

The impact of changing classifications on official fatal poisoning figures

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Abstract: Background: Official mortality registers are of fundamental importance in research, however the comparability of data across countries and different versions of ICD (International Classification of Diseases) must be monitored. The aim of this article is to examine the impact of ICD coding rules, as there were three major updates between 2002 and 2010 affecting fatal poisoning data.

Method: Data on all fatal poisonings registered by the Estonian Forensic Science Institute from 2000-2009 were coded according to ICD (effective in 2010), correspondence between forensic diagnosis and ICD categories and the impact of changes on ICD examined.

Results: Priority lists to select the main substance in the case of multi-substance poisoning do not always result in the most dangerous drug. In particular, highly toxic fentanyles are rated below psychostimulants, which leads (in the case of Estonia) to significant distortion of drug-related mortality patterns. Implementation of the updates to ICD coding rules stating that aspiration may be due to other conditions results in a 16.8% increase in drug-related mortality. Tranquillizers such as benzodiazepines and barbiturates are absent from this list altogether. There are no guidelines to deal with surrogate alcohol.

Conclusion: Implementation of the 2010 version of ICD must be carefully monitored by statistical authorities and researchers. The priority list for substances could be amended to give priority to fentanyles over psychostimulants and to frequently abused tranquillizers (benzodiazepines and barbiturates) over non-opioid analgesics. Certain combinations of toxic agents could have separate codes in ICD, especially if they have a coalitive effect.

Key Words: death certification, mortality, toxicology, international classification of diseases, illicit drugs.

Official mortality registers are important in research as they contain information on causes and circumstances of death and the demographic and socio-economic background of decedents collected with official death certificates.

Mortality data are highly standardized because they have been regulated for over 60 years by the World Health Organization (WHO) through the International Classification of Diseases (ICD) and, more recently, by other international bodies such as Eurostat [1, 2] and European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) [3].

The ICD specifies standard data collection forms, codes, the rules in nominating underlying cause of death and standard tables to disseminate information. The tenth

revision of ICD (ICD-10) is currently in use [4, 5]; work on ICD-11 has commenced, and its release is expected in 2015.

After the adoption of ICD-10 there were three major updates to the coding rules affecting fatal poisonings [6].

The first, adopted in 2002, was to give preference to acute poisoning over substance abuse syndromes. If these are both indicated on a death certificate, acute poisoning should be selected as the underlying cause of death and therefore appear in official statistics. The second update, adopted in 2003, was to provide mortality coders with rules for the identification of the main substance in the case of multi-substance poisoning, if the certifier did not do this.

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The third major update, adopted in 2005, states that asphyxia due to aspiration of mucus, blood (W80) or gastric content (W78) can be the result of disease condition or poisoning.

The EMCDDA has developed a methodology to extract drug-related mortality data from mortality registries based on ICDs 9 and 10. However, updates to ICD-10 may affect data comparability in ICD-based official statistics, whereas the implementation of ICD updates largely depends on the feasibility and willingness of national authorities to follow international guidelines. Implementation schedules may therefore vary across countries and even across different ICD updates in one country.

For example, US instruction manuals for mortality coders in 2007 already viewed inhalation of gastric content as a direct consequence of a wide range of diseases and external causes including poisonings [7].

However, the priority list for substances has yet to be implemented: combined poisoning by opiates and stimulants are recommended as code X44 ('Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances') [8] which is outside of the span of the illicit drug poisonings code, whereas poisonings with opiates and stimulants alone are given special codes. According to the 2006 ICD-10 update, such a combination should be coded X42 ('Accidental poisoning by and exposure to narcotics and psychodysleptics not elsewhere classified') and therefore included in illicit drug poisoning statistics.

The aim of this paper is to examine the impact of ICD-10 coding rules on fatal poisoning data based on cases certified by the Estonian Forensic Science Institute from 2000-2009.

Method

Data on all 4136 cases of fatal poisonings registered from 2000-2009 by forensic pathologists were transferred from the Estonian Forensic Science Institute (EFSI) to the Estonian Causes of Death Registry. The data file contained forensic diagnosis, manner of death (accident, suicide, assault or unknown), the date and place of autopsy, the personal data of the deceased (personal ID number, date of birth, date of death and age) and the list of noxious substances discovered by the forensic laboratory. Additionally, alcohol concentration in the blood and diagnosis-related comments were obtained from EFSI.

The causes of death were coded and the underlying cause of death selected according to the ICD-10 rules effective in 2010 (involving the three major updates mentioned above). Substance codes were assigned according to the US manual for mortality coders from 2010 [9]. Correspondence between forensic diagnosis and ICD codes was analysed. Poisonings involving carbon monoxide were often not coded as poisonings, as the vast majority was due to fires and the information provided was occasionally insufficient to select an ICD code for the external cause of death.

Results

There were 30 forensic diagnoses in this sample, of which 11 accounted for more than two cases (Table 1). All 1151 cases involving carbon monoxide and 30 cases of combined poisoning (carbon monoxide and usually alcohol) appear on the "CO" line (total N=1181) in Table 1. There were 2732 accidents by poisoning, most of them by alcohol (N=1433), followed by suicide (N=102), mostly by medicine (N=80). As there are specific codes for poisoning by alcohol, corrosive acids, unknown substances and contact with bees in ICD-10, these diagnoses correspond to up to three codes depending on manner of death.

Poisonings by most other alcohols (N=284, methanol, n-butanol, 2-propanol and unspecified surrogates) were coded to the same external cause categories (X45, X65 and Y15) as poisoning by ethanol. 27 cases (9.5%) were coded as poisoning by organic solvents classified to categories other than ethanol (ethylene glycol, diethyl ether and acetone). According to the 2010 ICD-10 update, aspiration (total number: 157) was treated as a result of poisoning and coded respectively.

As poisoning by illicit drugs corresponds to many ICD-10 codes, further investigation into the substances causing it is needed (Table 2). A total of 750 poisonings with illicit drugs were recorded. The majority of cases (N=408) are attributed to poisoning by "other synthetic narcotics" (T40.4), mainly fentanyl and 3-methylfentanyl, reflecting the wide spread of these substances in Estonia. A few cases in this category are attributed to tramadol, also coded T40.4. The second largest group (N=116) are "psychostimulants with abusive potential" (T43.6) which stands for amphetamine, ecstasy, MDMA and caffeine. Mixing fentanyles with psychostimulants seems to be very popular among Estonian drug users.

According to ICD-10 coding rules, psychostimulants are regarded as being more dangerous than fentanyles and other synthetic drugs (T40.3-T40.4); therefore, psychostimulants (T43.6) were selected as the underlying causes of death in these cases. The third group are opiates (T40.2, N=112), mainly morphine and unspecified opiates. As a combination of heroin (T40.1) with other opiates should, according to ICD-10 rules, be coded T40.2, there are only two poisonings with heroin alone. Heroin mostly appears in combination with morphine, so these cases are coded under opiates.

There are 42 poisonings with methadone (T40.3), seven with cocaine (T40.5) and 33 with "other and unspecified narcotics" (T40.6) of which one case is a combination of GHB and tramadol; the rest are unspecified. All of these cases fall within the EMCDDA's Selection B (ICD-10 substance codes T40.0-T40.9 and T43.6, excluding assault). Just 27 cases out of 750 (3.6%) recognized as poisoning by illicit drugs by forensic experts would not be included in Selection B. These cases involve, for example, sedative drugs, antidepressants, chloroquine, dimedrol and multi-substance poisonings.

Altogether, 18 cases were coded as poisonings with non-opioid analgesics, of which 11 were combinations with other medicines. There were also 14

Table 1: Cross-tabulation: forensic diagnoses N>2 (in columns) and ICD-10 external cause codes in rows

	Total	Poisoning by alcohol	Poisoning by carbon monoxide	Poisoning by illicit drugs	Poisoning by alcohol surrogates	Aspiration	Poisoning by medicines	Combined poisoning	Poisoning by unknown substance	Poisoning by acetic acid	Poisoning by household chemicals	Poisoning by honeybee poison
Total	4115	1448	1151	750	284	157	152	116	29	13	9	6
CO	1181		1151					30				
Accidents (X23, X40-46, X48-49)	2732	1433		729	268	154	42	74	16	4	6	6
Suicides (X60-66, X69)	102	2		2	4		80	2	3	8	1	
Assault	1						1					
X85	1						1					
Undetermined (Y10-16, Y19)	99	13		19	12	3	29	10	10	1	2	

Explanations to Table 1: CO – Involvement of carbon monoxide, not coded according to ICD; X23 - Contact with hornets, wasps and bees; X40 - Accidental poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics; X41 - Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified; X42 - Accidental poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified; X43 - Accidental poisoning by and exposure to other drugs acting on the autonomic nervous system; X44 - Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances; X45 - Accidental poisoning by and exposure to alcohol; X46 - Accidental poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours; X48 - Accidental poisoning by and exposure to pesticides; X49 - Accidental poisoning by and exposure to other and unspecified chemicals and noxious substances; X60 - Intentional self-poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics; X61 - Intentional self-poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified; X62 - Intentional self-poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified; X63 - Intentional self-poisoning by and exposure to other drugs acting on the autonomic nervous system; X64 - Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances; X65 - Intentional self-poisoning by and exposure to alcohol; X66 - Intentional self-poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours; X69 - Intentional self-poisoning by and exposure to other and unspecified chemicals and noxious substances; X85 - Assault by drugs, medicaments and biological substances; Y10 - Poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics, undetermined intent; Y11 - Poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent; Y12 - Poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified, undetermined intent; Y14 - Poisoning by and exposure to other and unspecified drugs, medicaments and biological substances, undetermined intent; Y15 - Poisoning by and exposure to alcohol, undetermined intent; Y16 - Poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours, undetermined intent; Y19 - Poisoning by and exposure to other and unspecified chemicals and noxious substances, undetermined intent.

multi-substance poisonings recognized as poisonings with medicines by forensic experts which would be included in Selection B because of the involvement of morphine (N=3), tramadol (N=3), fentanyl (N=1), caffeine (N=3), amphetamine (N=1) and MDMA (N=1), for example. The total number of Selection B cases in our study would be 896, including 128 cases of aspiration.

Another diagnosis used by forensic doctors in the past and absent from ICD-10 is poisoning by alcohol surrogates, not mentioning the exact substance. No guidelines were available to deal with this issue. Unspecified surrogates were coded to fusel oil (T51.3), which may lead to over-estimation in this category. The majority of cases, however, were due to methanol (T51.1, N=151). Ethylene glycol (T52.3) was ranked

third (N=16), followed by 2-propanol (T51.2, N=11) and acetone (T52.4, N=7) (Table 3).

Discussion

Over the 10-year period in question, 4136 poisoning cases were diagnosed by forensic doctors in Estonia. Poisonings involving carbon monoxide (N=1181) accounted for various external causes. For example, after house fires, poisoning with carbon monoxide has two external codes (X47 and X00), so they are difficult to classify – without one code the information remains insufficient.

Poisonings by alcohol (ethanol) was the biggest group with a total of 1448, coded mostly under X45 (accidental poisoning with alcohol), which also contains

Table 2. Diagnose = poisoning by illicit drugs. ICD-10 external cause codes in columns, ICD-10 substance codes in rows

	Total	X40	X41	X42	X43	X44	X62	Y11	Y12	Y14
Total	750	3	130	591	2	3	2	4	14	1
T37.2	1					1				
T39.2	2	2								
T39.3	1	1								
T40.0	1			1						
T40.1	2			2						
T40.2	112			110			1		1	
T40.3	42			35					7	
T40.4	408			406			1		1	
T40.5	7			7						
T40.6	33			28					5	
T40.7	2			2						
T41.1	2					2				
T42.1	3		3							
T42.3	4		3					1		
T42.4	4		4							
T42.7	1		1							
T43.0	5		5							
T43.2	1		1							
T43.6	116		113					3		
T44.3	2				2					
T45.0	1									1

Table 3. Diagnose = poisoning by alcohol surrogates. ICD-10 external cause codes in columns, ICD-10 substance codes in rows.

	Total	X45	X46	X49	X65	X66	Y15	Y16	Presence of ethanol stated	
		Accidental			Suicide		Unknown		Number	%
Total	284	245	22	1	3	1	9	3	53	18,7
T51.1	151	142			3		6		22	14,6
T51.2	11	9					2		6	54,5
T51.3	94	93					1		19	20,2
T51.8	1	1								0,0
T52.3	16		14					2	3	18,8
T52.4	7		6					1	2	28,6
T52.8	3		2			1			1	33,3
T52.9	1			1						0,0

other alcohols. This already shows the need for and importance of T codes according to substance in addition to X and Y codes according to intention. Unspecified surrogates (N=94) were coded to fusel oil (T51.3). This was a diagnosis from the early 2000s, when forensic doctors did not mention the exact other alcohol on the death certificate; this practice has since changed.

There were 750 cases (18%) of illicit drug poisonings in this study. The problems occurred in poisonings with heroin (N=2), where it is likely that cases of heroin metabolite 6-monoacetyl morphine being found in the biological sample were classified as poisonings with opiates (morphine). The group of poisonings by unspecified illicit drug (T40.6, N=33) is as big as it is because in the first few years of the study the Estonian Forensic Laboratory had fewer opportunities

and less experience in determining narcotics, fentanyles included. Multi-substance poisonings are known to be a challenge for classification and coding [10, 11].

The introduction of a priority list for substances with the 2006 update to ICD-10 is certainly a step forward. Currently it stands as follows: Opioids (T40.0-T40.2) > Cocaine (T40.5) > Psychostimulants with abusive potential (T43.6) > Synthetic narcotics, other and unspecified narcotics (T40.3-T40.4, T40.6) > Antidepressants (T43.0-T43.2) > Non-opioid analgesics (T39.-) > Drugs and substances not listed above.

Our data showed that 98 out of 116 cases (84.5%) coded as poisonings by psychostimulants were caused by a combination of psychostimulants with synthetic drugs, mostly fentanyles, classified to T40.3-T40.4. Such a high proportion of combined poisonings causes suspicion if

the selected substance was the main or even an important contributor to death. In combination with other substances, fentanyles – which are extremely toxic but have no special ICD code – must be ranked first ahead of opioids.

On the other hand, caffeine, which belongs to the psychostimulants group, causes death in very rare cases, but is ahead of synthetic narcotics and alcohol. Mentioned on the death certificate, caffeine can present the wrong information about the cause of poisoning death.

It is correct to use a diagnosis of combined poisoning in cases of poisoning by substances of a similar toxicity or if all of the determined substances are found in a lethal concentration or when the substances have a coalitive effect but appear in a therapeutic concentration. As such, in these cases it is not right to choose one substance for coding: a new code is needed for such combined poisonings.

In cases of death by aspiration of gastric content, Estonian forensic doctors did not always mention on death certificates in the past the reason for aspiration (mostly poisoning by narcotics or alcohol). Since 2010 it has been mandatory to indicate poisoning on medical death certificates if the substance has been determined; therefore, a certain increase in poisoning statistics is predictable. Implementation of ICD-10 is known to affect time series of poisoning mortality [12, 13]. According to our study, the implementation of the 2010 ICD-10 update affects poisoning statistics significantly: 98 cases of aspiration should be added to 616 poisonings in the X42 category (+15.9%), 48 to 170 in X41 (+28.2%) and 129 to 767 in Selection B (+16.8%).

The number of diagnoses of poisoning by unknown substances is quite low according to this study (N=29), but in routine work this causes problems. The first main group of these cases is patients who have been treated aggressively in the intensive care unit of a hospital, and after massive fluid infusion it is impossible to determine the substance that caused the poisoning. The other group is cases where preliminary and additional data and autopsy findings suggest that the cause of death is poisoning but a toxic agent cannot be determined in

the laboratory because there are so many new synthetic narcotics on the illegal drug market.

In poisoning cases, forensic doctors frequently have problems determining the manner of death as this requires correct additional data which is not always available. To avoid further legal problems, the ICD code for “poisoning of undetermined intent” is being used more and more frequently. Final decisions on intent are made at the end of police investigations.

Conclusions

The reliance on diagnosis poisoning by illicit drugs results in 2,5% under-reporting as a number of Selection B cases are diagnosed as combined poisoning or poisoning by medicines.

96.4% of poisonings by illicit drugs diagnosed by Estonian forensic doctors coincide with Selection B developed by EMCDDA. Implementation of the 2010 ICD-10 update stating that aspiration may be due to other conditions would result in a significant increase in observed drug-related mortality (16.8% in our data) and must therefore be carefully monitored by statistical authorities and researchers.

The priority list for substances introduced as part of the 2006 ICD-10 update could be amended to give priority to fentanyles over psychostimulants and to frequently abused tranquillizers (benzodiazepines and barbiturates) over non-opioid analgesics. Certain combinations of toxic agents could have separate codes in ICD, especially if they have a coalitive effect. The quality of causes of death statistics is sometimes a matter of heated debate [14, 15]; minor changes to ICD coding rules could greatly improve accordance between clinical data and official mortality registries.

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