Table 1: Country responses: Digitalisation - going from a paper death certificate to an (100%) electronic death certificate

| Country	Topic: Digitalisation - going from a paper death certificate to an (100%) electronic death certificate
	• **Could you describe the dataflow, from the source filling in the death certificate to the final destination (statistical institute or others)? The different stages through which a death certificate passes would be of interest.** • **If necessary, could you describe the process of making this transition between paper registration and electronic registration? What were the specific periods & phases? Have you planned a hybrid situation (paper/electronic) or an exit from the paper system and a direct transition to electronics?** • **Have you implemented direct cause-of-death coding using ICD-10 codes in the registration tool or does the doctor have to type? If you implemented direct ICD-10 coding in the tool, who set it up and is there still manual code checking? Does it contain a kind of decision tree to fill it out/to avoid obvious errors?** • **Is there a real time use of this digital data? And if not, have you planned a direct use of the data in case of epidemiological emergencies (such as COVID-19).**
Austria	Death certificates are recorded and coded by Statistics Austria. Since 2014, death data can be supplied completely electronically. However, 60 % of deaths are still recorded on paper, most of which are deaths outside hospitals. All paper notifications must be entered into the database via a voice recognition software. For 90% of deaths the recording happens within 10 days. There are two parallel mortality statistics, using different data: • In the statistics based on the central surveillance system, a COVID-19 death is defined as a laboratory-confirmed case of COVID-19 resulting in death, where the status "recovered" has NOT been present between the status "disease" and the status "death", so causality is not considered. https://covid19-dashboard.ages.at/dashboard_Tod.html • Statistics Austria provides stratified COVID-19 death statistics using data from death certificates, counting deaths where COVID-19 was reported as the underlying cause of death. Data for 2021 is available at the following website. In 8,7% of all deaths of 2021, COVID-19 was the underlying cause of death. http://www.statistik.at/wcm/idc/idcplg?IdcService=GET_PDF_FILE&RevisionSelectionMethod=LatestReleased&dDocName=127709 • In April, over 3.000 COVID-19 deaths that occurred between the start of the pandemic and the end of 2021 were retrospectively added to the mortality statistics in the central surveillance system (data from Statistics Austria). https://orf.at/stories/3260942/ Since 2019, all basic diseases in mortalities have been coded by Statistics Austria with the help of an electronic coding programme. This programme, called IRIS, converts medical texts into ICD codes. In 11/2020 the ICD-Codes U08,-, U09.- and U10.- were implemented. There is a complex decision tree (see below) to determine the underlying cause of death in place: Additional mortality reports: • There is a continuous monitoring of overall and excess mortality in Austria stratified by regions. https://wien1x1.at/mortality-provinces/ • In addition, there is an age-stratified analysis of all-cause-mortality rates comparing (COVID-19-) vaccinated vs. unvaccinated individuals between September and December 2021 (in German). https://www.statistik.at/web_de/statistiken/menschen_und_gesellschaft/gesundheit/covid19/127483.html

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Abfolge von Kodierregeln zur Ermittlung der zugrundeliegenden Todesursache
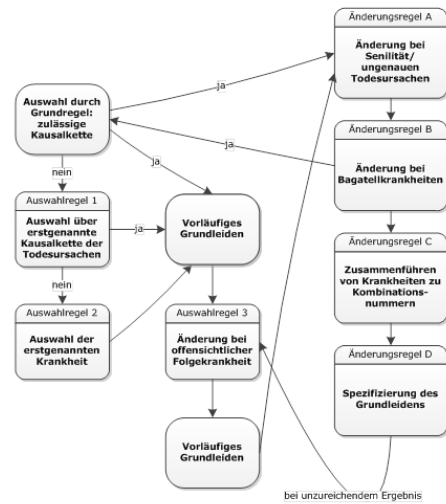
Quelle: Statistik Austria; Todesursachenstatistik. Grafik erstellt auf Basis des Regelwerks der WHO (Band 2), herausgegeben vom Deutschen Institut für medizinische Dokumentation und Information.
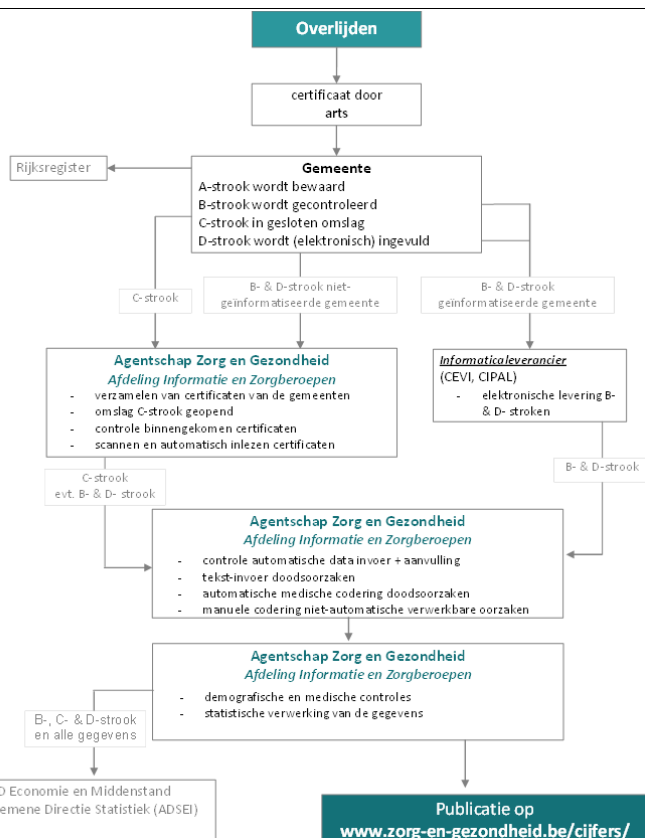
Belgium	• In Belgium the flow goes like this in Flanders and Brussels (and is similar to that but it's done by AVIQ instead of AZG in the steps that mention AZG), we expect a schema if possible which is clearer of the data flow with a short explanation as most of the time knowledge of the country and its subdivisions and competences is required. The graph allows us to have the information for ourselves and then be able to look up for the details to better understand later.
	In Belgium the "C strook" of the death certificate is the part containing the information about the cause of death (death certificate in Belgium has 4 parts A/B/C/D) :
	The death certificate is filed by the doctors especially the C part of the death certificate were he writes the chain of events that lead to deaths with "words".
	The forms for each municipality are collected and checked for completeness, then they are scanned and automatically entered into the programme. This is followed by checking and completing each form by the data entry team.
	The doctor has listed the causes of death. Those causes of death are entered manually by the data entry team. They are then translated into ICD-10 codes automatically (40%) or by coders. These are international codes that allow the data to be situated internationally. There are therefore international guidelines for converting descriptions of conditions and events leading to death into appropriate codes (more details on ICD-10 and the (semi-)automatic coding system. After the data are entered and given an underlying or original cause of death, they are checked in detail. These include both medical and demographic checks. For all detected (possibly apparent) inconsistencies, the certificate is looked up to verify the data. We usually report the 'underlying cause of death' on this website, unless otherwise stated.

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Source : https://www.zorg-en-gezondheid.be/databestand-sterftecertificaten-personen-van-1-jaar-of-ouder

- For the moment the process is 100% paper, the plan is to go to a 100% electronical version, so the question is should a hybrid phase be kept, or switch directly from one to other.
- There is no direct ICD-10 coding, but let's take France for example. They offer the possibility to transmit both (paper or electronic) and yet as in Belgium the cause of death is completed by the doctor leaving a box and the possibility to write immediately. They use a program which translates automatically handwritten certificate to typed and then another one (IRIS: https://www.bfarm.de/EN/Code-systems/Collaboration-and-projects/Iris-Institute/_node.html as a lot of countries attending to this meeting) which codes multiple causes of death and selects the underlying cause of death (according to the ICD recommendation). There is always a manual checking for the certificates that do not pass automatically or for which the causes of death and disease chains do not correspond to checks. There is also a random selection of some certificates to check the quality of the coding.
- There was no way to collect the COVID-19 deaths certificates immediately, so an ad-hoc surveillance was set-up as the paper death certificates are taking two/three years to be available (for the death from 2020 ⮕ end of 2022/beginning of 2023). However it's one of the main goals of the digitalization. Have a nearly real time access to the data.

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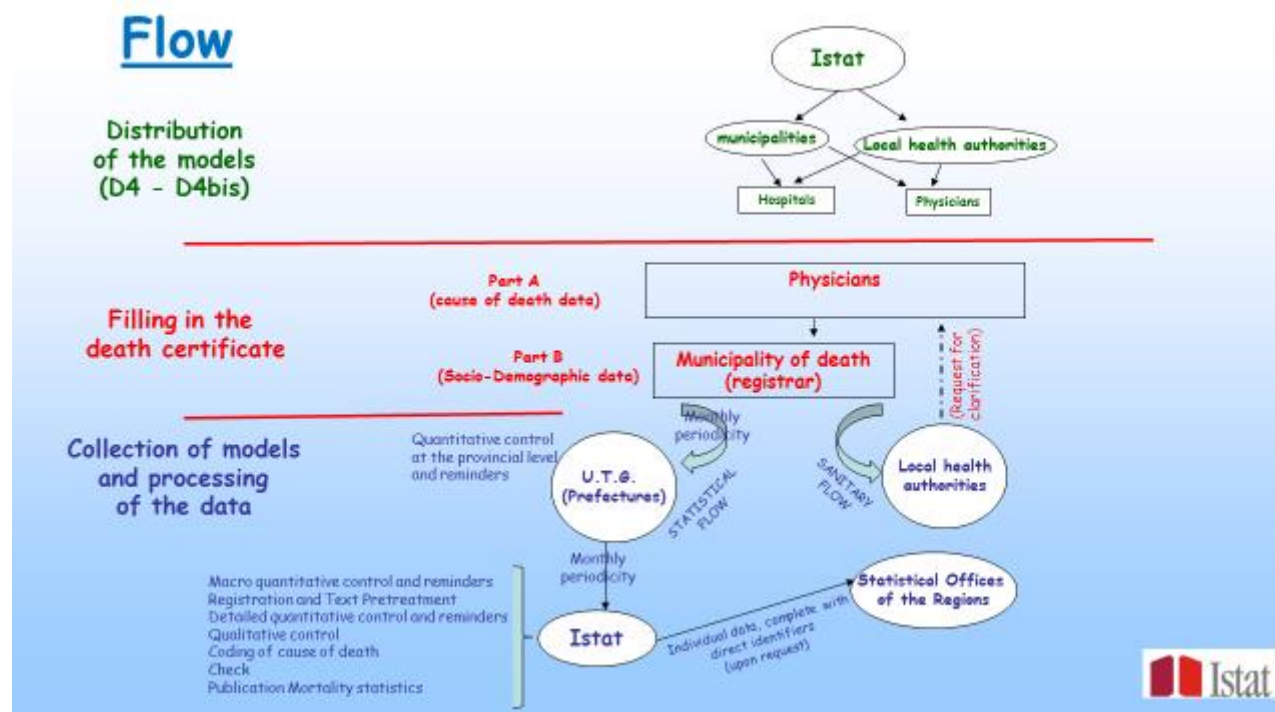|	
Croatia	• A) Death certificates (DC) are filled out on a paper form by coroners, who are all health professionals. The paper form is submitted to the Register of Deaths. B) Based on the data from the DC, the registrar creates an electronic record of the Statistical Report on Death (DEM-2) in which information about the deceased is entered, but not about the cause of death. A copy of the DC in paper form is sent to the Croatian Bureau of Statistics (CBS) for further processing. The death certificate is linked to the DEM-2 electronic record in such a way that the identifier of the DEM-2 electronic record is entered on the DC paper form. CBS processes data for vital statistics purposes. C) Next, CBS delivers the DC to the Croatian Institute of Public Health (CIPH) for processing the cause of death. Coding is done centrally and manually, applying the coding rules according to ICD-10 and Volume II. The cause of death is coded in CIPH in accordance with the Cooperation Agreement with CBS. Using the DEM-2 application, CIPH employees manualy enter the main cause of death code based on the diagnoses listed in the DC paper form, and encode other features related to reporting the health condition. • For some time, there has been an intention to establish an electronic record of Death Certificates (eDC) in Croatia. Changes to the legal framework are currently being worked on. Amendments to the Ordinance on the death certificate form, which will define the eDC, are underway. In the transition period, a hybrid way of working is to be expected, i.e. the use of the paper Death Certificate form and eDC. • No, at the mement coding is done centrally and manually. • Currently, it is not possible to use real-time data as it takes between 3-6 months from the time of the death event to the completion of processing of the DC forms. One of the significant incentives for the establishment of eDC is the possibility of using data for the purpose of epidemiological surveillance.
Czech Republic	• The Czech Republic has experience with electronic certificates since 2016. There are two ways in which the certificate can be completed: either as a certificate in the hospital or web-based online. About 85% of certificates are submitted in electronic form. Written certificates are manually transferred into the system. • Information about the diagnosis goes in one copy to the Ministry of Health and in a second copy to the civil registry and from there to the Czech Statistical Office. Daily data is sent from the MoH to the Statistical Office, where the record is linked to data from the register. • Data on a daily basis cannot be provided as the quality would be very low. Nevertheless, there is a kind of real-time evidence through the electronic system. • The WHO has recently introduced a new tool that works with ICD-11
Estonia	• Electronic data certificate is uploaded to Health Information System. Data from it are copied every working day to Causes of Death Registry database at NIHD. Data are processed according to the WHO guidelines including selection of underlying cause of death. Preliminary causes of death data are published monthly on the NIHD website. Final data are published annually, transferred to Statistics Estonia, WHO, Eurostat. • There was no hybrid situation. Medical Death Certificate is possible to fill in on paper or .pdf file if the electronic system does not work. • It is possible to enter ICD codes and free text. Free text is mandatory for underlying cause of death field (Ic). • All-cause mortality data are transferred weekly to Euro-MOMO network. It is very helpful to identify periods of elevated mortality, incl heatwaves, covid-19 and influenza pandemics. https://www.euromomo.eu/graphs-and-maps/
Finland	• A death certificate is written by the physician who pronounces the death. If the investigation of a cause of death requires an autopsy, the forensic pathologist draws up the death certificate once the data are completed. The Finnish Institute for Health and Welfare (THL) is responsible for the inspection and supervision of death certificates. The forensic pathologist of an area first inspects the accuracy of a certificate and then sends it to Statistics Finland. A health institution or doctor must also notify the Population Information System of a death. At Statistics Finland, the data in death certificates are compared with the Population Information System's data on the deceased. THL is also informed of any missing death certificates for the purposes of its supervisory duties. The diagnostic texts and cause-of-death codes provided by doctors are checked at Statistics Finland. The statistical cause of death is determined according to the selection and application rules of the International Classification of Diseases (ICD-10) compiled by the World Health Organisation (WHO). If the data on a death certificate are deficient, inconsistent or difficult to classify, coding is made with the help of the death certificate's event data or additional information is requested from a medical expert or the writer of the death certificate. When coding cases of poisoning, the research results from the register of forensic chemistry are often used as additional information. A medical expert handles around 500 cases every year. Additional information is requested from the writer of a death certificate in about 50 cases a year. Additional information is provided by the register of forensic chemistry for approximately 120 cases a year.

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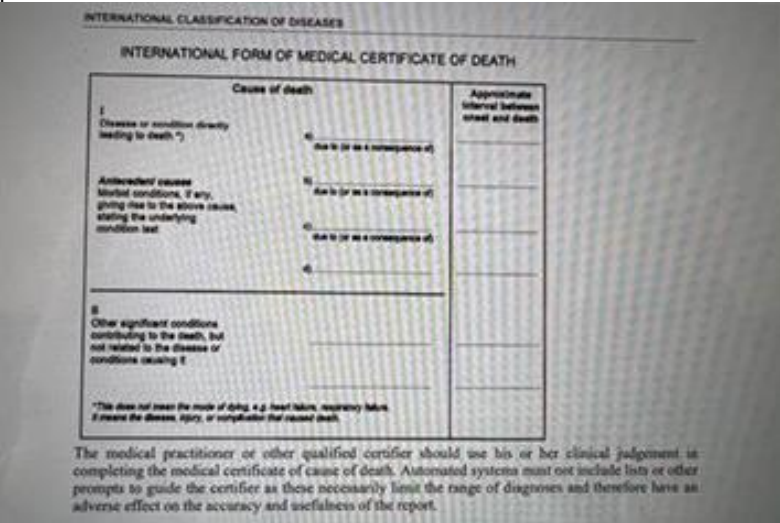|	
	• Death certificates are delivered to Statistics Finland by THL in either digital or hard-copy format. In 2020, approximately 15 per cent of death certificates were delivered in digital format. Death certificates in hard-copy format are scanned into image format at Statistics Finland and some data are read optically into the database. • During the COVID-19 pandemic, preliminary data on causes of death was made available for monitoring purposes. Detailed description of the death certification process can be found at https://stat.fi/en/statistics/documentation/ksyyt
Germany	***Death certificate as the basis for the causes of death statistic*** The regional statistical offices record the causes of death on the basis of paper-based death certificates (also known as cause of death certificate). These are issued by the doctor who inspects the body and certifies the death. The performance of the funeral inspection and the completion of the death certificate are regulated in the funeral laws or ordinances of the federal states. The death certificates are processed by health authorities, registry offices, statistical offices of the federal states and other authorities. Death certificates are Federal state specific; they consist of a confidential and a non-confidential part. The non-confidential part is handed to the next of kin for submission to the registry office. The confidential part is passed to the relevant statistical office; it consists of two parts: Part I has to be completed in full; the causal chain of diseases leading to the death is entered here: from the underlying disease to diseases indirectly causing the death to the direct cause of death. Part II can optionally include diseases that were a contributing factor towards the death but formed no direct part of the causal chain leading to the death. To ensure the quality of the survey and documentation of the causal chain by doctors, of the communication chain from the filling situation to the coding and of the coding by the signature will improve, a number of measures have been and are being taken and projects set up. ***Improvements through nationwide electronic certificate of death*** A nationwide electronic death certificate with a supportive user guidance in the collection and documentation of the causes of death chain by the physicians, and a media-break-free and thus accelerated and safer communication chain from the filling situation to coding would improve significantly the quality of the causes of death surveyed and the timeliness of statistics; both would contribute to an increase in the informative value of the statistics on causes of death in Germany and their international comparability. Together with the German Federal Statistical Office (DESTATIS), DIMDI has developed a concept for the introduction of a nationwide electronic death certificate in Germany as part of a project sponsored by the Federal Ministry of Health (BMG). In addition to the analysis of the entire process from the filling to the coding, the end of the communication chain, the technical aspects for an electronic recording for the creation of the cause of death certificate were also examined. https://www.bfarm.de/EN/Code-systems/Classifications/ICD/ICD-10-WHO/Causes-of-death-statistics/_node.html
Hungary	The Electronic Death Certificate (eHVB) is available from February 2021. Full introduction of the system was implemented in the end of last year. Civil registrars electronically receive data necessary for the procedure relating to deceased persons. The eHVB system is operated by the National Healthcare Service Center. The National eHealth Infrastructure (EESZT) is responsible for data integration between the eHVB and the Electronic Civil Status System (EAK). Pursuant to the act on the simplification and electronisation of certain procedures, according to rules currently in force, death certificates will be issued by physicians on paper from February as well, but after determination of the fact and time of death, the physician carrying out on-the-spot death confirmation will be responsible for registering data in the eHVB system necessary for registration as soon as possible, but no later than the first business day thereafter. The development project aims to establish a bidirectional connection between the Electronic Civil Status System and the eHVB to ensure that—subject to strict compliance with data protection rules—the competent civil registrars can access the personal data of deceased persons and the date certifying death through their own electronic system as well.

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Italy	• Death certificates are filled in manually by medical doctors on the place of death and causes of death are described. A copy of the certificate of death is sent to the residence place and a second copy is sent centrally to the National Institute of Statistics-ISTAT; here trained coders provide codification of the underlying cause of death using ICD-10 classification. The coded underlying cause of death is digitalized and an official database of national causes of death is then provided with a delay of 2 years. • The transition to electronic certification is provided for in Decree-Law 34 of May 2020, nevertheless needed implementing regulations have not been issued yet. The national Institute of Statistics-ISTAT would like a transition without a hybrid (paper/electronic) system period, but the organization of healthcare on a regional basis may make this necessary. • In Italy, the electronic certification has not been implemented yet, nevertheless the plan provides a form in which the certifying physician states the cause of death in writing. ICD-10 coding will not be available to the physician, in line with the WHO recommendation to avoid dropdown lists or other typing aids for certifying causes of death. Regarding the cause of death statement, the registration form will include some error checks, such as the consistency of the durations of the conditions (e.g. a condition reported as the cause of another must have a longer duration); filter questions (e.g. if the manner of death is accident/suicide/homicide, questions regarding external causes will appear and will be mandatory; the same for traffic accident); and checks of the completeness of the information (e.g. at least one cause of death should be entered; questions on pregnancy should be answered if the decedent is a woman in fertile period; etc.). In addition, spelling errors will be also displayed. • The draft decree implementing electronic certification provides for causes of death to be available in real-time to ISTAT and Territorial Health Authorities. However, there are no plans for joint activities between the Institute of Statistics and the Health Surveillance Systems.

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Lithunia	• The medical death certificate is filled in and issued by the examining physician (known cause), pathologist (sudden or unexpected death, maternal and infant deaths, child death, complication of medical procedures, when requested by relatives), a forensic medical expert (external causes, (suspicion of) violence, criminal abortion, unknown identity, or when required by police). Electronic medical death certificates are collected from the E. health system. The Medical death certificates (paper form) once a month are forwarded from the Civil Registration Office to the Causes of Death Registry. Coding is carried out at a central level. The specialists of the Causes of Death Registry manually code multiple causes of death and select the code of the underlying cause of death. The causes of death are classified by the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision Australian Modification (ICD-10-AM) on a national level. Underlying causes of death are defined by the International Statistical Classification of Diseases and Related Health Problems rules – ICD-10 Vol. 2. The Causes of Death Registry database contains an automatic quality of data transcription assurance system which checks the cause of death against the gender and age of the deceased. Visual control of register data, logic control during the data entry process, and computerized control after data entry. The entered data is checked against information on deceased persons provided by the Resident's Register and Statistics Lithuania. If the data on a death certificate is deficient, inconsistent, or lost information, the specialists of the Causes of Death Registry request additional information from the writer of the death certificate. Additional information is requested from the writer of a death certificate is about 530 cases a year (in 2021). • The Medical death certificates (paper form) and other documents once a month are forwarded from the Civil Registration Office to The Causes of Death Registry. Electronic medical death certificates are collected from the E. health system in 2018. In 2018 - 82 percent of electronic medical death certificates, in 2019 - 96.4 percent of electronic medical death certificates, in 2021 - 97,3 percent. • Doctors do not do coding. Centralized coding is made by specialists in the Causes of Death Registry. • Preliminary data on causes of death from electronic medical death certificates were made available for monitoring purposes.
Malta	The move towards digital death certification is underway and hopefully soon finalized. The process would be initiated by the certifying doctor (as with paper certificates). Then the various users of the death certificates will receive customized access to the death certificate in real time. Testing has already been done. We are not envisaging a complete exit from the paper system any time soon but we are hoping to digitize at least hospital or residence deaths which account for close to 60% of deaths in Malta. Primary care is more of a challenge but it will be made available through a we link. Digitization process is led by the Ministry responsible for CRVS in Malta. We have strictly barred Icd-10 coding of the death certificate as who guidelines insist on allowing the provision of free text in the death certificate.

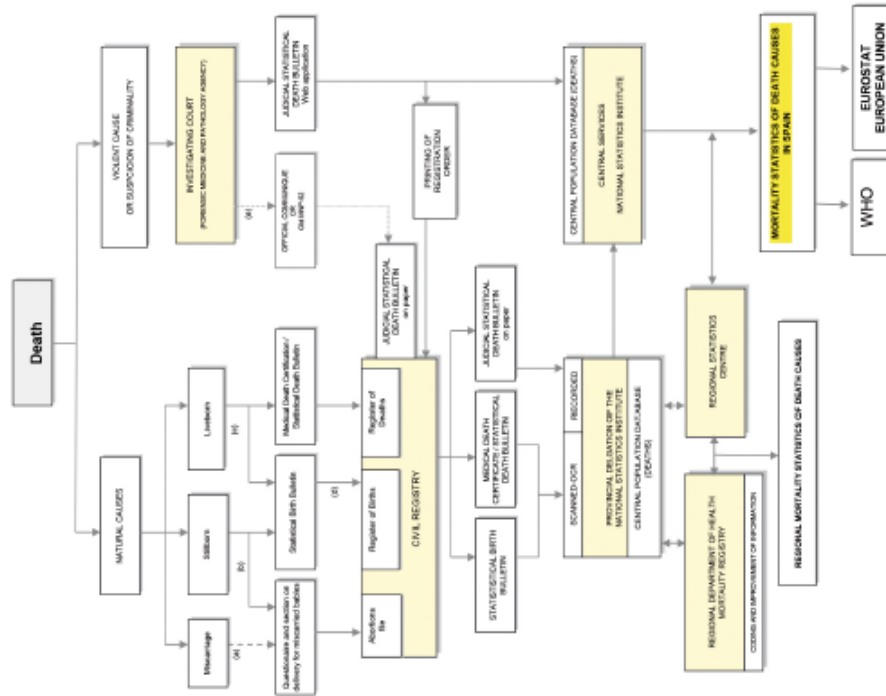www.phiri.eu

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Netherlands	• Paper certificates are filled out by certifier, are sent to municipality (by undertaker), municipality sends it to Statistical office. Certificates are then scanned and entered in a datafile through data entry. The datafile links to Iris software used to select underlying cause of death (sometimes manually, sometimes automatically). Datafile is extracted. • Changing the law, allowing for digital certification (it was not allowed before) Making digital certification possible from certifiers own system by developing software with the relevant healthcare software providers. Adapting internal software systems so digital certificates can be processed. • Doctors type medical terms (for now) which are changed into relevant ICD-10 codes after the certificate has entered the system at Statistics Netherlands. • Not yet, if we would receive digital certificates on a large scale we would like to look into the possibilities, but real time would still mean that the data would have to go through our internal coding process with the Iris software.
Poland	• An authorized medical worker fills out an electronic death / birth card in the office system or using the gabinet.gov.pl application. Data (in the form of a document) is stored centrally in the e-health system (P1). The death card and the birth card with an annotation about stillbirth from P1 System are transferred to: 1) the Central Statistical Office; 2) the National Institute of Public Health - the National Institute of Hygiene (NIZP-PZH); 3) the Chief Sanitary Inspectorate in terms of specific data in accordance with the Act; 4) the Registry Office (USC) in the scope of specific data pursuant to the Act; 5) to other entities authorized on the basis of separate provisions and to the extent specified in these provisions. The further process takes place in the area of competence of a given institution. • A pilot process in this process is not foreseen. From June 1, 2023, the electronic version of the death and birth card will be in force, with a stillbirth annotation. • The ICD-10 encoding functionality has already been implemented in the gabinet.gov.pl application and will also be used in the functional area of a death card and a birth card with a stillbirth annotation. • Yes, digital data will be recorded in real time in the e-health system (P1) and made available to other institutions also in real time on the basis of services triggered by them.
Portugal	Portugal is a pioneer of electronic death certificates, also in real time. Only a vanishing percentage are still filled out in paper.
Romania	• At the local level: DSP county: Deaths recorded in suspected/confirmed cases with COVID-19 are uploaded within a maximum of 24 hours, in the dedicated national IT platform, with their related data: date of death, comorbidities, admission to ICU, if the person was intubated or only received oxygen on the mask; At the national level: INSP-CNSCBT verifies the entry into the dedicated platform, by DSP, of the data and information related to the cases of deaths, sends it daily to the Ministry of Health, until 12 o'clock, makes available to the IHR office of INSP the information requested by WHO- IHR. Ordinului MS nr.1829/2020 https://www.cnscbt.ro/index.php/info-medical/3275-metodologia-de-supraveghere-a-covid-19-actualizare-01-08-2022/file • As described • There is still some manual checking. When the software cannot complete the process automatically, the remaining deaths are manually coded by staff trained in ICD-10 and its rules. • Yes, we're planning to use real time data in situation similar to Covid-19.
Serbia	Since January fully electronic. Certificate is filled out. Death certificate is checkebvy by regional public health insitutes. Main issue is lack of knowledge because not geschult wie ausgefüllt. Portal for death Sertificate: https://pepos.e-zdravlje.gov.rs/ Regulation (in Serbian) https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/ministarstva/pravilnik/2022/31/1
Slovenia	• Data source for the death certificates are coroners / medical doctors, regardless of place of death. For deaths in hospitals (approx. 55 % of all deaths in Slovenia), coroners are employed at hospitals; for deaths outside hospitals, coroners are medical doctors that are called at the place of death. Coroners fill in the death certificate which in together with death registration form sent to closest administrative unit (all together 60 AU in Slovenia) and from there, death certificates are sent to National Institute of Public Health.

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		• Slovenia is at the moment in the phase of redesigning the whole process. On one hand, the new rules of procedures for coroner services were adopted in July 2022 by Ministry of Health defining the process of coroner service, necessary documentation of coroners, the training, etc. On the other hand, National Institute of Public Health started a project of electronic death certification in 2021. In July 2023, all death certificates in Slovenia shall be in electronic form without a transition period (no mixed situation). We developed detailed specification of new dataflow (in Slovenian language). Data flow is included below. You need to be aware that the registration of death at Ministry of interior is done at the same time, and also Central register of patient data (EHR) plays important role in the whole process to help coroner defining the causes of death and also as to send the final death certificate in the health system (e.g. for GP of deceased person). Besides, we're fully aware of importance of stakeholders for the successful implementation of the project. We established the steering committee of the project, consisting of representatives of Ministry of Health, Ministry of Interior, Medical Chamber, Statistical office. • In the new system, direct coding will be used (no typing), but coding of underlying cause of deaths will be still checked manually. Obvious errors will be controlled in the system, but the coding decision tree is much more complex and we decided that due to centralization of the process and relatively small number of deaths (approx. 21.000 deaths annualy) it is too expensive to incorporate it. • Yes, we're planning to use real time data in situation similar to Covid-19.
Spain	 Figure 2 Institutional and documentary flowchart for the production of mortality statistics of death causes in Spain as applied to the region of Murcia	Reference: Cirera L, Salmerón D, Martínez C, Bañón RM, Navarro C. More than a decade of improvement in medical and judicial certification in the statistics of causes of death. Rev Esp Salud Pública.2018;92: June 6 e201806031.

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	• The Spanish cause of death reporting system is actually based on the use of paper death certificates templates. Since 2020, the most common used death certificate filled-in by practitioners is the published on the National Institute of Statistics (INE) portal and developed by the Collegiate Medical Organization https://www.ine.es/metodologia/t20/cues_def_20.pdf Information and Communication Technologies are used for reading, dumping and treatment of the data. These automatizated forms to treat the data varies for violent causes or crimes. Sometimes, different formats of death certificates are still used, mainly in big cities, e.g. those proceed from to emergency medical services (ambulances). Further information about quality of death certificates codification: https://repisalud.isciii.es/handle/20.500.12105/13605 • There is an initiative for digitalisation of death certificates conducted by an agreement between the Collegiate Medical Organization and the National Institute of Statistics. It was published in January 2021 in the Official State Gazette (BOE). It began in a small region of Spain in March 2021but it still in pilot phase. https://www.boe.es/boe/dias/2021/01/09/pdfs/BOE-A-2021-350.pdf
UK	• Death registration form for the UK – see URL file:///C:/Users/Ronan/Downloads/annexa%20(1).pdf. Doctors xertify deaths to the Registrar of Births and Deaths and are then forwarded to the Office of National Statistics for automatic ICD-10 coding using MUSE software: see https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/causeofdeathcodinginmortalitystatisticssoftwarechanges/january2020 • There is still some manual checking. When the software cannot complete the process automatically, the remaining deaths are manually coded by staff trained in ICD-10 and its rules. Deaths in neonates (under 28 days), stillbirths and deaths following a coroner's inquest are always coded manually in the ONS. • Yes, daily deaths are used in COVID-19 surveillance and prediction models.

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