ORIGINAL ARTICLE

The Lifetime Risk of Suicide in Schizophrenia

A Reexamination

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Background: The psychiatry literature routinely quotes a lifetime schizophrenia suicide prevalence of 10% based on 1 meta-analysis and 2 studies of chronic schizophrenics.

Objectives: To build a methodology for extrapolating lifetime suicide prevalence estimates from published cohorts and to apply this approach to studies that meet inclusion criteria.

Data Sources: We began with a MEDLINE search (1966-present) for articles that observed cohorts of schizophrenic patients. Exhaustive bibliography searching of each identified article brought the total number of articles reviewed to 632.

Study Selection: Studies included in the meta-analysis observed a cohort of schizophrenic patients for at least 2 years, with at least 90% follow-up, and reported suicides. Articles are excluded for systematic age bias (ie, adolescents).

Data Extraction: Extracted data included sample size, number of deaths, number of suicides, percentage of follow-up, and diagnostic system used. Data were extracted independently by 2 of us, and differences were resolved by consensus after re-review.

Data Synthesis: Studies were divided into 2 groups: 32 studies of schizophrenics enrolled at various illness points (25 578 subjects) and 29 studies of schizophrenics identified at either illness onset or first admission (22 598 subjects). Regression models of the intersection of proportionate mortality (the percentage of the dead who died by suicide) and case fatality (the percentage of the total sample who died by suicide) were used to calculate suicide risk in each group. The estimate of lifetime suicide prevalence in those observed from first admission or illness onset was 5.6% (95% confidence interval, 3.7%-8.5%). Mixed samples showed a rate of 1.8% (95% confidence interval, 1.4%-2.3%). Case fatality rates showed no significant differences when studies of patients diagnosed with the use of newer systems were compared with studies of patients diagnosed under older criteria.

Conclusion: This study estimates that 4.9% of schizophrenics will commit suicide during their lifetimes, usually near illness onset.

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In 1977, Miles[1] reviewed 34 studies that observed people with schizophrenia and estimated a 10% lifetime risk of suicide. Cited more than 270 times, this study has informed the writers of most major psychiatry and suicidology texts.[2-6] In addition, a widely cited 1990 review by Caldwell and Gottesman[7] references 2 long-term schizophrenia follow-up studies by Bleuler[8] and Tsuang,[9] wherein 12.8%[8] and 10.1%[9] of the deceased had died by suicide, to argue that the rate is 10% to 13%.

In his chapter on suicide in *The New Harvard Guide to Psychiatry*, Tsuang[10] cites his 10% figure[9] but notes that these suicides compose only 4% of his total sample of 195 Iowans with schizophrenia because less than 40% of the sample had died. The difference in these numbers exemplifies the difference between proportionate mortality (PM) (the percentage of the dead who died by suicide, 10% in this example) and case fatality (CF) (the percentage of the original sample who died by suicide, 4% in this example). Proportionate mortality provides information only about the dead. In most of the cohort studies we reviewed, a large proportion of the subjects are still alive, having survived the initial period of high suicide risk and having not yet entered the period of increased risk of death from other causes. Thus, the direct use of PM rates, as in the review by Caldwell and Gottesman,[7] assumes a constant rate of suicide over a lifetime and will therefore overestimate suicide risk.

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Miles[1] attempted to correct for this fact by fitting a curve to the declining percentages of deaths by suicide over time but was limited, in part, by the technology of the time.[11] However, even more sophisticated statistical modeling cannot account for the fact that beginning with PM calculations requires that both the decreasing rate of suicide over the schizophrenic illness[12] and the increasing rate of other causes of death (ie, heart disease and cancer) must be corrected for. That is, both the numerator and the denominator (suicides and deaths) change over the duration of follow-up.

Case fatality rates look at the number of suicides as a fraction of the total sample. While these will increase over a lifetime of follow-up, extrapolation requires correction of only the numerator, based on timing of suicides within the illness course. Particularly in schizophrenia, where suicides are known to concentrate early in the course of the illness,[12-14] CF is a preferable starting point. Such an approach has precedent in the literature.[15]

In addition to a consideration of statistical approaches, cohort composition will also affect an estimate of lifetime suicide risk. In his analysis of excess mortality in schizophrenia, Brown[16] notes that cohorts of first-episode schizophrenics have 2.7 times the excess mortality of samples of chronic schizophrenics and that suicide is the largest contributor to this excess. First-episode cohort studies thus provide the most accurate suicide risk assessment, as other cohorts will have already survived the period of greatest mortality.

What is needed, then, is a meta-analysis that distinguishes cohorts observed from illness onset or first admission from cohorts taken from chronic samples or samples of all-comers. It must also begin with CF calculations. We believe the combination of these 2 approaches yields the most accurate estimation of suicide risk in schizophrenia to date.

METHODS

Our analysis begins with strict inclusion criteria based on rigorous standards that parallel those of Harris and Barraclough.[17] Studies included for meta-analysis have a mean follow-up time of at least 2 years because of the known increase in suicide risk following hospitalization.[18,19] Consistent with other analyses, we require less than 10% loss to follow-up.[15,17] This minimizes the chance that unaccounted-for subjects also represent unaccounted-for suicides[20] and increases the confidence with which conclusions can be drawn from the data.[21]

Included studies document the number of suicides during the observation period and provide an overall cohort size; by this standard, studies documenting no suicides can be included.[22,23] Studies with a systematic age bias are excluded, so studies limited to adolescents are not considered. Studies of persons diagnosed as having schizoaffective illness are excluded, although it is possible that persons in the included cohorts had an undocumented comorbid affective illness. Finally, a distinction is made between studies that observed chronic or mixed chronic and new-onset patients (all-comers) and those that specifically observed patients from first hospital admission, documented illness onset, or first psychiatric contact.

The articles we cite cover nearly 90 years and include diagnostic criteria expressed by Bleuler,[24] Feighner et al,[25] and multiple iterations of the *International Classification of Diseases* and *DSM* systems. Studies used the accepted criteria of their time.

Studies were obtained through review of the bibliographies of the relevant review articles[7,16,17,26] and textbooks[2-6,10] as well as a computer search of the MEDLINE (1966-present) and PsychInfo (1984-present) databases. We exhaustively searched the bibliography of each article obtained, searching for additional references to cohorts of schizophrenics observed for any reason and repeated this process with each subsequent set of studies until all bibliographic references of interest were obtained. In this manner, we reviewed well over 600 articles. Several of the articles included would seem to have nothing to do with suicide but still fulfilled inclusion criteria.[27] Data from each article selected for inclusion were extracted independently by 2 of us (B.A.P. and J.M.B.).

Thirty-two studies of schizophrenics composed of all-comers and 29 studies observing schizophrenics from first admission or illness onset met inclusion criteria. Of note, no studies consisting exclusively of outpatient schizophrenics met inclusion criteria.

Data extracted from each study include only the number of patients, number of deaths, number of suicides, and length of follow-up. Survival status and length of follow-up for each subject would be preferable but are unavailable. Only deaths classified as suicides by the study in which they are reported are categorized as such.

For each of these 61 studies, 2 probability estimates were calculated. The first probability estimate is the CF prevalence, the probability that a subject will die by suicide during the course of the study (number of suicides divided by number of subjects). The second is the PM prevalence, the probability that a subject will die by suicide given that the subject will die during the course of the study (number of suicides divided by number of deaths in the study).

Each of these 2 probabilities, the PM prevalence and CF prevalence, along with 95% confidence intervals (CIs), were calculated using the generalized estimating equations[28] capabilities found in PROC GENMOD, a part of the SAS statistical package.[29]

The suicide mortality prevalence was determined by assuming that CF rates increase over time to an upper limit and that PM rates decrease to a lower limit that is the same as the CF upper limit. This common limit is an estimate of the theoretical point at which CF will equal PM—when all subjects have died—and is an estimate of the lifetime risk of suicide.

The regression model for the relationship between PM and length of follow-up was $\log_e[\mathrm{PM}/(1-\mathrm{PM})] = a - e \times \exp(-f \times \text{years of follow-up})$. This describes an exponential decay to the limit a, on a logit scale, with e and f positive constants describing the baseline value and the rate of decay, respectively. The regression model for CF as a function of follow-up length was similar: $\log_e[\mathrm{CF}/(1-\mathrm{CF})] = a + b \times \exp(-d \times \text{years of follow-up})$. This describes a limited exponential growth to the limit a, on a logit scale, with b and d positive constants describing the baseline value and the rate of growth, respectively. The parameter a was fit to the 2 models simultaneously and represents the limit to which the PM and CF measures converge as follow-up time approached infinity.

These nonlinear regression models were fit to 2 clusters of data. The first was extracted from articles considering only subjects who were identified early in the course of their illness. The second was extracted from articles describing collections of patients identified at any point in their illness. A modified regression model was required for the CF curve approximating the data collected from the second set of studies. The CF data from these articles would not support a 3-parameter

Table. Sixty-one Studies Meeting Inclusion Criteria

Source	Country	Sample Size	Follow-up, %	Average Follow-up Period, y	Deaths During Follow-up Period	Suicides During Follow-up Period	Proportionate Mortality, %*	Case Fatality, %†
Allebeck and Allgulander[30]	Sweden	304	100	8	Not given	25	NA	8
Biehl et al[31]	Germany	70	100	5	3	3	100	4
Bland and Orn[32]	Canada	45	96	14	2	1	50	2
Bland et al[33]	Canada	92	96	12	12	2	17	2
Brown et al[34]	United Kingdom	111	93	5	3	1	33	1
Harrison et al[35]	United Kingdom	99	96	12	4	2	50	2
Helgason[36]	Iceland	107	98	22	23	10	43	9
Johanson[37]	Sweden	138	100	14	23	3	13	2
Lim and Tsoi[38]	Singapore	482	100	15	71	41	58	9
Lindelius and Kay[14]	Sweden	187	90	18	16	11	69	6
Mason et al[39]	United Kingdom	67	94	12	5	3	60	4
Mortensen and Juel[40]	Denmark	9156	100	9	1100	508	46	6
Niskanen et al[41]	Finland	200	100	5	Not given	4	NA	2
Niskanen et al[41]	Finland	100	100	15	Not given	3	NA	3
Nyman and Jonsson[42]	Sweden	110	100	15	18	10	56	9
Osby et al[43]	Sweden	7784	99	14	1849	380	21	5
Peuskens et al[44]	Belgium	447	100	6	Not given	23	NA	5
Rennie[45]	United States	500	91	13	100	11	11	2
Rosanoff[46]	United States	169	100	6	23	1	4	1
Rupp and Fletcher[47]	United States	641	95	7	89	10	11	2
Salokangas[48]	Finland	175	99	2	14	8	57	5
Salokangas and Stengard[49]	Finland	227	100	2	8	5	63	2
Sartorius et al[50]	Various	756	90	5	42	14	33	2
Scottish Schizophrenia Research Group[22]	United Kingdom	47	96	5	1	0	0	0
Soskis et al[51]	United States	39	100	5	2	2	100	5
Thara and Eaton[52]	India	90	94	10	9	4	44	4
Tsoi and Wong[53]	Singapore	330	91	5	20	15	75	5
Wiersma et al[54]	Netherlands	82	93	15	9	8	89	10
Wilkinson[55]	United Kingdom	43	91	13	7	3	43	7
Total			**22 598**			**3453**	**1111**	

(*continued*)

model. In this alternate model, the *b* parameter was constrained to be equal to the *a* parameter: $\log_e[CF/(1-CF)] = a \times [1+\exp(-d \times \text{years of follow-up})]$. This had the effect of maintaining the same general form of the regression model, a limited growth from a baseline value to an upper limit, by constraining the approximate baseline CF estimate to be smaller than the final upper limit.

The 2 nonlinear regression curves were fit to the PM and CF estimates extracted from the various articles using weighted least squares, as implemented in SAS's PROC NLIN.[29] The weights used in the estimation procedure were equal to the number of subjects for the CF measurements and the number of deaths for the proportionate measurements.

RESULTS

The **Table** summarizes the studies selected for inclusion and documents the CF, PM, follow-up time, and sample size of each study.

For first-admission and new-onset samples, the generalized estimating equation yielded a CF estimate of 4.9% (95% CI, 4.3%-5.6%) and a PM of 30.6% (95% CI, 19.0%-49.1%). Among mixed samples of chronic and new-onset subjects, the CF rate was 2.3% (95% CI, 1.5%-3.5%), and the PM was 5.6% (95% CI, 1.4%-20.4%).

Nonlinear regression curves included data points weighted by sample size as shown in **Figure 1** for illness onset/first-admission cases and **Figure 2** for studies of mixed samples. Because point sizes are proportional to the log of the sample sizes, small samples are given disproportionate visual weight, although this artifact does not affect regression equation calculations. For the CF portion of the model, the weights were equal to the number of cases, and for the PM component, the weights were equal to the number of deaths (the denominators to each of the individual estimates). For the samples of all-comers, the originally proposed regression model for the CF data was overparameterized, as there was little evidence from the data for increasing CF rates as a function of time. As described in the "Methods" section, a slightly modified version of the model was employed in this case. The estimates of suicide mortality prevalence from the regression models (a transformation of parameter *a*) were 5.6% (95% CI, 3.7%-8.5%) for first-admission and new-onset samples and 1.8% (95% CI, 1.4%-2.3%) for samples of all-comers.

To analyze the impact of disparate diagnostic systems, we compared the CF rates of samples diagnosed exclusively with recent criteria (*DSM-III*[83] or later, *International Classification of Diseases, Ninth Revision*[84] or

Table. Sixty-one Studies Meeting Inclusion Criteria (cont)

Source	Country	Sample Size	Follow-up, %	Average Follow-up Period, y	Deaths During Follow-up Period	Suicides During Follow-up Period	Proportionate Mortality, %*	Case Fatality, %†
Allebeck and Wistedt[56]	Sweden	1190	99	10	231	33	14	3
Allgulander et al[57]	Sweden	4048	100	7	Not given	168	NA	4
Axelsson and Lagerkvist-Briggs[58]	Sweden	81	100	7	Not given	2	NA	2
Baxter and Appleby[59]	United Kingdom	1410	>90	14	Not given	44	NA	3
Black et al[60]	United States	688	92	4	26	14	54	2
Breier et al[61]	United States	74	91	7	4	3	75	4
Brown et al[34]	United Kingdom	339	92	5	10	3	30	1
Carone et al[62]	United States	79	100	5	8	8	100	10
Christensen[63]	Denmark	319	99	7	89	6	7	2
Cooper et al[23]	United Kingdom	33	94	11	1	0	0	0
Fenton et al[64]	United States	187	93	19	Not given	10	NA	5
Friis et al[65]	Norway	37	97	7	3	3	100	8
Harrow et al[66]	United States	79	100	3	6	6	100	8
Hoffmann[67]	Switzerland	58	100	2	1	1	100	2
Huber et al[68]	Germany	758	96	18	142	7	5	1
Kaplan and Harrow[69]	United States	71	100	8	Not given	1	NA	1
Knesevich et al[70]	United States	65	92	6	5	2	40	3
Moller et al[71]	Germany	61	95	7	2	2	100	3
Mortensen and Juel[72]	Denmark	6162	100	29	4569	56	1	1
Newman and Bland[73]	Canada	3623	100	5	301	97	32	3
Niskanen and Pihkanen[27]	Finland	204	100	4	12	4	33	2
Ogawa et al[74]	Japan	140	93	25	25	14	56	10
Pokorny[75]	United States	834	100	5	65	19	29	2
Prudo and Blum[76]	United Kingdom	100	95	5	6	5	83	5
Roder[77]	Denmark	246	100	11	Not given	11	NA	4
Rohde and Sargant[78]	United Kingdom	95	96	5	4	2	50	2
Sernyak et al[79]	United States	1415	100	4	95	10	11	1
Sernyak et al[79]	United States	2380	100	4	250	23	9	1
Shaffer et al[80]	United States	361	100	12	Not given	12	NA	3
Shepherd et al[81]	United Kingdom	121	99	5	9	3	33	2
Tsuang[9]	United States	200	98	37	79	8	10	4
Wieselgren and Lindstrom[82]	Sweden	120	93	5	10	7	70	6
Total			**25 578**			**5953**	**584**	

Abbreviation: NA, not applicable.
*Number of suicides divided by number of deaths in the study.
†Number of suicides divided by number of subjects in the study.

later, or *Research Diagnostic Criteria*[85]) with those diagnosed with older diagnostic systems. Of the 12 first-admission studies that used the new criteria (n=10375), the mean±SD CF rate was 4.9%±3.2%; this is not significantly different from the remainder of the first-admission studies (n=12223) with a mean±SD CF rate of 4.8%±2.4%. Among samples of all-comers, 15 studies used new criteria (n=10382) and showed a mean±SD CF rate of 2.3%±3.1%, identical to the mean±SD CF rate of 2.3%±1.8% seen in the remainder of the studies (n=15196).

COMMENT

This study is a meta-analysis of suicide risk in subjects with schizophrenia that draws on pooled data from diverse sources. Two points emerge robustly. First, it is possible to obtain an approximation of lifetime suicide risk by estimating PM and CF curves as a function of average follow-up time and evaluating the level to which the 2 curves converge. Second, first-admission and new-onset studies more accurately estimate suicide risk because they include the initial years of the illness when death by suicide is most likely.

Proportionate mortality estimates of lifetime prevalence are accurate only when (1) all subjects are observed until death or (2) suicides occur at the same rate over time, relative to the total number of deaths. The first condition is difficult to meet; no studies in our review observed all subjects until death. The second defies what we know about suicide in schizophrenia and causes of death in general. Young patients, early in the course of schizophrenia, are more likely to commit suicide than older patients; moreover, older patients are much more likely to die of other medical conditions. Thus, estimating suicide risk relative to total deaths returns an artificially high estimate for all subjects, particularly young persons. Such errors are particularly true for studies with a relatively short length of follow-up. Seven such studies showed a PM prevalence of suicide of 100%.[31,51,62,65-67,71]

Case fatality estimates do not suffer from this bias, since they allow individuals who have not yet died to provide information concerning the probability of suicide during follow-up. To be sure, CF prevalence risks missing future suicides and might thus provide a low estimate of lifetime prevalence. However, PM prevalence misses both future suicides and future deaths, and because suicides tend to occur earlier on in the course of follow-up, PM prevalence suffers from a more severe bias.

The difference in suicide risk between the group of studies restricted to first-admission and new-onset cohorts and the group composed of all-comers is striking. Indeed, the rate among cohorts observed from a beginning illness point (5.6%) is more than 3 times that of cohorts observed from any illness point (1.8%). Not only does this fact necessitate that future cohort studies begin as close to illness onset as possible to ensure accuracy and completeness, it also highlights the significant effect of suicides concentrated early in the course of the illness. The finding is more dramatic when considering the fact that among first-admission and new-onset samples, 30.6% of the deaths were due to suicide, while only 4.9% of deaths were suicides in samples of all-comers. This fact confirms the findings of several studies[32,53-55,86-88] and implies that suicide-prevention interventions are best directed at persons early in the course of their schizophrenic illness.

A number of potential sources of bias and several limitations must be noted. The principal limitation is that the estimates of lifetime risk of suicide presented here are based on composite data from collections of studies. The lack of specific follow-up times for individual subjects in the various studies makes it impossible to answer the research question using the preferred analytical approach, Kaplan-Meier, or other explicit survival analysis techniques. Our method of combining the only data that are available, CF and PM rates, across the various studies attempts to resolve this limitation, which unfortunately cannot be fully resolved in such a meta-analysis. Therefore, the estimates reported here are best viewed as approximations to the risk of suicide in subjects with schizophrenia. A second limitation to the modeling used to obtain the estimates of suicide risk is that, while the data conformed reasonably well to the mathematical models, the estimate of lifetime suicide risk in individuals identified soon after their diagnosis is based on an extrapolation beyond the observed data. The impact of these 2 analytical limitations is impossible to evaluate without a large long-term study, or studies, of subjects newly diagnosed as having schizophrenia.

Additional limitations are evident in this analysis. Only 2 of 61 studies[22,23] reported the number of suicides as zero. Several other published cohorts of people with schizophrenia made no mention of suicides occurring during follow-up. Without an explicit statement about suicide number, we elected not to include them in the meta-analysis. This decision may have artificially increased the suicide prevalence we calculated. Moreover, this analysis applies only to cases that came to clinical attention in certain treatment systems. It is not clear how many persons with schizophrenia spectrum psychoses fail to come to clinical attention (or deny symptoms or refuse research participation),

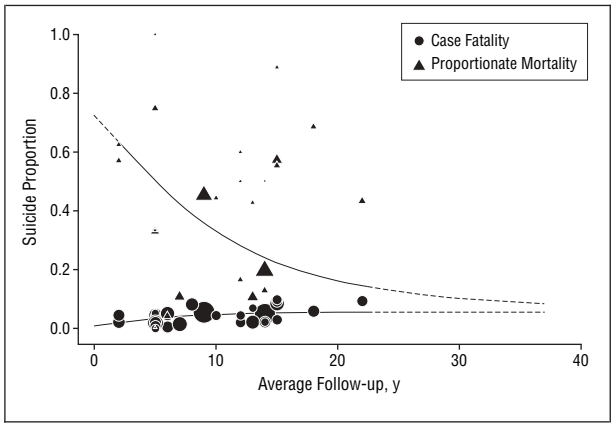

Figure 1. First admission and new-onset cases. Point size is proportional to the logarithm of the denominator.

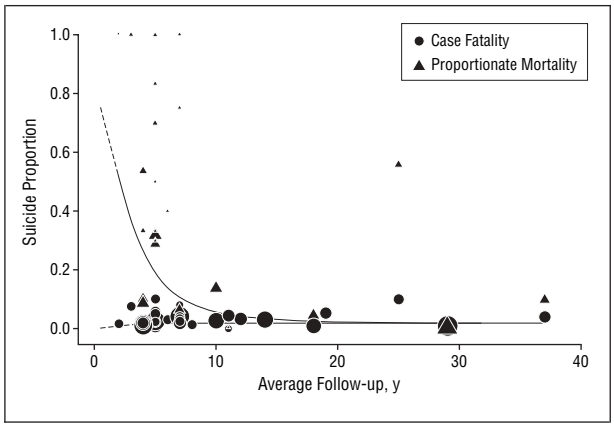

Figure 2. Mixed samples: new and chronic cases. Point size is proportional to the logarithm of the denominator.

but it is clear that the rate of suicide among these persons cannot be known. We also do not address in this meta-analysis such diagnoses as schizoaffective disorder and the ongoing debate in the descriptive psychiatry literature about whether this condition is an affective variant of schizophrenia or an entity in its own right. Future research must attend to not only the question of whether schizoaffectives are different from schizophrenics but also whether the group of schizophrenics itself is composed of subgroups with varying degrees of risk.

The analysis includes only suicides classified explicitly as such, excluding accidental deaths and other deaths of uncertain cause. Excluding these ambiguous cases likely only slightly diminishes suicide counts. Coroners over the last century have been shown to apply consistent standards of classification[89] and to underestimate suicide by exclusion of accidental/ambiguous deaths at a consistent rate of 15% to 20%.[90]

While the grouping together of first-admission and new-onset studies implies uniformity in identifying subjects at illness onset, this is probably not the case. When the schizophrenic process actually begins has been a subject of intense academic scrutiny for at least a century; first admission to psychiatric care is certainly an artifact of convenience. In the era of de-institutionalization, many persons may be managed exclusively as outpatients, and

at least 1 study suggests that these persons commit suicide at a higher rate than their admitted counterparts.[36] First hospital admission is the closest approximation presently extractable from the literature as a surrogate for illness onset.

Diagnostic criteria vary in the different samples, although included samples typically meet the diagnostic criteria used at the time of the study. All were published in peer-reviewed journals as studies of schizophrenics. Studies of schizoaffective patients or patients with other mood psychoses were not included. At least 1 study has shown no relative change in suicide rates with changing diagnostic criteria,[15] although this remains an obvious source of potential bias. To evaluate this, we compared CF rates among studies utilizing newer diagnostic criteria (*DSM-III* or later, *International Classification of Diseases, Ninth Revision* or later, or *Research Diagnostic Criteria*) with those using older or inconsistent criteria and found that the rates were nearly identical in each group.

The most accurate estimate of suicide risk would be obtained by maintaining follow-up on all individuals under study, rather than the aggregate data available in the articles. One approach to account for the nonconstant risk of suicide during follow-up is to apply regression models to describe the relationships between PM and CF prevalences as a function of the length of follow-up. With information about individual cases, it would be possible to clarify the association between age at schizophrenia onset and age at suicide. Do schizophrenics diagnosed at younger ages, for example, have a higher risk of suicide? Given that schizophrenia is typically diagnosed in the third decade of life, our data with its preponderance of suicides soon after diagnosis would suggest that suicide in this population is skewed toward a younger age.

In summary, this analysis reveals 3 central ideas. First, CF rates more accurately approximate suicide prevalence than PM rates, and an even more accurate prevalence estimate may be approximated with statistical reconciliation of these 2 statistics. Second, suicide in schizophrenia will occur in approximately 5.6% of subjects over their lifetimes. Third, first-onset and first-admission studies give the most accurate picture of the natural history of the disease, including the fact that suicides are concentrated early in the illness course. Intervention and prevention efforts are therefore best directed toward the early stages of the illness.

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REFERENCES

1. Miles CP. Conditions predisposing to suicide: a review. *J Nerv Ment Dis*. 1977; 164:231-246.
2. Siris SG. Depression and schizophrenia. In: Hirsch SR, Weinberger DR, eds. *Schizophrenia*. Cambridge, England: Cambridge University Press; 1995:137.
3. Pinals DA, Breier A. Schizophrenia. In: Tasman A, Kay J, Lieberman JA, eds. *Psychiatry*. Philadelphia, Pa: WB Saunders; 1997:936.
4. De Hert M, Peuskens J. Psychiatric aspects of suicidal behavior: schizophrenia. In: Hawton K, van Heeringen K, eds. *The International Handbook of Suicide and Attempted Suicide*. Chichester, England: John Wiley & Sons; 2000:121-134.
5. Black DW, Winokur G. Suicide and psychiatric diagnosis. In: Blumenthal SJ, Kupfer DJ, eds. *Suicide Over the Life Cycle: Risk Factors, Assessment, and Treatment of Suicidal Patients*. Washington, DC: American Psychiatric Press; 1990:144.
6. Siris G. Depression in the course of schizophrenia. In: Hwang MY, Bermanzohn PC, eds. *Schizophrenia and Comorbid Conditions*. Washington, DC: American Psychiatric Association Press; 2001:32.
7. Caldwell CB, Gottesman II. Schizophrenics kill themselves too: a review of risk factors for suicide. *Schizophr Bull*. 1990;16:571-588.
8. Bleuler M. *The Schizophrenic Disorders: Long Term Patient and Family Studies*. Clemens SM, trans. New Haven, Conn: Yale University Press; 1978.
9. Tsuang MT. Suicide in schizophrenics, manics, depressives, and surgical controls: a comparison with general population suicide mortality. *Arch Gen Psychiatry*. 1978;35:153-155.
10. Tsuang MT, Farone SV, Green A. Schizophrenia and other psychotic disorders. In: Nicholl AM, ed. *The New Harvard Guide to Psychiatry*. Cambridge, Mass: Belknap Press; 1999:258.
11. Inskip HM, Harris C, Barraclough B. Lifetime risk of suicide for affective disorder, alcoholism and schizophrenia. *Br J Psychiatry*. 1998;172:35-37.
12. Black DW, Winokur G. Age, mortality, and chronic schizophrenia. *Schizophr Res*. 1988;1:267-272.
13. Virkkunen M. Suicides in schizophrenia and paranoid psychoses. *Acta Psychiatr Scand*. 1974(suppl 250):1-305.
14. Lindelius R, Kay DWK. Some changes in the pattern of mortality in schizophrenia, in Sweden. *Acta Psychiatr Scand*. 1973;49:315-323.
15. Bostwick JM, Pankratz VS. Affective disorders and suicide risk: a reexamination. *Am J Psychiatry*. 2000;157:1925-1932.
16. Brown S. Excess mortality of schizophrenia: a meta-analysis. *Br J Psychiatry*. 1997;171:502-508.
17. Harris EC, Barraclough B. Suicide as an outcome for mental disorders: a meta-analysis. *Br J Psychiatry*. 1997;170:205-228.
18. Yarden P. Observations on suicide in chronic schizophrenics. *Compr Psychiatry*. 1974;15:325-333.
19. Pokorny AD. Prediction of suicide in psychiatric patients. *Arch Gen Psychiatry*. 1983;40:249-257.
20. Sims AC. Importance of a high tracing rate in long-term medical follow-up studies. *Lancet*. 1973;2:433-435.
21. Everitt BS. Analysis of longitudinal data. *Br J Psychiatry*. 1998;172:7-10.
22. Scottish Schizophrenia Research Group. The Scottish first episode schizophrenia study, VIII: five-year follow-up: clinical and psychosocial findings. *Br J Psychiatry*. 1992;161:496-500.
23. Cooper SJ, Kelly CB, King DJ. 5-Hydroxyindolacetic acid in cerebrospinal fluid and prediction of suicidal behavior in schizophrenia. *Lancet*. 1992;340:940-941.
24. Bleuler E. *Dementia Praecox or the Group of Schizophrenias*. Zinkin H, trans. New York, NY: International Universities Press; 1950.
25. Feighner JP, Robbins E, Guze SB, Woodruff RA Jr, Winokur G, Munoz R. Diagnostic criteria for use in psychiatric research. *Arch Gen Psychiatry*. 1972;26: 57-63.
26. Heilae H. Suicide in schizophrenia: a review. *Psychiatr Fenn*. 1999;30:14-57.
27. Niskanen P, Pihkanen TA. A comprehensive study of home treatment and hospital care in the treatment of schizophrenic and paranoid psychotic patients. *Acta Psychiatr Scand*. 1971;47:271-277.
28. Diggle PJ, Liang KY, Zeger SL. *Analysis of Longitudinal Data*. Oxford, England: Oxford University Press; 1994.
29. *SAS/STAT User's Guide, Version 6.12*. Cary, NC: SAS Institute, 1990.
30. Allebeck P, Allgulander C. Suicide among young men: psychiatric illness, deviant behavior and substance abuse. *Acta Psychiatr Scand*. 1990;81:565-570.
31. Biehl H, Maurer K, Schubart C, Krumm B, Jung E. Prediction of outcome and utilization of medical services in a prospective study of first-onset schizophren-

ics: a prospective 5-year follow up study. *Eur Arch Psychiatry Clin Neurosci*. 1986; 236:139-147.
32. Bland RC, Orn H. 14-year outcome in early schizophrenia. *Acta Psychiatr Scand*. 1978;58:327-338.
33. Bland RC, Parker JH, Orn H. Prognosis in schizophrenia: a ten-year follow-up of first admissions. *Arch Gen Psychiatry*. 1976;33:949-954.
34. Brown GW, Bone M, Balison B, Wing J. *Schizophrenia and Social Care*. London, England: Oxford University Press; 1966.
35. Harrison G, Croudace T, Mason P, Glazebrook C, Medley I. Predicting the long-term outcome of schizophrenia. *Psychol Med*. 1996;26:697-705.
36. Helgason L. Twenty years' follow-up of first psychiatric presentation: what could have been prevented? *Acta Psychiatr Scand*. 1990;81:231-235.
37. Johanson E. A study of schizophrenia in the male: a psychiatric and social study based on 138 cases with follow-up. *Acta Psychiatr Scand*. 1958;33(suppl) :125.
38. Lim LC, Tsoi WF. Suicide and schizophrenia in Singapore: a fifteen-year follow-up study. *Ann Acad Med Singapore*. 1991;20:201-203.
39. Mason P, Harrison G, Glasebrook C, Medley I, Dalkin T, Croudace T. Characteristics of outcome in schizophrenia at 13 years. *Br J Psychiatry*. 1995;167:596-603.
40. Mortensen PB, Juel K. Mortality and causes of death in first admitted schizophrenic patients. *Br J Psychiatry*. 1993;163:183-189.
41. Niskanen P, Lonnqvist J, Achte KA. Schizophrenia and suicides. *Psychiatr Fenn*. 1973;4:223-227.
42. Nyman AK, Jonsson H. Patterns of self-destructive behaviour in schizophrenia. *Acta Psychiatr Scand*. 1986;73:252-262.
43. Osby U, Correia N, Brandt L, Ekbom A, Sparen P. Mortality and causes of death in schizophrenia in Stockholm County, Sweden. *Schizophr Res*. 2000;45:21-28.
44. Peuskens J, De-Hert M, Cosyns P, Pieters G, Theys P, Vermote R. Suicide in young schizophrenic patients during and after inpatient treatment. *Int J Ment Health*. 1997;25:39-44.
45. Rennie T. Follow-up study of five hundred patients with schizophrenia admitted to the hospital from 1913 to 1923. *Arch Neuro Psychiatry*. 1939;41:877-891.
46. Rosanoff AJ. A statistical study of the prognosis in insanity. *JAMA*. 1914;62:3-6.
47. Rupp C, Fletcher EK. A 5- to 10-year follow-up study of 641 schizophrenic cases. *Am J Psychiatry*. 1940;96:877-888.
48. Salokangas RK. Prognostic implications of the sex of schizophrenic patients. *Br J Psychiatry*. 1983;142:145-151.
49. Salokangas RK, Stengard E. Gender and short-term outcome in schizophrenia. *Schizophr Res*. 1990;3:333-345.
50. Sartorius N, Jablensky A, Ernberg G, Leff J, Korten A, Gulbinat WH. Course of schizophrenia in different countries: some results of a WHO international comparative 5-year follow-up study. In: Hafner H, Gattaz, WF, Janzarik W, eds. *Search for the Causes of Schizophrenia*. New York, NY: Springer; 1987:107-113.
51. Soskis DA, Harrow M, Detre TP. Long-term follow-up of schizophrenics admitted to a general hospital psychiatric ward. *Psychiatr Q*. 1969;43:525-534.
52. Thara R, Eaton WW. Outcome of schizophrenia: the Madras longitudinal study. *Aust N Z J Psychiatry*. 1996;30:516-522.
53. Tsoi WF, Wong KE. A 15-year follow-up study of Chinese schizophrenic patients. *Acta Psychiatr Scand*. 1991;84:217-220.
54. Wiersma D, Nienhuis FJ, Slooff CJ, Giel R. Natural course of schizophrenic disorders: a 15-year followup of a Dutch incidence cohort. *Schizophr Bull*. 1998; 24:75-85.
55. Wilkinson DG. The suicide rate in schizophrenia. *Br J Psychiatry*. 1982;140:138-141.
56. Allebeck P, Wistedt B. Mortality in schizophrenia: a ten-year follow-up based on the Stockholm County in-patient register. *Arch Gen Psychiatry*. 1986;43:650-653.
57. Allgulander C, Allebeck P, Przybeck TR, Rice JP. Risk of suicide by psychiatric diagnosis in Stockholm County: a longitudinal study of 80,970 psychiatric inpatients. *Eur Arch Psychiatry Clin Neurosci*. 1992;241:323-326.
58. Axelsson R, Lagerkvist-Briggs M. Factors predicting suicide in psychotic patients. *Eur Arch Psychiatry Clin Neurosci*. 1992;241:259-266.
59. Baxter D, Appleby L. Case register study of suicide risk in mental disorders. *Br J Psychiatry*. 1999;175:322-326.
60. Black DW, Winokur G, Warrack G. Suicide in schizophrenia: the Iowa Record Linkage Study. *J Clin Psychiatry*. 1985;46:14-17.
61. Breier A, Schreiber JL, Dyer J, Pickar D. National Institute of Mental Health longitudinal study of chronic schizophrenia: prognosis and predictors of outcome. *Arch Gen Psychiatry*. 1991;48:239-246.
62. Carone BJ, Harrow M, Westermeyer JF. Posthospital course and outcome in schizophrenia. *Arch Gen Psychiatry*. 1991;48:247-253.
63. Christensen JK. A 5-year follow-up study of male schizophrenics: evaluation of factors in influencing success and failure in the community. *Acta Psychiatr Scand*. 1974;50:60-72.
64. Fenton WS, McGlashan TH, Victor BJ, Blyler CR. Symptoms, subtype, and suicidality in patients with schizophrenia spectrum disorders. *Am J Psychiatry*. 1997; 154:199-204.
65. Friis S, Hauff E, Island TK, Lorentzen S, Melle I, Vaglum P. The Ulleval acute ward follow-up study: a personal 7-year follow-up of patients with functional psychosis admitted to the acute ward of a catchment area. *Psychopathology*. 1991; 24:316-327.
66. Harrow M, Grinker RR, Silverstein ML, Holzman P. Is modern-day schizophrenic outcome still negative? *Am J Psychiatry*. 1978;135:1156-1162.
67. Hoffmann H. Age and other factors relevant to rehospitalization of schizophrenic outpatients. *Acta Psychiatr Scand*. 1994;89:205-210.
68. Huber G, Gross G, Schuttler R, Linz M. Longitudinal studies of schizophrenic patients. *Schizophr Bull*. 1980;6:592-605.
69. Kaplan KJ, Harrow M. Psychosis and functioning as risk factors for later suicidal activity among schizophrenia and schizoaffective patients: a disease-based interactive model. *Suicide Life Threat Behav*. 1999;29:10-23.
70. Knesevich JW, Zaleman SJ, Clayton PJ. Six-year follow-up with patients with carefully diagnosed good- and poor-prognosis schizophrenia. *Am J Psychiatry*. 1983; 140:1507-1510.
71. Moller HJ, Schmid-Bode W, Cording-Tommel C, Wittchen HU, Daudig M, von Zerssen D. Psychopathological and social outcome in schizophrenia versus affective/schizoaffective psychoses and prediction of poor outcome in schizophrenia: results from a 5-8 year follow-up. *Acta Psychiatr Scand*. 1988;77:379-389.
72. Mortensen PB, Juel K. Mortality and causes of death in schizophrenic patients in Denmark. *Acta Psychiatr Scand*. 1990;81:372-377.
73. Newman SC, Bland RC. Mortality in a cohort of patients with schizophrenia: a record-linkage study. *Can J Psychiatry*. 1991;36:239-245.
74. Ogawa K, Miya M, Watarai A, Nakazawa M, Yuasa S, Utena H. A long-term follow-up study of schizophrenia in Japan: with special reference to the course of social adjustment. *Br J Psychiatry*. 1987;151:758-765.
75. Pokorny AD. Prediction of suicide in psychiatric patients: report of a prospective study. *Arch Gen Psychiatry*. 1983;40:249-257.
76. Prudo R, Blum HM. Five year outcome and prognosis in schizophrenia: a report from the London Field Research Centre of the International Pilot Study of Schizophrenia. *Br J Psychiatry*. 1987;150:345-354.
77. Roder E. A prognostic investigation of female schizophrenic patients discharged from Sct. Hans Hospital, Department D, during the decade 1951-1960. *Acta Psychiatr Scand*. 1970;46:50-63.
78. Rohde P, Sargant W. Treatment of schizophrenia in general hospitals. *BMJ*. 1961; 5244:67-70.
79. Sernyak MJ, Desai R, Stolar M, Rosenheck R. Impact of clozapine on completed suicide. *Am J Psychiatry*. 2001;158:931-937.
80. Shaffer JW, Perlin S, Schmidt CW. The prediction of suicide in schizophrenics. *J Nerv Ment Dis*. 1974;159:349-355.
81. Shepherd M, Watt D, Falloon IRH, Smeeton N. The natural history of schizophrenia: a 5-year follow-up study of outcome and prediction in a representative sample of schizophrenics. *Psychol Med Monogr Suppl*. 1989;15:1-46.
82. Wieselgren IM, Lindstrom LH. A prospective 1-5 year outcome study in first-admitted and readmitted schizophrenic patients: relationship to heredity, premorbid adjustment, duration of disease and education level at index admission and neuroleptic treatment. *Acta Psychiatr Scand*. 1996;93:9-19.
83. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Third Edition*. Washington, DC: American Psychiatric Association; 1980.
84. World Health Organization. *International Classification of Diseases, Ninth Revision (ICD-9)*. Geneva, Switzerland: World Health Organization; 1977.
85. Spitzer RL, Endicott J, Robins E. *Research Diagnostic Criteria (RDC)*. 3rd ed. New York, NY: New York State Psychiatric Institute; 1977.
86. Hu WH, Chen-Ming S, Lee CT, Peng SL, Lin SK, Shen WW. A clinical study of schizophrenic suicides: 42 cases in Taiwan. *Schizophr Res*. 1991;5:43-50.
87. Pokorny AD. Suicide rates in various psychiatric disorders. *J Nerv Ment Dis*. 1964; 139:499-506.
88. Tsoi WF, Chia BH. Suicide and mental illness in Singapore. *Singapore Med J*. 1974;15:191-196.
89. Sainsbury P, Jenkins JS. The accuracy of officially reported statistics for purposes of epidemiological research. *J Epidemiol Community Health*. 1982;36: 43-48.
90. Speechley M, Stavraky KM. The adequacy of suicide statistics for use in epidemiology and public health. *Can J Public Health*. 1991;82:38-42.