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Ischemic heart disease: medical certificate of cause of death analysis

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Aim. According to data from the Moscow Oblast civil registry office in 2020, to analyze medical certificates of cause of death (MCCD), where the code from "Ischemic heart disease" (IHD) (I20-I25) group is indicated as underlying cause of death (UCD).

Material and methods. A total of 23193 deaths with I20-I25 codes (UCDs) were included. We assessed the prevalence of individual IHD types, the frequency and patterns of complications, the average age of deceased persons, the proportion of women and men, place of death registration.

Results. The average age of the deceased was 73,6±12,5 (men, 68,8±10,5; women, 78,4±12,5; p<0,0001). The proportion of women who died under the age of 70 was <20%, men — >50%. Half of the deaths were registered at home, a third in a hospital, and the rest elsewhere. Taking into account age and sex, inhospital death from myocardial infarction (MI) is recorded 12 times more often than in "other forms of acute IHD". Chronic forms of IHD were registered in 76,9% of cases; in 47,3%, such IHD form as "Atherosclerotic heart disease" was noted. The proportion of deaths from acute MI and deaths after MI was 37,3%. In 92,1% of MCCDs of "other forms of acute IHD", "acute coronary insufficiency" is indicated. Differences in the prevalence of various IHD forms between men and women were significant (p<0,0001). In female mortality pattern, there are 3 times less deaths from other (non-MI) acute forms of IHD and almost 2 times less deaths from old myocardial infarction and cardiac aneurysm. As the immediate cause of death, heart failure was indicated in 78,9%, while among those with prior MI — in 91%. In other acute forms of IHD, acute coronary insufficiency was indicated in 89%.

Conclusion. A high proportion of deaths with unspecified acute and chronic forms of IHD as the cause of death, especially in young men, requires a comprehensive study and development by the Russian Society of Cardiology of criteria for death from various IHD forms.

Keywords: ischemic heart disease, mortality, medical certificate of cause of death, underlying cause of death.

Relationships and Activities: none.

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In previous papers, we have repeatedly noted that the statistics of cardiovascular mortality are significantly influenced by subjective factors (defects in filling out medical certificates of cause of death (MCCD), different approaches to determining the underlying cause of death (UCD), including those associated with different interpretations of the International Classification of Diseases, Tenth Revision (ICD-10), the use of different codes for the same diagnosis) [1-3].

The underlying disease is often (but not always) considered to be UCD. Only one underlying disease with complications is recorded in MCCD Part I (Figure 1) [4]. In the Federal State Statistics Service (Rosstat) data (and in most other countries), the analysis of death causes is carried out only by UCD. Thus, if the MCCD indicates a complication of the underlying disease or causes contributing to death (concurrent, background), then such cases can only be analyzed if there are appropriate personalized databases (registers).

Ischemic heart disease (IHD), as defined by the World Health Organization and the International Society of Cardiology in 1979, defined as myocardial impairment due to an imbalance between coronary blood flow and myocardial requirements caused by changes in the coronary circulation [5]. In the presented definition, the term "coronary artery atherosclerosis" is not mentioned, and the presence of atherosclerosis is not equated with the concept of IHD, just as its absence does not exclude the presence of IHD. In the recommendations of the Russian Society of Pathologists, the concept of IHD includes pathological processes that occur as a result of acute or chronic myocardial ischemia caused by spasm, narrowing or obstruction of the coronary arteries with their atherosclerosis [6]. The Russian clinical guidelines for stable IHD (2020) indicate that "IHD is myocardial damage caused by impaired blood flow in the coronary arteries, resulting from organic (irreversible) and functional (transient) changes" [7]. Until 2019, foreign guidelines used the terms "coronary artery diseases", "stable coronary artery disease", and in 2019 the European Society of Cardiology proposed a new term "chronic coronary syndromes" [8]. In 2020, the second consensus document was published, according to which the concept of "ischemia with non-obstructive coronary arteries" is introduced [9].

Thus, at present there are no clear diagnostic criteria and definitions of what is IHD, especially as UCD. Such vagueness of the criteria implies a rather loose interpretation of the cause of death "due to IHD", contributes to significant differences in mortality rates from IHD between countries and regions. Based on the foregoing, the study of MCCD, in which one of the IHD types is indicated as UCD, is important for understanding the causes of death at the population level, evaluating the effectiveness of certain healthcare programs, planning and organizing preventive and therapeutic measures aimed at reduction in mortality rates.

22. Причины смерти	Приблизительный период времени между началом патологического процесса и смертью	Код по МКБ
I а) _____ болезнь или состояние, непосредственно приведшее к смерти		
б) _____ патологическое состояние, которое привело к возникновению вышеуказанной причины, указанной в пункте «а»		
в) _____ **первоначальная причина смерти указывается последней**		
г) _____ внешняя причина при травмах и отравлениях		
II. Прочие важные состояния, способствовавшие смерти, но не связанные с болезнью или патологическим состоянием, приведшим к ней, включая употребление алкоголя, наркотических средств, психотропных и других токсических веществ, содержание их в крови, а также операции (название, дата) _____ _____		

Figure 1. Fragment of account form № 106 "Medical certificate of cause of death".

Table 1

Grouping certain IHD forms depending on their clinical significance

	Codes	Names	Note
1	I21-I22.9	MI	In cases where the code did not match the text description of MI, the case was accounted as MI
2	I20, I24-I24.9	Other IHD forms	Text description includes unstable angina, acute coronary insufficiency, coronary thrombosis without MI, sudden coronary death, other acute IHD forms
3	I25-I25.0,1,8,9	Chronic IHD forms (unspecified forms)	This group includes all cases with these codes, if the text description did not contain MI, ischemic cardiomyopathy, or post-infarction cardiosclerosis/prior MI
4	I25.5	Ischemic cardiomyopathy	In cases where the code was not supported by the words "ischemic cardiomyopathy", the case was counted in group 3
5	I25.2	Prior MI/postinfarction cardiosclerosis	+ Any code from the I20-I25.9 group if the text indicates a prior MI/postinfarction cardiosclerosis as UCD
6	I25.3	Heart aneurysm	All cases are indicated with the correct code, except for 1 — non-existent code

Abbreviations: IHD — ischemic heart disease, MI — myocardial infarction, UCD — underlying cause of death.

The aim of the study was, according to data from the Moscow Oblast civil registry office in 2020, to analyze MCCD, where the code from IHD (I20-I25) group is indicated as UCD.

Material and methods

Data on the deceased was obtained from the MCCD using the four-digit ICD-10 codes entered into the database of mortality of Moscow Oblast residents in 2020.

The data analysis was carried out in several stages. At the first stage, all MCCDs were selected, in which codes from the IHD group (I20-I25) according to ICD-10 were indicated as UCD — a total of 23206. The analysis did not include cases if the IHD group codes were indicated only as an immediate cause of death (ICD) or a contributory cause of death. At the second stage, 13 cases of inconsistency between the textual diagnosis indicated as UCD and IHD codes (I20-I25) were excluded. Thus, the analysis included 23193 deaths with IHD as UCD, and 6 groups of causes were formed based on their clinical significance (Table 1).

At the third stage, the codes and description of complications were assessed. The following ICDs were taken into account:

- heart failure (HF), I50 and other codes, if HF was written in the text of immediate cause,
- hemopericardium/tamponade/cardiac rupture,
- myocardial infarction (MI) (listed as an immediate cause in addition to the specified UCD),
- other MI complications (rupture, thrombus),
- codes and textual description considering sudden death: ventricular fibrillation, acute coronary insufficiency/other types of acute IHD, cardiac arrest,
- pulmonary embolism (PE),
- cerebral edema,
- codes and textual description, considering incorrect textual description and/or coding of immediate cause (atherosclerotic cardiosclerosis, ischemic cardiomyopathy, diabetes, peritonitis),
- pneumonia (not hypostatic),
- peptic ulcer with bleeding or anemia due to bleeding,
- empty (not filled lines).

This study did not assess the frequency and pattern of concurrent and background diseases reported in Part II of the MCCD.

At stage 4, for each group, the following are determined:

1. The average age of the deceased with the calculating standard deviation.
2. Proportion of women and men.
3. Incidence of listed complications.

To compare the mean values, the nonparametric Mann-Whitney test was used, and the frequencies were compared using chi-squared test. Using logistic regression (Wald test), we assessed the influence of factors such as age, sex, place of death (hospital, home, other place) on the indication of MI or other acute IHD types in the MCCD as the death cause.

Results

The proportion of women and men who died was 50,2% and 49,8%, respectively. The mean age of the deceased was 73,6±12,5 years (minimum, 19 years; maximum, 103 years). The mean age of men and women was 68,8±10,5 years and 78,4±12,5 years, respectively ($p<0,0001$). More than half of those who died were between the ages of 70 and 89 (Table 2). However, among men, the proportion of deaths at the age of 50-69 years and 70-89 years

Table 2

Distribution of deaths by age group and sex

Age groups (years)	Abs.	%	Abs.	%	Abs.	%
			Men		Women	
<30	23	0,1	18	0,2	5	0,04
30-49	917	4,0	769	6,7	148	1,3
50-69	7398	31,9	5245	45,4	2153	18,5
70-89	12914	55,7	5043	43,7	7871	67,6
Over 90	1936	8,3	465	4,0	1471	12,6
Total	23187	100,0	11540	100,0	11648	100,0

was almost equal (~45%), and among women, the proportion of deaths in the 70-89 age group was almost 68%. The proportion of women who died under the age of 70 was 2,5 times less (<20%) than among men (>50%).

In a third of the deceased, death was registered in a hospital. In almost all age groups (with the exception of those aged 30-49), deaths at home predominated (Table 3). The minimum proportion of deaths in a hospital was registered at the age of up to 50 years, the maximum — at the age of 70-89 years.

Table 4 presents the odds ratio of MI as the death cause in the MCCD compared to other acute IHD forms as the UCD, taking into account factors such as sex, age, and place of death. Taking into account age and sex, death from MI in the hospital is recorded 12 times more often than in other acute IHD forms. The male sex is less often associated with death from MI than with other acute IHD forms: among all deaths from MI, the proportion of men was 51,2% (n=1682), and with other acute IHD forms — 77,1% (n=1593).

In the vast majority of MCCDs, chronic IHD forms were indicated (group 3), such as "atherosclerotic cardiosclerosis", "small-focal cardiosclerosis", "atherosclerotic cardiovascular disease" (47,3%). In 92,1% of MCCDs, in which code I24.8 (other forms of acute ischaemic heart disease) is indicated as UCD, the text indicates "acute coronary insufficiency"; in 8 cases, acute coronary syndrome was indicated as UCD (with code I24.8), while in 4 cases — acute IHD, unspecified. In the remaining MCCDs, code I24.8 was accompanied by the decoding "sudden death" or "IHD: angina". The proportion of deaths from acute MI and after MI (indicated in the MCCD as postinfarction cardiosclerosis (PICS), prior MI), heart aneurysm (probably as a result of myocardial infarction) was 37,3%. Among those who died from MI, the proportions of women (49%) and men (51%) were comparable, while the proportion of men was higher in the group of deaths from "other acute IHD forms " (77%), PICS (60,6%) and heart aneurysm (66,4%). The proportion of women is higher among those who died from ischemic cardiomyopathy (63,6%) and undefined chronic IHD forms (59,3%). In the structure of deaths in women, the proportion of "other acute IHD forms" is 3 times less and

Table 3

Mortality pattern for ischemic heart disease depending on the age group and place of death

Age group (years)	Parameter	Home	Hospital	Another place
<30	Abs.	11	2	10
	%	47,8	8,7	43,5
30-49	Abs.	372	99	446
	%	40,6	10,8	48,6
50-69	Abs.	3245	1897	2256
	%	43,9	25,6	30,5
70-89	Abs.	6102	4497	2315
	%	47,3	34,8	17,9
Over 90	Abs.	1057	512	367
	%	54,6	26,4	19,0
Total	Abs.	10787	7007	5394
	%	46,5	30,2	23,3

Table 4

Probability of indicating MI in MCCD as compared to "other acute IHD forms" depending on age, sex and place of death

Factors	P	OR	95% confidence interval	
			Lower	Upper
Male	<0,0001	0,536	0,46	0,62
Age	<0,0001	1,05	1,05	1,06
Place of death	reference value — died at home			
Hospital	<0,0001	12,5	10,5	15,7
Another place	0,12	0,9	0,7	1,0

Abbreviation: OR — odds ratio.

Table 5

The prevalence of certain IHD forms among men and women

Groups	Nosology	Abs.	% of IHD	Abs.	% of IHD	Abs.	% of IHD
				Men		Women	
1	MI	3299	14,2	1682	14,6	1617	13,9
2	Other acute IHD forms	2066	8,9	1593	13,8	473	4,1
3	Chronic IHD forms (unspecified)	10962	47,3	4461	38,6	6501	55,8
4	Ischemic cardiomyopathy	1511	6,5	550	4,8	961	8,2
5	Prior MI/postinfarction cardiosclerosis	5138	22,2	3114	27	2024	17,4
6	Heart aneurysm	217	0,9	144	1,2	73	0,6
Total	Ischemic heart disease	23193	100,0	11544	100,0	11649	100,0

Abbreviations: IHD — ischemic heart disease, MI — myocardial infarction.

Table 6

Mean age of those who died from various IHD forms

IHD forms	Mean	Standard deviation	Minimum	Maximum
MI	72,1	12,6	31	102
Other acute IHD forms	59,8	13,5	19	99
Chronic IHD forms (unspecified)	76,2	11,2	27	103
Ischemic cardiomyopathy	76,4	10,9	24	99
Prior MI/postinfarction cardiosclerosis	74,1	11,4	36	102
Heart aneurysm	74,1	11,3	46	96
Total	73,7	12,5	19	103

Abbreviations: IHD — ischemic heart disease, MI — myocardial infarction.

Table 7

The prevalence of the most common immediate causes of death in MCCD, depending on IHD forms

Groups by IHD forms	Common immediate causes of death
1	HF — 2203 (66,8%), hemopericardium/tamponade/rupture — 755 (22,9%), MI — 240 (7,3%). Total 97%
2	«Sudden death*» — 1837 (88,9%), HF — 217 (10,5%), empty lines — 0,3%. Total — 99,3%
3	HF — 9746 (88,9%), conditions that are unlikely to be attributed to immediate causes of death — 566 (5,2%), PE — 334 (3%). Total — 97,3%
4	HF — 1292 (85,5%), PE — 94 (6,2%), conditions that are unlikely to be attributed to immediate causes of death — 75 (5%). Total — 96,7%
5	HF — 4726 (92%), conditions that are unlikely to be attributed to immediate causes of death — 180 (3,5%), PE — 139 (2,7%). Total — 98,2%
6	HF — 193 (88,9%), PE — 13 (6%), «sudden death*» — 4 (1,8%). Total — 96,7%

Note: * — codes and text description implying sudden death, ventricular fibrillation (I49.0), other arrhythmias, acute coronary insufficiency/other acute IHD forms (I24.8), cardiac arrest (I46.9).

Abbreviations: IHD — Ischemic heart disease, MI — myocardial infarction, HF — heart failure, PE — pulmonary embolism.

almost 2 times less deaths from PICS and heart aneurysms (Table 5). Differences in the structure of death from different IHD forms between men and women were significant (p<0,0001).

In total, chronic IHD forms were registered in 76,9% of cases (among men — 71,6%, women — 82,1%; p<0,0001). The mean age of those who died from chronic IHD (75,6 years) was higher than from acute forms (67,4 years; p<0,0001). These differences are mainly due to the lower age of those who died from other (than MI) acute IHD forms (Table 6).

Significantly lower mean age of the deceased is observed in the group of "acute IHD forms (without

Table 8

The prevalence of the three most common immediate causes of death, depending on the place of death

Place of death	Common immediate causes of death
Hospital	HF — 5555 (79,3%), conditions that are unlikely to be attributed to immediate causes of death, 423 (6%), PE — 309 (4,4%). Total — 89,7%
Home	HF — 8711 (80,8%), «sudden death» 946 (8,8%), hemopericardium/tamponade/rupture — 439 (4,1%). Total — 99,3%
Another place	HF — 4111 (76,1%), «sudden death» 853 (15,8%), hemopericardium/tamponade/rupture — 201 (3,7%). Total — 95,6%

Abbreviation: HF — heart failure.

indication of MI)". The differences were significant (p<0,0001) in pairwise comparison (adjusted by Bonferroni and Thamhain methods) with the mean age of the deceased from other groups. The mean difference between the mean age of those who died in group 2 ranged from 12 years (compared with group 1) to 16 years (groups 3 and 4). The mean age of those who died from myocardial infarction was significantly less than in groups with chronic IHD forms, but the differences were not so significant (by 4 years on average with groups 3 and 4 and by 2 years with groups 5 and 6).

HF was most often indicated as UCD (n=18377; 79,2%), while the second most common cause was "sudden death" (ventricular fibrillation, acute coronary insufficiency, sudden death) (n=2029; 8,7%). Hemopericardium/tamponade were registered in 759 cases (3,3%), PE — 609 cases (2,6%), MI — 242 cases (1%), other complications (intracardiac thrombosis, coronary thrombus, septal defect as a current complication of acute MI) — 9 cases (<0,1%), cerebral edema — 53 (0,3%), pneumonia — 34 cases, and ulcer bleeding/anemia — 24 cases (<0,1%). In 829 (3,6%) MCCDs, diseases/conditions were indicated that can hardly be attributed to complications of the underlying disease, and in 223 (1%) MCCDs, the immediate cause lines were not filled in (Table 7).

Table 8 presents the 3 most common immediate causes depending on the place of death.

Discussion

The results of this study indicate a high proportion (70%) of out-of-hospital deaths among those who have one of the IHD codes as UCD. But these results do not allow us to conclude that the provision of care to IHD patients is inadequate. It cannot be ruled out that the majority of immediate causes of out-of-hospital deaths (ambulance, street, public place) had life-threatening cardiac arrhythmias (ventricular fibrillation), sudden cardiac arrest. But it is very difficult to confirm or refute in such situations, even with post-mortem examination. This hypothesis can be supported by the fact that before the age of 50, the proportion of out-of-hospital deaths was almost 90%. This proportion decreases in the age group from 50 to 90 years, and then increases again. In most of these cases, acute HF or coronary insufficiency, other acute IHD forms are indicated as immediate causes of death.

It is noteworthy that in almost half of all deaths (55% for women; 38% for men) chronic (unspecified) IHD forms, such as "atherosclerotic cardiosclerosis", "atherosclerotic heart disease", and "cardiosclerosis" are indicated as UCD. In the United States, the proportion of such deaths was 66,5% (67% for women, 66% for men) [10]. In fact, the number of such deaths is comparable to the number of deaths from acute MI and its consequences (heart aneurysm, ischemic cardiomyopathy, PICS). In almost 88% of deaths in our study, HF/acute coronary insufficiency/ventricular fibrillation/other acute IHD forms were registered as immediate causes of death.

Currently, based on the codes and analysis of the text recorded in the MCCDs, it is impossible to understand what proportion of deaths is due to or associated with surgical/endovascular interventions, despite the fact that in all statistical reports on the hospital activities there is an indicator of post-operative mortality. Although these treatments have been widely used for patients aged >50 years, ICD codes such as I97.0 (postpericardiotomy syndrome), I97.1 (other postprocedural cardiac functional disturbances); I97.8 and I97.9 (other post-procedural disorder of circulatory system) are extremely rare. Thus, in the United States, only 34 such cases were registered in the MCCD [10].

There is no clear guidance in the ICD and national guidelines on coding death causes in following cases: 1) sudden death in a person without pathology detected during life, 2) acute MI with and without endovascular/surgical revascularization, 3) chronic IHD forms and chronic progressive HF, taking into account the use of invasive treatment methods.

Therefore, it is difficult to understand the contribution of key pathological links leading to death, and therefore, to change approaches to healthcare organization. It cannot be ruled out that at present, both during life and after death, there is an IHD overdiagnosis, while a significant number of deaths may be due to another pathology that requires completely different approaches to treatment. For example, alcohol abuse (in the young) or undiagnosed cardiac amyloidosis (in the elderly).

Approaches to the definition of a particular pathology can significantly affect mortality rates from certain causes and groups of causes [2, 3, 11]. And this problem has been repeatedly discussed, as well as the problems of accounting causes of death from certain cardiovascular diseases/conditions outside the existing framework of the ICD-10. The Russian Society of Cardiology and the Society of Pathologists work on adapting the domestic clinical classification of IHD to the requirements and terminology of ICD-10 [6, 7]. Thus, according to the 2018 National Guidelines for Determining the Risk and Prevention of Sudden Cardiac Death, the main causes of cardiovascular death are the progression of chronic HF (50% of all deaths) and sudden cardiac death (50%) [12]. However, the analysis of MCCD data does not make it possible to draw such a conclusion, since there are no clear criteria for such an assessment and understanding of the death causes from and with IHD.

Study limitation. The limitation of this study includes the fact that when conducting a MCCD analysis, errors in filling in the MCCD and coding cannot be ruled out, as evidenced by both Russian and foreign researchers.

Conclusion

The study results indicate a significant proportion of out-of-hospital deaths and deaths from those IHD forms, which, unlike MI, do not have clear criteria for establishing a diagnosis. Immediate cause of death in such cases most often indicates acute HF or coronary insufficiency. At present, the issues of UCD differentiation against the background of "acute cardiac or coronary insufficiency" and accounting deaths after surgical and endovascular interventions, which is necessary to correct programs to reduce mortality rates, have not been fully resolved.

Relationships and Activities: none.

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