The Impact of Diabetes on LTC Disability and Mortality: Population Estimates from the National Long Term Care Survey

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Acknowledgements: This research was funded by the National Institute on Aging through grants 5R01AG028259, 5R01AG030612, 1R01AG032319, and 5P01AG008761. David L. Straley provided programming support.

ABSTRACT

Purpose: To estimate the impact of diabetes on expected lifetime years of LTC disability above age 65 using the 2004 NLTCS with LTC disability based on the HIPAA ADL and CI Triggers. **Methods**: Diabetes was assessed using Medicare files linked to the NLTCS. Disabled life expectancy (DLE) with and without diabetes was computed via Sullivan's (1971) method. A simulated intervention in diabetes-related disability was generated by recalculating the diabetic component of DLE using nondiabetic disability rates. **Results**: Total DLE at age 65 was 1.28 years for males and 2.38 years for females with 0.51 and 0.79 years respectively for persons with diabetes. The latter values drop to 0.26 and 0.43 years respectively under the simulated intervention. **Conclusions**: Nearly half of the lifetime years of disability for diabetics was associated with the diabetes. Approximately 20% of lifetime years of disability for males and 15% for females were associated with diabetes.

INTRODUCTION

Diabetes is a complex metabolic disease with micro- and macro-vascular consequences that has increased markedly in prevalence over the last two decades; it now afflicts nearly 25% of the U.S. elderly population (CDC, 2009; NCHS, 2009). The temporal pattern of change in diabetes' prevalence was distinct from that of other major cardiovascular disease risk factors such as cholesterol and smoking whose prevalence declined over the same period; its pattern was closer to that of obesity/overweight, a recognized risk factor for both diabetes and cardiovascular disease that also exhibited a rapid increase in prevalence over the same period (Gregg et al., 2005).

The impact of diabetes has been characterized in several ways. CDC (2009) reported that the percentage of diabetics aged 75 and older (75+) unable to perform their usual activities for at least one of the previous 30 days increased slightly from 26.2% in 1997 to 26.9% in 2004, while fluctuating between 26.6% and 29.6% during the intervening years; the corresponding percentages of noninstitutionalized diabetics with any mobility limitations were 83.5% in 1997 and 80.3% in 2004, but the rates dropped to a low of 77.2% in 2001. CDC (2009) also reported that the median duration of diabetes among noninstitutionalized diabetic adults aged 65–79 years remained stable at 9.4 years in 1997 and 2004, with a low of 9.1 years in 2003.

Freedman et al. (2007, Table 2) reported declining ADL (Activities of Daily Living) and IADL (Instrumental Activities of Daily Living) disability prevalence rates for noninstitutionalized diabetics aged 65+ for the period 1997–2004. The same table reported increasing prevalence rates for diabetes that can be combined with the declining conditional disability rates to yield prevalence rates for the joint status of diabetes and disability for noninstitutionalized persons that increased from 2.9% in 1997 to 3.1% in 2004, but fluctuated between 2.5% and 3.2% during the intervening years.

These results motivate attempts at better quantification of the total population impact of diabetes (i.e., including institutionalized persons) by generating estimates of the years of life expectancy at age 65 associated with the presence or absence of diabetes in combination with the presence or absence of disability, where disability is linked to the need for long-term care (LTC).

Such estimates can be generated from cross sectional data via Sullivan's (1971) method which has been shown by Imai and Soneji (2007) to be unbiased and consistent under appropriate stationarity assumptions. In cases where the stationarity assumptions are not met, the results are still informative with respect to the implications of cross-sectional diabetes prevalence rates in the same way as the standard period life table is informative with respect to the implications of cross-sectional mortality rates. In both cases, the results represent the consequences of assumptions that the current rates continue unchanged in future years.

This paper presents estimates of the impact of diabetes on LTC disability based on data from the National Long Term Care Survey (NLTCS) with linked Medicare diagnoses of diabetes, with the criteria for LTC disability based on the Health Insurance Portability and Accountability Act (HIPAA) of 1996 ADL and CI Triggers which are widely used in determining eligibility for LTC insurance benefits and the tax-treatment of LTC services (IRS, 1997).

METHODS

The NLTCS is a multi-round panel survey that covered both the community and institutionalized elderly population using nationally representative sampling of the Medicare enrollment files over the period 1982–2004 (with Medicare covering 97% of persons aged 65+; see Manton et al., 2006). Cross-sectional analysis of the NLTCS was enabled through supplemental sampling of newly eligible Medicare enrollees turning age 65 between survey rounds.

This study used the 2004 round of the NLTCS. The HIPAA ADL Trigger was implemented using six ADLs (bathing, continence, dressing, eating, toileting, and transferring); the trigger requires standby or active personal assistance for at least two of the six ADLs (Stallard, 2008).

The disability classification based on the HIPAA ADL Trigger is more stringent than the standard disability classification reported from the NLTCS which typically includes IADLs and equipment-based ADL limitations (Manton et al., 2006). The higher threshold helps to reduce the rate of "false negatives" resulting from the screening procedures used in the NLTCS to select respondents for the detailed interview (see Wolf et al., 2005).

The HIPAA CI Trigger targets persons who require substantial supervision due to severe cognitive impairment. The trigger was implemented in two parts. First, because the need for substantial supervision was not directly assessed in the NLTCS, this requirement was implemented indirectly by restricting the trigger to respondents who met (1) the NLTCS criteria for any ADL or IADL disability at the screener interview (which then qualified them for the detailed interview), or (2) the NLTCS criteria for IADL disability or indoor mobility impairment at the detailed interview, or (3) the HIPAA criteria for at least one ADL disability at the detailed interview.

Second, the classification of severe cognitive impairment in the detailed interview was based on the Short Portable Mental Status Questionnaire (SPMSQ) with severe cognitive impairment defined as 3 or more errors on the 10 questions, or affirmation that the respondent had dementia, Alzheimer's disease (AD), or other cognition problems sufficient to prevent completion of the

SPMSQ with a passing score of 0–2 errors. The cutoff at 3 errors is consistent with actuarial practice for LTC insurance models (Stallard and Yee, 2000).

This implementation effectively assumed that respondents who did not need help with any of nine IADLs (e.g., taking medicine, managing money, using a telephone) or seven ADLs (the six listed above, and indoor mobility) would not meet the requirement for substantial supervision. These restrictions are consistent with reports that (1) AD patients with IADL and ADL impairments were classified in levels 2–5 of the 5-level AD Dependency Scale (Stern et al., 1994) and (2) declines in IADL functioning for AD patients typically occur over a 12-year period beginning about one-third of the way through an 18-year course of the disease with declines in ADL functioning beginning about two years later (Stern et al., 1996).

Diabetes was assessed using billing/diagnosis records in the Standard Analytical Files (SAFs), for Parts A and B of the Medicare Program, linked to the NLTCS. All respondents with ICD-9-CM code 250 appearing at least two times in the 36 months preceding the 2004 NLTCS were classified as diabetic. Rates were adjusted to reflect differentials in disease reporting for health maintenance organization (HMO) vs. fee-for-service (FFS) enrollees.

The 36-month time period was consistent with Taylor et al.'s (2002) analysis of AD registry data which concluded that at least 36 months of data were needed to identify AD using Medicare data. The use of 2+ mentions of diabetes as a classification rule for diabetics in the Medicare files was consistent with Kinosian et al. (2000) who used it to protect against random coding errors and other reporting anomalies that can occur with a single mention of diabetes using the 1+ mentions criterion. The impact of alternative classification rules based on 1+, 2+, and 3+ mentions is assessed below.

Mortality probabilities were based on deaths in linked Medicare vital statistics data occurring within one year after the 2004 NLTCS.

Comparisons of diabetic and nondiabetic subpopulations were based on ratios of actual to expected counts (A/E ratios) with the expected disability or mortality counts among diabetics generated by application of the sex- and age-specific nondiabetic rates to the diabetic population counts over age and sex.

Disabled life expectancies (DLE) with and without diabetes were estimated by applying Sullivan's (1971) method to the 2004 period life tables used by the Social Security Administration (SSA, 2008). Disability was stratified according to the presence or absence of diabetes. A simulated intervention in diabetes-related disability was generated by recalculating the diabetic component of DLE with the diabetic disability rates replaced with the nondiabetic disability rates.

Sample weights were employed as described in Manton et al. (2006); standard errors (s.e.'s) of weighted estimators of binomial proportions were based on rescaled sample weights using procedures described in Potthoff et al. (1992). These procedures yielded an estimated design effect of 1.187. Standard errors of A/E ratios (which were ratios of binomial proportions) were based on the standard Taylor series approximation for quotients of random variables (e.g., Mood et al., 1974, p. 181). Standard errors of healthy and disabled life expectancies (HLEs and DLEs) were based on a modification of the simple random sampling method in Molla et al. (2001) that accounted for the estimated design effect.

RESULTS

Case Identification

Table 1 displays the joint distributions of two indicators of diabetes among 16,507 respondents to the 2004 NLTCS, stratified by HMO/FFS status over the 36 months preceding the survey. The columns identify the absence/occurrence of one or more mentions of diabetes in the diagnostic fields in the linked Medicare diagnosis/billing files. Within each of three HMO/FFS statuses, the rows identify the respondents in the NLTCS who answered "Yes" when asked "Do you now have diabetes?" The *Yes* category corresponds to self-reported diabetes while the *No/Not Asked* category included respondents who answered "No" or who were not asked the question because they did not receive a detailed interview.

The odds ratios (OR), reflecting the associations of the indicators, were highest for respondents who were only in FFS and lowest for respondents who were only in an HMO. Among the *Yes*-respondents who were only in FFS, 94.2% (956 of 1,015) had 1+ mentions of diabetes in the Medicare files. Among the *Yes*-respondents who were only in an HMO, only 16.7% (19 of 114) had 1+ mentions of diabetes in the Medicare files. This difference occurred because HMOs typically did not report diagnostic information to the Medicare system.

The top panel of Table 2 presents the corresponding distributions for the subset of 5,157 respondents who were only in FFS and who received the detailed interview where they were asked the question "Do you now have diabetes?" The results for the *Yes*-respondents were the same as in Table 1. However, the results for the *No*-respondents indicated that 82.8% of those who answered *No* had no mentions of diabetes in the Medicare files. The chi-squared statistic was 2,205.14 (1 d.f.; highly significant) and the odds ratio was 78.06 for the association of the two indicators of diabetes, with a correlation (Φ-coefficient) of 0.654.

Under the assumption that the Medicare classification based on 1+ mentions was accurate, the sensitivity of the diabetes question in the detailed interview was 57.3% and its positive predictive value (PPV) was 94.2%.

The middle panel of Table 2 presents the same distributions for the case where the Medicare classification was based on 2+ mentions of diabetes. Under the assumption that the revised Medicare classification was accurate, the sensitivity of the diabetes question in the detailed interview increased to 67.0%. Among the *Yes*-respondents, 92.6% (940 of 1,015; PPV) had 2+ mentions of diabetes in the Medicare files, down only 1.6% from the top panel.

The chi-squared statistic in the middle panel was 2,728.45 (1 d.f.; highly significant), the odds ratio was 99.83, and the correlation (Φ-coefficient) was 0.728, all substantially higher than the corresponding values in the top panel.

The bottom panel of Table 2 presents the same distributions for the case where the Medicare classification was based on 3+ mentions of diabetes. Under the assumption that the revised Medicare classification was accurate, the sensitivity of the diabetes question in the detailed interview increased to 71.8%. Among the *Yes*-respondents, 91.0% (924 of 1,015; PPV) had 3+ mentions of diabetes in the Medicare files, down 1.6% from the middle panel. In this case, however, the negative predictive value (NPV) of 91.2% exceeded the PPV of 91.0%, suggesting that 3+ mentions may be too restrictive as a classification rule for diabetics in the Medicare files.

Table 2 shows that the sensitivity of the NLTCS diabetes question appeared to increase as the Medicare classification rule was made more stringent. However, even at 3+ mentions the sensitivity remained below 72% while the positive predictive value (PPV) was 91% or higher.

The 91% or higher PPV is consistent with the 90.8% PPV estimated from the Veterans Health Study (VHS) for self-reported diabetes (based on three questions, including having “high blood sugar") and medical record reports of diabetes; the 72% sensitivity of the diabetes question in the NLTCS is much lower than the corresponding 85.6% of the diabetes questions in the VHS (Skinner, et al., 2005).

The low value of the sensitivity of the NLTCS diabetes question is consistent with other analyses of self-reported diabetes. For example, NCHS (2009, p. 276) reported prevalence rates of total and physician-diagnosed diabetes (obtained by self-report) among noninstitutionalized persons that implied sensitivities in the range 68–74% at age 60+ during the period 1988–2006, consistent with the results in the middle and bottom panels of Table 2. The extra cases were persons with fasting blood sugar levels of at least 126 mg/dL who did not self-report a physician diagnosis. This suggests that the sensitivity of the NLTCS probe could be increased by asking "Do you now have diabetes *or high blood sugar*?"

Use of 2+ mentions of diabetes as a classification rule for case identification in the Medicare files is consistent with Kinosian et al. (2000). It is more conservative than Taylor et al. (2002) who used 1+ mentions in their classification rule but less conservative than the use of 3+ mentions, which may represent an upper bound to the range of plausible rules.

Prevalence of Diabetes

Table 3 displays estimates of the prevalence of diabetes in the United States in 2004 by age and by combinations of age and sex based on the classification rule described above for persons enrolled only in Medicare FFS. The overall prevalence was 23.6% for both sexes, 25.1% for males, and 22.6% for females. The prevalence increased over age, reaching a peak at age 80–84, after which it declined. These estimates are consistent with other reports that diabetes now afflicts nearly 25% of the U.S. elderly population (CDC, 2009; NCHS, 2009).

The 20.2% prevalence estimate for age 65–69 is less reliable than for older ages because this group included persons who enrolled in Medicare during the 36 months preceding the survey, typically at age 65, which provided fewer opportunities to record 2+ mentions of diabetes. Counterbalancing this effect, however, is the fact that the 65-year old age group was underrepresented in the NLTCS because the replenishment sample for persons aged 65–69 years old was chosen about 9 months before the interviews were conducted. This means that respondents aged 65–67 at the time of the interview had from 9 to 35 months enrollment in Medicare, averaging 23 months, which provided substantial opportunities to record 2+ mentions of diabetes. Thus, the prevalence estimate for the subgroup aged 65–67 years was 18.4% compared with 22.3% for the subgroup aged 68–69 years, consistent with an increasing trend at these ages.

Prevalence of Disability

Table 4 displays the joint distribution of the HIPAA ADL and CI Triggers at age 65+ in the United States in 2004, with stratifications by the number of ADL impairments that met the HIPAA ADL Triggering criteria, or for respondents who met none of these criteria, dichotomized according to the absence or presence of an IADL or indoor mobility impairment. The bottom panel of Table 4 indicates that 81.9% of the population was nondisabled using all criteria, 82.0% was nondisabled based on the ADL and IADL/mobility criteria, and 89.9% met neither of the HIPAA triggers.

Table 5 displays the same distribution for the subset of the elderly population enrolled only in Medicare FFS. The bottom panel indicates that 81.5% (-0.4%) of the population was nondisabled using all criteria, 81.6% (-0.4%) was nondisabled based on the ADL and IADL/mobility criteria, and 89.5% (-0.4%) met neither of the HIPAA triggers. Elimination of

HMO enrollees produced an increase in all indicators of disability, with the largest increases (0.2%) in the total for 5 ADLs and the combination of the two HIPAA triggers.

The ratio of the actual number of Medicare HMO enrollees who met any HIPAA trigger to the number expected based on the age- and sex-specific rates for persons enrolled only in Medicare FFS was 81.3% (±5.6%; s.e.) indicating that the only-FFS enrollees had statistically significantly higher disability rates than HMO enrollees. This difference means that the disability estimates for all enrollees based on the only-FFS enrollees will be biased upward by a factor of about 1.036.

Table 6 displays estimates for the subset of the elderly population enrolled only in Medicare FFS according to whether the persons met or did not meet any HIPAA trigger and did or did not have diabetes, with stratifications by age and sex. The "Prevalence Rate" column contains the disability prevalence rates (i.e., the percentages of each row that met any HIPAA trigger). The "Expected" column indicates the number of diabetics that would meet any HIPAA trigger based on the disability prevalence rates for nondiabetics. The "A/E Ratio" column contains the ratios of the actual number of disabled diabetics to the number in the "Expected" column. The overall 1.87 A/E ratio indicates that diabetics were 87% more likely than nondiabetics to meet the HIPAA disability triggers. The A/E ratios declined with age for both sexes.

These results are consistent with an A/E ratio of 1.90 obtained from Wilkin et al. (2005, p. 52) for 271 LTC insurance claims for diabetics aged 65+ after removing the excess risk for diabetics from the denominators. The classification of a policyholder as diabetic was made at the time the policy was issued, but the presence of diabetes was not used to reject the application for LTC insurance in this study population. Wilkin et al.'s (2005, p. 52) policy-duration table indicated that the underwriting selection effect lasted less than one year, confirming this observation and supporting the comparison of their results with those in Table 6.

Though encouraging, the results are not fully comparable because some fraction of the nondiabetics in Wilkin's database would have developed diabetes between the time the policy was underwritten and the claim filed; such persons would be classified as nondiabetic in Wilkin's database but as diabetic in Table 6, lowering the A/E ratio in Wilkin's data to a level closer to that in Table 6. In addition, the implementation of the HIPAA triggers in the NLTCS is an approximation to the actual benefit eligibility procedures of LTC insurers such as reflected in Wilkin's database. The size and direction of the differences are unknown and they may differ for different LTC insurers.

Probabilities of Death

Table 7 displays estimates for the same subpopulation as in Table 6 with the HIPAA trigger indicator replaced by the 1-year mortality indicator. The "Probability of Death" column contains the percentages of each row that died within one year of the survey. The "Expected" column contains the number of diabetics that would die within one year based on the probabilities of death for nondiabetics. The "A/E Ratio" column contains the ratios of the actual number of dead diabetics to the number in the "Expected" column. The overall 1.61 A/E ratio indicates that diabetics were 61% more likely than nondiabetics to die within one year. The A/E ratios declined with age for females and for males below age 85.

These results are almost identical to the A/E ratio of 1.60 obtained from Wilkin et al. (2005, p. 54) for 327 deaths among diabetics aged 65+ after removing the excess risk for diabetics from the denominators. Moreover, Wilkin et al.'s (2005, p. 54) policy-duration table indicated that there was no underwriting selection effect for mortality. As noted above, the A/E ratios are not fully comparable because of the differences in the treatment of new cases of diabetes in the period between underwriting and claim filing. The finding that the A/E ratios in Tables 6 and 7 are very close to Wilkins' ratios indicates that the differences in the classifications of diabetics and implementations of the HIPAA triggers either were very small or, if large, were offsetting.

Tables 8 and 9 stratify the estimates in Table 7 by disability status. Table 8 shows that the excess mortality among disabled diabetics was only 5% higher than expected based on the disabled nondiabetic probabilities. The excess mortality for diabetics occurred almost solely among the nondisabled subpopulation, with an excess of 59%, as shown in Table 9.

The overall probability of death for disabled persons (23.0%, Table 8) was 7.57 times higher than for nondisabled persons (3.0%; Table 9). However, the A/E ratio was only 4.79 (=713,822/48,940), using the probabilities in Table 9 to compute the expected number of deaths in Table 8. Thus a substantial component of the excess mortality for disabled persons was due to age and sex differences between the disabled and nondisabled populations with the disabled population being older and having a higher proportion of females.

The estimated 5% excess mortality among disabled diabetics (Table 8) is sensitive to the choice of probabilities used to compute the expected number of deaths. An alternative set of estimates can be derived using the probabilities for nondisabled nondiabetics in Table 9 to compute the expected number of deaths in Table 8 for both nondiabetic and diabetic disabled persons. This calculation yields A/E ratios of 4.95 (±0.55) and 5.85 (±0.67) respectively for nondiabetic and diabetic disabled persons. The ratio of these two A/E ratios, 1.18 (=5.85/4.95) (±0.14), implies an 18% excess mortality among disabled diabetics.

The average of the two estimates implies an 11% excess mortality among disabled diabetics. It also implies that the 5.85 A/E ratio for diabetics might be better estimated as 5.50

(=4.95×1.11). In this case the absolute increase in risk for disabled diabetics would be 0.55 (=5.50−4.95), which is effectively the same as the absolute increase in risk for nondisabled diabetics, 0.59 (=1.59−1.00). These results indicate that the effect is not multiplicative; it may be additive.

These results are consistent with reports that disabled diabetics have higher mortality risks than disabled nondiabetics due to interactions of physical complications and cognitive impairments with the diabetes (Verbrugge and Jette,1994; Munshi, et al., 2006; CDC, 2009).

Healthy and Disabled Life Expectancies

Table 10 displays the components of life expectancy at age 65 for the absence and presence of diabetes and disability, by sex, based on the Social Security Administration's 2004 period life tables (SSA, 2008). Table 11 displays the results of a simulated intervention in diabetes-related disability generated by recalculating the diabetic component of DLE with the diabetic disability rates replaced with the nondiabetic disability rates.

Total DLE at age 65 was 1.28 years for males and 2.38 years for females with 0.51 and 0.79 years respectively for persons with diabetes (Table 10). The latter values dropped to 0.26 and 0.43 years, respectively, representing relative declines of 49.3% and 45.8%, under the simulated intervention (Table 11).

Total DLE at age 65 was 1.03 years for males and 2.02 years for females under the simulated intervention (Table 11), representing relative declines of 19.5% and 15.2%, respectively, compared with the baseline calculations (Table 10).

Total lifetime with diabetes but no disability was 3.65 years for males and 3.58 years for females, which increased to 3.90 and 3.94 years respectively under the simulated intervention.

Total lifetime without either diabetes or disability was 11.73 years for males and 13.53 years for females, and was unaffected by the simulated intervention.

Figures 1 and 2 display the relative survival functions for males and females for combinations of diabetes and disability where the combinations are in the same order as in Tables 10 and 11, with increasing mortality risks for the later combinations. The areas between the plots in Figures 1 and 2 are equal to the life expectancy components in Table 10. The areas under the uppermost plots in Figures 1 and 2 are the sex-specific total life expectancies at age 65.

The total life expectancy values in Table 10 are 0.4 and 0.5 years lower for males and females, respectively, than the values reported by NCHS (2009, p. 203). These differences are due to the different methodologies used by the SSA and NCHS in their life table computations and reflect sources of uncertainty beyond the statistical variability represented in the standard errors in Table 10.

DISCUSSION

The purpose of this paper was to estimate the impact of diabetes on expected lifetime years of LTC disability above age 65 using the 2004 NLTCS with LTC disability based on the HIPAA ADL and CI Triggers. The NLTCS is recognized as the best single source of data on disability covering both the institutionalized and noninstitutionalized populations (Freedman et al., 2002). Nonetheless, the use of the NLTCS for the purpose of this paper required careful consideration of the details of the disease and disability reporting and the development of new algorithms for dealing with the coding and completeness of the information provided.

Identification of diabetics in the 2004 NLTCS can be based on self-reports of diabetes among respondents to the institutional and noninstitutional detailed interviews, but not among respondents who were screened out of the detailed interviews. Identification of diabetics in the linked Medicare files can be based on diagnoses of diabetes in the various billing records, information that is not complete for respondents who had enrolled in HMOs. Comparisons of the self-reports of diabetes in the detailed interviews with the diagnostic reports for respondents who had enrolled only in Medicare's fee-for-service program provided confidence that the latter could be used to classify diabetic and nondiabetic respondents.

Identification of disabled persons in the 2004 NLTCS based on the HIPAA ADL and CI Triggers can be based on the answers to a large set of questions on the detailed interview (Stallard, 2008). One feature new to the 2004 round was the full re-screening of all respondents who were automatically scheduled to receive the detailed interview. This change addressed questions that had emerged over prior rounds due to the accumulation of persons in the "healthy supplement" who had never screened into the detailed interview and the screener status of the automatic detailed interviewees. The 2004 screener facilitated an indirect implementation of the "substantial supervision" component of the HIPAA CI Trigger based on the assumption that a cognitively impaired person who did not meet the screening criteria for IADL and ADL help was not currently in need of supervision.

The exclusion of HMO enrollees from the current analysis induces a small but statistically significant upward relative bias (about 3.6%) in the disability prevalence estimates compared with the corresponding estimates for the combined population of HMO and FFS enrollees.

The impact of diabetes on LTC disability and mortality was characterized in several ways.

Diabetics were 87% more likely than nondiabetics to meet the HIPAA disability triggers and 61% more likely than nondiabetics to die within one year following the NLTCS interview. These results were consistent with independent estimates for an insured population derived from Wilkin et al. (2005).

Stratification of the study population by disability status indicated that the excess mortality for diabetics was not a multiplicative effect; it may be an additive effect that is independent of the presence or absence of disability. The detection of excess mortality for diabetics at both levels of disability is consistent with Verbrugge and Jette's (1994) characterization of the disablement process in which diabetes serves as a pathological precursor to disability and as a source of feedback effects for disabled persons due to new pathologies such as diabetes retinopathy.

Based on the simulated intervention, the analysis indicated that nearly half of the lifetime disability for diabetics was associated with the diabetes. This calculation assumed that the incidence of disability among diabetics would be the same as among nondiabetics, which would be true if diabetes did not serve as a risk factor for disability.

The reduction in the lifetime disability of the total population would be approximately 20% for males and 15% for females, under the simulated intervention. Conversely, the current levels of disability are 18–25% larger than they would be if diabetes were to be controlled or eliminated.

These calculations assume that "second-order" effects are negligible. A more refined analysis would require the development of a multi-state life table for the states represented in Figures 1 and 2, which would require longitudinal data for at least two rounds of the NLTCS or other survey where a constant set of classification rules could be applied at each round. An important component of such a model would be a careful analysis of the impact of changes in the incidence and severity of diabetes on the transitions of the multi-state life table model.

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Table 1. Association between Indicators of Diabetes based on the Number of Mentions of ICD 250 in the Medicare Files and Self-Reports of Diabetes in the NLTCS Detailed Interview, by HMO/FFS Status during the 36 Months Preceding the NLTCS Interview

		Diabetes in Medicare				
HMO/FFS Status over 36 Months	Diabetes in NLTCS Detailed Interview	No Mentions	1+ Mentions	Total	Statistic	Value
Only in HMO	No/Not Asked	1,691	46	1,737	OR	7.35
	Yes	95	19	114	s.e.(OR)	2.15
	Total	1,786	65	1,851	X^2	57.98
Only in FFS	No/Not Asked	9,824	2,883	12,707	OR	55.21
	Yes	59	956	1,015	s.e.(OR)	7.50
	Total	9,883	3,839	13,722	X^2	2,381.07
Mixed HMO & FFS	No/Not Asked	695	157	852	OR	25.82
	Yes	12	70	82	s.e.(OR)	8.38
	Total	707	227	934	X^2	178.56
Total		12,376	4,131	16,507		

Table 2. Association between Indicators of Diabetes based on the Number of Mentions of ICD 250 in the Medicare Files and Self-Reports of Diabetes in the NLTCS Detailed Interview using three Alternative Cutoffs for the Number of Mentions, for Respondents who Completed an NLTCS Detailed Interview and were Enrolled Only in Medicare FFS During the Preceding 36 Months

	Diabetes in Medicare						
Diabetes in NLTCS Detailed Interview	Below Cutoff	Meets Cutoff	Total	Statistic	Value	Statistic	Value
	Diabetes = 1+ Mentions of ICD 250 in Medicare Files						
No	3,430	712	4,142	OR	78.06	NPV	0.828
Yes	59	956	1,015	s.e.(OR)	10.95	PPV	0.942
Total	3,489	1,668	5,157	X^2	2,205.14	Φ	0.654
Specificity	0.983						
Sensitivity		0.573					
	Diabetes = 2+ Mentions of ICD 250 in Medicare Files						
No	3,680	462	4,142	OR	99.83	NPV	0.888
Yes	75	940	1,015	s.e.(OR)	12.95	PPV	0.926
Total	3,755	1,402	5,157	X^2	2,728.45	Φ	0.728
Specificity	0.980						
Sensitivity		0.670					
	Diabetes = 3+ Mentions of ICD 250 in Medicare Files						
No	3,779	363	4,142	OR	105.71	NPV	0.912
Yes	91	924	1,015	s.e.(OR)	12.99	PPV	0.910
Total	3,870	1,287	5,157	X^2	2,941.88	Φ	0.756
Specificity	0.976						
Sensitivity		0.718					

Table 3. Prevalence of Diabetes in the United States, 2004, Age 65 and Above, for Both Sexes, by Sex, and by Age: for Persons Enrolled Only in Medicare FFS During the Preceding 36 Months

	Diabetes in Medicare				
Age	0-1 Mentions	2+ Mentions	Total	Percent	s.e.(Pct.)
		Both Sexes			
65-69	5,752,402	1,453,121	7,205,523	20.2%	0.8%
70-74	5,179,819	1,766,208	6,946,027	25.4%	0.9%
75-79	4,606,763	1,596,522	6,203,285	25.7%	0.9%
80-84	3,621,027	1,294,436	4,915,462	26.3%	1.0%
85-99	2,183,087	622,181	2,805,268	22.2%	1.3%
90-94	1,015,041	218,073	1,233,114	17.7%	1.8%
95+	304,236	64,393	368,628	17.5%	3.2%
Total	22,662,375	7,014,933	29,677,307	23.6%	0.4%
		Males			
65-69	2,729,386	707,891	3,437,278	20.6%	1.1%
70-74	2,318,892	828,134	3,147,025	26.3%	1.3%
75-79	1,834,597	743,265	2,577,862	28.8%	1.5%
80-84	1,397,802	555,962	1,953,764	28.5%	1.7%
85-99	727,259	217,655	944,913	23.0%	2.2%
90-94	274,183	67,912	342,095	19.9%	3.5%
95+	60,435	15,001	75,437	19.9%	7.5%
Total	9,342,554	3,135,821	12,478,375	25.1%	0.6%
		Females			
65-69	3,023,016	745,230	3,768,245	19.8%	1.1%
70-74	2,860,927	938,075	3,799,002	24.7%	1.1%
75-79	2,772,166	853,257	3,625,423	23.5%	1.2%
80-84	2,223,225	738,474	2,961,698	24.9%	1.3%
85-99	1,455,829	404,526	1,860,355	21.7%	1.6%
90-94	740,859	150,160	891,019	16.9%	2.1%
95+	243,801	49,391	293,192	16.8%	3.6%
Total	13,319,821	3,879,112	17,198,933	22.6%	0.5%

Table 4. Distribution of HIPAA Triggers by ADL/IADL Disability Level, United States 2004, Age 65 and Above

	HIPAA Trigger					
ADL/IADL Disability Level*	Neither	CI only	ADL only	ADL & CI	Total	s.e.(Tot. Pct.)
			Number of Persons			
Nondisabled	29,668,332	64,014			29,732,346	
IADL+Mobility Only	2,214,475	382,542			2,597,017	
1 ADL	698,834	251,692			950,526	
2 ADLs			268,546	202,027	470,573	
3 ADLs			231,219	192,294	423,514	
4 ADLs			261,289	257,720	519,009	
5 ADLs			294,215	440,844	735,060	
6 ADLs			176,327	632,877	809,204	
Total	32,581,641	698,247	1,231,597	1,725,762	36,237,248	
			Percent Distribution			
Nondisabled	81.9%	0.2%			82.0%	0.3%
IADL+Mobility Only	6.1%	1.1%			7.2%	0.2%
1 ADL	1.9%	0.7%			2.6%	0.1%
2 ADLs			0.7%	0.6%	1.3%	0.1%
3 ADLs			0.6%	0.5%	1.2%	0.1%
4 ADLs			0.7%	0.7%	1.4%	0.1%
5 ADLs			0.8%	1.2%	2.0%	0.1%
6 ADLs			0.5%	1.7%	2.2%	0.1%
Total	89.9%	1.9%	3.4%	4.8%	100.0%	
s.e.(Tot. Pct.)	0.3%	0.1%	0.2%	0.2%		

* Note: Institutional residents were treated as IADL impaired if no ADL impairments were reported.

Table 5. Distribution of HIPAA Triggers by ADL/IADL Disability Level, United States 2004, Age 65 and Above: for Persons Enrolled Only in Medicare FFS During the Preceding 36 Months

	HIPAA Trigger					
ADL/IADL Disability Level*	Neither	CI only	ADL only	ADL & CI	Total	s.e.(Tot. Pct.)
			Number of Persons			
Nondisabled	24,174,573	53,405			24,227,979	
IADL+Mobility Only	1,803,520	317,713			2,121,233	
1 ADL	596,742	206,455			803,197	
2 ADLs			222,945	184,923	407,867	
3 ADLs			203,666	164,638	368,304	
4 ADLs			213,182	229,221	442,403	
5 ADLs			262,366	391,358	653,724	
6 ADLs			130,084	522,516	652,600	
Total	26,574,836	577,573	1,032,243	1,492,656	29,677,307	
			Percent Distribution			
Nondisabled	81.5%	0.2%			81.6%	0.4%
IADL+Mobility Only	6.1%	1.1%			7.1%	0.2%
1 ADL	2.0%	0.7%			2.7%	0.2%
2 ADLs			0.8%	0.6%	1.4%	0.1%
3 ADLs			0.7%	0.6%	1.2%	0.1%
4 ADLs			0.7%	0.8%	1.5%	0.1%
5 ADLs			0.9%	1.3%	2.2%	0.1%
6 ADLs			0.4%	1.8%	2.2%	0.1%
Total	89.5%	1.9%	3.5%	5.0%	100.0%	
s.e.(Tot. Pct.)	0.3%	0.1%	0.2%	0.2%		

* Note: Institutional residents were treated as IADL impaired if no ADL impairments were reported.

Table 6. Ratio of Actual to Expected Number of Diabetics Meeting Any HIPAA Trigger Assuming that Non-Diabetic Prevalence Rates Would Apply in the Absence of Diabetes, United States 2004, Age 65 and Above, by Sex and Age

			Meets Any HIPAA Trigger							
Diabetes in Medicare	Sex	Age	No	Yes	Total	Prevalence Rate	s.e.(P.R.)	Expected	A/E Ratio	s.e.(A/E)
0-1 Mentions	Male	65-74	4,925,963	122,315	5,048,278	2.4%	0.4%			
		75-84	3,010,325	222,073	3,232,399	6.9%	0.7%			
		85+	840,219	221,658	1,061,877	20.9%	2.0%			
		Total	8,776,507	566,046	9,342,554	6.1%	0.4%			
	Female	65-74	5,726,936	157,007	5,883,943	2.7%	0.3%			
		75-84	4,533,488	461,902	4,995,391	9.2%	0.7%			
		85+	1,618,869	821,618	2,440,488	33.7%	1.6%			
		Total	11,879,293	1,440,528	13,319,821	10.8%	0.4%			
	Total		20,655,801	2,006,574	22,662,375	8.9%	0.3%			
2+ Mentions	Male	65-74	1,420,908	115,116	1,536,025	7.5%	1.1%	37,216	3.09	0.64
		75-84	1,120,063	179,165	1,299,227	13.8%	1.6%	89,260	2.01	0.31
		85+	217,677	82,892	300,569	27.6%	4.2%	62,741	1.32	0.24
		Total	2,758,648	377,173	3,135,821	12.0%	0.9%	189,218	1.99	0.21
	Female	65-74	1,533,024	150,280	1,683,304	8.9%	1.1%	44,917	3.35	0.61
		75-84	1,286,646	305,084	1,591,730	19.2%	1.6%	147,181	2.07	0.23
		85+	340,717	263,361	604,077	43.6%	3.3%	203,370	1.29	0.12
		Total	3,160,387	718,725	3,879,112	18.5%	1.0%	395,467	1.82	0.13
	Total		5,919,035	1,095,898	7,014,933	15.6%	0.7%	584,685	1.87	0.11
Total			26,574,836	3,102,472	29,677,307	10.5%	0.3%			

Table 7. Ratio of Actual to Expected Number of Deaths among Diabetics Assuming that Non-Diabetic Death Rates Would Apply in the Absence of Diabetes, United States 2004, Age 65 and Above, by Sex and Age

			Status 1 Year After NLTCS							
Diabetes in Medicare	Sex	Age	Survived	Died	Total	Probability of Death	s.e.(P.D.)	Expected	A/E Ratio	s.e.(A/E)
0-1 Mentions	Male	65-74	4,926,353	121,926	5,048,278	2.4%	0.4%			
		75-84	3,043,399	188,999	3,232,399	5.8%	0.7%			
		85+	904,938	156,939	1,061,877	14.8%	1.8%			
		Total	8,874,690	467,864	9,342,554	5.0%	0.4%			
	Female	65-74	5,820,880	63,063	5,883,943	1.1%	0.2%			
		75-84	4,817,736	177,655	4,995,391	3.6%	0.4%			
		85+	2,125,548	314,939	2,440,488	12.9%	1.1%			
		Total	12,764,164	555,657	13,319,821	4.2%	0.3%			
	Total		21,638,854	1,023,521	22,662,375	4.5%	0.2%			
2+ Mentions	Male	65-74	1,448,492	87,533	1,536,025	5.7%	1.0%	37,098	2.36	0.53
		75-84	1,185,894	113,334	1,299,227	8.7%	1.3%	75,966	1.49	0.28
		85+	233,755	66,814	300,569	22.2%	3.9%	44,422	1.50	0.32
		Total	2,868,140	267,681	3,135,821	8.5%	0.8%	157,486	1.70	0.21
	Female	65-74	1,618,147	65,157	1,683,304	3.9%	0.8%	18,041	3.61	1.03
		75-84	1,500,828	90,902	1,591,730	5.7%	1.0%	56,608	1.61	0.33
		85+	530,044	74,033	604,077	12.3%	2.2%	77,955	0.95	0.19
		Total	3,649,020	230,092	3,879,112	5.9%	0.6%	152,604	1.51	0.20
	Total		6,517,160	497,773	7,014,933	7.1%	0.5%	310,090	1.61	0.14
Total			28,156,013	1,521,294	29,677,307	5.1%	0.2%			

Table 8. Ratio of Actual to Expected Number of Deaths among Diabetics Meeting Any HIPAA Trigger Assuming that Non-Diabetic Death Rates Would Apply in the Absence of Diabetes, United States 2004, Age 65 and Above, by Sex and Age

			Status 1 Year After NLTCS							
Diabetes in Medicare	Sex	Age	Survived	Died	Total	Probability of Death	s.e.(P.D.)	Expected	A/E Ratio	s.e.(A/E)
0-1 Mentions	Male	65-74	100,000	----	122,315	----	----			
		75-84	173,000	49,000	222,073	22.1%	4.6%			
		85+	152,000	70,000	221,658	31.6%	5.1%			
		Total	424,430	141,617	566,046	25.0%	3.0%			
	Female	65-74	145,000	----	157,007	----	----			
		75-84	363,000	99,000	461,902	21.4%	3.1%			
		85+	604,000	217,000	821,618	26.4%	2.5%			
		Total	1,112,543	327,985	1,440,528	22.8%	1.8%			
	Total		1,536,973	469,601	2,006,574	23.4%	1.5%			
2+ Mentions	Male	65-74	93,000	----	115,116	----	----	----	----	----
		75-84	124,000	55,000	179,165	30.7%	5.7%	40,000	1.39	0.39
		85+	42,000	41,000	82,892	49.5%	9.0%	26,000	1.57	0.38
		Total	259,052	118,121	377,173	31.3%	3.8%	86,970	1.36	0.24
	Female	65-74	122,864	27,416	150,280	18.2%	5.2%	----	----	----
		75-84	261,191	43,893	305,084	14.4%	3.3%	65,000	0.67	0.18
		85+	208,571	54,790	263,361	20.8%	4.1%	70,000	0.79	0.17
		Total	592,626	126,099	718,725	17.5%	2.3%	146,381	0.86	0.15
	Total		851,678	244,220	1,095,898	22.3%	2.0%	233,351	1.05	0.13
Total			2,388,650	713,822	3,102,472	23.0%	1.2%			

Note: "----" indicates fewer than 11 respondents in cell or derived rate; adjacent cells were rounded to nearest 1,000 to suppress indicated cell value.

Table 9. Ratio of Actual to Expected Number of Deaths among Diabetics Not Meeting any HIPAA Trigger Assuming that Non-Diabetic Death Rates Would Apply in the Absence of Diabetes, United States 2004, Age 65 and Above, by Sex and Age

			Status 1 Year After NLTCS							
Diabetes in Medicare	Sex	Age	Survived	Died	Total	Probability of Death	s.e.(P.D.)	Expected	A/E Ratio	s.e.(A/E)
0-1 Mentions	Male	65-74	4,826,622	99,341	4,925,963	2.0%	0.3%			
		75-84	2,870,311	140,014	3,010,325	4.7%	0.6%			
		85+	753,327	86,892	840,219	10.3%	1.7%			
		Total	8,450,260	326,248	8,776,507	3.7%	0.3%			
	Female	65-74	5,675,935	51,001	5,726,936	0.9%	0.2%			
		75-84	4,454,581	78,908	4,533,488	1.7%	0.3%			
		85+	1,521,105	97,764	1,618,869	6.0%	1.0%			
		Total	11,651,621	227,672	11,879,293	1.9%	0.2%			
	Total		20,101,881	553,920	20,655,801	2.7%	0.2%			
2+ Mentions	Male	65-74	1,355,495	65,413	1,420,908	4.6%	0.9%	28,655	2.28	0.59
		75-84	1,061,660	58,403	1,120,063	5.2%	1.1%	52,096	1.12	0.28
		85+	191,933	25,744	217,677	11.8%	3.6%	22,511	1.14	0.40
		Total	2,609,088	149,560	2,758,648	5.4%	0.7%	103,262	1.45	0.23
	Female	65-74	1,495,283	37,740	1,533,024	2.5%	0.6%	13,652	2.76	0.96
		75-84	1,239,637	47,009	1,286,646	3.7%	0.9%	22,395	2.10	0.62
		85+	321,474	19,243	340,717	5.6%	2.1%	20,576	0.94	0.37
		Total	3,056,394	103,993	3,160,387	3.3%	0.5%	56,623	1.84	0.37
	Total		5,665,482	253,553	5,919,035	4.3%	0.4%	159,885	1.59	0.20
Total			25,767,363	807,473	26,574,836	3.0%	0.2%			

Table 10: Components of Life Expectancy at Age 65, United States 2004, Absence and Presence of Diabetes and Disability, by Sex

	Health Status				
Item & Sex	No Diabetes & No Disability	Diabetes & No Disability	No Diabetes & Disability	Diabetes & Disability	Total Life Expectancy
Years					
Males	11.73	3.65	0.78	0.51	16.67
Females	13.53	3.58	1.59	0.79	19.50
Percent					
Males	70.4%	21.9%	4.7%	3.0%	100.0%
Females	69.4%	18.4%	8.2%	4.1%	100.0%
s.e.(Pct.)					
Males	0.7%	0.6%	0.3%	0.3%	
Females	0.7%	0.6%	0.4%	0.3%	

Table 11: Components of Life Expectancy at Age 65, United States 2004, Absence and Presence of Diabetes and Disability, by Sex: Assuming that Non-Diabetic Disability Rates Apply to Diabetics

	Health Status				
Item & Sex	**No Diabetes & No Disability**	**Diabetes & No Disability**	**No Diabetes & Disability**	**Diabetes & Disability**	**Total Life Expectancy**
Years					
Males	11.73	3.90	0.78	0.26	16.67
Females	13.53	3.94	1.59	0.43	19.50
Percent					
Males	70.4%	23.4%	4.7%	1.5%	100.0%
Females	69.4%	20.2%	8.2%	2.2%	100.0%
s.e.(Pct.)					
Males	0.7%	0.6%	0.3%	0.2%	
Females	0.7%	0.6%	0.4%	0.2%	

Figure 1. Relative Survival at Ages 65+, United States 2004, Absence and Presence of Diabetes and Disability, Males

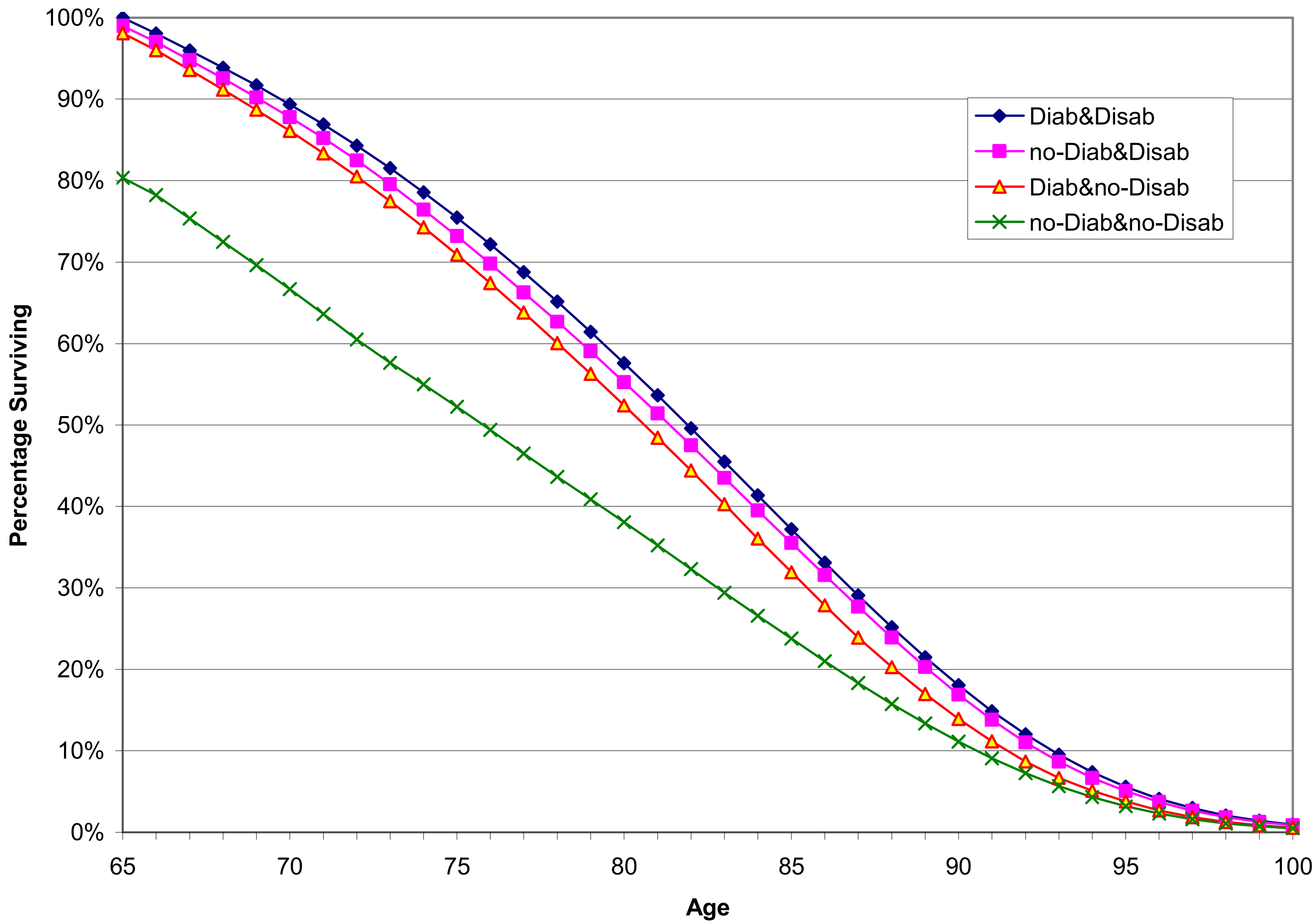

Figure 2. Relative Survival at Ages 65+, United States 2004, Absence and Presence of Diabetes and Disability, Females