ORIGINAL ARTICLE

ONLINE FIRST

Declining Autopsy Rates and Suicide Misclassification

A Cross-national Analysis of 35 Countries

Nestor D. Kapusta, MD; Ulrich S. Tran, DSc; Ian R. H. Rockett, MA, MPH, PhD; Diego De Leo, MD, PhD, FRANZCP; Charles P. E. Naylor, MA, MB, BChir, FRCPath, FRCPA, DMJ; Thomas Niederkrotenthaler, MD, MMSc, PhD; Martin Voracek, DSc, DMSc, PhD; Elmar Etzersdorfer, MD; Gernot Sonneck, MD

Context: Suicides are prone to misclassification during death ascertainment procedures. This problem has generated frequent criticism of the validity of suicide mortality statistics.

Objective: To employ an external measure of the validity of cause-of-death statistics (ie, national autopsy rates) and to examine potential misclassification of suicide across countries from Europe to Central and Northern Asia.

Design: Cross-national analysis.

Setting: Thirty-five countries.

Participants: Aggregated mortality data.

Main Outcome Measures: Data from 35 countries during the period from 1979 to 2007 were used to analyze the association of suicide rates with autopsy rates and death rates of undetermined and ill-defined causes, respectively. Analyses were cross-sectional and longitudinal.

Results: Cross-sectionally, a 1% difference in autopsy rates among nations was associated with a suicide rate difference of 0.49 per 100 000 population. Longitudinally, a 1% decrease in the autopsy rate aligned with a decrease of 0.42 per 100 000 population in the suicide rate. These cross-sectional and longitudinal associations were robust after adjustment for unemployment, degree of urbanization, and prevalence of undetermined or ill-defined deaths. Associations strengthened when analyses were confined to 19 European Union member countries.

Conclusion: Autopsy rates may spatially and temporally affect the validity of suicide mortality statistics. Caution should be exercised in comparing international suicide rates and evaluating interventions that target suicide rate reduction.

Arch Gen Psychiatry.
Published online June 6, 2011.
doi:10.1001/archgenpsychiatry.2011.66

RESEARCHERS HAVE SOUGHT to explain the variation in national suicide rates since the 19th century.[1] Epidemiologic studies of suicide and evaluations of prevention programs are based on official statistics. Although there is consensus that suicide determinants are complex, national suicide rates may be variably influenced by death certification and registration procedures as well as by substantive factors.[2] Comprehensive cross-national comparisons of suicide rates suggest that these rates may also be affected by differential suicide misclassification.[3]

Suicide deaths are generally perceived as underreported or prone to misclassification during cause-of-death ascertainment procedures. In the *International Classification of Diseases, Ninth Revision (ICD-9)* and the *International Statistical Classification of Diseases, 10th Revision (ICD-10)*, the major external causes of morbidity and mortality are coded as assault, accident, intentional self-harm (suicide), or undetermined intent. Studies that questioned the validity of suicide statistics, based on the classic hypothesis that suicides are hidden within the undetermined intent category, suggest that suicide rates may be underestimated by 10% to 22%.[4-7] This potential for suicide misclassification is associated with variable ascertainment procedures among countries.[7] However, several cross-national studies conflict as to whether the magnitude of the rate for injury deaths of undetermined intent in a country can invalidate its suicide statistics and, hence, whether variation in this measure may also compromise international suicide rate comparisons.[8-12]

There is copious but conflicting evidence that suicides are hidden within injury deaths of undetermined intent. How-

Author Affiliations are listed at the end of this article.

ever, a deficiency of studies examining this association lies in their assumption that suicide misclassification is confined mainly to this undetermined category. It would be more appropriate if such investigations also incorporated deaths from ill-defined and unknown causes and unintentional injury, including poisoning.[3,13-16] However, theoretically, all illness and disease categories can obscure suicides.[17] Methodologically, the true extent of suicide misclassification cannot be determined by comparing mutually exclusive cause-of-death categories. A more appropriate evaluation of potential misclassification should use an external validation criterion.

Validity of suicide and other cause-of-death statistics is based on the quality of death certificates. In equivocal cases, death certificate data are supplemented by autopsy results and evidence of comorbidity.[12-14] Thus, autopsies improve accuracy of causes of death.[18] They have revealed substantial inaccuracies in international death certificates, with error rates ranging between 20% and 30%.[17,19] Assuming that suicide is underreported, we expected a positive correlation between national autopsy rate and national suicide rate.

Given the grossly decreased autopsy rate in many countries,[20,21] coupled with an assumption that autopsies ensure the quality of official statistics on all causes of death, evidence that misclassification of suicide is linked to variable performance of autopsies could have implications that transcend suicide investigation, analysis, and prevention. One implication should be the need for countries to improve the validity of their mortality statistics by reversing any downward trajectory in their autopsy rate, and another implication is that national funding priorities for research and prevention should reflect the relative and absolute magnitude of the true causes of death.

In our European-Asian study, we first evaluated the classic suicide misclassification hypothesis. We used all available data from each country to examine whether the rate of undetermined deaths may predict cross-national differences in suicide rates. We operationalized the undetermined category to comprise deaths classified under injury of undetermined intent, and then we expanded it to include deaths classified under ill-defined and unknown causes. Second, in evaluating a new misclassification hypothesis, we used the autopsy rate as an external validation criterion to predict cross-national variation in suicide rates. We analyzed 3 decades separately to assess consistency between the classic and new misclassification hypotheses, based on the undetermined death rate and the autopsy rate, respectively. Third, to evaluate temporal changes, we modeled the association between the autopsy rate and the suicide rate longitudinally. In this multivariate analysis, we adjusted for the rate of undetermined deaths, the unemployment rate, and the degree of urbanization. To test for model robustness, we repeated the analysis on a smaller sample confined to 19 European Union (EU) countries.

METHODS

Cause-specific mortality rate per 100 000 population, autopsy rate per 100 deaths, unemployment rate as percentage of total labor force, and percentage of population living in urban areas (ie, degree of urbanization) were obtained from the World Health Organization European Health for All Database (http://www.euro.who.int/hfadb). Retrieved data sets for the main covariate (ie, autopsy rate) were available for 35 countries from Europe and Central and Northern Asia. The official rates forwarded to the World Health Organization do not distinguish the respective proportions of autopsies that are clinical and forensic. These proportions might vary, both between and within countries, depending on national legislation and societal attitudes toward death ascertainment procedures.[21] Reliable suicide mortality data from Turkey are not available and, therefore, not forwarded to the World Health Organization. For comparative purposes, the Turkish suicide rate estimate in our **Figure** was derived from the medical literature[22] and was not included in statistical analyses.

Categories of mortality included suicide (*ICD-9* codes E950-E959 or *ICD-10* codes X60-X84), undetermined injury intent (*ICD-9* codes E980-E989 or *ICD-10* codes Y10-Y34), and symptoms, signs, ill-defined conditions, and unknown causes (*ICD-9* codes E780-E799 or *ICD-10* codes R00-R53 and R55-R99). No ethics approval was necessary because only aggregated national-level data were used.

The cross-sectional analyses of associations of suicide rates with undetermined death rates, ill-defined death rates, and autopsy rates were based on available annualized data for the 3 decades constituting our observation period (ie, 1979-2007). We used the Spearman rank correlation coefficient (ρ) to measure respective associations in each bivariate cross-sectional analysis. Multiple linear regression analyses were conducted to estimate the association between the autopsy rate and the suicide rate for the most recent decade under review (ie, 1998-2007). These analyses adjusted for the undetermined death rate, based on the preceding bivariate results, and also the unemployment rate and the degree of urbanization. We conducted sensitivity analyses to factor in the effect of national outliers, as appropriate.

We applied generalized estimating equation regression models to test the longitudinal association of the suicide rate with the autopsy rate, the undetermined death rate, the ill-defined death rate, the degree of urbanization, and the unemployment rate.[23,24] Generalized estimating equation regression handles both correlated (eg, longitudinal) data and missing data and is appropriate for examining average population effects of factors and covariates. To account for missing data and to obtain robust effect estimates, values of dependent and independent variables were averaged over each successive 5-year period from 1979 to 2007. The effects of observation period were considered as nuisance factors. Because suicide rates are nonnegative and known to be positively skewed (ie, cluster toward lower rates), the dependent variable was assumed to follow a gamma distribution. Specification of the correlation matrix of successive observation periods was based on the evaluation of the quasi-likelihood independence model criterion of the different models tested. Standard errors and confidence intervals of parameters were calculated with robust variance estimation techniques. SPSS version 17 (SPSS Inc, Chicago, Illinois) was used for the bivariate and multivariate analyses and for generating graphic output and other statistics.

Both the cross-sectional and longitudinal analyses were conducted using all available countries with appropriate data, which we designated as model 1. To test the robustness of this model, we also used model 2, which was based on the subset of 19 EU countries (including Switzerland and Norway as EU-associated countries). Our underlying assumption was that the EU sample reflects more homogenous cause-of-death ascertainment procedures than does the parent sample.

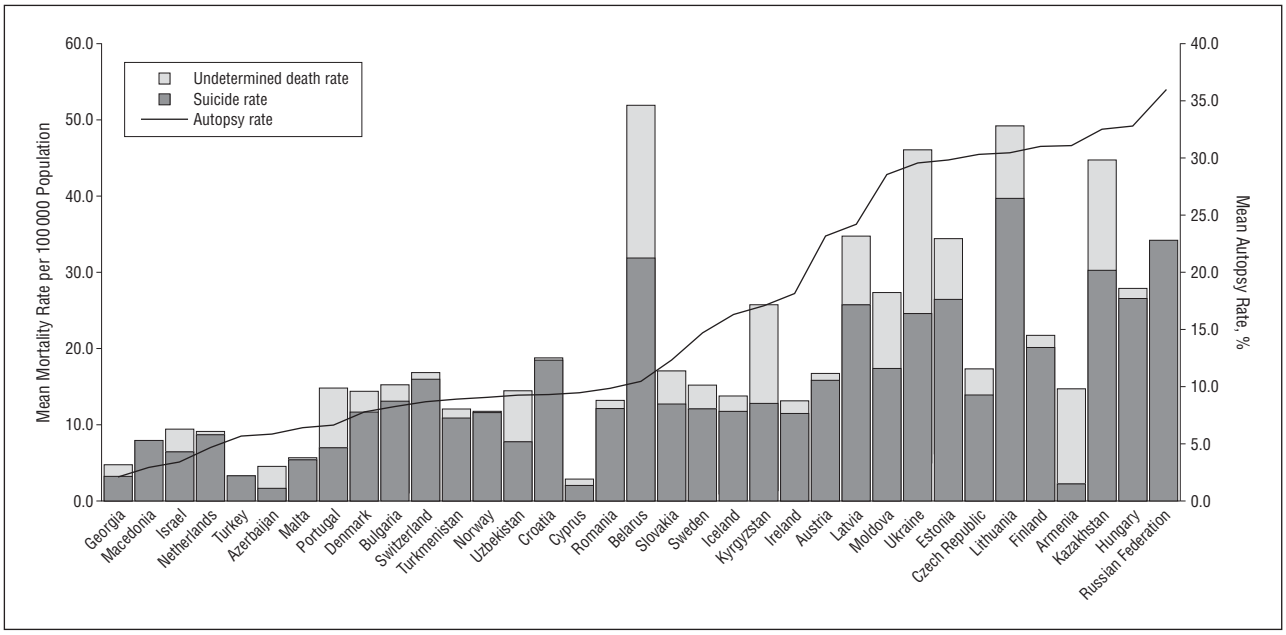

Figure. Mean undetermined death rates, suicide rates, and autopsy rates from 35 countries during the period from 1979 to 2007. The official rates forwarded to the World Health Organization do not distinguish the respective proportions of autopsies that are clinical and forensic. These proportions might vary, both between and within countries, depending on national legislation and societal attitudes toward death ascertainment procedures.[21] Reliable suicide mortality data from Turkey are not available and, therefore, not forwarded to the World Health Organization. For comparative purposes, the Turkish suicide rate estimate was derived from the medical literature[22] and was not included in statistical analyses.

RESULTS

CROSS-SECTIONAL ANALYSIS

Classic Suicide Misclassification Hypothesis

The suicide rate and the undetermined death rate showed no correlation for the first 2 decades under review (ie, 1979-1987 and 1988-1997) but were positively correlated for the last decade (ie, 1998-2007) (**Table 1**). The suicide rate and the ill-defined death rate were negatively associated for the first decade, a result not replicated for the 2 ensuing decades. When the bivariate analyses were confined to the EU countries, only 1 significant correlation emerged. It was between the suicide rate and the ill-defined death rate and pertained to the first decade only.

New Suicide Misclassification Hypothesis

The suicide rate and the autopsy rate correlated highly and positively across all 3 decades for the larger sample of countries, a finding that was affirmed in the EU sample (Table 1). For the most recent decade (1998-2007), the positive association between the autopsy rate and the suicide rate was significant in a bivariate linear regression analysis (R^2=0.44; β=0.66; t=4.95; $P<.001$; n=33). It remained significant in a multiple regression analysis, in which there was adjustment for the undetermined death rate, the unemployment rate, and the degree of urbanization (**Table 2**). This finding manifested for both models. The autopsy rate parameters remained significant as a result of eliminating Lithuania, as an outlier, from the multivariate analysis for model 1 (R^2=0.45; β=0.45; t=2.66; P=.014; n=30) and model 2 (R^2=0.66; β=0.704; t=3.96; P=.002; n=18). The results persisted following elimination of outliers Armenia and Belarus, as well as Lithuania, from model 1 (R^2=0.74; β=0.79; t=6.09; $P<.001$; n=28).

Longitudinal Analysis

Expressed as percentages, cross-national suicide rate changes and autopsy rate differences between the last 2 decades under review are presented in the eTable (http://www.archgenpsychiatry.com). The rank-order correlation coefficient summarizing changes in suicide rates and autopsy rate differences was ρ=0.39 (P=.03; n=31), indicating that the largest decreases in suicide rates characterized those countries that registered the largest decreases in their autopsy rates. The effect of autopsy rate changes was modeled by a generalized estimating equation regression model for the entire observation period (ie, 1979-2007). Compared with an independence model (assuming observation periods to be uncorrelated) and a first-order autoregressive model (assuming observation periods to be serially correlated with decreasing magnitude), a compound symmetric structure of the correlation matrix (assuming equal correlations between all observation periods) yielded the best model fit. In the full model (model 1; n=35), observation periods were highly correlated (r=0.81). Observation period, autopsy rate, and urbanization all emerged as significant factors and covariates.

In model 1, the autopsy rate showed a strong association with the suicide rate. Across all 35 countries comprising our larger sample, a 1% increase in the autopsy rate equated to an increase of 0.42 suicides per 100 000

Table 1. Cross-sectional Associations of Suicide Rates With Respective Autopsy Rates and Undetermined and Ill-Defined Death Rates, by Decade

Suicide Rate per Observation Period	Autopsy Rate	Undetermined Death Rate	Ill-Defined Death Rate
EU and Non-EU Countries			
1979-1987			
ρ	0.682[a]	–0.313	–0.515[a]
P value	.003	.24	.004
Countries with available data, No.	17	16	29
1988-1997			
ρ	0.722[a]	0.043	0.037
P value	≤.001	.81	.84
Countries with available data, No.	33	33	34
1998-2007			
ρ	0.682[a]	0.346[a]	–0.001
P value	≤.001	.045	.99
Countries with available data, No.	33	34	35
EU Countries			
1979-1987			
ρ	0.699[a]	–0.280	–0.657[a]
P value	.011	.35	.006
Countries with available data, No.	12	13	15
1988-1997			
ρ	0.835[a]	0.288	–0.040
P value	≤.001	.23	.87
Countries with available data, No.	18	19	19
1998-2007			
ρ	0.771[a]	0.415	–0.223
P value	≤.001	.07	.34
Countries with available data, No.	19	20	20

Abbreviations: EU, European Union; ρ, Spearman rank correlation coefficient.
[a] Statistically significant at $P<.05$.

Table 2. Cross-sectional Multiple Regression Analysis of Autopsy Rates and Suicide Rates by Model for 1998-2007[a]

Variable	β	*t*	*P* Value	R^2
Model 1				
31 EU and non-EU countries[b]				
Constant		–0.21	.83	
Autopsy rate	0.49[c]	3.02	.006	
Undetermined death rate	0.36[c]	2.13	.04	0.48
Unemployment rate, %	0.14	0.94	.36	
Urban population, %	0.11	0.71	.48	
Model 2				
19 EU countries				
Constant		–0.21	.83	
Autopsy rate	0.62[c]	3.81	.002	
Undetermined death rate	0.33	1.97	.07	0.71
Unemployment rate, %	0.11	0.60	.56	
Urban population rate, %	0.06	0.38	.71	

Abbreviation: EU, European Union.
[a] Suicide rate is a dependent variable.
[b] Only 31 countries were available for this analysis based on accessible data (eTable).
[c] Statistically significant at $P<.05$.

population. Urbanization had a nominally significant, albeit weak effect on suicide rates, whereas undetermined death rates showed no significant effect on suicide rates. Tests of effects in the generalized estimating equation regression analysis are provided in **Table 3**. These results persisted through the application of model 2. Autopsy rates still exerted the strongest effect on suicide rates, with a 1% increase being accompanied by an increase of 0.45 suicides per 100 000 population. Undetermined death rates did not significantly affect suicide rates.

Finally, we conducted a sensitivity analysis using the leave-one-out cross-validation method. The β coefficient for the autopsy rate ranged between 0.38 and 0.48 for the complete country sample, and between 0.43 and

Table 3. Longitudinal Generalized Estimating Equation Analysis of Covariate Effects on Suicide Rates

Variable	Effect Tests			β (95% CI)
	Wald χ^2	*df*	*P* Value	
Model 1				
35 EU and non-EU countries				
Intercept	0.23	1	.64	
Observation period[a]	11.55	5	.042	
Autopsy rate	25.94	1	<.001	0.42[b] (0.26-0.58)
Undetermined death rate	1.74	1	.19	0.29 (–0.14 to 0.72)
Urban population, %	5.11	1	.024	0.07[b] (0.01-0.13)
Unemployment rate, %	2.23	1	.14	0.11 (–0.04 to 0.26)
Model 2				
19 EU countries				
Intercept	1.36	1	.24	
Observation period[a]	8.02	5	.16	
Autopsy rate	14.1	1	<.001	0.45[b] (0.21-0.68)
Undetermined death rate	0.38	1	.54	0.24 (–0.52 to 0.99)
Urban population, %	0.00	1	.99	0.00 (–0.08 to 0.08)
Unemployment rate, %	0.71	1	.40	0.13 (–0.17 to 0.41)

Abbreviations: CI, confidence interval; EU, European Union.
[a] Five-year observation periods from 1979 to 2007.
[b] Statistically significant at $P < .05$.

0.54 for the EU sample. No major changes in estimates emerged from sensitivity analyses in which (1) ill-defined death rates were entered as an additional covariate and (2) undetermined and ill-defined death rates were combined (data not shown).

COMMENT

Our study presents evidence that variable death ascertainment procedures may affect the magnitude of suicide rates. The classic but controversial suicide misclassification hypothesis, which allows for possible suicides being mainly hidden within injury deaths of undetermined intent, does not consistently explain cross-national variation in suicide rates, even when also incorporating mortality classified under symptoms, signs, ill-defined conditions, and unknown causes. By contrast, the national autopsy rate, which we proposed as an external and more appropriate criterion of validity, emerged as a major predictor of the suicide rate in both cross-sectional and longitudinal analyses.

Whereas injury of undetermined intent appears as the cause-of-death category most susceptible to obscuring suicides,[14,25] some classic studies suggested that any such misclassification would not adversely affect the validity of international comparisons of suicide rates.[8,11] Other mortality categories highly prone to obscuring suicides are unintentional poisoning[26,27] and symptoms, signs, ill-defined conditions, and unknown causes.[13-15] A study of 15 EU countries concluded that, although misclassification of suicide under injury of undetermined intent could be a contributor, it fails to explain spatial and temporal variation in suicide rates.[10] Another time-trend analysis of 4 Nordic countries produced similar conclusions but factored in autopsy rates in evaluating the misclassification hypothesis.[16] A decreasing suicide rate coincided with a decreasing autopsy rate across these countries.

Historically, some researchers have argued that the magnitude of reported suicide rates is an artifact of type and interpretation of different social, medical, and legal rules as well as a product of the efforts and resources devoted to ascertain, count, and report defined suicide cases.[28,29] Indeed, reported suicide rates may be perceived as socially constructed because they stem from operationalized definitions of suicide. In-depth analyses of the quality of suicide data are rare, even though most suicidologists concede the propensity for suicides to be underreported.

Allowing that heterogeneous death certification and registration procedures influence national suicide rates,[2] we believe that autopsy rates could affect suicide registration by affecting the validity of overall cause-of-death statistics. Based on death certificates alone, diagnoses have a positive predictive value ranging between 25% and 90%.[19] Hence, increasing the autopsy rate may reduce suicide misclassification.

CLASSIC SUICIDE MISCLASSIFICATION HYPOTHESIS

The classic suicide misclassification hypothesis evolved in the early 1970s and was based on the assumption that suicides are hidden in nonspecific cause-of-death categories, mainly injury of undetermined intent. Accordingly, suicide rates could be negatively associated with death rates of undetermined intent,[14,25] but our cross-national analysis of 3 decades of mortality data only revealed a positive association between suicide rates and undetermined death rates. Because some research suggested that suicides may also be hidden within other nonspecific death categories, we expanded the scope of the classic hypothesis to include ill-defined and unknown causes. However, the association between the suicide rate and the death rate for the larger indeterminate category was significant only for the first decade. Thus, neither

the classic hypothesis nor its expanded version consistently accounted for spatial and temporal variation in national suicide rates.

NEW SUICIDE MISCLASSIFICATION HYPOTHESIS

Under the assumption that autopsies improve diagnostic accuracy of causes of death,[3,17-19] we adapted a hypothesis from Reseland et al[16] that autopsy rates predict cross-national variation in suicide rates. We found a consistently strong positive cross-sectional correlation between autopsy rates and suicide rates for all 3 decades represented in our observation periods. Countries with high autopsy rates registered high suicide rates. Hungary, Austria, and 4 Baltic Sea countries (Estonia, Latvia, Lithuania, and Finland) are traditionally known as the countries with the highest suicide rates in Europe. Although some evaluations of the Finno-Ugrian suicide hypothesis propose a genetic link for the explanation of this geographic suicide cluster,[30] these countries also exhibit the highest autopsy rates. Our cross-sectional estimates showed that a 1% difference between national autopsy rates was associated with a suicide rate difference of 0.49 per 100 000 population. This estimate rose to 0.62 when we confined the analysis to our smaller EU sample.

CHANGING AUTOPSY AND SUICIDE RATES

Countries registering the largest reductions in the autopsy rate between the last 2 decades of our study showed the largest reduction in suicide rate. This finding indicates a dose-response relationship. Ecological studies from several countries have explored the reasons for the decreases in official national suicide rates. Although a number of studies suggested that the decreases corresponded to increased antidepressant sales, the findings have been inconsistent.[31-40] Accordingly, autopsy rates have recently entered as a potential confounder into the spirited debate on whether increased use of antidepressants is driving the observed reduction of suicide rates in many countries across the globe.[41] Denmark, for example, experienced increased use of antidepressants and a concurrent decrease in suicide rates. However, a population-based linkage study[42] found that Danish patients receiving antidepressant treatment accounted for no more than 10% of this rate change. Of particular note, our study showed that Denmark recorded not only the largest decrease in the suicide rate but a strong reduction in its autopsy rate.

IMPLICATIONS FOR VITAL STATISTICS AND EPIDEMIOLOGY

More consistently than findings from most previous studies, our results seriously question the reliability and validity of national suicide statistics. First, countries with low autopsy rates may report far less than optimal suicide statistics, and these low rates may even compromise the quality of their cause-of-death statistics more generally. Second, our research highlights a need for revision of many studies examining the temporal effect of external factors on suicide rates. Concurrent decreases in autopsy rates suggest that observed decreases in suicide rates are partially artifactual. This possibility had already surfaced in an investigation of declining Nordic suicide rates.[16] We acknowledge, however, that trends in suicide rates could be etiologically complex. Impetus for the decrease in autopsy rates may have emanated from changing attitudes among physicians, medical students, and relatives of suicide victims toward autopsies, which in turn could have affected the allocation of funding.[20,21,43-49] At a higher level of abstraction, an ever-increasing demand for cost-effectiveness in the health system may have decreased autopsy rates and diverted available funds to other priorities, such as improvement of mental health services. Hence, decreasing suicide rates may be a joint product of artifactual factors that increase misclassification and substantive factors that improve mental health treatment. Yet, our analyses show that autopsy rates are associated with both the magnitude and the direction of suicide rates. For this reason, caution should be exercised in evaluating interventions by means of temporal and spatial analyses of the variation in suicide rates. Such research may overstate the effectiveness of these interventions.

In sum, a host of factors likely coalesce to increase the probability that suicide case ascertainment is more deficient when autopsy rates are low rather than high. Although it is well known that official suicide rates have been decreasing in many European countries since the mid-1980s,[50] our research suggests that these decreases harbor a sizable artifactual component that warrants in-depth investigation.

The ecologic nature of our study precludes causal inference from the association between national autopsy rate and national suicide rate. A topic for future research, this association may also derive from other aspects of cause-of-death ascertainment not considered here, although the autopsy rate may still serve as a strong indirect indicator of the quality of suicide ascertainment procedures in a given country. Variable within-national and international cause-of-death ascertainment procedures, which involve follow-up inquiries to the certifier to help resolve doubt or inconsistency, may differentially influence the validity of suicide and other cause-of-death statistics.[51,52] For example, continuous updating and revision of suicide statistics, as well as standardization of case ascertainment procedures, have been recently claimed for Australia and the EU.[53-55] Another limitation for our study is that autopsies vary in their legal basis. For example, some Anglophone jurisdictions distinguish forensic autopsies authorized by a legal officer and clinical autopsies to which next of kin have consented. Elsewhere, legal and administrative schemes may provide a different basis for autopsies, affecting both how they are conducted and how suicide data are generated. Moreover, our source at the World Health Organization does not clarify whether autopsy data are forensic, clinical, or both, nor does it include autopsies performed with entirely different legal underpinnings. Utilization of autopsies by type may follow different chronologies.[56]

Very likely, both the data and the method of calculating the autopsy rate vary widely cross-nationally. Reported decreases in overall autopsy rates may actually reflect changes in forensic or clinical autopsies, or both,

or neither. In some countries, forensic autopsies may be increasing while clinical autopsies are decreasing. In Anglophone jurisdictions, suicides and deaths that may be suicides (ie, unintentional injury deaths, homicides, and deaths from unknown causes) are almost always included in the forensic autopsy group. However, unclear from our data are whether suicides should universally be assumed to be among the deaths subjected to a declining autopsy rate. Differences in the type of system of legal death investigation (eg, whether there is a generic criminal investigation, whether a medical examiner performs the autopsy, or whether a coroner-based system is used[57,58]) as well as qualitative variation within shared systems may variably affect autopsy performance, autopsy rates, and thus suicide case ascertainment cross-nationally. Similarly, countries might have differentially substituted minimally invasive or "partial" autopsies for traditional autopsies and, hence, contributed to the rate decrease and also confounded observed associations between autopsy rates and suicide rates.[21] Yet another study limitation is that we were unable to account for variable national legal regulations and prohibitions on suicide that might influence whether coroners and medical examiners deliberately misclassify some suicides in order to protect families and other survivors.

The database used in our study is the most comprehensive source of mortality statistics and autopsy rates available. However, some populous European countries, such as France, Germany, Poland, Italy, Spain, and Great Britain, were excluded from our study because of the absence of requisite autopsy data. Also a limiting factor is the existence of other unresolved alternative explanations for the observed variation in international suicide rates. Most notably, justifying a genetic explanation, migrant studies show that suicide risk for immigrants correlates with that for their countries of origin.[59] Unclear, however, is whether immigrants and local citizens share the same autopsy rate and death ascertainment procedures because ethnicity, socioeconomic status, and citizenship may affect suicide misclassification.[60] Definitely, to maintain the quality and validity of suicide statistics in particular and vital statistics in general, further investigations and data quality monitoring are strongly recommended.

Submitted for Publication: November 1, 2010; final revision received March 2, 2011; accepted April 7, 2011.
Published Online: June 6, 2011. doi:10.1001/archgenpsychiatry.2011.66
Author Affiliations: Department of Psychoanalysis and Psychotherapy (Dr Kapusta), Department of General Practice, Center of Public Health (Dr Niederkrotenthaler), and Institute for Medical Psychology, Center of Public Health (Dr Sonneck), Medical University of Vienna, Ludwig Boltzmann Institute for Social Psychiatry (Dr Sonneck), and Departments of Clinical, Biological, and Differential Psychology (Dr Tran) and Basic Psychological Research (Dr Voracek), School of Psychology, University of Vienna, Austria; Furtbach Hospital for Psychiatry and Psychotherapy, Stuttgart, Germany (Dr Etzersdorfer); Department of Community Medicine and Injury Control Research Center, West Virginia University, Morgantown, West Virginia (Dr Rockett); and Australian Institute for Suicide Research and Prevention, National Centre of Excellence in Suicide Prevention, World Health Organization Collaborating Centre for Research and Training in Suicide Prevention, and Life Promotion Clinic, Mount Gravatt Campus, Griffith University (Dr De Leo), and Forensic and Scientific Services, Queensland Health, Clinical and Statewide Services Division (Dr Naylor), Brisbane, Queensland, Australia.
Correspondence: Nestor D. Kapusta, MD, Department for Psychoanalysis and Psychotherapy, Medical University of Vienna, Waehringer Guertel 18-20, A-1090 Vienna, Austria (nestor.kapusta@meduniwien.ac.at).
Author Contributions: Dr Kapusta had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Financial Disclosure: None reported.
Online-Only Material: The eTable is available at http://www.archgenpsychiatry.com.

REFERENCES

1. Durkheim E. *Le suicide: Étude de sociologie.* Paris, France: Félix Alcan; 1897.
2. Hawton K, van Heeringen K. Suicide. *Lancet.* 2009;373(9672):1372-1381.
3. Jougla E, Pavillon G, Rossollin F, De Smedt M, Bonte J. Improvement of the quality and comparability of causes-of-death statistics inside the European Community: EUROSTAT Task Force on "causes of death statistics". *Rev Epidemiol Sante Publique.* 1998;46(6):447-456.
4. Holding TA, Barraclough BM. Psychiatric morbidity in a sample of accidents. *Br J Psychiatry.* 1977;130:244-252.
5. Holding TA, Barraclough BM. Psychiatric morbidity in a sample of a London coroner's open verdicts. *Br J Psychiatry.* 1975;127:133-143.
6. Holding TA, Barraclough BM. Undetermined deaths-suicide or accident? *Br J Psychiatry.* 1978;133:542-549.
7. Atkinson MW, Kessel N, Dalgaard JB. The comparability of suicide rates. *Br J Psychiatry.* 1975;127:247-256.
8. Barraclough BM. Differences between national suicide rates. *Br J Psychiatry.* 1973;122(566):95-96.
9. Rockett IRH, Thomas BM. Reliability and sensitivity of suicide certification in higher-income countries. *Suicide Life Threat Behav.* 1999;29(2):141-149.
10. Chishti P, Stone DH, Corcoran P, Williamson E, Petridou E; EUROSAVE Working Group. Suicide mortality in the European Union. *Eur J Public Health.* 2003;13(2):108-114.
11. Sainsbury P, Jenkins JS. The accuracy of officially reported suicide statistics for purposes of epidemiological research. *J Epidemiol Community Health.* 1982;36(1):43-48.
12. Phillips DP, Ruth TE. Adequacy of official suicide statistics for scientific research and public policy. *Suicide Life Threat Behav.* 1993;23(4):307-319.
13. Ohberg A, Lonnqvist J. Suicides hidden among undetermined deaths. *Acta Psychiatr Scand.* 1998;98(3):214-218.
14. Lindqvist P, Gustafsson L. Suicide classification: clues and their use: a study of 122 cases of suicide and undetermined manner of death. *Forensic Sci Int.* 2002;128(3):136-140.
15. Rockett IRH, Hobbs GR, De Leo D, Stack S, Frost JL, Ducatman AM, Kapusta ND, Walker RL. Suicide and unintentional poisoning mortality trends in the United States, 1987-2006: two unrelated phenomena? *BMC Public Health.* 2010;10:705.
16. Reseland S, Le Noury J, Aldred G, Healy D. National suicide rates 1961-2003: further analysis of Nordic data for suicide, autopsies and ill-defined death rates. *Psychother Psychosom.* 2008;77(2):78-82.
17. Shojania KG, Burton EC, McDonald KM, Goldman L. Changes in rates of autopsy-detected diagnostic errors over time: a systematic review. *JAMA.* 2003;289(21):2849-2856.
18. Kircher T, Nelson J, Burdo H. The autopsy as a measure of accuracy of the death certificate. *N Engl J Med.* 1985;313(20):1263-1269.
19. Shojania KG, Burton EC, McDonald KM, Goldman L. *The Autopsy as an Outcome and Performance Measure.* Rockville, MD: Agency for Healthcare Research and Quality; 2002. Evidence Report/Technology Assessment 58.
20. Shojania KG, Burton EC. The vanishing nonforensic autopsy. *N Engl J Med.* 2008;358(9):873-875.

21. Burton JL, Underwood J. Clinical, educational, and epidemiological value of autopsy. *Lancet*. 2007;369(9571):1471-1480.
22. Sayil I. Review of suicide studies in Turkey. *Crisis*. 1997;18(3):124-127.
23. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika*. 1986;73:13-22. doi:10.1093/biomet/73.1.13.
24. Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*. 1986;42(1):121-130.
25. Linsley KR, Schapira K, Kelly TP. Open verdict v. suicide: importance to research. *Br J Psychiatry*. 2001;178:465-468.
26. Barraclough BM. Poisoning cases: suicide or accidents. *Br J Psychiatry*. 1974;124 (0):526-530.
27. Brådvik L, Berglund M, Frank A, Lindgren A, Löwenhielm P. Number of addictive substances used related to increased risk of unnatural death: a combined medicolegal and case-record study. *BMC Psychiatry*. 2009;9:48.
28. Douglas JD. *The Social Meanings of Suicide*. Princeton, NJ: Princeton University Press; 1967.
29. Wilkins JL. Producing suicides. *Am Behav Sci*. 1970;14:185-201. doi:10.1177/000276427001400203.
30. Voracek M, Marusic A. Testing the Finno-Ugrian Suicide Hypothesis: geographic variation of elderly suicide rates across Europe. *Nord J Psychiatry*. 2008; 62(4):302-308.
31. Bramness JG, Walby FA, Tverdal A. The sales of antidepressants and suicide rates in Norway and its counties 1980-2004. *J Affect Disord*. 2007;102(1-3):1-9.
32. Barak Y, Aizenberg D. Association between antidepressant prescribing and suicide in Israel. *Int Clin Psychopharmacol*. 2006;21(5):281-284.
33. Morgan OW, Griffiths C, Majeed A. Association between mortality from suicide in England and antidepressant prescribing: an ecological study. *BMC Public Health*. 2004;4:63.
34. Carlsten A, Allebeck P, Brandt L. Are suicide rates in Sweden associated with changes in the prescribing of medicines? *Acta Psychiatr Scand*. 1996;94(2): 94-100.
35. Kelly CB, Ansari T, Rafferty T, Stevenson M. Antidepressant prescribing and suicide rate in Northern Ireland. *Eur Psychiatry*. 2003;18(7):325-328.
36. Reseland S, Bray I, Gunnell D. Relationship between antidepressant sales and secular trends in suicide rates in the Nordic countries. *Br J Psychiatry*. 2006; 188:354-358.
37. Barbui C, Campomori A, D'Avanzo B, Negri E, Garattini S. Antidepressant drug use in Italy since the introduction of SSRIs: national trends, regional differences and impact on suicide rates. *Soc Psychiatry Psychiatr Epidemiol*. 1999;34(3): 152-156.
38. Guaiana G, Andretta M, Corbari L, Mirandola M, Sorio A, D'Avanzo B, Barbui C. Antidepressant drug consumption and public health indicators in Italy, 1955 to 2000. *J Clin Psychiatry*. 2005;66(6):750-755.
39. Helgason T, Tómasson H, Zoega T. Antidepressants and public health in Iceland: time series analysis of national data. *Br J Psychiatry*. 2004;184:157-162.
40. Kapusta ND, Niederkrotenthaler T, Etzersdorfer E, Voracek M, Dervic K, Jandl-Jager E, Sonneck G. Influence of psychotherapist density and antidepressant sales on suicide rates. *Acta Psychiatr Scand*. 2009;119(3):236-242.
41. Isacsson G, Rich CL, Jureidini J, Raven M. The increased use of antidepressants has contributed to the worldwide reduction in suicide rates. *Br J Psychiatry*. 2010;196(6):429-433.
42. Erlangsen A, Canudas-Romo V, Conwell Y. Increased use of antidepressants and decreasing suicide rates: a population-based study using Danish register data. *J Epidemiol Community Health*. 2008;62(5):448-454.
43. Ayoub T, Chow J. The conventional autopsy in modern medicine. *J R Soc Med*. 2008;101(4):177-181.
44. Xiao J, Krueger GR, Buja LM, Covinsky M. The impact of declining clinical autopsy: need for revised healthcare policy. *Am J Med Sci*. 2009;337(1):41-46.
45. Loughrey MB, McCluggage WG, Toner PG. The declining autopsy rate and clinicians' attitudes. *Ulster Med J*. 2000;69(2):83-89.
46. Goodin J, Hanzlick R. Mind your manners: part II, general results from the National Association of Medical Examiners Manner of Death Questionnaire, 1995. *Am J Forensic Med Pathol*. 1997;18(3):224-227.
47. Walker S, Chen L, Madden R. Deaths due to suicide: the effects of certification and coding practices in Australia. *Aust N Z J Public Health*. 2008;32(2):126-130.
48. Lu TH, Sun SM, Huang SM, Lin JJ. Mind your manners: quality of manner of death certification among medical examiners and coroners in Taiwan. *Am J Forensic Med Pathol*. 2006;27(4):352-354.
49. Farrow R, Arensman E, Corcoran P, Williamson E, Perry IJ. Irish coroners' attitudes towards suicide and its prevention. *Ir J Med Sci*. 2009;178(1):61-67.
50. DeLeo D, Evans R. *International Suicide Rates and Prevention Strategies*. Göttingen, Germany: Hogrefe & Huber Publishers; 2004.
51. Mathers CD, Fat DM, Inoue M, Rao C, Lopez AD. Counting the dead and what they died from: an assessment of the global status of cause of death data. *Bull World Health Organ*. 2005;83(3):171-177.
52. Mathers CD, Boerma T, Ma Fat D. Global and regional causes of death. *Br Med Bull*. 2009;92:7-32.
53. De Leo D, Dudley MJ, Aebersold CJ, Mendoza JA, Barnes MA, Harrison JE, Ranson DL. Achieving standardised reporting of suicide in Australia: rationale and program for change. *Med J Aust*. 2010;192(8):452-456.
54. De Leo D. Australia revises its mortality data on suicide. *Crisis*. 2010;31(4):169-173.
55. Värnik P, Sisask M, Värnik A, Laido Z, Meise U, Ibelshäuser A, Van Audenhove C, Reynders A, Kocalevent RD, Kopp M, Dosa A, Arensman E, Coffey C, van der Feltz-Cornelis CM, Gusmão R, Hegerl U. Suicide registration in eight European countries: A qualitative analysis of procedures and practices. *Forensic Sci Int*. 2010; 202(1-3):86-92.
56. Lunetta P, Lounamaa A, Sihvonen S. Surveillance of injury-related deaths: medicolegal autopsy rates and trends in Finland. *Inj Prev*. 2007;13(4):282-284.
57. Ranson D. Death investigation. In: Payne-James J, Busuttil A, Smock W, eds. *Forensic Medicine: Clinical and Pathological Aspects*. London, England: Greenwich Medical Media; 2003:13-25.
58. Rutty JE. The evolution of the nurse's role in death investigation. In: Rutty GN, ed. *Essentials of Autopsy Practice: Current Methods and Modern Trends*. London, England: Springer Verlag; 2006:1-13.
59. Voracek M, Loibl LM. Consistency of immigrant and country-of-birth suicide rates: a meta-analysis. *Acta Psychiatr Scand*. 2008;118(4):259-271.
60. Rockett IRH, Wang S, Stack S, De Leo D, Frost JL, Ducatman AM, Walker RL, Kapusta ND. Race/ethnicity and potential suicide misclassification: window on a minority suicide paradox? *BMC Psychiatry*. 2010;10:35.