Essay

Suicide Misclassification in an International Context: Revisitation and Update

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Abstract: International misclassification of suicide, particularly undercounting, has long been a scientific concern. An important question is whether official national suicide data are sufficiently reliable and valid to justify their use in international comparative studies or longitudinal intervention studies. Is cross-national variation in rates of suicide, in part or whole, an artifact of such factors as medicolegal ascertainment practices and procedures, legal prohibitions, and sociocultural condemnation? In a revisitation and update of a conference paper, this essay addresses the process of suicide case ascertainment, known sources of suicide misclassification, and explores approaches for assessing misclassification and potential misclassification. Validity of suicide certification, particularly sensitivity, appears more problematic than reliability for users of international suicide data. However, a poisoning pandemic and declining autopsy rates may be depressing data reliability as well as sensitivity.

Keywords: Suicide, Suicidology, Validity, Reliability, Misclassification, Poisoning, Undetermined intent

International misclassification of suicide, particularly undercounting, has long been a scientific concern (e.g., Zilboorg, 1936; Douglas, 1967; McCarthy & Walsh, 1975; Sainsbury & Jenkins, 1982; Speechley & Stavraky, 1991; Jougla, Pequignot, Miras, Chappert, Rossollin et al., 2002; Rockett, 2010). An important question is whether official national suicide data are sufficiently reliable and valid to justify their use in international comparative studies or longitudinal intervention studies. Is cross-national variation in rates of suicide, in part or whole, an artifact of such factors as medicolegal ascertainment practices and procedures, legal prohibitions, and sociocultural condemnation? In a revisitation and update of a conference paper (Rockett & Smith, 1995), this essay addresses the process of suicide case ascertainment, known sources of suicide misclassification, and explores approaches for assessing misclassification and potential misclassification.

Investigative Process and Mortality Classification

Manner and Cause-of-Death Ascertainment

When an individual dies, medicolegal authorities need to determine, classify, and code manner and cause-of-death. Table 1 shows that natural causes, or physical diseases, predominated as the manner of death in the 27 European Union and associated countries whose data we accessed for 2006 through the European Health for All Database (HFA-DB) (World Health Organization, 2011a). The same was the case for the United States as our twenty-eighth country, which we added for comparative purposes (Centers for Disease Control and Prevention, 2011).

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Table 1: Percentage of deaths attributed to natural causes for selected countries, 2006

	Deaths from natural causes in %		Deaths from natural causes in %
Malta	96.1	Hungary	93.3
Bulgaria	95.7	Sweden	93.2
Netherlands	95.5	Austria	93.0
United Kingdom	95.4	Poland	92.7
Ireland	95.1	Norway	92.7
Germany	95.1	USA[a]	92.6
Spain	94.4	Switzerland	92.4
Romania	94.4	Luxembourg	92.3
Italy	94.4	France	91.4
Denmark	94.3	Slovenia	90.2
Cyprus	94.2	Finland	88.5
Slovakia	94.1	Estonia	88.3
Czech Republic	93.6	Latvia	88.2
Portugal	93.4	Lithuania	86.3

Data Sources: World Health Organization, *European Health for All Database (HFA-DB)*; Data for Estonia, Hungary, Slovakia, and Spain are for 2005 and for Portugal 2004. [a] United States Centers for Disease Control and Prevention, CDC WONDER.

Our basis for choosing the 27 European Union countries was the availability of manner and cause-of-death data, which we could include in our subsequent discussion of suicide data validity.

Within classification of manner of death, natural causes of death are the residual relative to the following broad alternative ICD-10 injury death categories: accident, assault, intentional self-harm, and event of undetermined intent. Unlike mortality from natural causes, injury deaths require medicolegal authorities to determine decedent intent in order to resolve manner of death. The authorities further need to establish their nature, such as poisoning, contusion, asphyxiation, laceration, or a combination of them. Determination of intent occupies a higher level of abstraction than nature of injury, and frequently extends well upstream of the medical domain. While our focus is suicide, intentional injury mortality embraces homicide as well as suicide. We recognize that, all other things being equal, the authorities should first rule in or out homicide in ascertaining manner of death, and rule out injury before classifying manner of death as natural causes.

According to the World Health Organization (WHO), suicide determination requires that the fatal injury was *self-inflicted* and that the decedent *deliberately intended* to take his or her own life (O'Carroll, 1989). Normally, the decision-making process on manner of death begins with a proximate physician. However, when a suicide or other unnatural death is suspected, police are frequently the first authorities at the scene. This introduces the legal perspective. Actions by the police include questioning relatives, witnesses, and physicians, and locating notes and observing aspects indicative of accident, assault, or suicide (Marcikić, Ugljarević, Dijanić, Dumencić & Pozgain et al., 2003; Lindqvist & Gustafsson, 2002; Ward, Shields, & Cramer, 2011). Commonly police are assisted directly by a coroner, medical examiner, or ancillary personnel. Countries that rule a death as suicide, based only on satisfying the legal criterion of "beyond reasonable doubt" may be systematically obscuring suicides within other cause-of-death categories, such as injury of undetermined intent and unintentional poisoning (Atkinson, Kessel & Dalgaard, 1975; Kelleher, Corcoran, Keeley, Dennehy & O'Donnell, 1996; Linsley, Schapira, & Kelly, 2001), and ill-defined and unknown causes (Phillips & Ruth, 1993; Rockett & Smith, 1995; Jougla et al., 2002; De Leo, Dudley, Aebersold, Mendoza, Barnes et al., 2010; Gjertsen & Johansson, 2011).

A recent WHO survey showed that, for a majority of 84 responding countries, registered deaths were certified by medical examiners, coroners, or other medicolegal authorities (World Health Organization, 2005). Typically, medical examiners and coroners differ markedly in their qualifications, training, and selection. Medical examiners are usually medically qualified, and are often credentialed forensic pathologists as well. Coroners may have law degrees, medical degrees, both, or neither as is common in the United States (Committee on Identifying the Needs of the Forensic Science Community, 2009). Coroners and medical examiners can vary substantially in their attitudes towards certifying a death as suicide owing to contrasting philosophies and perspectives (Atkinson, 1978; Timmermans, 2005). Three-quarters of the 84 responding countries in the WHO survey reported that they followed up with the certifier to resolve doubt or inconsistency in classifying manner of death (World

Health Organization, 2005). Assignment of an ICD-code to an underlying-cause-of-death reported on the death certificate may vary considerably cross-nationally due to heterogeneity in certifiers, clinical coders, administrative officers, clerks, statistical technicians, and other information managers (Claassen, Yip, Corcoran, Bossarte, Lawrence et al., 2010). Training in death certification, beyond identifying and certifying the underlying cause of death, is also highly deficient in many countries (e.g., Myers & Farquar, 1998; Devis & Rooney, 1999; Pritt, Hardin, Richmond & Shapiro, 2005).

With suicide and other causes of death, case ascertainment is more objective when investigators are scientifically trained (Committee on Identifying the Needs of the Forensic Science Community, 2009). Such training, especially when encompassing forensic pathology, reduces the discretionary component of a death investigation. In contrast to *the balance of probabilities* approach of medical examiners, coroners conduct their investigations using a legal *burden-of-proof* approach, which may make them more prone to undercounting suicide (Clarke-Finnegan & Fahy, 1983). On the other hand, medical examiners may be more conservative than coroners (Pescosolido & Mendelsohn, 1986), and more concerned about getting it wrong than getting it right (Timmermans, 2005). In U.S. states with a medical examiner system, the medical examiner possesses sole authority to rule a death a suicide or not, based on the accessible evidence. In the United Kingdom, a formal judicial coroner court makes a final determination on suicide based on testimony from a variety of sources, including forensic experts. Serious undercounting of suicide still seems highly probable (O'Donnell & Farmer, 1995). Whether suicide case ascertainment is the ultimate responsibility of coroners, medical examiners, or the police, cross-national heterogeneity in practices and procedures will likely spawn an artifactual component in observed variation in international suicide rates.

Autopsies and Toxicological Testing

The WHO survey indicates that the autopsy can be a key instrument in assigning manner and cause-of-death (World Health Organization, 2005). Autopsy rates have important implications for the quality of cause-of-death statistics (Kircher, Nelson & Burdo, 1985; Larsen & Linnerup, 2011). Data derived from the European Health for All Database (HFA-DB) for 35 European and Asian countries for the period 1999-2008 produced a mean national autopsy rate of 16% (Kapusta, Tran, Rockett, De Leo, Naylor et al., 2011), with rates ranging between 2% and 36%. A low autopsy rate increases the likelihood that suicides are misclassified under alternative causes of death (Shojania, Burton, McDonald & Goldman, et al., 2002; 2003). Almost a global phenomenon, a long-term decline in autopsy rates augurs negatively

for the quality of international suicide data. Indeed, building upon research confined to four Nordic countries (Reseland, Le Noury, Aldred & Healy, 2008), a much larger three-decade cross-national study reported a strong positive association between the autopsy rate and the suicide rate (Kapusta et al., 2011). This association manifested both cross-sectionally and longitudinally. Besides embracing a far larger geographical domain than the first study, this study also indicated that the association between autopsy and suicide rates harbored much stronger implications for differential suicide misclassification internationally than respective rates of deaths of undetermined injury intent and deaths from ill-defined and unknown causes. Although reinforced by the findings from the second study, the first study cast serious doubts that observed declines in national suicide rates could be substantially explained by antidepressant therapy. Nevertheless, both studies possessed the limitation of employing ecological rather than individual-level or multi-level data.

Also of importance, autopsies often include a toxicological examination, which may be a crucial element in determining poisoning suicides. Elaborated upon in the next section, the problem of misclassification of poisoning suicides is a growing concern in certain nations, as exemplified by research conducted in the United States (Breiding & Wiersma, 2006; Rockett, Hobbs, De Leo, Stack, Frost et al., 2010) and Taiwan (Chang, Sterne, Lu & Gunnell, 2010).

Suicide Classification

Suicide Methods and Differential Undercounting

Some degree of suicide undercounting will be universal, since suicide is not a default or residual option for medicolegal authorities (O'Carroll, 1989; Timmermans, 2005). Complicating suicide case ascertainment is the observation that undercounting is nonrandom (Platt, Backett & Kreitman, 1988). Undercounting probably varies considerably across nations (Rockett & Thomas, 1999; Kapusta et al., 2011). Misclassification of suicide is also influenced by a differential capacity for case ascertainment according to the methods or mechanisms that were used by the decedents. Without strong corroborative evidence such as witnesses, a prior suicide attempt, or a suicide note, more active suicide methods, like hanging, shooting, and cutting, appear to make suicide case ascertainment less complicated for medicolegal authorities than less active methods such as poisoning, gassing, and drowning (e.g., Platt et al., 1988; Lindqvist & Gustafsson, 2002; Rockett, Wang, Stack, De Leo, Frost, et al., 2010).

Poisoning mortality from drug overdoses has greatly escalated in the United States in particular

(Warner, 2009; Bohnert, Fudalej, & Ilgen, 2010). However, there is now a poisoning pandemic due to drug overdoses and pesticide ingestion (e.g., Gunnell, Eddleston, Phillips & Konradsen, 2007; Vicente, Giraudon, Matias, Hedrich & Wiessing, 2009; Zhou, Liu, Li, 2011). Poisoning suicides often may be ascertained only through toxicological testing. A lethal overdose of a poison is suggestive of suicide (Bennett, Vaslef, Shapiro, Brooks & Scarborough, 2009; Darke, Duflou & Torok, 2010), especially in adults, when the medicolegal authorities are unable to tie implicated substances to abuse by the decedent. On the other hand, suicide case ascertainment may be impeded when alcohol and/or other psychoactive substances while involved in a death were not the lethal agent (Barraclough, 1974; Lindqvist and Gustafsson, 2002). Therefore, co-occurrence may induce misclassification of true suicides (Jarvis, Boldt & Butt, 1991; Salib, 1996; Stanistreet, Taylor, Jeffrey & Gabbay, 2001), since it is known that medicolegal authorities variably factor in substance abuse as a determinant of suicide in case ascertainment (Crepeau-Hobson, 2010).

The global epidemic of fatal poisonings may be compromising suicide data validity on a grand scale, and diminishing the international reliability of suicide data as well. Joint consideration of two U.S. studies informs this issue. The first study used national multiple-cause-of-death (MCOD) data to examine the likelihood that decedents from two pooled manner of death categories, suicide and mortality of undetermined injury intent, would be classified as undetermined (Rockett, Wang et al., 2010). Suicide is a firm manner-of-death category, basically comprising true suicides, while undetermined intent is a much softer alternative by definition. The authors of the MCOD study constructed a model to predict the likelihood that a decedent would be classified under undetermined intent, their proxy for the likelihood of suicide misclassification. By far the strongest predictor was whether mechanism of injury was "less active" versus "more active." The less active group (predominantly fatal poisoning cases) was 46 times as likely as the more active group (predominantly fatal hanging and firearm cases) to be classified by medicolegal authorities under undetermined intent.

The second U.S study, which employed underlying cause-of-death data, suggested that national suicide and unintentional poisoning mortality trends markedly overlap, and that the latter trend represents a potentially huge reservoir for hidden suicides (Rockett, Hobbs et al., 2010). Officially, the unintentional poisoning mortality rate rose almost fourfold between 1987 and 2007 (Centers for Disease Control and Prevention, 2011). By contrast, the suicide rate declined by 18% between 1987 and 2000

before registering a 10% rebound up through 2007. If current data were available, they may well reveal convergence between the unintentional poisoning mortality and suicide rates. About 40,000 Americans died by poisoning in 2007. Seventy-five percent of these deaths were classified as unintentional, 16% as suicide, 10% as undetermined intent, and 0.2% as homicide. The proportion of poisoning deaths officially attributable to suicide seems implausibly small. Likely related, and similarly implausible, poisoning has not officially become a more common method of suicide in the United States (Rockett, Hobbs, et al., 2010) despite the nexus between access and use of methods (Marzuk, Leon, Tardiff, Morgan & Stajic, 1992). Punctuating the heightened potential for associated suicide misclassification, fatal poisonings now predominate among injury deaths of undetermined intent (Rockett, Hobbs, et al., 2010).

Over 90% of U.S. poisoning deaths are prescription and nonprescription drug overdoses, with prescription opioid painkillers now being the most problematic drugs (Warner et al., 2009). Analysis of data from the 2007 Nationwide Emergency Department Sample (NEDS) (Xiang, Zhao, Xiang, & Smith, 2011) profoundly reinforces the likelihood that poisoning suicides in the United States are grossly underestimated. Forty-one percent of the 161,000 drug-related emergency department visits attributed to painkillers reflected suicidal intent, and 40% were unintentional (Xiang et al., 2011). Undetermined intent was the manner of external cause of injury code attached to the remaining visits. If the total facts were accessible, it is likely that the visits coded as undetermined intent would distribute equally across the suicidal and unintentional categories. National emergency department data from the Drug Abuse Warning Network (DAWN) revealed a 30% increase in drug-related suicide attempts between 2005 and 2007 alone, and a 55% increase in those involving narcotic pain medications (Substance Abuse and Mental Health Services Administration, 2010). Assessment of intentionality among patients in the NEDS study involved psychiatric evaluation (Xiang et al., 2011), a process with no effective analogy in suicide case ascertainment in the United States. The analogous process in principle, the psychological autopsy, is rarely conducted there (U.S. Public Health Service, 2001). A psychological autopsy involves in-depth review of medicolegal records and followback interviews with family, friends and acquaintances of a decedent to look specifically for possible antecedents of his or her suicide or possible suicide (Cavanagh, Carson, Sharpe & Lawrie, 2003; Scott, Swartz & Warburton, 2006). Exacerbating the problem of suicide misclassification, this valuable forensic tool has continuously departed from its original purpose of helping officials resolve manner of death or intentionality in ambiguous, uncertain, and equivocal

cases (Shneidman & Farberow, 1957; Jobes, Berman & Josselson, 1986; Pouliot & De Leo, 2006).

If suicide and unintentional poisoning mortality trends really overlap, then suicide may constitute a failing category with respect to its understanding and prevention in the United States, and predictably in other countries as well. Psychiatric data amplify this possibility. Psychiatric disorders, including substance use disorders, are major determinants of suicide (Harris & Barraclough, 1997). A meta-analysis of 27 psychological autopsy studies and a systematic review of 22 case-control studies and 54 case series jointly indicated that approximately 90% of suicides had a diagnosable psychiatric disorder at the time of their deaths (Cavanaugh, Carson, Sharpe & Lawrie, 2003; Arsenault-Lapierre, Kim, & Turecki, 2004). A psychological autopsy study conducted in New Brunswick, Canada, found that between 42% and 65% of suicide cases had a comorbid psychiatric disorder (Séguin, Lesage, Chawky, Guy, Daigle et al., 2006). Despite the profound connection between psychiatric disorders and suicide, MCOD studies indicate serious underdocumentation of psychiatric disorders on death certificates of suicides (Ruzicka, Choi, & Sadkowsky, 2005; Rockett, Wang, Lian, & Stack, 2007; Rockett, Lian, Stack, Ducatman, & Wang, 2009). The U.S. MCOD study found that decedents with no mention of psychiatric comorbidity on their death certificates carried a three-fold greater potential for suicide misclassification than their opposites (Rockett, Wang et al., 2010). This finding may signify that corresponding deficits in diagnosis and records, at the level of forensic death investigations, adversely impact the validity of suicide case ascertainment.

Similar to poisoning, although typically of smaller magnitude, drowning can be highly problematic for medicolegal authorities in assigning manner of death in the absence of witnesses, suicide notes, and other compelling corroborative evidence (Knight, 1996; Lunetta, Smith, Penttila & Sajantila, 2003). Drowning can be a prominent cause of death within injury of undetermined intent (Ohberg and Lonnqvist, 1998). Even when authorities suspect suicide, there are no specific characteristics at autopsy to diagnose a drowning suicide, and consequently they may relegate many true drowning suicides to the undetermined intent or unintentional drowning categories (Salib & Agnew, 2005; Parai, Krieger, Tomlinson & Adlaf, 2006; Ohberg and Lonnqvist, 2007).

Slow Suicide

Slow suicides, that is, those whose duration extends over several months or even years, seem rarely likely to be registered as suicides in any country (McIntosh & Hubbard, 1988). Whether common or not, a suicidal decision by some individuals may lead to a protracted, tortuous, and lethal trail of excessive use of alcohol and/or other psychoactive substances, malnutrition or undernutrition, or some combination of intentional destructive behaviors. A more obvious, but probably grossly underreported kind of slow suicide is one that commences with an attempt and culminates months later in death from medical complications. Such *sequelae* of suicide attempts are often forgotten or ignored by the healthcare community, and the complication frequently becomes the official underlying cause-of-death (Etzersdorfer, Fischer & Sonneck, 1992). In short, while slow suicide is a real phenomenon, which can directly encompass physical disease in the death process, suicide is usually and understandably operationalized as an acute injury phenomenon.

Decedent Sociodemographics

Cross-national population heterogeneity could have implications for artifactual differences in international suicide rates. Sociodemographic characteristics of suicide decedents, for example, all possess potential for inducing differential misclassification by medicolegal authorities. This issue is illustrated through reference to three such characteristics: age, gender, and race. With respect to age, elderly deaths are less thoroughly investigated than deaths of younger people. Older people are more likely to die from natural causes than younger counterparts, which probably accounts for their lower autopsy rates (Ahronheim, Bernhoic & Clark, 1983; World Health Organization, 1992; Nemetz, Leibson, Naessens, Beard & Tangalos, 1997). They may also be more prone to choose less active or nonviolent methods of suicide, such as drug overdose (Draper, 1996), and slow methods like starvation or deliberate neglect of necessary personal medical attention and treatment (Miller, 1979; McIntosh & Hubbard, 1988). These factors can collectively promote an expectation of greater inaccuracy and incompleteness of suicide certification for the elderly (Schmidtke & Weinacker, 1991). On the other hand, and plausibly related to precluding or minimizing social stigma, medicolegal authorities may be more protective of families of younger people than older people who commit suicide (Rockett, Wang et al., 2010).

Male suicide rates almost invariably exceed female rates across the globe (World Health Organization, 2009), with a few exceptions, most notably in China (Law & Liu, 2008). While this situation may accurately portray the general direction of observed gender differences in international suicide rates, differential misclassification may ensue from females being more inclined than males to select less active suicide methods or mechanisms (Kolmos & Bach, 1987; Rockett, Hobbs et al., 2010). Indeed, adjusting for mechanism of injury death eliminated a

gender differential in potential suicide misclassification (Rockett, Wang et al., 2010). Also warranting more intensive and extensive investigation is the relationship between race, ethnicity, and differential suicide misclassification. A pioneering study conducted in the United States provides direct evidence of this connection. This New York City study, which focused on race and misclassification, compared city health department records of suicides with the suicide records of the office of the medical examiner (Warshauer & Monk, 1978). The medical examiner suicide cases served as the criterion or gold standard. In addition to cases signed out to the health department, they included cases medically diagnosed as suicide, but not attaining equivalent legal status, and cases overlooked by the health department because it had not requested final disposition. Following the introduction of codes for injury of undetermined intent under ICD-8, black suicide cases were almost twice as likely to be undercounted as white cases in health department records. One key factor was the relatively high use by blacks of an equivocal method of suicide, jumping. However, case histories were less complete for blacks than whites. Unknown is whether racism and racial socioeconomic differences influenced history taking. The U.S. MCOD study provided a strong albeit indirect link between race/ethnicity and differential suicide misclassification (Rockett, Wang et al., 2010). Similarly, this study showed a strong inverse association between degree of educational attainment of decedents and potential suicide misclassification. While sociodemographic characteristics variably relate to suicide underenumeration within a country, such differentials are probably much smaller in some countries than others. Thus, adjusting international suicide rates for population composition may ease problems with use of these data.

Sociocultural Milieu

The search for the meaning of suicides must transcend purely individual characteristics and circumstances to incorporate the sociocultural milieu in which these events occur. Like individual-level sociodemographic heterogeneity, sociocultural heterogeneity at the national, regional, and local or community levels could generate artifactual differences in international suicide rates. Dating back to the work of the French sociologist Emile Durkheim in the nineteenth century, religion is a sociocultural variable which has received serious attention from suicidologists (Durkheim, 1897/1951). A famous Durkheimian hypothesis is that adherents of religions or religious denominations, which foster a high degree of social integration, are less prone to suicide than counterparts whose religious affiliation encourages or is permissive towards individualism or the pursuit of free inquiry. The social integration argument was used by Durkheim to explain lower reported suicide rates in Roman Catholic than Protestant countries. A plausible alternative explanation to that of Durkheim in accounting for international suicide rate differences, such as those still frequently reported between predominantly Roman Catholic and Protestant countries, is that these differences reflected variation in the social condemnation of suicide and the reluctance of physicians to certify a death a suicide (Gibbs, 1961).

Some scholars and researchers contend that suicide rates are actually socially constructed, and that the greater the social condemnation of suicide, and the smaller the community support for suicide investigations, the more deficient the reporting (Douglas, 1967; Davis & Spelman, 1968). Whether the impetus is religion, religiosity, legal prohibitions, life insurance policies, or other factors, social condemnation may have motivated suicide decedents to disguise their intentionality. Moreover, it may similarly function to encourage family and friends, and sometimes even medicolegal authorities themselves, to withhold or suppress crucial evidence like a suicide note, or knowledge of behavior or conversation consistent with suicidal ideation. The economic underpinnings of a country or smaller jurisdiction likely directly impact the quantity and quality of resources available to support forensic death investigations in general, and suicide and potential suicide investigations in particular. In one egregious example of social construction of suicide rates that occurred locally, a combination of social and economic pressures motivated the Office of the Medical Examiner, in the New York City borough of Manhattan, wilfully to misclassify suicides within accidental or unintentional injury mortality (Whitt, 2006).

Assessing Measurement of Suicide Rates

Reliability

At least three empirical approaches have been employed by epidemiologists to assess the reliability or precision of international suicide statistics (Speechley & Stavraky, 1991). The first, labeled the experimental approach, is aimed at determining whether medicolegal officials differ in assigning manner of death in a common set of cases. A blinded study, in which Danish and English officials made such assignments for a sample of cases of their opposites, attributed differentials in reported suicide rates to variable ascertainment procedures (Atkinson et al., 1975). However, this finding conflicted with that from another study involving English and Scottish officials (Ross & Kreitman, 1975). These discrepant findings might be explained by the fact that the Anglo-Scottish officials restricted the cases they reviewed to those with an equivocal manner of death.

A second approach to assessing data reliability compares rankings of suicide rates of immigrants in a particular country with rankings in the countries of origin. Two studies utilizing national U.S. (Sainsbury & Barraclough, 1968) and Australian data (Whitlock, 1971), respectively, demonstrated a high degree of consistency between rankings. Rank-order correlation coefficients ranged between 0.8 and 0.9. The authors of both studies concluded that cross-national differences in reported suicide rates were real, and hence not artifacts of variable case ascertainment procedures. These procedures were assumed to be consistent within countries, a weak assumption. The medicolegal system in the United States is diverse and highly decentralized (Committee on Identifying the Needs of the Forensic Science Community, 2009). While all Australian states and territories possess a coronial system, national reporting of suicide has not invariably depended upon it (Cantor & Dunne, 1990). Moreover, immigrants in the United States (Massey, 1995) and Australia (Chiswick, Lee & Miller, 2002) are not uniformly distributed geographically by their ethnicity. Persistent concerns about the reliability of international suicide rates generated a third approach for assessment, namely, rate reformulation.

With rate reformulation, cross-national comparisons are conducted using reported suicide rates and rates combining suicide with other cause-of-death categories prone to obscuring suicides. A 22-nation mortality study, which compared suicide rates with combined rates for suicide and injury of undetermined intent, generated a rank-order correlation coefficient of 0.89 (p<0.001) (Barraclough, 1973). A second study, based on 19 European countries, adopted the same technique, except that accidental or unintentional poisoning deaths were also added to suicides and injury deaths of undetermined intent (Sainsbury & Jenkins, 1982). The correlation coefficient of 0.96 (p < 0.001) reflected highly congruent rankings. A 20-nation study compared the suicide rate with the combined rate for suicide, unintentional poisoning, unintentional drowning, and other violence (as a proxy for injury of undetermined intent) by age and gender (Rockett & Thomas, 1999). Rank-order correlation coefficients ranged between 0.95 and 0.98 for males and 0.93 and 0.98 for females (p<0.001). Thus, expanding the suicide rate category in all of the aforementioned studies, in order to allow for possible misclassification under the main competing injury causes-of-death, did not appreciably alter the rankings reported for suicide rates alone.

Besides epidemiologists, sociologists are the main utilizers of international suicide statistics for research purposes. Sociological interest is driven primarily by the quest for understanding social causation through macro-explanations of cross-national rate variation involving such forces as economic development, industrialization, urbanization, and religion (Quinney, 1965; Barth, Sögner, Gnambs, Kundi, Reiner et al. 2011; Shah, 2008; Stack, 1983). Groundwork for a fourth approach for assessing the reliability of international suicide data was evident in an innovative sociological study (Pescosolido & Mendelsohn, 1986). Taking official U.S. county-level suicide rates as the dependent variable, the authors performed a two-step multivariate analysis using as predictors both putative social causation factors and a set of social construction factors. The latter variables were explicitly incorporated into their model to determine whether systematic misreporting rendered official suicide data inappropriate for testing social causation theories. These variables were as follows: type of system charged with classifying manner of death, procedures for selecting medicolegal officials, and nature of facilities accessible to these officials over the course of an investigation. The authors concluded that while systematic misreporting occurred, it exerted a minor impact on the "explanatory" power of social causation predictors of suicide rates. However, their study was confined to a single country and one racial group, whites. It also omitted age as a covariate, and failed to factor in variable suicide case ascertainment procedures between coroners and medical examiners (Jobes, Berman & Josselson, 1987). Despite such deficiencies, there is a need to apply the research question from that study to the international arena using multivariate, multilevel statistical procedures.

To the extent that they are representative, the reported studies have provided some confidence up to now that international suicide data were spatially and even temporally reliable enough for scientific purposes. However, their reliability is threatened by recent developments, such as the poisoning pandemic, which, while global, is markedly uneven in its growth and composition across space and time. The importance of this pandemic for spatial and temporal data reliability remains an empirical question. Likely diminished by the global downward trend in national autopsy rates (Reseland et al., 2008; Kapusta et al., 2011), as well as by the poisoning pandemic, the validity of international suicide data is far more difficult than their reliability to dismiss as a scientific concern for users.

Validity and Specificity

Adopting language from disease screening and diagnosis, the validity of suicide data can be examined from the complementary perspectives of specificity and sensitivity. Specificity represents the percentage of deaths that are true nonsuicides. Since suicides tend not to be overreported, at least in democratic higher-income countries, the specificity of suicide certification should not be problematic for international research that utilizes their data. Specificity is inferred to reach or approach 100%, since suicide is not a default option for medicolegal officials (O'Carroll, 1989; Timmermans, 2005).

Table 2: Ratio of undetermined injury intent and ill-defined and unknown cause mortality rates to suicide rates for selected countries, 2006

Country	Suicide rate per 100,000	Ratio of undetermined injury intent mortality rate *to* suicide rate	Ratio of undetermined injury intent & ill-defined and unknown cause mortality rates *to* suicide rate
Cyprus	2.4	0.10	18.26
Portugal	9.6	0.60	7.07
Poland	14.3	0.43	4.45
Latvia	19.3	0.36	4.07
Bulgaria	10.5	0.18	3.36
Netherlands	8.7	0.06	3.01
Denmark	10.6	0.26	2.93
Estonia	18.7	0.55	2.58
Spain	6.6	0.02	2.42
France	15.4	0.04	2.30
United Kingdom	6.5	0.53	2.13
Norway	11.2	0.00	2.10
Germany	9.8	0.22	1.93
Italy	5.2	0.03	1.75
Sweden	12.0	0.23	1.57
Slovakia	11.9	0.40	1.50
Luxembourg	13.1	0.09	1.48
Switzerland	14.9	0.06	1.30
Malta	6.0	0.07	1.20
Lithuania	28.9	0.46	1.03
Czech Republic	12.2	0.34	0.97
Slovenia	22.8	0.16	0.80
USA [a]	11.2	0.15	0.58
Austria	13.4	0.12	0.57
Romania	11.9	0.11	0.45
Ireland	9.1	0.16	0.40
Finland	19.0	0.08	0.32
Hungary	23.2	0.04	0.10

Data Sources: World Health Organization, *European Health for All Database (HFA-DB);* Data for Estonia, Hungary, Slovakia, and Spain are for 2005 and for Portugal 2004. [a] United States Centers for Disease Control and Prevention, CDC WONDER

Validity and Sensitivity

Sensitivity represents the percentage of correctly certified suicides. With considerable cross-national variation, sensitivity of suicide certification likely falls well short of the generally high standard attained by specificity. This is due to the interplay of forces already identified, such as sociodemographic characteristics of suicide decedents, their choice of method, duration of dying, the prevalent sociocultural milieu, and nature and training of medicolegal decision makers and staff.

Although the number of misclassified suicides cannot be determined exactly, we could estimate upper and lower limits of the sensitivity of suicide certification. Our upper limit would be 100% under an assumption that the reported suicide rate captures all true suicides. We could estimate a lower limit for

sensitivity under an assumption that deaths categorized as unintentional poisoning, unintentional drowning, and injury of undetermined intent are misclassified suicides. More specifically, this estimate would be calculated as the ratio of the suicide rate to the combined mortality rates for suicide, unintentional poisoning, unintentional drowning, and undetermined intent. One study, which was confined to democratic higher-income countries, reported such lower limit estimates for each gender (Rockett & Thomas, 1999). Based on death certificate data these crude national estimates ranged from 52% to 90% for males and 52% to 91% for females. While many deaths in the nonsuicide categories, which form the basis for such estimates, would likely not be misclassified suicides, an hypothesized offset would come from misclassification of suicides within other nonsuicide cause-of-death categories, including all forms of

unintentional injury (ICD-10:V01-X59) and ill-defined and unknown causes (R95-R99). The elusive ideal would involve basing sensitivity calculations on a suitable criterion standard, such as medical examiner or coroner records that incorporate psychological autopsies. Due to sociocultural constraints, and a concomitant dearth of economic resources and appropriately trained death investigators, it is likely that evidence-based sensitivity estimates of suicide certification would generally be much lower in less developed than more developed countries.

An intuitive variant of sensitivity estimates in assessing the validity of cross-national suicide data is ratio expansion factors which can be readily applied to official suicide rates. We will illustrate these expansion factors using the two most imprecise cause-of-death categories that we documented as being highly prone to contain misclassified suicides, namely, injury of undetermined intent and ill-defined and unknown causes. Both categories reflect data deficits by definition. However, ill-defined and unknown causes is an even more imprecise cause-of-death category than undetermined intent, since the latter explicitly identifies injury deaths by mechanism and the former fails to distinguish whether pertinent deaths were from injury or disease. The ratio of the rate of undetermined intent mortality to the suicide rate is a conservative and conventional expansion factor for estimating a true suicide rate. A second rate ratio, which relates the combined death rate for undetermined intent and ill-defined and unknown causes to the suicide rate, can serve as a liberal expansion factor.

Table 2 presents recent suicide rates for 28 countries. Joint examination of the accompanying conservative and liberal rate expansion factors, in the form of the two sets of rate ratios, suggests caution in interpreting the ratio of the rate of mortality of undetermined intent to the suicide rate alone as even appropriate as a conservative indicator of the degree of suicide undercounting. For example, high potential for undercounting is apparent from the magnitude of the respective ratios of the rate of undetermined intent mortality and suicide for Portugal, Poland, and Latvia, but not for Cyprus, the Netherlands, France, or Norway. Yet all seven countries show potential for substantial suicide undercounting through their respective high rate ratios of combined deaths of undetermined intent and ill-defined and unknown causes to suicide. We conclude that numerous within and across nation incongruencies, between the two sets of expansion factors, indicate that there is a large artifactual component in the observed variation in suicide rates for the 28 countries whose mortality data we accessed.

We contend that a simple although crude assessment can be made of international suicide data quality through joint reference to rate expansion factors based on mortality from undetermined intent and ill-defined causes. Nevertheless, our prior discussion suggests that the utility of this approach may now be complicated or even diminished by the threat to this data quality inherent in the poisoning pandemic. Poisoning suicides are highly prone to misclassification by officials under both injury of undetermined intent and ill-defined and unknown causes. We did factor this likelihood into the combined rate ratio. However, neither of our rate ratios allowed for poisoning suicide misclassification under unintentional poisoning mortality, or potential misclassification within the two leading chronic disease cause-of-death categories, cardiovascular disease and cancer. Misclassification of poisoning suicides under these two disease categories, as well as within ill-defined and unknown causes, should be most problematic in the case of the elderly (Schmidtke & Weinacker, 1991).

Conclusion

Unless specifically addressing issues of data quality, international suicide studies typically use underlying cause-of-death data that derive from national death certificates. For the more developed countries, research has suggested that such data have attained acceptable standards of reliability up to now. However, variable patterns of poisoning death rates and autopsy rates may be compromising these standards. Far less questionable, the validity of suicide certification, or more precisely its sensitivity, poses persisting problems for scientific users.

Scientists using international suicide data from more developed democratic countries for comparative and analytic purposes should be cautious about drawing inferences without implementing appropriate adjustments or controls for individual-level and contextual hetrogeneity. Indeed, we believe that it is timely for pervasive in-depth investigations to be conducted to answer definitively our initial question of whether these data are suitable for what sociologists call social causation studies and epidemiologists label correlational or ecological studies, as well as for intervention studies. We anticipate that the quality of suicide data from less developed countries is grossly deficient, and thus of very limited value for such research.

Suicide is widely acknowledged as a public-health problem (World Health Organization, 2011b) despite the likelihood of serious undercounting (Rockett, 2010). Identifying high-risk groups for suicide, understanding its etiology, and designing and implementing effective prevention programs are

ultimately contingent upon obtaining an accurate and detailed description of its magnitude. There is a grave need to improve the sensitivity of suicide certification in most countries. To this end, and hence to enhance comparability of suicide data, there would be great value in WHO convening a global working group to standardize criteria for defining suicide and ascertaining cases, along the lines of the collaborative multi-disciplinary and multi-organizational effort in the United States that was coordinated by the Centers for Disease Control and Prevention in the 1980s (Rosenberg, Davidson, Smith, Berman, Buzbee et al., 1988). A comprehensive update of the 1971 WHO survey, too, would assist formation of such a group and specification of its responsibilities (Brooke, 1974).

While not necessarily the panacea for addressing suicide data problems, we recommend extensive international use of the psychological autopsy in investigating deaths of uncertain manner (Cavanagh, Carson, Sharpe & Lawrie, 2003; Pouliot & De Leo, 2006; Scott, Swartz & Warburton, 2006). If psychological autopsies were implemented in all or a random sample of such cases, including drug overdoses, this would assist in computing correction factors to refine estimates of true suicide rates. Benefits would also accrue for etiologic understanding and prevention of suicide. For these to occur, there would need to be a reversal of the now common practice of using psychological autopsies to enrich the understanding of validated suicides only (INSERM Collective Expertise Centre, 2004), at the expense of helping resolve intentionality in deaths from equivocal, ill-defined, or unknown causes (Pouliot & De Leo, 2006; Scott et al., 2006). There is renewed interest in the topic of suicide data quality, and hopefully one consequence will be pervasive incorporation of this original motivation for such autopsies (Shneidman & Farberow, 1957). In conclusion, we endorse application of an exciting new tool for improving understanding and prevention of suicide at the contextual level, the sociological autopsy (Scourfield, Fincham, Langer & Shiner, 2010; Fincham, Langer, Scourfield & Shiner, 2011).

Acknowledgments

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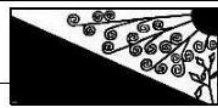Quinney, R. (1965). Suicide, homicide, and economic development. *Social Forces*, 43(3), 401-406.

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