survival curves for three groups, the least developed countries with a life expectancy of 52 years, the less developed countries with a life expectancy of 65 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%. Finland is amongst the countries with the highest life expectancy in the world at close to 80 years for both sexes with 88% of people still alive at 65.

Future mortality improvements are expected to emerge more slowly and mainly at older ages since mortality rates at younger ages are already very low. In the context of the Canada Pension

Plan, more and more contributors are expected to reach the retirement age of 65 and CPP retirement beneficiaries are expected to receive their benefit for a longer period. Methodologies involving stochastic time series models have been developed in both Canada and the United States for illustrating the evolution, as well as volatility, of mortality rates. The main advantage of a stochastic projection is that it provides a reasonable quantification of the range of uncertainty around the best estimate projection.