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Quality analysis of the completion of death certificates in Madrid

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ABSTRACT

The Death Certificate (DC) is an important medical-legal. However, despite its importance, the professionals involved are not well trained and consequently there exist many errors in completion. This situation can cause misclassification in mortality statistics, but also it means that many natural deaths end up being studied by the medical examiner, entailing a waste of resources. An analysis of 1974 DCs in Madrid is carried out to assess the quality of the completion, discover the main errors in the certificates and analyse possible improvement strategies. The study highlights that the demographic and personal information about the deceased is mostly correct; in 16,2 % of the cases the official document was not used; 91 % of the DCs in the sample have a certain degree of error (major or minor); and 38,4 % of the documents chain of causes were incorrect. The main measure proposed is increased training for certifiers, which should begin with activities at undergraduate level and continue later with periodic training workshops. In addition, we consider it essential to digitalise DCs in Spain. This would greatly facilitate completion. It is also proposed that medical examiners use, in Spain, a document similar to the official DC so that the statistics of violent and natural deaths which have required the medical examiners' intervention will improve.

1. Introduction

The Death Certificate (DC) is a medical-legal document which is necessary to record the death of a person in the Civil Registry [1–9]. Furthermore, it is essential for the study of mortality causes [2–14]. Considering the relevance of this document, it is important that its content be reliable and trustworthy for an effective development of public health policies based on the information it provides [7,9,12,14–19]. Moreover, it is important for research and as a means of evidence in various judicial proceedings which may require certification of any information contained in the DC document [5,20]. The completion of the DC is one of the physician's responsibilities [1,4,9,21–23]. It is a medical procedure necessary in medical assistance at the end of life which, if left undone in Spain, requires judicial intervention [24]. The absence of a DC is notified to the Court along with the requirement of a medical examiner's intervention and a legal autopsy [4,24]. When a death is natural and occurs in a patient with a known medical history, activating this procedure wastes a large amount of public resources [18] and may well cause emotional damage and imply medical-legal consequences for relatives of the deceased [9,22,25].

In Spain, external post-mortem examinations are performed by attending physicians. Normally, it is recommended that the certifier is the physician who usually attends the patient, but any doctor who acknowledge deceased antecedents or can access to patient's medical records is allowed to certify. Spanish system does not have a coroner who can sign the DC. Thus, when the cause of death cannot be established after external examination of the body or analysis of the patient's medical records or in case of violent Manner Of Death (MOD) (accident, suicide or homicide), the judge should be notified, and medical examiner will proceed with the post-mortem external examination and legal autopsy if necessary [17]. The DC should be completed in natural deaths in which the cause of death can be

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deduced from the clinical records. Medical examiner is not allowed to complete the DC having a special document in these cases with judicial intervention. In Spain, there is only one accepted document of DC, the one distributed by the National Organisation of Medical Colleges (OMC) [26]. However, some hospitals and health services have developed their own form. Up until 2009, the OMC document model used contained very basic information. In 2009 the OMC implemented a new certificate model seeking to comply with the model proposed by the World Health Organisation [27]. This new model collects more detailed information and uses a completion system that enables faster codification and facilitates data interpretation by the National Statistics Institute (INE). The document has subsequently been updated: the municipality of the deceased has been added in the section referring to place; numerical identification by the physician has been made more detailed for accuracy; after the coronavirus pandemic, a section was added regarding the biological hazard of the corpse, in compliance with the Police Morgue Sanitation guidelines; and the latest update registers the possible medical inconveniences for cremation.[5]

Despite its usefulness, the DC is a document that generates conflict for the physician responsible [22]. In Spain, there is not regular education on DC, so it depends on each medical education programme or on the interest of doctors to practice this area specifically. Furthermore, training for its completion is lacking and there is insufficient awareness of its importance [2,5,6,8,14,16–18,28,29]. Therefore, several studies in various countries have compiled the deficits and mistakes commonly produced in filling out the document that hinder the adequate use of the DC and even compromise its utility for public health [5,6,9,11–13,25,28,30–37].

In 2019, we presented a pilot study that could be useful as a reference for the development of a more comprehensive study about the completion of the DC in the city of Madrid (Spain) [38]. This study showed that physicians found the new DC more difficult to complete than the old one, that the new document was missing a section for the place of death and observations, that there was an abusive use of the term “cardiorespiratory arrest” as an immediate cause of death and that stressing the importance of training for physicians in filling in the DC was considered advisable to avoid the unnecessary judicialization of natural deaths. The need was posed for a more in-depth assessment of the DC completion considering only those variables that specifically affect the **two** main functions of the document: it's use at the Civil Registry to record the decease (identification, date, time and location) and the mortality statistics (causes of death, time of evolution and chain of causes). Another goal of the research was to observe if a further practice in the completion of the new document by the OMC over time showed an improvement, as the initial study had proven a faultier completion of the new document than that of the old one.

The objective of this research is thus to prove the possible existence of mistakes or flaws in the completion of the certificate and the differences between the documents in use regarding their different formats. For this purpose, a descriptive cross-sectional study of DC documents was carried out to prove if physicians fill out each section of the document correctly, which are the main mistakes made and to propose improvements that can make the completion of the document easier.

2. Material and methods

This research consists of a descriptive cross-sectional study of 1974 DCs documents from the municipality of Madrid. The sample was gathered from the Civil Registry (authorisation for the sample collection was granted by the judge in charge of deceases at the Civil Registry of Madrid) selecting all the documents produced in May 2018. From the collected documents, one was discarded for being illegible, making it impossible to gather all its information. In addition, 18 documents were discarded because they were not death certificates but forensic reports (issued by the medical examiner acting as the physician for the civil registry in cases that had been judicialized but in which the examining judge had agreed the judicial autopsy did not need to be performed). The sample analysed therefore added to a total of 1958 DCs. Only the necessary data for the study were gathered, protecting the confidentiality of the deceased.

A file with all the analysed variables has been attached as supplementary material.

Regarding the cause of death, the immediate, underlying and intermediate causes plus the “other conditions” section are all researched. In relation to the immediate and underlying causes, the completion of the document is considered adequate when it refers to an entity coded in the CIE-10, regardless the device or origin of the decease. On the other hand, an DC completion is considered faulty when the registered cause is incorrectly defined (such as cardiorespiratory arrest, cardiac arrest, respiratory arrest), when more than one cause is recorded, when the section is left blank, if the underlying and immediate causes are the same, or when the cause is secondary to a trauma and therefore it is a case of violent death. Considering the intermediate causes and the other conditions, the study was limited to noting if the sections were filled out or not. In all 4 cases additional information was collected regarding the registry of the time of evolution of the entities recorded and if it was properly recorded or not.

For this research, previously researched items are selected, choosing those which are important regarding the document's functions, and major and minor mistakes are distinguished.

Considering other similar studies, major and minor mistakes made in the completion of the document have been differentiated, as shown in Table 1:

The SPSS statistics package (v. 25) has been used for the analysis and use of the data, allowing the frequency and percentage of each variable categorised to be presented as a descriptive analysis. Subsequently, a statistical contrast of variables was carried out through chi-square contingency tables for a 95 % confidence interval among independent variables. For the contingency table, each of the variables from column A of Table 2 was combined with the different items of column B.

Next, the cluster analysis using the usual methodology of the SPAD programme plus a ranking analysis to obtain the typology of certificates were performed, using the following variables:

1. Document employed (document by the OMC or by the hospital).
2. Place of death (home, public hospital, private hospital and care centre).
3. Underlying cause (adequately filled out with CIE-10 criteria or poorly coded).
4. Immediate cause (rightly or wrongly coded).
5. Chain of causes correctly completed (yes or no).

Finally, as a multi-variant method for an automatic classification of subjects (according to their variables profile) the cluster analysis was chosen, following an ascending hierarchy order, and the results were presented in graphics through a dendrogram. The statistical programme SPAD 8 was used to obtain typologies and their characterisation, applying the multiple correspondence analysis technique, followed by an ascending hierarchy cluster analysis. The typologies or homogeneous groups were described through the present features, applying the chi-square test.

[5] Both the old document before 2009 and the new one updated in August 2022 are provided attached as supplementary material.

Table 1
List of major and minor mistakes analysed.

Major mistakes	– Identification of the deceased. – Place is specified. – Time of death. – Date of death. – Immediate cause by devices and systems. – Underlying cause by devices and systems (CIE-10). – Correct chain of causes. – Violent death. – Autopsy performed. – The death is due to an accident.
Minor mistakes	– The commentary to the location is signed. – The time of evolution of the immediate cause is filled in. – The time of evolution of the underlying cause is filled in. – Abbreviations or initials are used. – Corrections made in the certificate.

Table 2
Items analysed in contingency tables.

Column A	Column B
Document employed	– Place is specified
Place of death	– The commentary of the location is signed
Specific place of death	– Identification of the deceased
Manner of completion	– Time of death
	– Date of death
	– Immediate cause by devices and systems
	– Time and evolution of immediate cause is filled out
	– Underlying cause by devices and systems (CIE-10)
	– Time of evolution of underlying cause is filled out
	– Intermediate cause
	– Time of evolution of intermediate cause is filled out
	– Other conditions contributing to death
	– Time of evolution of other conditions is filled out
	– Correct chain of causes
	– Use of abbreviations or initials
	– Corrections of mistakes made in the document
	– Violent death
	– Autopsy performed
	– The death is a consequence of an accident

3. Results

In the sample analysed, (1958 cases), in 3 cases (0.2 %) the old form by the OMC was used, in 1637 of the certificates (83.6 %) the new document by the OMC was used and in 318 cases (16.2 %) a document by the relevant healthcare service was used. The healthcare centres that have their own death certificate document are Hospital Universitario La Paz, Hospital Universitario Ramón y Cajal, Hospital Universitario Infanta Leonor and the Summa 112 emergency service.

Regarding the document used for the completion, there are several services (10 % of documents) that use their own document instead of the official DC issued by the OMC. These documents cannot be analysed automatically by computer programmes. Consequently, more time is required to obtain statistical information. On the other hand, they often include, many times, information that is nor legally required (like patient number, marital status or name of the parents of the deceased) while other data are missed (for example, time of evolution of the causes, possibility of being an unnatural death or if a clinical autopsy was required).

The following Table 3 shows the main results after a descriptive study of the sample:

Considering the headings and the CIE-10 coding, tumours must be considered as the most common underlying cause of death (573 cases, 29.3 %), followed by cardiovascular caused diseases (326 cases, 16.6 %) and by infectious diseases (277 cases, 14.1 %).

On the other hand, in the underlying cause of death section we find a faulty completion in 277 certificates (14.1), whereas the number of faulty completions rises to 1552 in the case of the immediate cause of death (79.4 %), especially due to the use of the term "cardiorespiratory arrest", which is recorded in up to 1082 cases (55.3 %). Regarding the sections for the intermediate cause of death and other conditions contributing to death, Fig. 1 shows how the completion was carried out:

Regarding the time of evolution of each of the items, Table 4 shows when it was completed and if the completion was correct or not:

Following an assessment by the authors of the chain of causes in the certificate, it was concluded that it was correct in 1206 cases (71.6 %), while it was incorrect in 752 cases (38.4%).

The use of abbreviations appeared in 209 certificates (10.7 %), though in most of them the terms were easily understandable (COPD, PAH, HIV, and so on).

Most of the certificates were free of corrections in the document (1686 cases, 86.1 %). When containing corrections, most of them were checked with the physician's signature, thus appearing in 232 documents (11.8 %). On 3 occasions the mistakes were corrected and signed by a doctor different to the one signing the death certificate (0.2 %) and 29 cases (1.5 % of the documents) contained cross-outs that did not impede the reading of the certificate.

Regarding the sections related to the possibility of a violent death, from the whole sample, 322 certificates (16.4 %) were missing the corresponding sections. In relation to the rest of the sections, Fig. 2 shows the completion of violent death, clinical autopsy and death as consequence of an accident sections.

Spanish DC includes a section in which it has to be registered if it was a violent death: in 1611 of the documents (82,3 %) it was marked that it was not a violent death while only 25 (1,3 %) were uncomplete. On the other hand, 1341 certificates (68 %) stated that the death was not a consequence of an accident while in 277 of the documents (14 %) this section was uncomplete. Finally, 1406 documents (71,8 %) pointed out that autopsy was not required while in 218 cases (11,1 %) this part was empty. The DCs that were not official but issued by the hospital (322 cases) did not have any section to register if the death was violent, an accident or whether clinical autopsy was needed.

It was observed that the certificates in the sample showed a high percentage of mistakes made in the document, as shown in Fig. 2. Considering the whole of the results of the sample and classifying them between major mistakes and minor mistakes, it can be concluded that only 174 cases (8.8 % of the sample) are free of mistakes in the completion of the document.

Next, contingency charts that have been statistically relevant regarding the type of document used, the place of death and the manner of completion, are shown. Due to the number of cases in the sample (1958), all results are relevant because the sample is equivalent to the whole Population of statistical units (statistical universe), not a small representative sample, hence the data with high residuals are considered as descriptive data of interest.

If we consider the completion of the updated version of the official DC issued by the OMC, 69 % of them correctly collect the name of the centre, whilst 10 % of the cases show only the street where the centre is located, not specifying the name of the centre ($p < 0.000$). In any case, although the addition of the location is not part of the implicit content of the new OMC document, in 89,9 % of these cases this is not signed as a commentary or observation. This datum has statistical significance ($p < 0.000$). Furthermore, a correct filling out of the time using the 4 digits is more frequent when the new document by the OMC (99.3 %) or the document from the hospital (91.2 %) are used, with a statistical significance of ($p < 0.000$). It is

Table 3
Most important results of the descriptive study.

Place of death	Number of DC (n)	Percentage (%)
Home	340	17,4
Public hospital	1031	52,7
Private hospital	420	21,5
Healthcare residence	164	8,4
PLACE OF DEATH DETAILS	**NUMBER OF DC (n)**	**PERCENTAGE (%)**
Name of centre specified	1130	57,8
Name of centre and street specified	455	23,2
Only name of street is mentioned	173	8,8
Document provided by the hospital	195	10,0
MANNER OF COMPLETION	**NUMBER OF DC (n)**	**PERCENTAGE (%)**
ID / Passport / NIE (foreign resident document)	1895	96,8
DATE OF DEATH	**NUMBER OF DC (n)**	**PERCENTAGE (%)**
Date registered in numbers	1836	93,8
Date registered in numbers and writing	118	6,0
TIME OF DEATH COMPLETION	**NUMBER OF DC (n)**	**PERCENTAGE (%)**
Completed correctly (4 no. format)	1917	97,9
Completed with 3 numbers	39	2,0

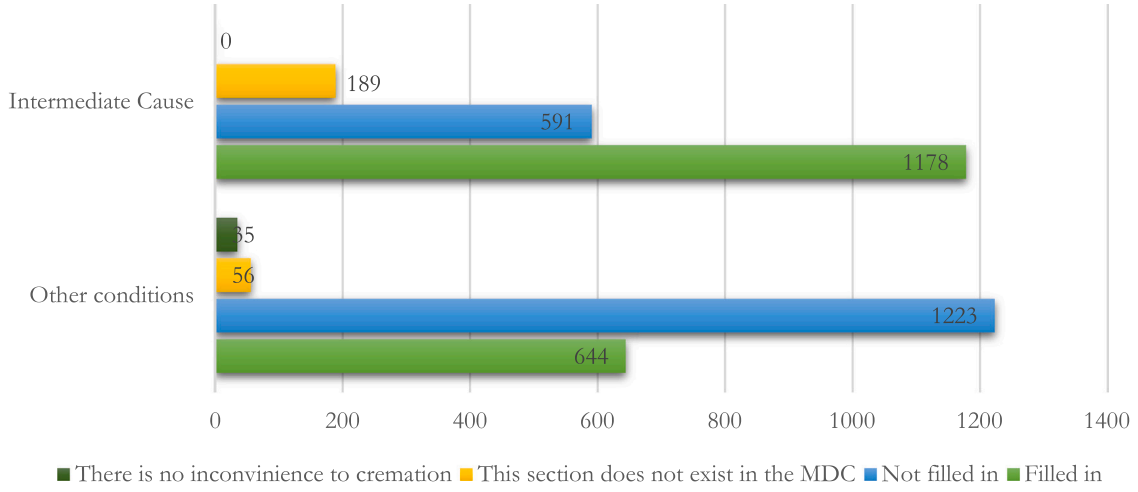

Fig. 1. Completion of sections of "intermediate cause of death" and "other conditions".

Table 4
Completion of time of evolution of each item.

	The section is filled in	Number	%
Immediate cause	No	1395	71.2
	Yes, but is badly completed	11	0.6
	Yes, and is completed correctly	230	11.7
	The immediate cause was not completed	0	0
	The section is missing in the document	322	16.4
	Not assessable	0	0
Intermediate cause	No	887	45.3
	Yes, but is badly completed	15	0.8
	Yes, and is completed correctly	191	9.8
	The intermediate cause was not completed	544	27.8
	The section is missing in the document	321	16.4
	Not assessable	0	0
Underlying cause	No	1374	70.2
	Yes, but is badly completed	13	0.7
	Yes, and is completed correctly	238	12.2
	The underlying cause was not completed	10	0.5
	The section is missing in the document	322	16.4
	Not assessable	1	0.1
Other conditions contributing to death	No	415	21.2
	Yes, but is badly completed	10	0.5
	Yes, and is completed correctly	66	3.4
	"Other conditions" section not completed	1143	58.4
	The section is missing in the document	323	16.5
	Not assessable	1	0.1

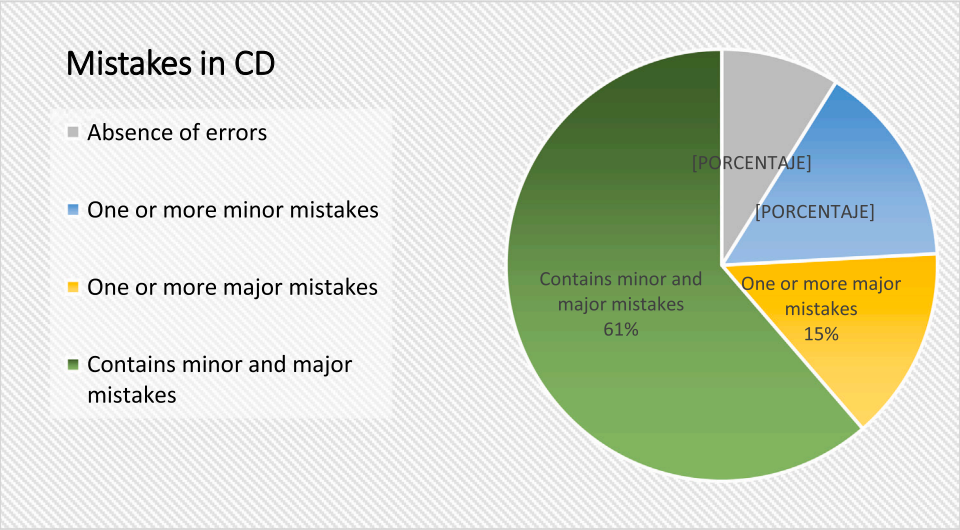

Fig. 2. Diagram representing mistakes in the completion of DC.

also more frequent that the date is filled out in numbers when the new document by the OMC (99.8 %) or the hospital's own document (63.5 %) are used, while it is usually completed in writing when using the old OMC document (66,7 %), with a statistical significance of ($p < 0,000$). In our sample, the most frequent underlying cause of death in residencies or nursing homes were the causes related to the circulatory system (28 %) and infectious diseases (20.1%); while in hospitals they were tumours (27.1 % in public hospitals and 52.1 % in private hospitals), whereas in deceases occurring at home the most common underlying cause was also related to the circulatory system (32.4 %) with a significance of ($p < 0.000$). Regarding the immediate cause, the term cardiorespiratory arrest was used in 62.9 % of the certificates signed at the patient's home, in 53.2 % of the documents signed for deceases in public hospitals, 47.4 % of documents signed in private hospitals and in 73.8 % of deaths that occurred in healthcare residencies, with a significance of $p < 0.059$. It is interesting to note that there is no statistical correlation between the document used in the certification or the place of death and a correct completion of the chain of causes.

As shown in Fig. 3 and in Table 5, the clusters classification provides the following 4 categories as a result:

4. Discussion

In the studied sample it is observed that the best completed sections are the identification of the deceased and the data of death (date and time), which facilitates the recording of the decease by the Civil Registry. However, it has been proven that there is a deficit when filling the DC: 93.6 % of the analysed documents showed at least one mistake in their content. This result is similar to those of Pritt et al. [13] where up to 82 % of certificates presented at least one type of error. Other studies (Greek investigation carried out by Katsakiori et al. [37]) show fewer errors: in this case 60,6 % of documents presented some kind of error. Some of the problems detected in other studies from different countries have also been proven present in our results, such as the abuse of the term "cardiorespiratory arrest" appearing in 79.4 % of the cases, the generic absence in the completion of the time of evolution in each process, or an incorrect chain of causes that appears in 38.4 % of the DC. These deficits can mean an obstacle for the death certificate in fulfilling its function. Another study in Italy, for example, showeded that in 34 % of cases the manner or cause of death were poorly recorded [8] with an over-diagnosis of coronary heart disease, hypertensive cardiovascular disease, and cancer. While in Germany, Eckert et al. [33] found around 27 % of major errors in the DCs sample that they studied.

Among all the documents analysed, 318 of them (16,2 %) were not the official document belonging to five different institutions. In some cases, as in the 112 Emergency Service home assistance, the solution of providing their own document has been sought in order not to delay the procedure while the family obtains the official OMC document at the pharmacy. In these cases where institutions have developed their own document, it would be useful for them to establish a system together with the funeral services that would allow the use of the official DC or, to the contrary, improve their own document so that it has, at least, the same sections as the OMC document to avoid a deficit in the data gathered at a hospital level. Besides, the manual filling out of the certificates produced by the hospitals complicates their automatic reading by the INE, which implies dedicating more resources to processing such documents.

Furthermore, the cluster analysis shows that completion in public hospitals using the OMC document is of better quality (with a good coding of the underlying cause and a correct chain of causes) even if the coding of the immediate cause is incorrect. Meanwhile, when these same public hospitals employ their own document, the coding of the underlying cause and the chains of causes are incorrect, despite the coding of the immediate cause being better, thus hindering the registration of the cause of death by the INE (National Statistics Institute). At the same time, the completion of the document in private hospitals, even when using the OMC document, is of worse quality because of the deficiencies in the coding of the underlying and immediate causes and of the chain of causes.

It is positive that there is only one official DC model which contributes to greater uniformity of national data. Germany, for example, have a different DC for each state and that implies difficulty in training, certification (for physicians working in more than one state) and data collection [33]. In any case, with regard to the use of the official OMC document, it is essential to proceed to a digitalisation of the document in order to achieve an improvement in quality, as well as to standardise the use of a common document by all centres and professionals [39]. Once implemented, the digitalisation of the document would facilitate its monitoring to undertake improvements if necessary [33]. Some countries (for instance, France and Portugal) have already started using electronic DC to improve certification, statistical data collection and patient data protection [14,15]. The OMC has already conducted a trial for the telematic completion of the document tested in the region of Castilla La Mancha during 2022, but it lacked broad participation, impeding

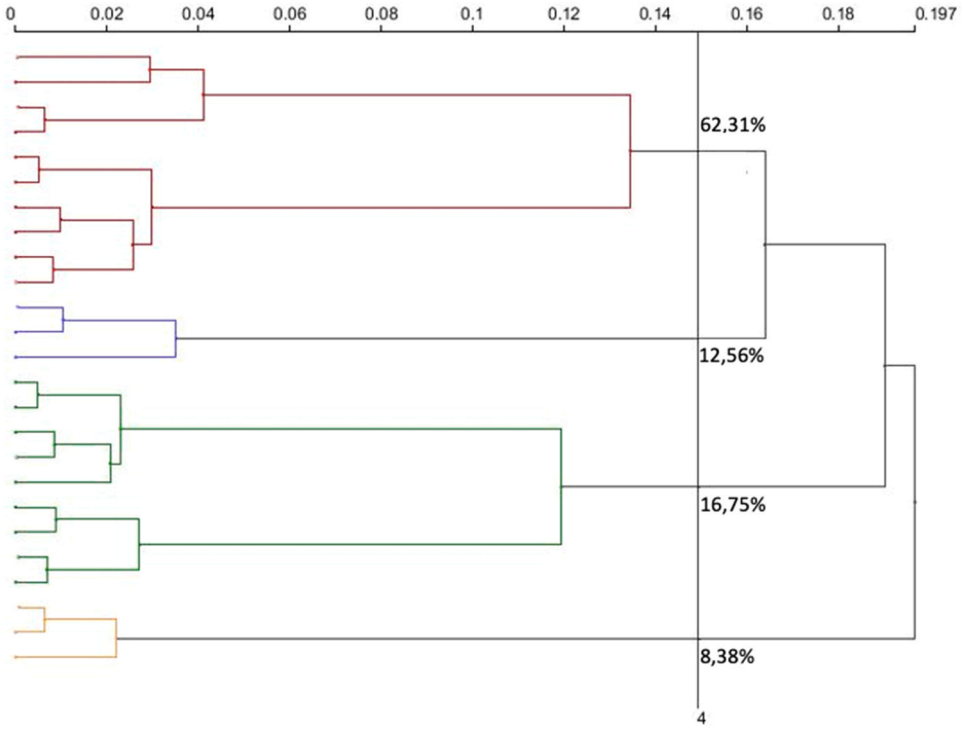

Fig. 3. Dendrogram after cluster analysis.

Table 5
Clusters classification in 4 groups.

Class 1 (Count: 1220 - Percentage: 62.31%)			
Label of the variable	Characteristic modality	% of modality in partition	% of modality in sample
Place of death	Public hospital	63,7	52,7
Underlying cause	Correct	100,0	85,9
Correct chain of causes	YES	85,6	61,6
Immediate cause	Wrong	84,3	79,5
Document used	OMC	87,8	83,8
Class 2 (Count: 328 - Percentage: 16.75%)			
Label of the variable	**Characteristic modality**	**% of modality in partition**	**% of modality in sample**
Document used	Issued by the institution	50,6	16,2
Underlying cause	Wrong	52,1	14,1
Immediate cause	Correct	50,6	20,5
Correct chain of causes	NO	83,8	38,4
Place of death	Public hospital	77,4	52,7
Place of death	Home	22,3	17,4
Class 4 (Count: 246 - Percentage: 12.56%)			
Label of the variable	**Characteristic modality**	**% of modality in partition**	**% of modality in sample**
Place of death	Private hospital	65,4	21,5
Correct chain of causes	NO	96,3	38,4
Document used	OMC	100,0	83,8
Underlying cause	Wrong	31,3	14,1
Place of death	Home	34,1	17,4
Immediate cause	Wrong	89,0	79,5
Class 2 (Count: 164 - Percentage: 8.38%)			
Label of the variable	**Characteristic modality**	**% of modality in partition**	**% of modality in sample**
Place of death	Healthcare residency	100,0	8,4
Document used	OMC	98,2	83,8
Immediate cause	Wrong	90,2	79,5

assessment of the utility and efficacy of the digital DC at a practical level. Thus a greater effort would be needed to achieve such digitalisation which in other countries has provided a more accurate certification, with fewer errors and better use for mortality statistics [14,15,33,40,41]. On the other hand, digitalisation following the WHO allow a better comparison between different countries.

In relation to the pilot study, it can be stated that the quality in the completion of the OMC document has improved with time. However, as in other studies, our results prove that it is still essential to stress the importance of training the physicians how to complete the document and about its relevance at the public administration level, especially in the field of mortality statistics [2,6,14,18,19,23,32,34]. The solution for an improvement in the completion of the DC implies, as a preliminary step, an adequate training from an undergraduate level, also including practical activities in the OSCE (Objective Structured Clinical Examination, ECOE in its Spanish initials) and an updating for practicing physicians during their postgraduate period. However, this is not only a Spanish issue, as it is a common need in other countries as well [8,42].

Regarding the completion of DC in Court cases, at present, in Spain, the DC completion is incompatible with the function of the medical examiner [43]. In the cases that require judicial intervention, the medical examiner will fill out an 'advance of the autopsy' for the purpose of the inscription of the deceased in the Civil Registry; or a forensic medical report in the cases in which the judge considers that a judicial autopsy is not necessary [24]. Though these documents are also part of mortality statistics [23], they do not always follow the OMC model, but instead gather more basic information of judicial interest. Therefore, the statistical data of all the deaths with a judicial procedure is incomplete [36,44–46], as has already been shown, for instance, in the case of suicides [47]. This problem has been identified in other countries, such as Italy [36]. This hinders the quality of the statistics by the INE in all these cases. For this reason, it is proposed that the forensic documents are made to comply with the WHO guidelines, aiming to have a more reliable statistical registry in judicial cases. In fact, in Portugal, digitalisation

also led to an improvement in recording data of judicial deaths [15]. Moreover, as proposed by Minelli et al. [36], it would be useful if medical examiner could modify statistical information after the case has been completed.

The fact that filling in the DC can pose a challenge is undeniable [3,48], but the cause of death is a presumptive diagnosis [8,9,11,13]. Absolute accuracy is not expected, but doctors should make an effort to avoid mistakes and complete a proper DC [7,9,10,29]. That is why it is mandatory to explore the body and to study the medical records looking for the most probable underlying cause of death and to stablish the appropriate MOD [4,8,17,20]. For instance, a multi-centre study in Germany indicated that 1200 homicides go unnoticed every year [17]. Actually, a study carried out in Germany informed that As suggested Di Vella et Campobasso [8], an external double peer review of the DC to check the manner and causes of death would be useful. Other authors suggest the involvement of the medical examiner to check the possible manner and cause of death [13,39,49]. The Netherlands has already started to use the advice of medical examiner advice in cases where the attending physician is in doubt, and it has been considered a good experience with a positive effect on public health statics [49].

We can conclude that there is still work to be done [8] and that the implication of Sanitary Authorities and coordination of all the institutions involved is essential to developing a more efficient DC, which should be as similar as possible to the document proposed by the World Health Organisation (WHO) [33,39,40]. Meanwhile, doctors should be trained to improve the completion of the document [13]. Thus, the document will be more useful and there will be better mortality statistics with more efficient healthcare policies [19]. A broader awareness of the importance and consequences of all the administrative and legal consequences of the DC should also entail less judicial intervention in natural deaths, with a better use of public resources [50].

Ethics approval and consent to participate

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CRediT authorship contribution statement

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Pilar Pinto Pastor, Andrés Santiago-Saez. The first draft of the manuscript was written by Pilar Pinto Pastor and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Author contributions

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Data availability

All the material reviewed during the study is available at the Civil Registry of Madrid. The database with all the information encoded in.xls format can be provided.

Competing interests

The authors declare that they have no competing interests

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.forsciint.2023.111568.

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