Hospital-Diagnosed Dementia and Suicide: A Longitudinal Study Using Prospective, Nationwide Register Data

Annette Erlangsen, Ph.D., **Steven H. Zarit, Ph.D.**, and **Yeates Conwell, M.D.**
National Centre for Register-based Research (AE), University of Aarhus, Denmark; Center for the Study and Prevention of Suicide (AE, YC), Psychiatry, University of Rochester Medical Center, NY; and Department of Human Development and Family Studies (SHZ), The Pennsylvania State University, PA.

Abstract

Objective—The current study aims to examine the risk of suicide in persons diagnosed with dementia during a hospitalization and its relationship to mood disorders.

Design—Event-history analysis using time-varying covariates.

Setting—Population-based record linkage.

Participants—All individuals aged 50+ living in Denmark (N = 2,474,767) during January 1, 1990 through December 31, 2000.

Measurements—Outcome of interest is suicide. Relative risks are calculated based on person-days spent in each stratum.

Results—A total of 18,648,875 person-years were observed during the 11-year study period. During this period, 136 persons who previously had been diagnosed with dementia died by suicide. Men and women aged 50–69 years with hospital presentations of dementia have a relative suicide risk of 8.5 (95% confidence interval: 6.3–11.3) and 10.8 (95% confidence interval: 7.4–15.7), respectively. Those who are aged 70 or older with dementia have a threefold higher risk than persons with no dementia. The time shortly after diagnosis is associated with an elevated suicide risk. The risk among persons with dementia remains significant when controlling for mood disorders. As many as 26% of the men and 14% of the women who died by suicide died within the first 3 months after being diagnosed whereas 38% of the men and 41% of the women died more than 3 years after initial dementia diagnosis.

Conclusions—Dementia, determined during hospitalization, was associated with an elevated risk of suicide for older adults. Preventive measures should focus on suicidal ideation after initial diagnosis but also acknowledge that suicides can occur well after a dementia diagnosis has been established.

Keywords

Suicide; dementia; Alzheimer disease; old age; elderly persons; Denmark

Dementia is related to a substantial health care burden.[1] Worldwide, the prevalence rate of dementia is estimated to be 0.6%–1.9% among persons aged 65–69 years and 10%–33%

among those aged 85 years and older.[2] Given the increasing proportion of older adults,[3] dementia is bound to become a growing health care expenditure in future decades.[4]

Older adults also have high suicide frequencies and in many countries the highest suicide rates are found among the oldest old.[5] Thus far, the relationship between dementia and suicide has been assessed through case reports and clinical studies. Although case reports suggest that dementia might be associated with an increased risk of suicide,[6–10] clinical studies document lower risks among patients with dementia than other inpatients.[8,11–14] Although attempted suicides are reported to be rare among inpatients with dementia,[15,16] a recent Chinese study found that more than 10% of demented inpatients had been admitted after a suicide attempt.[17] The prevalence rate of suicidal ideation is estimated to range between 0.9% and 42%.[12,18]

Specific types of dementia, such as Huntington and Alzheimer diseases, are mentioned by case reports as potential predictors for suicidal behavior.[7,9,18–20] Furthermore, early stages of dementia,[6,10,20] intact awareness of disease and its course,[6,8–10,21] and accessibility to means[6,8] might increase the risk of suicide.

Comorbid mental disorders, particularly mood disorders, are frequently listed as contributing to suicide in dementia patients.[6,9,10,19,22] Having dementia is found to increase the probability of developing depression,[23,24] Although depressive symptoms are found to predict cognitive decline,[25] there are diverging results on whether depression increases the probability of developing dementia.[24,26,27] Nevertheless, suicidal behavior in demented persons might entirely be explained by the presence of depressive disorders.[6,18] It yet remains to be confirmed whether depressive disorders act as a mediator for suicide in persons with dementia. As in the general population, chronic and other somatic diseases are expected to be associated with an elevated risk of suicide among demented persons.[5,28]

Based on the existing knowledge, it is not possible to determine whether dementia is a protective or risk predictor with regard to suicide. A lower risk of suicide among persons with dementia is hypothesized to be due to: a) limited cognitive skills[8,11,29] and b) restricted saccess to means of suicide and possibility of planning a suicidal act through increased surveillance.[12,29]

Specific features of the dementia disorder might increase the risk of suicide. Neurochemical changes may occur in the brain as a result of the dementing process, such as alterations in central serotonergic function, that are associated with impulsive aggression and suicidal behavior.[30–32] Behavioral and psychological symptoms of dementia, including depression, might complicate the course of the disorder additionally. Insight into the disease and its course might increase hopelessness,[21] diminishing cognitive capacities might impair a demented person's skills of problem solving, and social changes, such as forced retirement, giving up driving and, particularly, becoming dependent on help from others ("becoming a burden"), may further increase risk.[33,34]

A growing number of older adults implies higher absolute numbers of persons affected by dementia and suicide. To improve preventive measures, the relationship needs to be clarified. The current study aims to examine the association between persons diagnosed with dementia and risk for suicide. Furthermore, the potential role of mood disorders as a mediator will be analyzed.

Large populations are needed for generating sufficient statistical power to study relatively rare events, such as dementia and suicide.[10,12] Danish data registers cover each single individual in the entire nation and provides an outstanding resource for analyzing the association in a longitudinal setting.

METHODS

Individual-level data on all persons aged 50 years and over living in Denmark during January 1, 1990 through December 31, 2000 were included in the analysis. Comprehensive data are captured prospectively by administrative registers and can be linked for each individual using the unique personal identification number. Following registers were linked by Statistics Denmark: The Centralized Civil Registry, The Registry of Causes of Death, The National Registry of Patients (covering somatic hospitalizations), and The Danish Psychiatric Central Registry (covering psychiatric hospitalizations). The project was approved by the Danish Data Protection Agency and the University of Rochester's Research Subjects Review Board. Given the nature of the data, an informed consent from subjects was not required.

Classification Codes

Dementia, suicide, as well as stratifying variables on mood disorders and chronic comorbidity were all recorded according to the International Classification of Diseases and Related Health Problems (ICD). Until 1994, the 8th revision of ICD was applied; thereafter the 10th was implemented.[35,36] The 9th revision of the ICD was never applied in Demark.

Persons who received a main or subdiagnosis of dementia during a fulltime admission to psychiatric or somatic hospital (ICD-8: 290, 293.0, 293.1, 293.4, 293.9, 294.9, 309.6; ICD-10: F00–F04, F06–F09, G30) were considered as having dementia. Historic data on somatic (since 1985) and psychiatric hospitalizations (since 1972) were included to obtain as complete records of past disorders as possible. Furthermore, we distinguished between the following subtypes of dementia: Alzheimer disease (ICD-8: 290.1–290.9; ICD-10: F00), vascular dementia (ICD-8: 290.0; ICD-10: F01), and other and unspecified types of dementia (ICD-8: 293.0, 293.1, 293.4, 293.9, 294.9, 309.6; ICD-10: F02–F04, F06–F09). Psychiatric hospitalizations for mood disorders were coded in ICD-8 as 296.0–296.3, 296.8, 296.9, 298.0, 301.1 and in ICD-10 as F30–F34, F38, F39.

A total of 21,394 subjects received a diagnosis of dementia during a hospitalization. Of these, 65% were diagnosed during psychiatric admission, 30% during somatic admission, 5% were diagnosed both at psychiatric and somatic hospitalizations.

Suicide was defined as the following causes of death: ICD-8: 950–959; ICD-10: X60–X84, Y87, or where the manner of death was listed as being suicide.

A revised version of the Charlson's comorbidity index was implemented to control for coexisting chronic disorders. This index assigns a weighted value to persons presenting specific comorbid disorders depending on their lethality.[37] Using available references on ICD-9 and ICD-10 codes,[38,39] the measure was transformed to ICD-8 codes. ICD-9 is an extended version of ICD-8 and some categories were less explicit in the earlier version. Certain categories of chronic disorders were therefore not specified in the 8th revision, e.g., it was not possible to distinguish between "liver disease" and "severe liver disease." As dementia is the explanatory variable, it was omitted from the index.

Dynamic Cohort Study

The entire Danish population aged 50 or older was observed during an 11-year period using a dynamic cohort design. Persons aging 50 years during the observation period and immigrants fulfilling the age inclusion criteria entered the observation group on the date of the event. Similarly, subjects migrating or dying by other causes of death were right-hand censored on the date of the event. Individuals who received a diagnosis of dementia during a psychiatric or somatic hospitalization were considered as having dementia from that date

onward. The impact of predictors associated with dementia was analyzed in six full models: time since first diagnosis of dementia, main versus subdiagnosis of dementia, subtypes of dementia, current psychiatric hospitalization, presence of other psychiatric disorders, and presence of mood disorders. All of these models were stratified for calendar year, age (50–69, 70+ years), marital status (never married, married, divorced, and widowed), living status (living with someone, living alone), and chronic disorders (Charlson's comorbidity index). With the exception of living status, which was updated on a yearly basis, all covariates were updated on the exact registered date of change.

Person-years and suicide rates were calculated using the number of person-days spent in each stratum.

Event-history analysis was applied to calculate the relative suicide risks using time-varying covariates.[40,41] Proportional hazard models of the following type were fitted:

$$\ln \mu_i(t) = \gamma(t) + \sum_{jk} \alpha_{jk} \, x_{ij}(t) y_{ik}(t)$$

where $\mu_i(t)$ denotes the hazard or probability that individual i will commit suicide at time t while (t) is the baseline and $_{jk}$ a coefficient that is estimated for specific combinations of level j of variable x and level k of variable y for individual i.

Data management was carried out using the SAS software package and relative risks were calculated using the aML software.[42,43] The hazard models were developed stepwise and the estimates from the previous model were used as starting values in the next round. All covariates were evaluated in univariate models before being included in the multivariate analysis. The covariates were added stepwise to the full model whereas all the intermediate steps of the calculations were controlled and assessed for multiplicative effects. Models were estimated over two rounds with all effects freed up in the last round. The 95% confidence intervals (CIs) were calculated and asymptotic two-sided p values were derived from t tests where $df > 2,000,000$. As a compromise to an overly conservative Bonferroni adjustment, an level of 0.01 was used to determine significance.

RESULTS

A total of 2,467,539 persons (1,165,054 men and 1,302,485 women) accounting for 18,648,875 person-years (8,545,231 men and 10,103,643 women) were included in the study (Table 1). During the 11-year observation period, 5,699 persons (3,557 men and 2,142 women) died by suicide. Of those, 136 (80 men and 56 women) had previously been diagnosed with dementia during a hospitalization.

The persons aged 70 and over account for the largest proportion of hospital-diagnosed dementia in terms of person-years. For both men and women, the highest suicide rates are found among those aged 50–69 years diagnosed with dementia.

The suicide risks in Table 2 are calculated relative to the reference groups with the set value of 1.0; for instance, men aged 70 years and older with no presentation of dementia have a 1.5-fold higher suicide risk than those aged 50–69 years ($^2 = 18.5$, df = 2, p <0.0001). Persons aged 50–69 with a hospital diagnosis of dementia have an 8- to 10-fold higher risk of suicide than those with no diagnosis ($^2 = 18.5$, df = 2, p <0.0001). Persons aged 70 and older with a dementia diagnosis have a threefold higher suicide risk than to individuals in the same age range with no dementia ($^2 = 18.5$, df = 2, p <0.0001). Even though marriage is found to act as a protective factor against suicide in persons with no dementia, it does not

have the same impact among demented persons ($^2 = 32$, df = 8, p <0.0001). Also, older men with dementia who are living with someone have a significantly higher risk of suicide than those living alone ($^2 = 18.39$, df = 8, p = 0.0185). The presence of chronic comorbidity does not seem to affect the suicide risk among persons with dementia.

The first 6 months after having been hospital diagnosed with dementia are associated with elevated suicide risks compared with those who have been diagnosed for a longer time, both for men ($^2 = 37.13$, df = 11, p <0.0001) and women ($^2 >33.17$, df = 11, p = 0.0005). Irrespective whether male subjects had received a main or subdiagnosis of dementia, these had higher risk of suicide than those with no diagnosis ($^2 = 37.13$, df = 11, p <0.0001) and ($^2 = 37.13$, df = 11, p <0.0001), respectively. Similar results and significance levels were obtained for female subjects. Albeit the 95% CIs indicate that vascular dementia was associated with a significantly lower risk of suicide than Alzheimer disease for women ($^2 = 30.42$, df = 12, p = 0.0024).

Older men with dementia who are currently admitted to psychiatric hospital have a threefold higher suicide risk than those not hospitalized ($^2 = 39$, df = 12, p <0.0001). Among women the risk increases from 3.8 to 11.3 ($^2 = 25.81$, df = 12, p = 0.0114). Nevertheless, the suicide risk among current patients with dementia is lower than same age patients with other disorders.

Older men who at some point, not necessarily at the same time, have been diagnosed for both dementia and other psychiatric disorders during hospitalizations show higher levels of suicide risk than found for those solely diagnosed with dementia ($^2 = 39$, df = 12, p <0.0001). The same is the case for older women ($^2_{[12]} = 39$, p <0.0001). Among persons who have been diagnosed both with dementia and mood disorders, men ($^2 = 39$, df = 12, p <0.0001) and women ($^2 = 39$, df = 12, p <0.0001) show higher risks than those diagnosed with dementia only. Still, the risk of suicide in persons diagnosed with dementia but not mood disorders is higher than the reference group of persons with none of those disorders for both men ($^2 = 39$, df = 12, p <0.0001) and women ($^2 = 39$, df = 12, p <0.0001).

One in four of the male suicides took place within 3 months of the initial hospital diagnosis as seen in Table 3. For women with dementia, one in seven of the suicides occurred during the first 3 months. Approximately 20% of male and 13% of female suicides took place more than 10 years after initial diagnosis.

CONCLUSIONS

This is to our knowledge the first study examining the association between dementia and suicide using nationwide data. The main finding is that persons with a hospital diagnosis of dementia have an elevated risk of suicide compared with the general population. The risk was found to be more pronounced among women aged 50–69 years than among those aged 70 and over. The first months after having received a diagnosis of dementia seem to be particularly stressful for the patient. It is, however, important to acknowledge that suicides also occur well after initial diagnosis. We find that the risk of suicide associated with dementia remains significant after controlling for mood disorders.

It is important to note that the current study covers all persons who have been diagnosed with dementia during a fulltime hospitalization up to 18 years before study start. The findings cannot be generalized to persons with dementia who have not received the diagnosis while hospitalized. The outstanding qualities of the data, however, do provide us with insights on the association between dementia and suicide beyond previous findings.

Congruent with earlier clinical studies, currently admitted patients with dementia display a lower suicide risk than patients with other disorders. Nevertheless, the time during hospitalization as well as after discharge is associated with significant higher suicide risks than for the general population of older adults.

Dementia, as diagnosed during hospitalizations, seems to be more stressful for a younger than older individual. For women, a significant difference in risk was found between persons with dementia aged 50–69 (relative risk: 10.8; 95% CI: 7.4–15.7) and those aged 70 and over (relative risk: 3.4; 95% CI: 2.4–5.0). Previous reports of suicides among demented persons are largely limited to case reports in which the age span varies from 57 to 87 years.[6,8–10] One reason why the younger persons react stronger to a hospital diagnosis of dementia than the older age group could be that the disorder sets in at an "off-time," i.e., an age where dementia is relatively uncommon and unexpected.[44]

The relationship between mood disorders and suicide is well established for older adults.[13,45] It is, therefore, not surprising that individuals diagnosed during hospitalizations with both dementia and mood disorders have higher suicide risk than those only diagnosed with dementia. However, the suicide risk associated with dementia seems not to be entirely mediated by mood disorders as some studies have suggested. The risk of suicide in demented persons remained significant after controlling for current or previous diagnoses of mood disorders. Of all the consulted case reports, only one describes a suicide in a demented person that apparently was not affected by mood disorders.[8]

Additional analysis (table not shown) failed to obtain conclusive findings on the temporal relationship between dementia and mood disorders. This is possibly due to small case numbers.

The first 6 months after initial hospital diagnosis of dementia are correlated with an elevated suicide risk compared with later on. Interestingly, as many as 12 of the 80 male suicides (15%) took place within the first month after being diagnosed, whereas just one female suicide occurred. Four of the previously mentioned case reports provided information to calculate the time between diagnosing dementia and subsequent suicide. In one of those, the suicide occurred within "several weeks" of being diagnosed with dementia[6] whereas the three others took place 2–3 years after dementia was determined.[8,10]

Being diagnosed with dementia is a highly significant stressor for suicide. Preventive measures should address the anxieties and potential suicidal ideation that might arise in the time immediately after receiving a diagnosis. In the context of older adults who might present other chronic diseases and severe disabilities, it is important to offer sufficient consultation time and practical aid with care arrangement for future needs to ensure that the patient is able to come to terms with the challenges that the disorder presents.

Approximately one of six suicides occurred 10 years or later after initial hospital diagnosis. Given the cognitive decline manifesting itself during the course of dementia,[1] it is surprising that persons so many years after initial diagnosis are capable of planning and carrying out a suicidal act. Furthermore, many of these used violent methods, for instance, four of the seven female suicides were carried out by hanging. One explanation could be that some of these persons might mistakenly have been diagnosed with dementia. Although it only brings limited validation, among those 24 persons dying by suicide 10 years or later after first diagnosis 19 experienced subsequent hospitalizations and 53% of those were again diagnosed with dementia, i.e., the diagnosis was given at least twice. In terms of prevention, it is important to note that suicides can occur many years after the diagnosis of dementia has been established.

All examined subtypes of hospital-diagnosed dementia were associated with significantly higher risks of suicide than for persons without a dementia diagnosis. For women, vascular dementia was related to a lower risk than Alzheimer disease and other and unspecified types of dementia. This stands in contrast to a recent report on suicides among community dwellers.[46] Previous case reports, which specify type of disorder, only list suicides among persons with Alzheimer disease.[8,10] Given recent developments in the diagnostic criteria for dementia,[1] it cannot be excluded that some of the subjects diagnosed with vascular dementia might have had other types of dementia.

The prospects of becoming increasingly dependent on the care of a significant others and the fear of being a burden might explain the higher suicidality among older individuals diagnosed with dementia. This may partially also explain why married and older men who are living with someone have a higher suicide risk than singles. The Danish welfare system provides free health care and, depending on own financial situation, covers up to 100% of all expenses related to living in nursing homes and in-home care for individuals who do not have others to care for them. Nevertheless, the emotional support to older individuals with dementia might still be lacking.

Limitations should be acknowledged. As mentioned above, the analyses are based on a subsample of all dementia cases, i.e., subjects diagnosed with dementia during a hospitalization. Furthermore, no information was available on which examinations and tests had been performed to establish the dementia diagnosis. It is possible that some patients had delirium and were misdiagnosed with dementia. In others the dementia disorder might not have been identified while hospitalized and, thus, not diagnosed. Information on mood and other disorders was also restricted to hospital presentations. The validity of the dementia and mood disorder diagnosis is therefore limited. Future research is needed to address the suicide risk among persons with dementia not diagnosed during hospitalizations. Given the large number of hypothesis, we acknowledge a higher probability of Type I errors. A lower level was selected to improve the validity of the findings.

The validity of the suicide registration among elderly, and particularly among those with competing disorders, might be less precise than among younger age groups. Yet, the registration of suicides in Denmark has been evaluated to be reliable across the age span.[47]

Although the population-based and nationwide coverage as well as the longitudinal and prospective data collection are clear advantages of the registers, the nature of the data prevents us from examining other relevant predictors. For instance, clinical information on symptoms and stage of the disorder are lacking. Future research is needed to address the influence of cognitive skills, stage of disorder, insight to disease, provided support and care as well as level of educational attainment on the risk of suicide among elderly who suffer from dementia.

The association between dementia and suicidality was examined beyond the clinical setting of previous studies. Having been diagnosed with dementia during a hospitalization is related to an elevated suicide risk, which persists after controlling for presentations of mood disorders. The risk is more pronounced among women aged 50–69 years than among those aged 70 and over. Although there is a particular high risk of suicide in the time shortly after first hospital presentation for dementia, it is important to note that persons also a number of years after initial diagnosis remain at risk for carrying out suicidal acts.

Acknowledgments

References

1. Zarit, SH.; Zarit, J. Mental Disorders in Older Adults: Fundamentals of Assessment and Treatment. New York: Guildford Press; 2006. Dementia, delirium and other cognitive problems; p. 40-77.

2. Ferri CP, Prince M, Brayne C, et al. Global prevalence of dementia: a Delphi consensus study. Lancet. 2005; 366:2112–2117. [PubMed: 16360788]

3. Population Reference Bureau. [Accessed October 26, 2006] Trends in ageing, by world region. 2006. Available at: http://www.prb.org/Content/NavigationMenu/PRB/PRB_Library/Graphics_Bank/Aging/Aging.htm

4. Sørensen J, Gudex C, Andersen C. Demenssygdommes fremtidige økonomiske belastning af social- og sundhedsvæsnet [The future economic burden of dementia on the Danish health and social services]. Ugeskr Laeger. 2006; 168:3432–3436. [PubMed: 17032611]

5. Harwood, D.; Jacoby, R. Suicide behaviour among the elderly. In: Hawton, K.; van Heeringen, K., editors. The International Handbook of Suicide and Attempted Suicide. West Sussex, United Kingdom: John Wiley & Sons Ltd; 2000. p. 275-291.

6. Margo GM, Finkel JA. Early dementia as a risk factor for suicide. Hosp Community Psychiatry. 1990; 41:676–678. [PubMed: 2361677]

7. Cina SJ, Smith MT, Collins KA, et al. Dyadic deaths involving Huntington's disease. Am J Forensic Med Pathol. 1996; 17:49–52. [PubMed: 8838470]

8. Ferris SH, Hofeldt GT, Carbone G, et al. Suicide in two patients with a diagnosis of probable Alzheimer disease. Alzheimer Dis Assoc Disord. 1999; 13:88–90. [PubMed: 10372951]

9. Vega U, Kishikawa Y, Ricanati E, et al. Suicide and Alzheimer disease. Am J Geriatr Psychiatry. 2002; 10:484–485. [PubMed: 12095909]

10. Lim WS, Rubin EH, Coats M, et al. Early-stage Alzheimer disease represents increased suicidal risk in relation to later stages. Alzheimer Dis Assoc Disord. 2005; 19:214–219. [PubMed: 16327348]

11. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry. 1997; 170:205–228. [PubMed: 9229027]

12. Schneider B, Maurer K, Fröhlich L. Demenz und Suizid. Fortschr Neurol Psychiatr. 2001; 69:164–169. [PubMed: 11386121]

13. Erlangsen A, Mortensen PB, Vach W, et al. Psychiatric hospitalization and suicide among the very old in Denmark: population-based register study. Br J Psychiatry. 2005; 187:43–48. [PubMed: 15994570]

14. Erlangsen A, Zarit SH, Tu X, et al. Suicide among older psychiatric inpatients: an evidence-based study if a high-risk group. Am J Geriatr Psychiatry. 2006; 14:734–741. [PubMed: 16943170]

15. Lyness JM, Conwell Y, Nelson JC. Suicide attempts in elderly psychiatric inpatients. J Am Geriatr Soc. 1992; 40:320–324. [PubMed: 1556358]

16. Chiu HFK, Lam LCW, Pang AHT, et al. Attempted suicide by Chinese elderly in Hong Kong. Gen Hosp Psychiatry. 1996; 18:444–447. [PubMed: 8937913]

17. Tsai CF, Tsai SJ, Yang CH, et al. Chinese demented inpatients admitted following a suicide attempt: a case series. Int J Geriatr Psychiatry. 2007; 22:1106–1109. [PubMed: 17436346]

18. Draper B, MacCuspie-Moore C, Brodaty H. Suicidal ideation and the 'wish to die' in dementia patients: the role of depression. Age Ageing. 1998; 27:503–507. [PubMed: 9884008]

19. Rubio A, Vestner AL, Stewart JM, et al. Suicide and Alzheimer's pathology in the elderly: a case-control study. Biol Psychiatry. 2001; 49:137–145. [PubMed: 11164760]

20. Barak Y, Aizenberg D. Suicide amongst Alzheimer's disease patients: a 10-year survey. Dement Geriatr Cogn Disord. 2002; 14:101–103. [PubMed: 12145457]

21. Turnbull Q, Wolf AM, Holroyd S. Attitudes of elderly subjects towards "truth telling" for the diagnosis of Alzheimer's disease. J Geriatr Psychiatry Neurol. 2003; 16:90–93. [PubMed: 12801158]

22. Snowdon J, Baume P. A study of suicide of older people in Sydney. Int J Geriatr Psychiatry. 2002; 17:261–269. [PubMed: 11921155]

23. Nilsson FM, Kessing LV, Sørensen TM, et al. Enduring increased risk of developing depression and mania in patients with dementia. J Neurol Neurosurg Psychiatry. 2002; 73:40–44. [PubMed: 12082043]

24. Vinkers DJ, Gussekloo J, Stek ML, et al. Temporal relation between depression and cognitive impairment in old age: prospective population based study. BMJ. 2004; 329:881–883. [PubMed: 15345599]

25. Chodosh J, Kado DM, Seeman TE, et al. Depressive symptoms as a predictor of cognitive decline: MacArthur studies of successful aging. Am J Geriatr Psychiatry. 2007; 15:406–415. [PubMed: 17353297]

26. Hendrie HC. Epidemiology of dementia and Alzheimer's disease. Am J Geriatr Psychiatry. 1998; 6:S3–S18. [PubMed: 9581216]

27. Kessing LV, Nielsson FM. Increased risk of developing dementia in patients with major affective disorders compared to patients with other medical illnesses. J Affect Disord. 2003; 73:261–269. [PubMed: 12547295]

28. Erlangsen A, Vach W, Jeune B. The effect of hospitalization with medical illnesses on suicide risk in the oldest old: a population-based register study. J Am Geriatr Soc. 2005; 53:771–776. [PubMed: 15877551]

29. Conwell Y. Dementia. Crisis. 1995; 16:5. [PubMed: 7614833]

30. Lorke DE, Lu G, Cho E, et al. Serotonin 5-HT2A and 5-HT6 receptors in the prefrontal cortex of Alzheimer and normal aging patients. BMC Neurosci. 2006; 7:36. [PubMed: 16640790]

31. Mann JJ. Role of the serotonergic system in the pathogenesis of major depression and suicidal behavior. Neuropsychopharmacology. 2005; 21:99–105.

32. Mann JJ, Waternaux C, Haas GL, et al. Toward a clinical model of suicidal behavior in psychiatric patients. Am J Psychiatry. 1999; 156:181–186. [PubMed: 9989552]

33. Hooyman, NR.; Kiyak, HA. A Multidisciplinary Perspective. Boston: Allyn and Bacon; 1995. Personality and social adaptation in old age, in Social Gerontology; p. 210-222.

34. Anstey KJ, von SC, Sargent-Cox K, et al. Prevalence and risk factors for depression in a longitudinal, population-based study including individuals in the community and residential care. Am J Geriatr Psychiatry. 2007; 15:497–505. [PubMed: 17545450]

35. International Statistical Classification of Diseases and Related Health Problems. Geneva: World Health Organisation; 1965. 8th Rev

36. International Statistical Classification of Diseases and Related Health Problems. Geneva: World Health Organisation; 1992. 10th Rev

37. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987; 40:373–383. [PubMed: 3558716]

38. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992; 45:613–619. [PubMed: 1607900]

39. Sundararajan V, Henderson T, Perry C, et al. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. J Clin Epidemiol. 2004; 57:1288–1294. [PubMed: 15617955]

40. Elandt-Johnson, R.; Johnson, N. Survival Models and Data Analysis. New York: John Wiley & Sons; 1999.

41. Allison, PD. Regression for Longitudinal Event Data. Newbury Park: Sage Publications; 1984. Event History Analysis.

42. SAS System for SunOP. Cary, NC: SAS Institute Inc; 2003.

43. Lillard, LA.; Panis, CWA. Multiprocess Multilevel Modeling aML. Ver 2. Los Angeles, CA: EconWare; 2003.

44. Neugarten BL. Dynamics of transition of middle age to old age. J Geriatr Psychiatry. 1970; 4:71–87. [PubMed: 5527462]

45. Conwell Y, Duberstein PR, Cox C, et al. Relationships of age and axis I diagnoses in victims of completed suicide: a psychological autopsy study. Am J Psychiatry. 1996; 153:1001–1008. [PubMed: 8678167]

46. Peisah C, Snowdon J, Gorrie C, et al. Investigation of Alzheimer's disease-related pathology in community dwelling older subjects who committed suicide. J Affect Disord. 2007; 99:127–132. [PubMed: 17011041]

47. Kolmos L, Bach E. Sources of error in registering suicide. Acta Psychiatr Scand Suppl. 1987; 76:22–43. [PubMed: 3481190]

TABLE 1

Person-Years, Number of Suicides and Suicide Rate per 100,000 With Respect to Hospital-Diagnosed Dementia Among Adults Aged 50 Years and Over in Denmark (N = 2,474,767) During 1990–2000

	Person-Years			Suicide			Suicide Rate per 100,000	
	Total	Dementia	% of All	Total	Dementia	% of All	Total	Dementia
Men								
50–69	6,074,150	15,846	(0.3)	2,158	47	(2.2)	35.5	296.6
70+	2,471,081	19,042	(0.8)	1,399	33	(2.4)	56.6	173.3
Total	8,545,231	34,888	(0.4)	3,557	80	(2.2)	41.6	229.3
Women								
50–69	6,281,435	12,854	(0.2)	1,232	28	(2.3)	19.6	217.8
70+	3,822,209	39,659	(1.0)	910	28	(3.1)	23.8	70.6
Total	10,103,643	52,513	(0.5)	2,142	56	(2.6)	21.2	106.6

TABLE 2

Relative Risk of Suicide in Association With Hospital-Diagnosed Dementia Among Adults Aged 50 Years and Over in Denmark (N = 2,474,767) During 1990–2000

	Men				Women			
	Relative Risk[a]	95% CI	N	(%)	Relative Risk[a]	95% CI	N	(%)
Age								
No dementia								
50–69	1.0		2111	59.3	1.0		1227	57.3
70+	1.5[b]	[1.4–1.6]	1366	38.4	1.1[b]	[1.0–1.2]	859	40.1
Dementia								
50–69	8.5[b]	[6.3–11.3]	47	1.3	10.8[b]	[7.4–15.7]	28	1.3
70+	4.7[b]	[3.4–6.7]	33	0.9	3.4[b]	[2.4–5.0]	28	1.3
Marital status[c]								
No dementia								
Never married	2.0[b]	[1.8–2.3]	423	11.9	1.5[b]	[1.3–1.8]	144	6.7
Married	1.0		1787	50.2	1.0		803	37.5
Divorced	2.3[b]	[2.1–2.5]	590	16.6	2.2[b]	[1.9–2.5]	371	17.3
Widowed	2.4[b]	[2.2–2.6]	677	19.0	1.7[b]	[1.5–1.9]	768	35.9
Dementia								
Never married	8.2[b]	[4.4–15.2]	10	0.3	3.7[d]	[1.2–11.5]	3	0.1
Married	7.2[b]	[5.3–9.8]	43	1.2	10.8[b]	[7.1–16.4]	23	1.1
Divorced	7.4[b]	[4.4–12.2]	15	0.4	9.2[b]	[5.1–16.7]	11	0.5
Widowed	4.8[b]	[2.7–8.5]	12	0.3	4.6[b]	[2.9–7.2]	19	0.9
Living status[e]								
No dementia								
Living with someone	1.0		1809	50.9	1.0		770	35.9
Living alone	1.8[b]	[1.6–1.8]	1668	46.9	2.0[b]	[1.7–2.3]	1316	61.4
Dementia								
Living with someone	8.8[b]	[6.1–12.6]	38	1.1	7.2[b]	[3.6–14.4]	18	0.8

	Men				Women			
	Relative Risk[a]	95% CI	N	(%)	Relative Risk[a]	95% CI	N	(%)
Living alone	3.6[b]	[2.3–5.5]	42	1.2	6.5[b]	[4.4–9.6]	38	1.8
Presence of chronic comorbidity[f]								
No dementia								
No chronic comorbidity	1.0		2477	69.6	1.0		1580	73.8
Chronic comorbidity	1.9[b]	[1.7–2.0]	1000	28.1	1.8[b]	[1.6–2.0]	506	23.6
Dementia								
No chronic comorbidity	4.9[b]	[3.7–6.3]	55	1.5	4.5[b]	[3.3–6.2]	38	1.8
Chronic comorbidity	4.2[b]	[2.9–6.3]	25	0.7	5.4[b]	[3.4–8.6]	18	0.8
Time since first diagnosis of dementia[g]								
No dementia	1.0		3477	97.8	1.0		2086	97.4
Dementia diagnosed								
Within last 6 months	13.5[b]	[9.1–20.2]	24	0.7	13.7[b]	[8.5–22.1]	13	0.6
Within last 6 months to 5 years	2.8[b]	[2.0–3.9]	33	0.9	3.2[b]	[2.1–4.9]	26	1.2
More than 5 years ago	3.0[b]	[2.0–4.5]	23	0.6	4.9[b]	[2.9–8.1]	17	0.8
Main versus subdiagnosis[g]								
No dementia	1.0		3477	97.8	1.0		2086	97.4
Dementia								
Main diagnosis	3.7[b]	[2.7–5.0]	40	1.1	5.3[b]	[3.7–7.5]	40	1.1
Subdiagnosis	3.3[b]	[2.4–4.6]	40	1.1	2.8[b]	[1.8–4.1]	40	1.1
Subtypes of dementia[g]								
No dementia	1.0		3477	97.8	1.0		2086	97.4
Dementia								
Alzheimer disease	4.4[b]	[2.9–6.5]	24	0.7	8.9[b]	[5.5–14.3]	19	0.9
Vascular dementia	2.1[d]	[1.3–3.5]	16	0.4	2.4[b]	[1.5–3.8]	18	0.8
Other or unspecified types of dementia	5.4[b]	[4.0–7.4]	40	1.1	5.0[b]	[3.2–7.7]	19	0.9
Current psychiatric hospitalization[g]								
No dementia								

	Men				Women			
	Relative Risk[a]	95% CI	N	(%)	Relative Risk[a]	95% CI	N	(%)
Not admitted	1.0		3375	94.9	1.0		1964	91.7
Admitted	43.5[b]	[35.8–52.7]	102	2.9	65.3[b]	[54.4–78.5]	122	5.7
Dementia								
Not admitted	3.2[b]	[2.6–4.1]	68	1.9	3.8[b]	[2.9–5.0]	50	2.3
Admitted	11.8[b]	[6.7–20.9]	12	0.3	11.3[b]	[5.1–25.2]	6	0.3
Presence of other psychiatric disorders[g]								
No dementia								
No other disorders	1.0		2876	80.9	1.0		1426	66.6
Other disorders	12.6[b]	[11.5–13.7]	601	16.9	19.4[b]	[17.6–21.4]	660	30.8
Dementia								
No other disorders	2.0[d]	[1.2–3.2]	16	0.4	1.7	[0.9–3.2]	9	0.4
Other disorders	8.1[b]	[6.3–10.3]	64	1.8	12.0[b]	[9.0–16.1]	47	2.2
Presence of mood disorders[g]								
No dementia								
No mood disorders	1.0		3134	88.1	1.0		1660	77.5
Mood disorders	14.4[b]	[12.9–16.1]	343	9.6	18.8[b]	[16.9–20.9]	426	19.9
Dementia								
No mood disorders	2.8[b]	[2.0–3.8]	39	1.1	3.3[b]	[2.2–4.8]	27	1.3
Mood disorders	10.8[b]	[8.0–14.7]	41	1.2	12.2[b]	[8.5–17.7]	29	1.4
Total			3557	100.0			2142	100.0

Notes: Reference groups are given in bold.

[a] Asymptotic two-sided p values were calculated using t tests with *df* >2,000,000.

[b] Significance level of 0.001.

[c] Model controlled for calendar year and current age.

[d] Significance level of 0.01.

[e] Model controlled for calendar year, current age, and current marital status.

f Model controlled for calendar year, current age, current marital status, and living status.

g Model controlled for calendar year, current age, current marital status, living status and history of chronic disorders.

TABLE 3

Distribution of Suicides With Respect to Time Interval Between First Hospital Diagnosis of Dementia and Suicide Among Adults Aged 50 Years and Over Who Died by Suicide in Denmark (N = 2,474,767) During 1990–2000

Time Between First Diagnosis of Dementia and Suicide	Men		Women	
	No. Suicides	%	No. Suicides	%
1 month	12	15	1	2
1–3 months	9	11	7	13
4–12 months	11	14	13	23
1–3 years	18	23	12	21
3–10 years	14	18	16	29
10 years	16	20	7	13
Total	80	100	56	100