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Review Article

A scoping review on the errors in medical certification of the cause of death in India

Payal Singh[1], Divya Khanna[2,5], Priyanka Sharma[2], Yagnik Vaza[6,7], Akash Anand[4,5], Atul Madhukar Budukh[5,7], Pankaj Chaturvedi[5,8,9] & Satyajit Pradhan[3,5,#]

[1]Varanasi Cancer Registry, Departments of [2]Preventive Oncology, [3]Radiation Oncology, & [4]Medical Superintendent, [#]Mahamana Pandit Madan Mohan Malaviya Cancer Centre and Homi Bhabha Cancer Hospital, Tata Memorial Centre, Varanasi, Uttar Pradesh, [5]Homi Bhabha National Institute, [6]Unit for Strengthening Cause of Death Data, [7]Centre for Cancer Epidemiology, & [8]Advanced Centre for Treatment, Research and Education in Cancer, Tata Memorial Centre & [9]Department of Surgical Oncology, Tata Memorial Hospital, Mumbai, India

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Medical certification of the cause of death provides epidemiological information for developing cause-specific mortality and disease trends, guiding the monitoring of health programmes and allocating health resources. Therefore, providing correct information on the cause of death is essential. This study describes the errors in medical certification of the cause of death in India. We conducted a scoping review through a systematic inquiry in four databases, PubMed, ProQuest, Google Scholar and EBSCO, for all published articles reporting errors in medical certification of cause of death in India between December 31, 1998 and December 31, 2020. The review outcomes were the proportion of major and minor certification errors reported. Out of 135 screened studies, 20 were included based on the eligibility criteria. We observed a high proportion of certification errors and a large proportion of variation. Major certification errors were in the form of incorrect underlying cause of death (8.5-99.2%) and incorrect chain of events leading to death (12-64.7%). Minor certification errors in the form of missing clerical details, abbreviations and illegible handwriting were 0.3-100 per cent. The proportion of incomplete death certificates ranged between 12-100 per cent. Absence of time intervals was the most common type of certification error (62.3-99.5%). Training of doctors to accurately certify the medical cause of death and its addition to medical education is urgently needed to ensure accurate information for mortality-related statistics. A uniform methodology for auditing and reporting errors in medical certification of cause of death should be adopted.

Key words Audit - cause of death- curriculum - death certificate - ICD-10- mortality - training programmes

A death certificate (DC) is a medico-legal record stating the medical cause, time, place and manner of an individual's death. The medical certification of cause of death (MCCD) provides epidemiological information for developing cause-specific mortalities and disease trends. Policymakers require this information to prioritize health and research resources distribution, and monitor the impact of health programmes[1,2]. The

effects of DCs on families, learning programmes, health-related policies, monitoring, research and indicators are substantial[3,4].

Geographical coverage of mortality registration ranges from nearly 100 per cent in Europe to ~50 per cent in Asia-Pacific, and less than 10 per cent in Africa[5]. In India, only 20 per cent of deaths are registered, and 50-60 per cent of the registrations are incorrect[4,6]. The time series data on MCCD in India (1991-2015) demonstrates a significant but gradual increase in the frequency of medically certified cases. During this period, the proportion of registered deaths that were medically certified fluctuated between 12.7 to 22 per cent. In addition, since all deaths do not occur in hospitals, hospital-based mortality statistics cannot reflect the actual scenario. Hence, the verbal autopsy is used in the sample registration system[7].

It is not uncommon to find MCCD having errors due to illegible handwriting, incompletely filled certificates, incorrect medical causes and manners of death. Despite poor medical certification status in India, less importance is given to teaching death certification in undergraduate medical courses[8]. However, several studies have reported certification errors in MCCD from different parts of India. A comprehensive review of all these published studies that can report the burden and pattern of certification errors is still lacking. With this background, we aimed to describe the status of MCCD in India regarding the proportion and types of certification errors reported in previous Indian studies and the methodology adopted by these studies for identifying errors in death certification.

Material & Methods

Literature search methodology: We conducted a systematic inquiry in four databases, namely PubMed, ProQuest, Google Scholar and EBSCO, with the MeSH and free text words such as 'cause of death' or 'medical cause of death certificate' or 'death registration' or 'death audit' or 'death certification' or 'hospital deaths' or 'vital statistics' or 'quality of death certificates' or 'validation of cause of death' or 'death certificate' and 'India', published between December 31, 1998 and December 31, 2020. We did not attempt to search for any unpublished data. The bibliography list of all included studies was also cross-referenced to ensure a full literature search. Authors of the articles for which full text was not accessible online were requested, and the full text thus obtained was included in this inquiry.

Eligibility criteria:

Criteria for inclusion: This study included published investigations (in English) conducted on the cause of death (COD) certification in India and reported the frequency of certification errors.

Criteria for exclusion: Mortality studies from India that were not evaluating death certification errors were excluded such as knowledge, attitude and practice studies of the certifying physicians[9], survival studies[10], disease registry[11], verbal autopsy-based studies[12-14] *etc*. Studies for which full text was not accessible and news or media reports that were not published in scientific journals were also excluded (Figure).

Article selection and data extraction: Articles/titles/abstracts with the keywords were screened by two independent investigators based on the defined eligibility criteria. Two researchers independently screened all headings, abstracts and full-text documents and resolved disagreements by consensus or consulting with the third researcher. Subsequently, information for the following was abstracted from the included studies: *(i)* place of study, *(ii)* study design, *(iii)* number of death certificates assessed, *(iv)* types and percentage of errors in MCCD, *(v)* completeness of the death certificate, *(vi)* methodologies adopted in the audit of death certificates.

Outcome measures:

Definitions of cause of death: The World Health Organization (WHO) defines the cause of death (COD) in relation to writing MCCD[15]. The underlying cause of death (UCOD) is 'the disease or the injury which initiated the train of morbid events leading directly to the death or the circumstances of the accident or violence that produced the fatal injury'[15]. Immediate cause of death (ICOD) is 'disease or condition directly leading to death'[15]. Antecedent cause of death is 'morbid conditions, if any, giving rise to the immediate cause of death'[15]. Contributory conditions are 'all other diseases or conditions believed to have unfavourably influenced the course of the morbid process and thus contributed to the fatal outcome but which were not related to the disease or the condition directly causing death'[15]. Disease-related symptoms and modes of dying, such as cardiac and respiratory arrest, are not included in these definitions[15].

The outcome measure was the proportion of certification errors reported in the included studies, which were categorized as major and minor based on

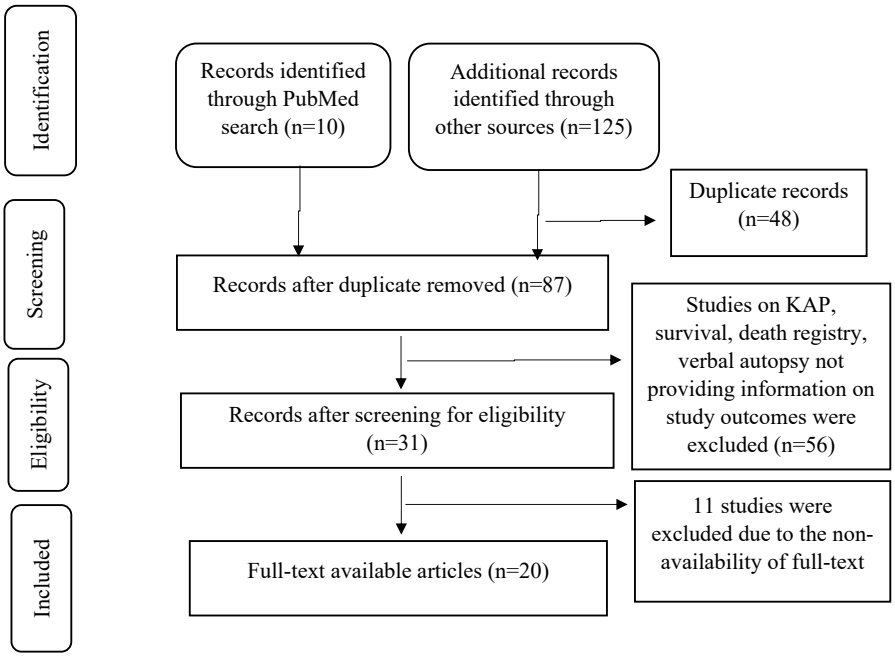

Figure. PRISMA flowchart showing the process of articles selected for the review.

the method of audit described by Myers and Farquhar[16]. Major errors were the errors that could influence the correct identification of the underlying cause of death, such as: *(i)* the mechanism of death or non-specific condition mentioned as an underlying cause of death, *(ii)* improper sequence of events leading to death, *(iii)* mentioning two or more causally unrelated, aetiology-specific diseases (competing causes) in part I of MCCD, and *(iv)* based on the clinical review of medical records it was found that the COD was not acceptable. Minor errors were: *(i)* use of abbreviations, *(ii)* absence of time-intervals in parts I and II of the MCCD, *(iii)* technical or clerical errors in the form of wrong or missing personal identifiers (age, gender and place of residence), incomplete certifying physician details, illegible handwriting and incomplete or wrong clerical details in the MCCD. Many studies reported incomplete information in part I and/or part II of the MCCDs. We categorized this as a major error (Table I)[16].

Data analysis: Data collected during the review was entered and analyzed using Microsoft Excel. Descriptive statistics in frequencies and proportions were reported for the outcome variables.

Results

A total of 135 studies were screened, and 20 studies[6,8,17-34], were included in the review based on the eligibility criteria. Studies for which the full text was not available (n=11) were excluded (Figure). The abstracted information from the included studies is mentioned in Table II.

Characteristics of the studies included: The included studies assessed a total of 17,106 DCs and the number of DCs covered in each study was in the range of 45 DCs[19] to 7392 DCs[34]. Most of these studies were conducted in Gujarat State (7 studies)[8,18-20,24,26,34] followed by Maharashtra (4 studies)[25,27,28,30] and the rest were from Delhi[17], Chandigarh[32], Uttar Pradesh[23], Odisha[22], Madhya Pradesh[6], Andhra Pradesh[33], Telangana[31] and Tamil Nadu.[29] Majority of the studies were observational (17 studies)[6,17-22,24-28,30-34] and three were interventional[8,23,29]. The interventional studies conducted death certification training for resident doctors and teaching faculty and assessed the effect on the post-intervention quality of death certification. All interventional studies reported a reduction in certification errors post-intervention. Interventions were in the form of seminars, training sessions and participatory workshops. One study[29] provided case-based scenarios before and after intervention in the form of training on death certification and compared the certification errors for the case scenarios; these studies were conducted at tertiary care teaching hospitals[6,8,18-20, 22,23,25-30,33] (Table II).

Major certification errors: The included studies reported substantial errors in the UCOD (8.5-99.2%),

Table I. Definition of major and minor errors in death certificates

Type of error	Definition
Major errors	
Mechanism of death listed without an underlying cause	A mechanism or nonspecific condition is listed as the underlying cause of death
Improper sequencing	The sequence of events does not make sense; the underlying cause of death is not listed on the lowest completed line of part I
Competing causes	Two or more causally unrelated, etiologically specific diseases listed in part I
Unacceptable cause	Wrong cause of death based on the review of clinical records or any one of the above errors (either alone or in combination)
Incomplete MCCD	MCCD information in part I and/or II is incomplete
Minor errors	
Abbreviations	Abbreviations used to identify diseases
Absence of time intervals	No time intervals are listed in parts I or II
Mechanism of death followed by a legitimate underlying cause of death	Use of a mechanism but qualified by an etiologically specific cause of death
Technical or clerical errors	Mentioning wrong personal identifiers (such as age, gender, & place of residence), incomplete certifying physician details, illegible handwriting, and incomplete or wrong clerical details in the MCCD

MCCD, medical certification of cause of death. *Source*: Ref.16

the ICOD (0.3-79.9%) and the chain or sequence of events preceding death (12-64.7%). Modes or mechanisms of death, such as cardiopulmonary arrest, were incorrectly mentioned as the COD in the range of 8.9-86 per cent. An unacceptable COD was reported in the range of 13.2-92.9 per cent (Table III)[20-36]. Out of the 12 studies that evaluated the completeness of the DC, all but one reported a very high proportion of incompleteness in DCs (Table III)[20-36].

Minor certification errors: Missing time intervals for COD was the most reported certification error in the included studies (62.3-99.5%). Other reported errors were wrong personal identification (0.3-100%), incomplete certifying physician details (0.5-64.2%), abbreviations (29.3-98%) and illegible handwriting (15.0-52.3%) (Table III)[20-36].

Patterns of reporting certification errors: Death certification audit studies have been reported from only selected States in India, such as Gujarat, Maharashtra, Uttar Pradesh, Odisha, Tamil Nadu, Andhra Pradesh, Telangana, Delhi and Chandigarh. Published data for death certification errors was lacking from many other States.

We found that the pattern of reporting death certification errors was not uniform. The outcomes for reporting certification errors varied in the included studies (Tables II and III). We reviewed the included articles for their adopted methodologies to audit death certification. Ten studies described the standardized definitions or guidelines used for reporting certification errors[6,8,20,21,23,26,30,32-34]. All studies except for four[17,18,24,31] mentioned using the WHO-prescribed format for reporting the MCCD in their study settings. Eight studies mentioned reviewing the deceased's medical records during the evaluation of MMCD[8,17,18,22,24,32,33,34]. Six studies described the process of MCCD in their study settings[6,8,17,19,19,33]. The conduction of training of reviewers for death certification was mentioned in six studies[18,23,24,25,32,33]. Two studies mentioned the independent reviewing of the DCs by two investigators and the method of resolving the disagreements in the death certification assessment[8,32]. Three studies assessed the International Classification of Disease (ICD-10) coding for the COD[6,19,34]. One study[29] assessed certification errors in the case-based scenarios before and after intervention in the same training session.

Discussion

Globally, a more significant proportion of deaths are contributed by the low- and middle- income countries, which have weak COD registration systems and high death certification errors that potentially hinder

Table II. Characteristics of the reviewed studies

Author/yr/ place of study	Study design	Sample size	Key findings	Type of study setting & qualifications of the certifying doctors
Patel *et al*[6] (2017); Madhya Pradesh	Observational	53 death certificates	Not a single certificate was error-free. The immediate, antecedent, & underlying cause of death were inaccurate in 79.2, 75.5, & 67.9% of DCs, respectively	Tertiary teaching medical college. Physicians' qualification NA, Ward setting details NA
Pandya *et al*[8] (2009); Gujarat	Interventional: The frequency of major & minor errors in death certificates was examined before & after conducting 3 workshops, each of 90 min, for the post-graduate residents	198 death certificates	Significant decrease in major certification errors post-intervention	Tertiary teaching hospital. All clinical residents. Qualification & ward settings details NA
Prakash *et al*[17] (2010); Delhi	Observational	259 death certificates	32% had an incorrect cause of death. Among these, 27% mentioned the mode of dying as COD	Referral oncology center with surgical, radiation, medical, & palliative oncology doctors. Qualification & ward settings details NA
Agarwal *et al*[18] (2010); Gujarat	Observational	296 death certificates	In 86% of DCs, the immediate cause of death was mentioned as a mode of death	Tertiary teaching hospital. Qualification & ward settings details NA
Patel *et al*[19] (2011); Gujarat	Observational	45 death certificates	Not a single certificate was error-free. Major errors in 57.5% DCs. Minor errors in 92.5% of DCs. 80% of DCs reported mode of death as the immediate cause of death	Tertiary teaching hospital. Casualty, Intensive care unit, medical ward, & others (not specified), Qualification detail NA
Shah *et al*[20] (2012); Gujarat	Observational	3212 death certificates	Major errors: The accuracy of immediate cause, antecedent cause, & underlying cause was 44, 55, & 69.9%, respectively. Only 1.2% of the certificates were accurate	Tertiary health institute. Qualifications & ward settings details NA
Lanjewar *et al*[21] (2013); Not mentioned	Observational	229 death certificates	58% of DCs were completely filled. Out of completely filled certificates, 82.7% had an accurate COD	Medicine & allied, surgery & allied, pediatrics, forensic medicine, obstetrics, & gynecology departments. Qualifications details NA
Dash *et al*[22] (2014); Odisha	Observational	151 death certificates	Major errors : The antecedent cause was filled in 27%, & the underlying cause was filled in only 0.8%. Most MCCD forms were incomplete (96.19%). Gender was missing in 45.7%	Tertiary care teaching institute. Qualifications & ward settings details NA
Azim *et al*[23] (2014); Uttar Pradesh	Interventional; pre & post-intervention audit conducted for reporting death certification errors. The intervention included an interactive educational programme for residents training for super speciality	150 death certificates	Significant decrease in major certification errors post-intervention	Tertiary care teaching institute. Resident doctors are undergoing subspecialty training in Critical Care Medicine. Ward setting details NA

Contd...

Author/yr/ place of study	Study design	Sample size	Key findings	Type of study setting & qualifications of the certifying doctors
Ganasva *et al*[24] (2015); Gujarat	Observational	1942 death certificates	Immediate, antecedent, & underlying causes were reported in 95.9, 27, & 0.8% of the DC, respectively. Only 1.1% were completely filled	Private practitioners from 12 wards of Municipal Corporation. Qualifications & ward settings details NA
Pokale *et al*[25] (2016); Maharashtra	Observational	98 death certificates	Two major errors were combined in 35.6% of DCs, three major errors in 8.6%, & at least one minor error in 99.3% of DCs. The most common error was the absence of a time interval (98.9%)	Tertiary care hospital. The majority are issued by the medicine department. Qualifications details NA
Ahir *et al*[26] (2018); Gujarat	Observational	523 death certificates	Only 20.1, 26.8, & 28.9% of MCCD forms were accurate in determining the immediate cause, antecedent cause, & UCOD	Tertiary care teaching hospital. Qualifications & ward settings details NA
Uplap *et al*[27] (2019); Maharashtra	Observational	410 death certificates	All DCs were incomplete & inaccurate. Mode of dying mentioned as immediate or antecedent cause of death in 86 & 41% , respectively. Multiple causes in 56% DCs	Tertiary care hospital. Resident medical officers. Qualifications & ward settings details NA
Patil *et al*[28] (2019); Maharashtra	Observational	278 death certificates	Completeness for the immediate, antecedent, & underlying cause of death was 99.7, 98.3, & 88%, respectively. Sequencing errors in 64.7%, Unacceptable COD in 37.8%	Tertiary care teaching hospital. Qualifications & ward settings details NA
Sudharshan *et al*[29] (2019); Tamil Nadu	Interventional; pre- & post-assessment of accuracy in writing MCCD for case-based scenarios given before & after a lecture on writing MCCD.	80 physicians	Significant decrease in major & minor certification errors post-intervention	Teaching hospital. Teaching faculty, post-graduates, junior residents, & interns (who have completed medicine & surgery postings). Ward setting not applicable
Raje[30] (2011); Maharashtra	Observational	353 death certificates	19% of deaths were in the incorrect sequence. Multiple COD: 25%. Use of abbreviations: 68%. Illegible name & signature of certifying physician: 85%	The teaching hospital attached a Medical College. Qualifications & ward settings details NA
Sheikh *et al*[31] (2012); Telangana	Observational	156 death certificates	Modes of death reported as COD in 37.8 certificates	General Hospital. Medical doctors. Qualifications & ward settings details NA
Gupta *et al*[32] (2013); Chandigarh	Observational	1251 death certificates	Any error: 97.1% *vs.* 73.3% ($P<0.05$). Any major error: 61.9% *vs.* 45.0% ($P<0.05$). Any minor error: 96.5% *vs.* 92.6 ($P<0.05$)	Tertiary pediatric hospital. Qualifications details NA
Srinivasulu *et al*[33] (2014); Andhra Pradesh	Observational	110 death certificates	Not a single form was error-free 47% reported major errors, 21% minor errors	Rural medical college hospital. Qualifications & ward settings details NA
Jain *et al*[34] (2015); Gujrat	Observational	7392 death certificates	Only 2% of certificates were completely filled. Modes of death were COD in 82.2%. Completeness for the immediate, antecedent, & underlying cause was 95.56, 66.67, & 40%, respectively	Municipal Corporation's Registrar Birth & Death office. The doctors' qualifications are not accessible. Ward setting details NA

DC, death certificate; COD, cause of death; NA, not available

Table III. Description of type of errors in the medical certification of cause of death

Category	Number of studies describing the certification error	Proportion of errors (%)
Minor certification errors		
Wrong personal identifiers[21,24,25,29,30,31,32]	7	0.3 - 100
Incomplete certifying physician details[20,23,24,27,28,32,35]	7	0.5 - 64.2
Use of abbreviations[21,24,25,29,30,31,32]	7	29.3 - 98
Illegible handwriting[21,24,30]	3	15 - 52.3
Absence of time intervals[8,10,20, 21,22,24,25,26,27,29,30,31,34,35]	14	62.3-99.5
Incomplete/wrong clerical details in the MCCD[22,29,30,32]	4	2.7 - 100
Major certification errors		
Incorrect underlying cause of death[8, 10,21,24,25,26,29,34,35]	9	8.5 - 99.2
Incorrect immediate cause of death[8,20,24,26,29,30,32,35]	8	0.3 - 79.9
Incorrect chain/sequence of events[8,10,21,25,32,34]	6	12 - 64.7
Modes of dying as a cause of death[8,21,22,33,35]	5	8.9 - 86
Others (not acceptable cause of death)[10,25,30]	3	13.2 - 92.9
Incompleteness of MCCD in part I & part II of MCCD[21,22, 25,26,27,29,30,31,32,34,35,36]	12	21-100

establishing disease control priorities and evaluating the impact of existing health programmes[35,36]. We conducted a scoping review of studies reporting certification errors in MCCD in India between December 31, 1998 and December 31, 2020. This review describes the proportion and types of errors and the methodology adopted by these studies for identifying errors in death certification. As per authors' knowledge, no other review existed that utilized the findings of the MCCD assessment studies across India to understand the burden and pattern of certification errors.

We identified large proportions of major and minor certification errors and wide variations in reporting the certification errors among the included studies. Researchers have reported similar observations working in other countries and with other sub-populations[37-39]. This review detected 12 types of certification errors (6 major and 6 minor) in the included studies. The highest proportion of reported major certification errors was for incompleteness, where the MCCDs had incomplete information for part I and part II (21-100%), followed by inaccurate UCOD (8.5-99.2%) and not acceptable COD (13.2-92.9%); of the 12 studies examining the completeness regarding part I and part II of the MCCD majority reported a very high percentage of incompleteness. Incomplete DCs can affect the selection of the accurate UCOD, leading to an underestimation of the actual disease burden and affecting policy-making and resource allocation for prevention and control[40]. Checking the completeness of the MCCD as part of quality control and developing a tracking mechanism to ensure the completion of such incomplete MCCDs is required in every hospital setting[39].

A global systematic review reported that the highest rates of wrong UCOD were reported in India and Pakistan[39]. UCOD initiates the chain of events leading to death and the most crucial COD from a public health perspective[41]. The correct identification of UCOD is a critical step for developing and monitoring strategies for diseases of public health importance. Additionally, an accurate UCOD is mandatory for completeness and accurate death registration reporting and comparison at national and international levels[39]. We observed that incorrectly assigning mechanisms/ modes of death, such as cardio-respiratory arrest as a UCOD, ranged between 8.9 and 86 per cent. In line with this, the systematic review also reported that the highest rates of this error were reported in India and Greece[39]. Data regarding mechanisms of death are of no analytical value and may also cause ambiguity and misinterpretation of the COD. The ICD codes assigned for such CODs are often regarded as 'garbage codes' that are not useful for public health analysis. When such errors are large, it may often lead to bias in the actual mortality pattern[42-44]. This form of certification error is a significant challenge in LMICs, where most deaths occur without any medical attention at the time of death[35].

We observed that minor certification errors in the form of clerical mistakes in the personal information of the decedents ranged from 0.3-100 per cent. The included studies reported that MCCDs had incomplete or incorrect information regarding the age, sex and

place of residence of the deceased. Inaccurate age and sex-related reporting will impact age and sex-specific mortality statistics[45]. Similarly, incorrect or missing details of the place of residence can affect the understanding of the geospatial distribution of the diseases[46,47]. Such clerical errors may also cause technical difficulties in claims related to insurance, pensions and inheritance[4].

We observed that errors in abbreviations and illegible handwriting were reported in high proportions. Abbreviations and illegible handwriting though generally regarded as minor certification errors[48-50], some authors have argued that these can be considered major certification errors[39]. DCs are legal documents often intended for audiences with non-medical backgrounds, such as coders, family members, judicial authorities and other public health stakeholders and researchers[39]. Hence, using abbreviations and illegible handwriting can cause misinterpretation of COD, inaccurate ICD coding and false statistics. A recent systematic review reporting common errors in MCCD reported that abbreviations and illegibility led to serious coding errors[39]. Therefore, physicians should entirely refrain from writing abbreviations and illegible handwriting when compiling the DCs.

We observed that 8 (40%) studies had reviewed the MCCD with the medical records of the decedents. To conduct a validation study of the COD data from hospitals, the gold standard procedure will be an autopsy[51]. However, the frequency of autopsies is decreasing due to operational factors, growing distrust and mostly reserved for medico-legal cases[52]. Hence, validating the MCCD by reviewing the medical records and developing gold standard diagnoses for the diseases should be a practice to understand the type of errors in MCCD and formulate remedial measures. These methods for validation are rarely applied in Indian hospital settings. The systematic review performed by Rampatige *et al*[53] has proposed a framework for conducting medical records reviews, which researchers can use for death audit-related studies[53]. However, the application of this framework will be limited by lack of good medical record keeping in many hospitals. Recently, the Indian Council of Medical Research (ICMR) published a detailed framework for conducting an audit of the MCCD at a health facility, which would help the health facilities minimize errors and ensure completeness and timely submission of the MCCD data. The framework will also help establish a death certification review system in facilities[54].

We observed that blinding or independent reviewing of the DC was mentioned in two studies[8,32]. Blinding makes intentional or unintentional bias difficult, thereby enhancing the reliability of study findings[55]. Several studies have adopted the strategy to blind the reviewers for the original MCCD and, based on their review of medical records, generate the chain of events and the COD report[56,57]. About 6 (30%) studies mentioned the conduction of training for review of death certification[13,14,15,18,19,24]. WHO recommends orientation and training for conducting mortality and morbidity reviews for the personnel involved in mortality and morbidity audits to improve the quality of healthcare[58]. We observed that a strategy for resolving the disagreement was reported in only two studies. When more than one reviewer abstracts data from the same medical records, there is a chance of disagreement and an explicit procedure should be identified to resolve such disagreement[59].

We identified a wide range of certification errors, which reflected the lack of a uniform pattern of MCCD and the process of auditing the MCCD. The reviews conducted in several countries have reported such variations in certification errors. These variations may affect the generalizability of the study findings as well as inter-state comparisons. Hence, training certifying physicians for MCCD and adopting a uniform, systematic assessment approach to audit MCCD across all hospitals is critical to improving the quality of MCCD and death audits[53]. Though most of the included studies mentioned the prescribed WHO format for MCCD, it has been reported that many health settings, especially in rural and remote regions, do not use the standardized format for death certification. All hospitals should uniformly use the WHO-prescribed format for COD certification and auditing purposes. The WHO has also laid down guidelines for auditing facility-based paediatric and maternal deaths[58]. Similarly, there is a need to develop standardized guidelines for other disease-specific death audits to improve the quality of care.

Findings from the included interventional studies highlighted the usefulness and feasibility of training physicians for MCCD, which could raise the quality of death certification and the nation's vital registration systems. Previous interventional studies from India[8,23,29], the United States of America (USA)[60,61], Peru[62] and Spain[63] have demonstrated that training of certifying physicians for the COD certification improves the quality of DCs and reduces both major and minor certification errors. A workshop-led educational intervention study from five teaching hospitals in the

USA showed that the intervention group improved death certification more than the printed-handout group. The workshop group demonstrated a significant reduction in identifying inaccurate cardiac causes as COD from 56 to 6 per cent ($P<0.001$)[60]. A meta-analysis assessing the effectiveness of training in improving the quality of MCCD reported a substantial reduction in errors among participants who received training, with pooled risk differences in the range of 15-33 per cent. The study also reported reduced diagnostic errors through refresher training and regular dissemination of MCCD quality assessment findings[64].

There are several limitations to the study. We found that the included studies had a very heterogeneous population, where some studies were conducted exclusively for the paediatric population[32] and others on cancer patients[17]. Also, in the interventional studies, the time duration and method of the training interventions varied. We could not find any randomized interventional studies. We also observed varied subjectivity in the assessment of MCCD, which could have affected our study outcomes. Furthermore, we observed a lack of a standardized method for reporting the death certification errors in the included studies, which resulted in difficulty in comparing the results over time and among different regions. We could not find many studies that utilized strategies to limit the bias by blinding the investigators or validating the MCCD with the deceased's medical records. Lastly, we defined the study period as December 31, 1998 and December 31, 2020 and did not include the published articles in the last three years. In the year 2020, the world witnessed the unprecedented impact of the COVID-19 pandemic on healthcare, which led to several discussions at national and international forums regarding the under-reporting as well as excess mortality reporting due to misclassification related to COVID-19 infection globally[65,66].The government of India took several interventions to counter these errors in death reporting, where ICMR developed several guidelines and software for COD reporting since the onset of the pandemic[67,68].

A high proportion of errors in the medical certification as the cause of death have been reported in the reviewed studies from India. There is a pressing need to ensure accurate information in the medical certification of the cause of death, which will impact mortality statistics, public health policy, research and learning. Therefore, teaching medical certification of cause of death must be incorporated into medical education. There is a need to follow a standardized approach for auditing death certificates as well.

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For correspondence: Dr Divya Khanna, Department of Preventive Oncology, Mahamana Pandit Madan Mohan Malaviya Cancer Centre and Homi Bhabha Cancer Hospital, Tata Memorial Centre, Varanasi 221 005, Uttar Pradesh & Homi Bhabha National Institute, Mumbai 400 094, Maharashtra, India
e-mail: dkhannakgmc@gmail.com