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SUBJECT: Demographic Factors Used to Project Medicare Expenditures—Incorporation of Time-to-Death to Account for Increasing Longevity on the Age-Sex Distribution of Spending

In the *2020 Annual Report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds* (2020 Medicare Trustees Report), the demographic factors used to project Medicare expenditures were improved to reflect the increasing longevity of Medicare beneficiaries. Specifically, the demographic factors now account for the changing mix of Medicare enrollees over time on the basis of age, sex, and time-to-death (TTD); in prior reports, the demographic factors accounted for age and sex only. Medicare spending is much higher for those closer to death, regardless of age, and much lower for those further from death, and the incorporation of TTD into the modeling allows future mortality improvements to be reflected in the health spending projections.

Incorporating TTD as a demographic factor in the 2020 Medicare Trustees Report has important implications for the financial status of the Medicare program. The Trustees project that there will be continued mortality improvement for the Medicare population at all ages—a development that would lead to a greater proportion of beneficiaries at any given age being further from death than in prior years. Accordingly, the TTD adjustment results in lower projected spending and an improvement in the outlook for the financial status of the Medicare program. The 2020 report reflects this methodological enhancement, but it also captures many other factors that affect the outlook relative to the 2019 report and that are not discussed in this paper.

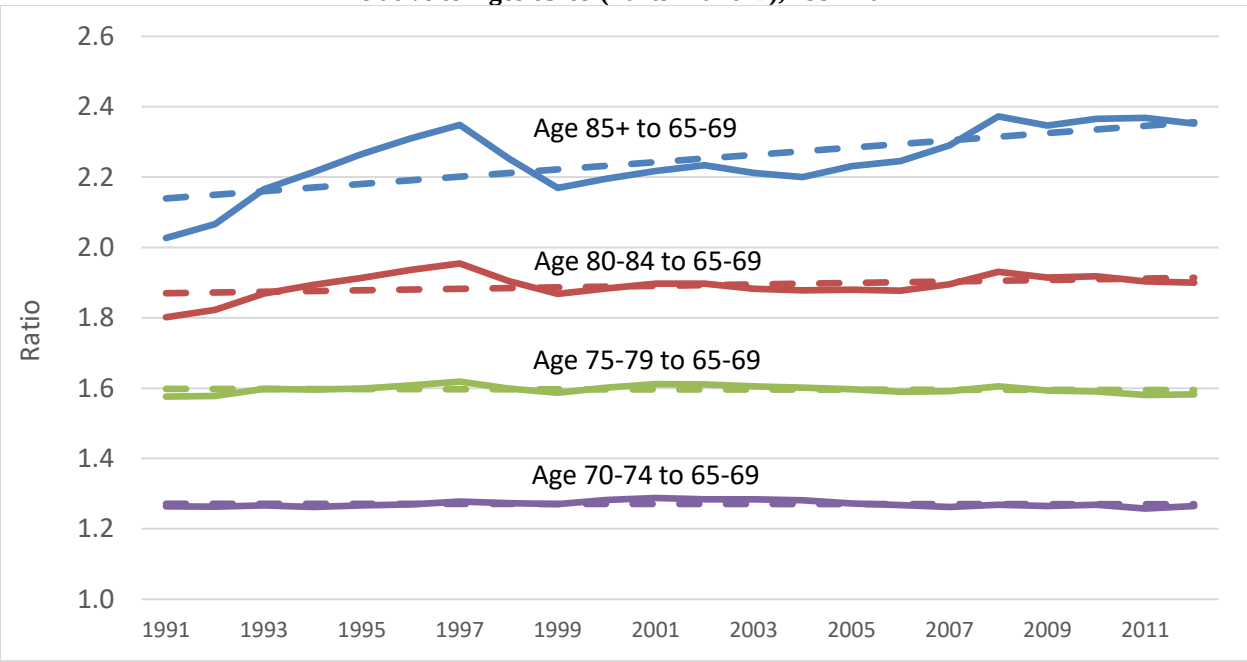
This memorandum summarizes the key issues associated with incorporating TTD into the 2020 Medicare Trustees Report. The Background section discusses the conceptual rationale for reflecting TTD and provides data that show how doing so improves the explanatory power of the demographic factors. The Methodology section discusses the data used to estimate the demographic factors in the 2020 report, provides estimates of these factors for Parts A, B, and D, examines the ways in which the factors reflecting the TTD adjustment compare to prior methods, and discusses the modeling considerations associated with incorporating the adjustment into the Medicare projections. Finally, the Illustration section estimates the impact of the methodological change to the demographic factors on the financial outlook of the Medicare program, using information from the 2019 report to show results with and without incorporation of TTD.

BACKGROUND

The impact of demographic changes on the growth of Medicare spending is estimated over a 75-year period in the Medicare Trustees Report. In the 2019 and prior reports, the estimates captured the effect on spending of projected shifts in Medicare enrollment across age and sex categories, assuming that the distribution of per enrollee spending by age and sex remained fixed over time.

Figure 1 presents Medicare (Parts A and B) spending by age group relative to those aged 65 to 69 during 1991-2012. While relative spending for the age groups 70-74, 75-79, and 80-84 remained largely the same throughout this period, the ratio for those aged 85 and older increased significantly, suggesting that assuming a constant distribution of per enrollee spending may not be supported.

Figure 1. Ratio of Medicare Fee-For-Service Spending per Beneficiary per Month by Age Group Relative to Ages 65-69 (Parts A and B), 1991-2012



Source: Medicare claims from the Chronic Conditions Warehouse.
Note: Dashed lines are trendlines.

Part of the trend for the oldest age group can be explained by the increased life expectancy of Medicare beneficiaries, so that at any given age, as mortality improves, a beneficiary would be further away from death.[1] Research has shown that Medicare spending per enrollee is strongly correlated with proximity to death.[2]

[1]The other key factor that explains this trend is the rapid increase in the use of skilled nursing facility and hospice care over the historical period, which has been assumed to have a mostly one-time impact on the ratio of spending by age group.

[2]Riley, G.F. and J.D. Lubitz. 2010. "Long-Term Trends in Medicare Payments in the Last Year of Life." *Health Services Research* 45(2):565-576; Spillman, B.C. and J. Lubitz. 2000. "The effect of longevity on spending for acute

In considering this phenomenon, the 2016-17 Medicare Technical Panel recommended that OACT further explore its demographic methods to consider reflecting not just the age and sex composition of the Medicare population but also shifts in enrollment by time-to-death (TTD) that occur as life expectancy increases over time[3]:

> **Recommendation 5-1:** The Panel recommends that the Trustees consider developing an approach to incorporate time to death into projections to account for the impact of rising longevity and changes in health on the age-sex distribution of spending over time.

Table 1 shows that per beneficiary Medicare spending in the final years of life is significantly higher than such spending for those who are farther away from death.

Table 1. Medicare Fee-For-Service Spending per Beneficiary per Month (Parts A and B), by Age and Time-To-Death (TTD), 2012-2014

Age	Time to Death (Years) 0	1	2	3	4	5+	Average
65 to 69 years	$6,270	$2,720	$1,676	$1,316	$1,095	$389	$539
70 to 74 years	$6,386	$2,701	$1,685	$1,333	$1,122	$479	$699
75 to 79 years	$6,029	$2,509	$1,596	$1,290	$1,100	$559	$863
80 to 84 years	$5,348	$2,229	$1,467	$1,207	$1,042	$614	$1,027
85+ years	$4,171	$1,845	$1,287	$1,102	$968	$649	$1,261
Ratio of 85+ to Ages 65 to 69	0.7	0.7	0.8	0.8	0.9	1.7	2.3
Relative to Average Medicare Beneficiary for Each Age Group							
65 to 69 years	11.6	5.0	3.1	2.4	2.0	0.7	1.0
70 to 74 years	9.1	3.9	2.4	1.9	1.6	0.7	1.0
75 to 79 years	7.0	2.9	1.8	1.5	1.3	0.6	1.0
80 to 84 years	5.2	2.2	1.4	1.2	1.0	0.6	1.0
85+ years	3.3	1.5	1.0	0.9	0.8	0.5	1.0

Source: Medicare claims data from the Integrated Data Repository; based on exposure months.

A Medicare fee-for-service (FFS) beneficiary who is aged 85 years or older would spend, on average, roughly 2.3 times as much as a beneficiary between the ages of 65 and 69. This is the effect that was captured by the demographic factors used in prior reports; as there are more Medicare enrollees at older ages, average Medicare spending will be higher. However, proximity to death is a much more important explanatory factor for spending per beneficiary than age, since higher spending due to age is true only for those who are at least 5 years away from death.

There are a number of observations that can be made about the distribution of health spending by age and TTD. First, while there is higher health spending at each age for those who are in their

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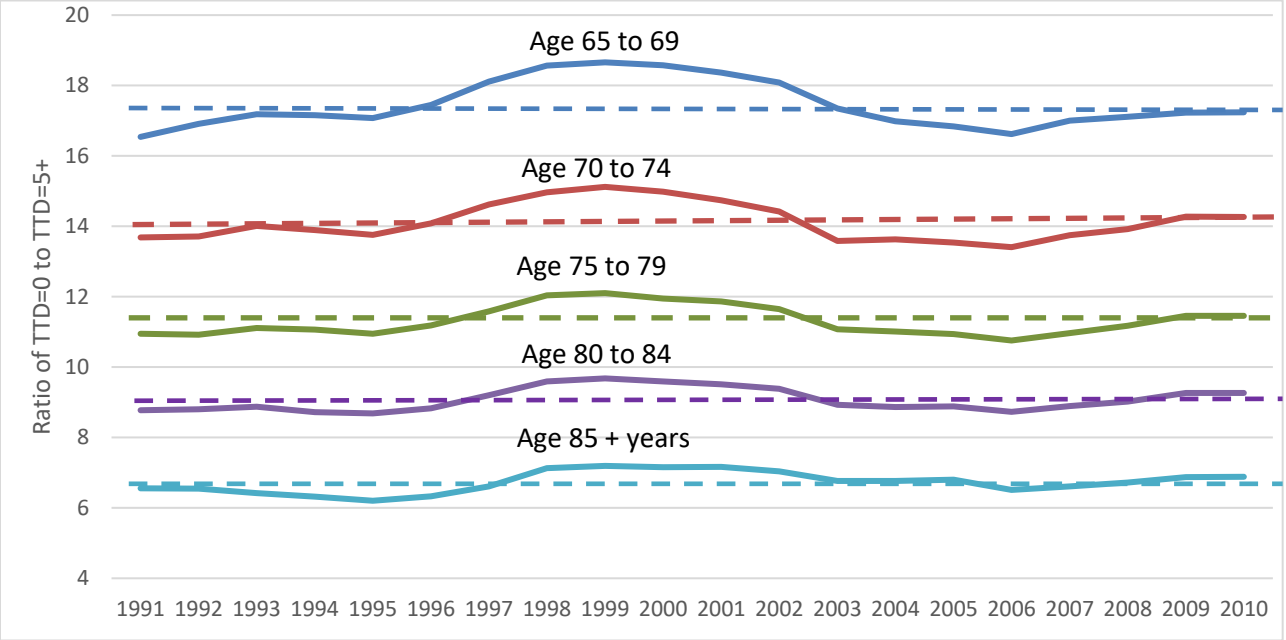
and long-term care." *N Engl J Med* 342(19):1409-1415; Lubitz, J. and R. Prihoba. 1984. "The Use of Medicare Services in the Last Two Years of Life." *Health Care Financing Review* 15:117-131.

[3]Technical Review Panel on the Medicare Trustees Report. *Review of the assumptions and methods of the Medicare Trustees' financial projections. 2017.* (p. 37). Available at https://aspe.hhs.gov/system/files/pdf/257821/MedicareTechPanelFinalReport2017.pdf.

year of death, the amount of spending for those who die generally decreases at older ages. This is consistent with other research that shows that the intensity of interventions may change based on the age and overall health status of a patient, including a shift from more invasive curative care to palliative care.[4] Second, health spending for those who are 5 or more years from death increases quite considerably with age, likely because individuals acquire and maintain additional chronic conditions as they grow older. Finally, a beneficiary aged 65 to 69 who is in the year of death spends nearly 12 times what an average beneficiary aged 65 to 69 spends, and, although this ratio falls for each broad age group, it is still over 3 for those who are aged 85 and older.

Over time, improvements in mortality at any given age would mean that more beneficiaries were further from death. Demographic factors that incorporate TTD would capture this effect and somewhat offset the higher expected costs of a population that is getting older. As noted earlier, the ratio of average health spending for beneficiaries aged 85 and older relative to those aged 65 to 69 increased quite considerably during 1991-2012. Over roughly the same period, however, the ratio *TTD=5+ to TTD=0* was relatively stable within every age group, as shown in figure 2.

Figure 2. Ratio of Medicare Fee-For-Service Spending per Beneficiary per Month (Parts A and B), for TTD=0 to TTD=5+, by Age Group, 1991-2010



Source: Medicare claims from the Chronic Conditions Warehouse.
Note: Dotted lines reflect the average ratio over the 1991-2010 period.

This stability is critical to the estimation of the demographic factors used in the Medicare spending projections. Under the prior method, the ratio of spending for those aged 85 and older relative those aged 65 to 69 would have been assumed to be constant at the base period value (for instance, the ratio of 2.3 shown in table 1). By incorporating TTD into the demographic factors and assuming that relative spending by TTD within age categories remains constant, the projections would no longer assume that relative spending by age remains constant in the future.

[4] See footnote 2.

In the 2020 report, for example, the ratio for those aged 85 and older relative to those aged 65 to 69 increases to 2.43 by 2094.[5]

Expressed in algebraic terms, Equation (1) below shows the derivation of the demographic factors when only age and sex are accounted for. This approach assumes that average spending by age and sex in year t remains constant over time, and the impact of demographics is measured by changing only the distribution of Medicare enrollment by age and sex between year t and year $t+1$:

$$(1) \quad D_t = \sum_{g=1}^{2} \sum_{a=1}^{N_a} \left(e_{g,a,t} / e_t \right) \times h_{g,a}$$

D_t = Index of spending for mix of enrollment across age and sex
$e_{g,a,t}$ = enrollment by sex g, age cohort a, in time period t
e_t = total enrollment across all cohorts in time period t
$h_{g,a}$ = base year spending per beneficiary per month for sex g, age cohort a
N_a = number of age cohorts

Equation (2) then reflects the demographic factors when the TTD adjustment is incorporated. This approach assumes that average spending by age, sex, and TTD in year t remains constant over time, and the impact of demographics is measured by changing the distribution of Medicare enrollment by age, sex, and TTD between year t and year $t+1$:

$$(2) \quad D'_t = \sum_{g=1}^{2} \sum_{a=1}^{N_a} \sum_{d=1}^{N_d} \left(e_{g,a,d,t} / e_t \right) \times h_{g,a,d}$$

D'_t = Index of spending for mix of enrollment across age, sex, and TTD
$e_{g,a,d,t}$ = enrollment by sex g, age cohort a, TTD group d, in time period t
e_t = total enrollment across all cohorts in time period t
$h_{g,a,d}$ = base year spending per beneficiary per month for sex g, age cohort a, TTD group d
N_a = number of age cohorts
N_d = number of TTD cohorts

METHODOLOGY

Data

For consistency with the standard sources used for the actuarial models, all data for spending and Medicare exposure (member-months) were based on information available in the Integrated Data Repository (IDR). The base-year period used for the spending weights in the TTD demographic indexes reflects the mean of the 3 most recent years of data available. To generate spending data

[5] For Part A, the ratio would increase from 3.8 in 2014 to 4.2 in 2094.

by TTD that reflect information about an individual who has survived at least 5 years, data with a 5-year lead time are required; that is, by using data that extend through 2019, it is possible to generate the distribution of exposure by TTD through 2014. The 3-year base period for the demographic indexes in the 2020 report thus reflects the mean for 2012 through 2014.

The Medicare enrollment estimates by age, sex, and TTD reflect experience through 2019, and projections for 2020 and beyond reflect the demographic assumptions from the 2020 Old-Age, Survivors, and Disability Insurance (OASDI) and Medicare reports. The mortality projections in the 2020 reports are used for the TTD adjustments. As mortality rates decrease, a proportion of individuals at each age would be further from death. For example, in the 2020 report, roughly 1.5 percent of beneficiaries aged 65 to 69 were projected to die in 2018, but by 2094 this proportion falls to slightly less than 1 percent. Similarly, for that same age group, in 2018 roughly 91 percent of beneficiaries are projected to live at least another 5 years, whereas by 2094 this percentage increases to 95 percent.[6]

Additionally, FFS mortality rates are consistently slightly higher than population-wide rates for most age and gender groupings, and there is no clear trend in the differential. For consistency with Medicare FFS enrollment over 65 years, a projection of FFS mortality rates was developed based on (i) the projected FFS and Medicare Advantage (MA) shares of enrollment and (ii) an assumption that, for the population over age 65 during the 2016-2018 period, the average difference between FFS and MA mortality rates remains constant over the projection. The following equation shows how these measures are derived using available population and mortality data:

$$q_S = \frac{l_F}{l_S} \times q_F + \frac{l_M}{l_S} \times q_M + \frac{l_i}{l_S} \times q_i$$

q_S, q_F, q_M, q_i: probability of death for Social Security population, FFS, MA, and ineligible[7]
l_S, l_F, l_M, l_i: population count of Social Security population, FFS, MA, and ineligible
$(q'_F - q'_M)$: FFS-MA mortality differential measured in IDR mortality data
Assuming $q_F = q_i$, then $q_F = q_S + \frac{l_M}{l_S} \times (q'_F - q'_M)$

At this point, no change has been made to the demographic considerations for the disabled population. Specifically, this group has been modeled without accounting for variations in age or sex factors. The health spending for disabled individuals in the 2020 report does not vary based on age, sex, or time-to-death.

Methods and Results

The contribution to spending growth from demographic shifts is estimated at the level of each individual type of service, and indexes capturing this contribution are used as an input to actuarial models by type of service. For Part A, the individual services modeled are inpatient

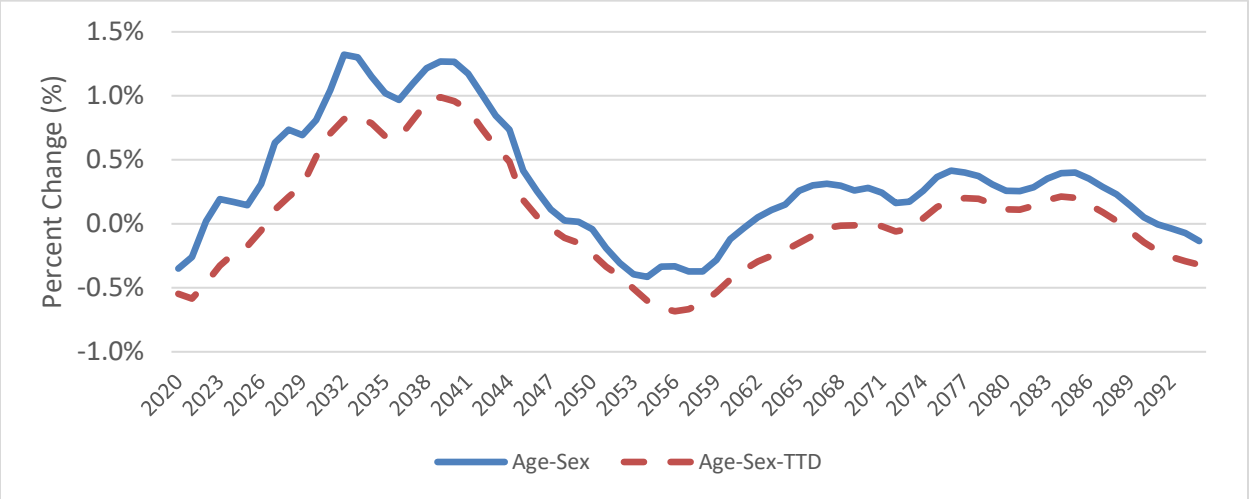
[6]Similarly, for the 85+ age group, roughly 14 percent of beneficiaries were projected to die in 2018, and 41 percent of beneficiaries are projected to live for 5 or more years. By 2094, these results change to 11 percent and 51 percent, respectively.

[7]The term "ineligible" refers to individuals not enrolled in Medicare Part A or Part B, in addition to any measurement error in the population counts.

hospital, skilled nursing facility, home health care, and hospice.[8] For Part B, the individual services are physician, outpatient hospital, and durable medical equipment. Part D is modeled in two parts: by Covered Plan Paid and by reinsurance for outliers. The magnitude of the effect of controlling for TTD is largest for types of services in which utilization tends to be most concentrated in the last year of life. Thus, for Part A services, which can be relatively highly concentrated in the last year of life, the impacts are larger than for Part B or Part D.

Figure 3 shows an overall Part A demographic factor based on weighting together, for each individual service, the demographic factors from the 2020 report, which reflect TTD. (The weights are the Part A spending shares by service in each year.) Figure 3 also shows the contribution from the demographic factors when only age and sex are reflected.

Figure 3. Growth in Part A Demographic Factors, with and without TTD, 2020-2094



As would be expected, the contribution of demographic factors to Part A spending is smaller when TTD is reflected because of the assumption of continued mortality improvement over the projection period. In figure 3, the variations over time between the age-sex and the age-sex-TTD demographic factors are attributable to cohort effects. (For instance, differences in the distribution of the use of services by baby boomers when they reach older ages narrow the differential between 2040 and 2055.) When standardized for a constant age-sex mix, the relative differences between the two measures (with and without TTD) are much more stable over time.

[8]Due to previous limitations in detailed data availability, the 2020 report represents the first time that any demographic adjustment is included for hospice services.

Figure 4 shows the same comparison for Part B, with the demographic factors calculated (as they were with Part A) by weighting together demographic factors for each individual service by their spending shares. While the spending contribution of demographic factors with TTD is lower than it is without, the differential for Part B is smaller than for Part A because Part B services are less acute and because the distribution of Part B spending is less concentrated in the period right before death.

Figure 4. Growth in Part B Demographic Factors, with and without TTD, 2020-2094

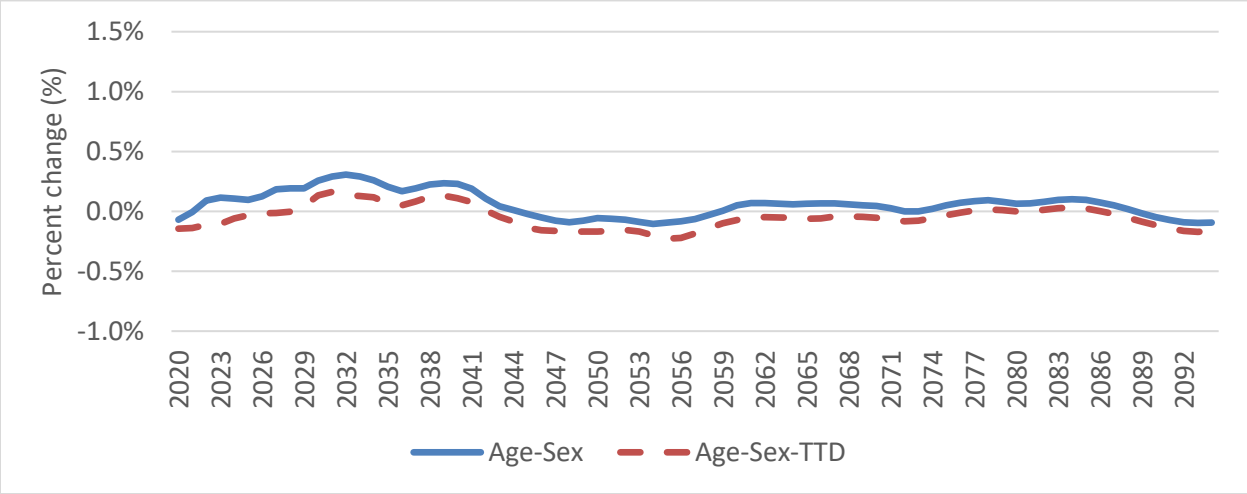


Figure 5 shows the demographic factors for Part D with and without TTD. For Part D, the impact of incorporating TTD into the demographic factors is smaller than for either Part A or Part B. This lesser effect occurs, in part, because the underlying distribution of spending by age-sex-TTD for Part D is much more evenly distributed than for other parts of Medicare.

Figure 5. Growth in Part D Demographic Factors, with and without TTD, 2020-2094

Modeling Considerations

For the 2020 report, historical Medicare spending growth for each service was decomposed using the factors that influence spending, including demographics that now reflect TTD. This decomposition resulted in a reduction in the contribution to spending growth explained by demographic change (relative to prior reports) and an offsetting increase in the contribution to growth in the use and intensity of services (which in the projection models is typically estimated as a "residual"). When the short-range projections by type of service were developed for the 2020 report, the contribution of the residual category was evaluated based on the new historical pattern that accounted for the TTD adjustment. For Parts B and D, the change in the historical contribution of the residual was well within the bounds of uncertainty in the projection of the residuals, and therefore this projection was not altered.[9] For Part A, the change in the historical contribution of the residual more closely aligned with the projected residuals, so again the projection was not altered.

For the long-range projections, the implication on the residual must be evaluated within the context of the "factors contributing to growth" model[10] since that model is used to derive the demographic-adjusted per enrollee spending growth rates over the last 50 years of the projection period. The factors model projects growth in per capita national health expenditures (NHE), a population-wide scope that encompasses all age groups. Accordingly, to maintain conceptual consistency with the TTD-based methodology for indexes that define demographic effects for Medicare, it is necessary to incorporate the effects of TTD into the population-wide demographic effects that are reflected in the model.

Generating an NHE-level age-TTD demographic index requires base-year spending and time series by age-TTD for the entire U.S. population in order to match the scope of the NHE. Unfortunately, no adequate data source on spending and enrollment by age and TTD exists for the non-Medicare population. However, a study that addressed the comparative effects of TTD across selected major countries in the Organisation for Economic Co-operation and Development assumed that average end-of-life medical spending for people younger than 65 is the same as such spending for older people.[11] Using those findings as the basis for the factors model, it was assumed that spending in the final year of life for Medicare beneficiaries aged 65 to 69 is equivalent to spending in the final year of life for persons in all under-65 age groups. The logic underlying this estimate is that the intensity of treatment for those in their last year of life is likely to be roughly comparable regardless of age. For the composition of the overall population by TTD, mortality rates by age were used to group individuals either in their last year of life or one or more years from death (essentially a survivor/decedent split). As a result, for the overall

[9]Note that this is the case just for the TTD effect; the residual may have changed in the 2020 report relative to the 2019 report for other reasons.

[10]See https://www.cms.gov/files/document/long-term-projection-assumptions-medicare-and-aggregate-national-health-expenditures.pdf.

[11]E. B. French, J. McCauley, M. Aragon, P. Bakx, M. Chalkley, S. H. Chen, B. J. Christensen, H. Chuang, A. Côté-Sergent, M. De Nardi, E. Fan, D. Échevin, P.-Y. Geoffard, C. Gastaldi-Ménager, M. Gørtz, Y. Ibuka, J. B. Jones, M.Kallestrup-Lamb, M. Karlsson, T. J. Klein, G. de Lagasnerie, P.-C. Michaud, O. O'Donnell, N. Rice, J. S. Skinner, E.van Doorslaer, N. R. Ziebarth, E. Kelly. "End-of-life medical spending in last twelve months of life is lower than previously reported." *Health Affairs*. (Millwood) **36**, 1211–1217 (2017). Available at https://www.healthaffairs.org/doi/full/10.1377/hlthaff.2017.0174.

NHE population there are two TTD categories—TTD=0 years and TTD=1+ years—whereas for the Medicare population there are six TTD categories—0, 1, 2, 3, 4, and 5+.

As was described previously regarding the residual impact on the Medicare spending data at the service level, changing the definition of the demographic contribution for overall NHE also affects the residual that is estimated using the factors model. Since the mortality improvement of the overall population leads to demographic factors that increase less rapidly when TTD is incorporated, the historical residual would grow more quickly than if TTD were not reflected. However, this effect is small given the range of uncertainty associated with the residual projection in the factors model, and analysis of the historical mean and trend supports retaining the current assumption for the contribution of the residual. Thus, all else being equal, incorporation of TTD into the demographic factors at the NHE level would not affect the demographic-adjusted per enrollee spending growth rates that are used for the Medicare projections over the last 50 years of the projection period.

ILLUSTRATION

The 2020 report was prepared based on demographic factors that included impacts for age, sex, and TTD. While a detailed comparison was not developed regarding what the impacts on Medicare financing would have been had a different set of demographic factors been used in the 2020 report, such an analysis was conducted as if TTD had been incorporated in the 2019 report. That analysis followed the same methodology for incorporating TTD as described above (using the prior year's data sources), as well as a few additional technical changes that were incorporated into the 2020 report but not the 2019 report.[12] Additionally, this exercise assumed that the underlying residual projections used in last year's report were unchanged.

In the 2019 Trustees Report, the Part A (Hospital Insurance, or HI) trust fund exhaustion date was 2026, and the HI actuarial balance was –0.91 percent. When TTD and the other technical changes were included, the HI exhaustion date was 2027, and the HI actuarial balance was −0.49 percent. While reflecting TTD had a significant impact in lowering Part A costs, that impact was partially offset by the inclusion of age and sex for hospice services.

As expected, the impact on Part B spending of incorporating TTD was smaller. In the 2019 report, the Part B share of GDP in 2029 and 2093 was estimated to be 2.5 percent and 3.1 percent, respectively. Incorporating TTD and other technical changes did not affect the share of GDP in 2029, but doing so lowered the share to 2.9 percent in 2093.

Finally, the impact on Part D was minimal. According to the 2019 report, the Part D share of GDP is an estimated 0.64 percent in 2029, the same as when TTD is reflected. In 2093, the share falls slightly from 1.07 percent, as shown in the 2019 report, to 1.06 percent after incorporating TTD and other technical changes.

[12]The other changes include incorporating a hospice demographic adjustment (age-sex-TTD); updating the age-sex distribution of enrollment for Parts A, B, and D for greater consistency; developing the MA enrollment projections on an age-sex basis and calculating the FFS enrollment as the difference from total enrollment; calculating the Part B long-range demographic factors separately by type of service; and updating the simulation for the impact of the Part D coverage gap closure for 2020.

CONCLUSION

The 2020 Medicare Trustees Report includes the impact of the changing demographic composition of the Medicare population by accounting for the distribution of enrollment by age, sex, and TTD. In prior reports, the demographic factors accounted for age and sex only. The incorporation of TTD increases the explanatory power of the spending projections because the demographic factors reflect the increasing longevity of Medicare beneficiaries as mortality improves. For the 2020 report, incorporating TTD into the demographic factors has important implications for the financial status of the Medicare program, and it results in an improved outlook because the Trustees assume that mortality rates will improve in the future as they have in the past. The magnitude of the impact of the TTD adjustment on the financial status of Medicare will depend on the rate of mortality improvement assumed by the Trustees. Regardless of the direction or magnitude of the impact, the revised methodology is likely to increase the accuracy of the demographic factors that underlie the Medicare projections.

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