Teaching cause-of-death certification: lessons from international experience

Eindra Aung,1 Chalapati Rao,2 Sue Walker3

ABSTRACT

Background and objective The accuracy of cause-of-death statistics substantially depends on the quality of cause-of-death information in death certificates, primarily completed by medical doctors. Deficiencies in cause-of-death certification have been observed across the world, and over time. Despite educational interventions targeted at improving the quality of death certification, their intended impacts are rarely evaluated. This review aims to provide empirical evidence that could guide the modification of existing educational programmes, or the development of new interventions, which are necessary to improve the capacity of certifiers as well as the quality of cause-of-death certification, and thereby, the quality of mortality statistics.

Design A literature review using keywords: death; certification; education/training.

Data sources The primary search through PubMed. Reference lists in individual articles from the primary search and also manual searching of other databases such as Google Scholar and OpenDOAR.

Eligibility criteria for selecting studies Evaluation studies which assessed educational interventions for medical students and doctors on correct completion of death certificates.

Results All educational interventions identified in this review improved certain aspects of death certification although the statistical significance of evaluation results varies with the type of intervention: printed educational material alone being the intervention with the least educational impact and interactive workshops being the most effective intervention.

Conclusions Pragmatic education on best practice for cause-of-death certification is a basic step to ensure accurate information for each individual case, leading to the production of high quality mortality statistics for epidemiology, public health policy and research. Development of new educational interventions or modification of existing programmes should be based on evidence of the benefits from current and past interventions provided under varying circumstances.

BACKGROUND

Complete and accurate death certificates are essential for the medico-legal management of individual cases of death.1 They are also the foundation of high quality mortality data in the form of standardised, comparable, cause specific mortality statistics over time and place.2 Such data are required for decision making within clinical departments, hospitals and healthcare systems. Analysis of mortality trends and differentials form the basis for evidence based epidemiological evaluations, which are subsequently used to assess the impact of public health interventions, and set disease control priorities at national and international levels.

There are three basic sources for population level mortality data. These are civil registration and vital statistics systems; sample surveys; and population censuses.3 Of these, the optimal source of routine and timely mortality and cause-of-death data is the civil registration system, in which deaths are registered under legal and administrative provisions. Data quality is determined by the degree of coverage of the resident population by civil registration, the completeness and timeliness of the registration data, and the quality of reporting and investigation into the cause(s) of death in each case. The quality of cause-of-death statistics needs detailed assessment in terms of the reliability and validity of the data,4 which are dependent on accuracy in the certification, coding5 and statistical presentation6 of causes of death.

Causes of in-hospital deaths are certified by attending physicians or medical residents. For deaths outside hospitals, many countries require certification of death and its cause by medically qualified practitioners. Where this is not possible or where there are medico-legal implications, certification is conducted by coroners, sometimes supported by medical examiners or forensic pathologists. In many developing countries, however, causes of out-of-hospital deaths (with and/or without medico-legal implications) are often recorded by local registrars through household enquiry or may not be recorded at all. Therefore, despite the importance of cause specific mortality data at various levels, only countries with complete medical certification of deaths have the potential to derive good quality data from civil registration systems.7 An international analysis revealed that only 31 out of 192 countries in the world produced high quality cause-of-death statistics for 2004.8 Even this categorisation was based on a crude index of data quality—that is, proportion of deaths classified to symptoms, signs or ill defined conditions being <10%. In several of these 31 countries, detailed small scale studies have identified problems with data validity, when registered causes were compared with reference diagnoses from pathological autopsies or medical record chart reviews.9–14

A fundamental issue that leads to poor quality statistics is the inadequacy of information on causes of death recorded on the death certificate. In the past few decades, a range of interventions have been implemented in different countries to improve the quality of cause-of-death information on the death certificate. These include improvements in death certificate formats; training programmes for physicians and medical students on completion of death...
certificates; provision of self learning educational materials; implementation of cause-of-death query systems; periodic peer auditing of death certificates; and increasing autopsy rates.5 15–21 It has been observed that inadequate performance of doctors in the medical certification of cause of death is a principal reason for inaccurate data.22–27 The main objective of this paper is to use findings from a detailed review of the literature on educational interventions to improve the quality of death certification. The specific objectives of the review are: first, to analyse information about evaluation studies reporting quantitative impact measures of education on improving the quality of death certification; and second, to provide a descriptive assessment of qualitative observations focusing on the timing, content and duration of training programmes, and the overall utility of different training methods. These quantitative and qualitative findings provide empirical evidence that could guide the modification of existing training programmes, or the development of new interventions, which are necessary to improve the quality of cause-of-death certification, and thereby, the quality of mortality statistics.

METHODS
Search strategy
A comprehensive literature search was conducted to identify published articles on the subject of training and education in completing death certificates. The search strategy was implemented on electronic databases, and the primary search was conducted on the PubMed database (1951—April 2009). The query translation on the search terms in PubMed was as follows: \("\text{death}\[\text{MeSH Terms}\] \text{OR} \"\text{death}\[\text{All Fields}\]\) AND \("\text{certification}\[\text{MeSH Terms}\] \text{OR} \"\text{certification}\[\text{All Fields}\]\) AND \("\text{education}\[\text{Subheading}\] \text{OR} \"\text{education}\[\text{All Fields}\]\) AND \("\text{training}\[\text{All Fields}\] \text{OR} \"\text{education}\[\text{MeSH Terms}\] \text{OR} \"\text{training}\[\text{All Fields}\]”.

Screening and selection
Articles identified from this initial search were screened for specific content about education on death certification, and such articles were selected for more detailed review. At the next stage, the selected articles were scrutinised for information on quantitative evaluation of any educational programme on cause-of-death certification. Articles which provided these details were selected for the detailed quantitative analysis on comparative effectiveness of educational interventions. Reference lists for these articles were also scrutinised to identify additional articles with the relevant information. All articles identified following the initial screening were included in the qualitative assessment of effectiveness of educational interventions to improve cause-of-death certification.

Analytical methods
In the articles eligible for the quantitative analysis, information was abstracted regarding the study design employed, type of educational intervention being assessed, nature of participants, duration of training programme, and the methods used for statistical evaluation. The qualitative analyses focused on content related to educational needs of participants, the type and subject matter covered in the education programmes, and other specific aspects that require attention in designing educational interventions.

RESULTS
Search results
Out of 129 articles that were identified from the initial PubMed search, information on training or education regarding death certification was available in 58 articles, for which either abstracts or full texts were available. The other 71 articles were discarded since they either did not include information relevant to the objectives of this review, or the abstract or the full text article could not be accessed. Several types of information related to death certification education were mentioned in these 58 articles, and table 1 provides a summary of these articles according to information types. The articles were grouped into three broad categories: those reporting on important outcomes, those with recognition and description of educational needs in death certification, and those focusing on specialised training or specific circumstances.

As can be seen from table 1, almost half of the articles from the PubMed search clearly stated that more education or better education was needed, while another 10 articles implied the same in the form of statements noting the inadequacy of education in death certification. Several articles listed the educational needs for cause-of-death certification in more detail, and a few articles provided descriptions of specific interventions, or for educational purposes, the death certification procedure in special circumstances such as for cocaine-related deaths. Similarly, several articles underscored the importance of consultation with or referral to a medical examiner or coroner when required, while others mentioned specialised education needs and interventions for these personnel. Articles also identified specific problems, errors or inaccuracies in death certification, with some of them also describing an association between characteristics of specific groups of certifiers (eg, age, professional experience, specialty of certifiers, death certification training received and demography) with such problems. A few of the reviewed articles pointed out that inaccuracy in death certificates persisted despite training.

The PubMed review identified only 11 articles with abstract or full text available in English that were related to the formal evaluation of an educational intervention to improve death certificate completion. Through additional search, three
more articles on the evaluation of an educational intervention to improve accuracy in completing death certificates were identified. Out of these 14 articles on evaluation, five were in Spanish, with translated abstracts in English. With the help of a translator, key results from these Spanish articles for which we have access to full text in Spanish are included in this review. Figure 1 shows steps involved in the selection of these 14 evaluation studies.

Characteristics of evaluation studies
Table 2 summarises the broad features of the 14 evaluation studies that report quantitative evidence on the effectiveness of educational interventions. The 14 articles are from six countries, and were published between 1989 and 2007. The majority of these studies conform to the ‘before–after comparison’ study design, probably the simplest method for evaluating educational interventions. The wide range of educational interventions tested (printed materials, videos, theoretical seminars and interactive workshops delivered in various combinations), and the spectrum of participants (interns, residents, specialists and community physicians) in the different studies typify the challenges encountered in education delivery in this area.

In all of the studies but one, a major criterion for assessment was improvement in the recording of underlying causes of death. However, the methods for assessing the improvement in death certification practices differed between studies. Only five out of the 14 studies assessed the improvement by auditing actual death certificates completed over a 1–6-month period of time after the educational intervention. The other nine studies based their assessment on scoring of mock death certificates completed using case scenarios. Among these, only two studies reported on the conduct of a post-intervention assessment after a certain period of time (1 month and 3 months, respectively). It is reasonable to infer that post-intervention assessments conducted after a time interval, rather than at the end of the seminar, are more effective in assessing the effects of the intervention in the long term. Similarly, auditing of actual death certificates completed over a certain period of time is more likely to capture change in actual death certification practices compared to scoring of mock death certificates.

Effectiveness of interventions based on printed materials
The evidence contained in these articles suggests that printed educational material alone is probably the intervention with least educational impact, although slightly better death certification practices were observed. While a letter to medical interns in the UK in 1989 instructing them of the rules for recording alcohol abuse in case notes and on death certificates did result in significant improvement, another study in Australia found that reading educational material alone reduced major certification errors, but did not demonstrate a statistically significant change in certification practice among residents. A randomised controlled trial in France tested the utility of certification examples with accompanying certification guidelines in comparison to certification examples alone, and found no notable differences in the quality of certification. However, the group that received guidelines had slightly better results for the majority of the criteria considered. Finally, a recent, randomised controlled trial in the USA compared the impact of an interactive workshop with that of printed educational material, and found that the workshop format proved to be the more effective intervention. This has highlighted the need for education to be more than merely the provision of reading materials.

Use of training videos
The use of video as an educational tool also has limited impact on the quality of death certification, with only a slightly better overall score in the intervention group reported in one of the studies. A randomised controlled trial evaluated the impact of a video in addition to a lecture, in comparison with the lecture alone, in two groups of undergraduate medical students in the UK, and found that the video resulted in only a marginally significant improvement (p=0.046). A video could potentially be more useful, as observed from a ‘before–after comparison’ study in Canada where it was used in conjunction with a tutorial, group discussion and mock death certification during a half-day workshop for community physicians. However, the combination of educational methods, skills and experience of participants, and duration of the programme probably influenced the overall outcome of each of these studies evaluating educational videos.

Audit of certification practice
Feedback on accuracy, comprehensiveness and adherence to the requirements for death certification is a useful adjunct educational intervention. This was assessed during a detailed ‘audit–intervention–re-audit’ study evaluating quality of death certification in the elderly care department of a district general hospital in the UK. Initially, results of a retrospective audit of every death certificate issued during a 4-month period were disseminated to hospital staff during a clinical governance meeting, in the form of anonymous feedback. In addition, individualised performance data were provided to each certifier. Further, doctors recruited to the hospital during the study period received instruction on death certification during induction training. A re-audit carried out 5 months after the feedback demonstrated improvements in accuracy and legitimacy (ie, meeting the legal requirements) in death certification. An important aspect of this study lies in the use of official death certificates in the audit, which provides a realistic assessment of certification practice.

**Figure 1** Flowchart of PubMed literature review and selection of articles for analyses.

<table>
<thead>
<tr>
<th>Title</th>
<th>Type of study</th>
<th>Year &amp; location</th>
<th>Training duration</th>
<th>Intervention</th>
<th>Participants</th>
<th>Evaluation method</th>
<th>Summary of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving death certificate completion: A Trial of Two Training Interventions</td>
<td>Randomised controlled trial and before and after evaluation of 2 training interventions</td>
<td>2006 †, US</td>
<td>45 min workshop</td>
<td>Group I: interactive workshop using the guidelines for optimal completion of death certificates. Group II: printed instruction material as a handout that outlined the guidelines.</td>
<td>Internal medicine residents, assigned to group I or II using an internet based randomisation program</td>
<td>Scoring of death certificates filled out using a different sample case before intervention and 1 week after intervention by each group</td>
<td>▶ Both groups showed a significant improvement in all areas of death certificate scoring.</td>
</tr>
<tr>
<td>Improving the accuracy of death certification</td>
<td>Before and after evaluation</td>
<td>1996 * (three seminars over 6 months), Canada</td>
<td>75 min</td>
<td>Seminar on process of and terminology in death certification, interactive completion of death certificate based on 10 case scenarios and identification of errors in mock death certificates</td>
<td>Internal medicine residents</td>
<td>Audit of actual death certificates filled out over a 12 month period before and those filled out over a 6 month period after intervention</td>
<td>▶ Significant reduction in proportion of certificates with at least one major error.</td>
</tr>
<tr>
<td>Death duties: Workshop on what family physicians are expected to do when patients die</td>
<td>Before and after evaluation</td>
<td>2007 †, Canada</td>
<td>Half-day</td>
<td>Workshop on death counts video, Coroners Act tutorial, death certification process review, small group discussion on case scenarios, mock death certification and presentation</td>
<td>Community (family) physicians</td>
<td>Scoring of death certificates filled out using case scenarios before intervention and 3 months after intervention; Pre- and post-intervention questionnaire survey</td>
<td>▶ Decline in use of mechanisms of death and increase use of more specific diseases as the underlying cause of death.</td>
</tr>
<tr>
<td>Evaluating an educational intervention to improve the accuracy of death certification among trainees from various specialties</td>
<td>Before and after evaluation</td>
<td>2007 †, Spain (over an 18 month period)</td>
<td>90 min</td>
<td>Interactive workshops on current legislation and most common errors in death certification, distinction between causes and mechanisms of death, recommendations to improve certification</td>
<td>Medical trainees (family/ internal/ critical care medicine, anaesthesiology, general surgery)</td>
<td>Scoring of death certificates filled out using the same case scenario before and at the end of workshop</td>
<td>▶ Improvement in knowledge on death certification and the Coroners Act.</td>
</tr>
<tr>
<td>A pilot programme to improve causes of death certification in primary care of Catalonia, Spain</td>
<td>Before and after evaluation</td>
<td>2006 †, Spain</td>
<td>90 min</td>
<td>Theoretical and practical seminar including regulations and criteria on how to certify causes of death</td>
<td>Primary care physicians: 96 general practitioners, 33 family and community medicine specialists, 15 paediatricians</td>
<td>Scoring of death certificates filled out using the same 3 case scenarios before and at the end of seminar</td>
<td>▶ Significant reduction in the proportion of certificates with errors.</td>
</tr>
<tr>
<td>Learning and satisfaction in the workshops of pre- and postgraduate medicine for the improvement of the accuracy of certifications of causes of death 1992–1998</td>
<td>Before and after evaluation</td>
<td>1992–1996 *, Spain</td>
<td>2 h</td>
<td>Workshops of theoretical and practical components on usefulness of mortality statistics and the International WHO norms of certification</td>
<td>Medical students, interns, doctors</td>
<td>Scoring of death certificates filled out before and after intervention</td>
<td>▶ Good initial qualifications were improved after the intervention.</td>
</tr>
<tr>
<td>A good death certificate: improved performance by simple educational measures</td>
<td>Before and after evaluation</td>
<td>2004 *, UK</td>
<td>2 h</td>
<td>Feedback on audit findings collectively in a clinical meeting and individually. The topic was highlighted during the induction of new doctors. Those unable to attend were sent paper copies of the feedback</td>
<td>Senior house officers (SHOs), staff grades, specialist registrars, consultants. New SHOs during re-audit</td>
<td>Audit of actual death certificates filled out over a 4 month period before and those filled out over a 3 month period after intervention</td>
<td>▶ Statistically significant improvements in the groups of indicators of concept and result of certification.</td>
</tr>
<tr>
<td>Evaluation of seminars on international criteria for medical certification of cause of death</td>
<td>Before and after evaluation</td>
<td>1996 †, Spain</td>
<td>Theory: 2 sessions of 45 min</td>
<td>Theoretical seminar: detailed explanation of death certificates and WHO's international criteria for certification of causes of death</td>
<td>44 doctors</td>
<td>Audit of actual death certificates filled out over a 6 month period before and those filled out over a 6 month period after intervention</td>
<td>▶ Significant reduction in proportion of certificates not meeting legal criteria as well as that of certificates with mistakes and omissions.</td>
</tr>
<tr>
<td>Title</td>
<td>Type of study</td>
<td>Year &amp; location</td>
<td>Training duration</td>
<td>Intervention</td>
<td>Participants</td>
<td>Evaluation method</td>
<td>Summary of results</td>
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<tr>
<td>Efficacy of an informative seminar in the certification of causes of death</td>
<td>Before and after evaluation</td>
<td>1993*, Spain</td>
<td>60 min</td>
<td>Theoretical seminar: importance of mortality statistics and the role of a doctor in improving the quality of statistics; WHO’s international criteria and procedure for certification of the causes of death</td>
<td>6th year medical students</td>
<td>Scoring of death certificates filled out using 5 case scenarios before intervention and 6 other case scenarios after intervention</td>
<td>Significant improvement in the majority of indicators on quality of death certification (underlying cause of death, logical sequence, multiple cause of death, use of abbreviations and lower case letters)</td>
</tr>
<tr>
<td>The efficacy of an information seminar on certification of the causes of death</td>
<td>Before and after evaluation</td>
<td>1985*, Spain</td>
<td>Theoretical seminar: usefulness of mortality statistics and death certification according to WHO’s international criteria for certification of causes of death</td>
<td>Physicians (60% are general practitioners)</td>
<td>Scoring of death certificates filled out before and after intervention</td>
<td>Significant improvement in the median score from mock death certification</td>
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<tr>
<td>Alcohol and death certification: influencing current practice and attitudes</td>
<td>Non-randomised controlled trial</td>
<td>1989 †, UK</td>
<td>A letter to the intervention group at the start of their posting, informing them of changes to the coroner’s rules and the importance of recording alcohol abuse in case notes and death certificates. No informative letter in the control group</td>
<td>Two cohorts of pre-registration housemen: an earlier group (control) and the following group (intervention)</td>
<td>Review of case notes and death certificates filled out over a 3 month period by each cohort for appropriate reference to alcohol</td>
<td>Improvement in recording details in the alcohol history</td>
<td></td>
</tr>
<tr>
<td>An evaluation of an educational intervention to improve death certification practice</td>
<td>Before and after evaluation</td>
<td>1991*, Australia</td>
<td>Reading the educational material which highlights common misconceptions in death certificate completion</td>
<td>Resident staff</td>
<td>Audit of actual death certificates filled out over a 1 month period each before and after intervention</td>
<td>Fewer major certification errors (no statistical significance)</td>
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<tr>
<td>Randomised comparison of death certification with and without guidelines</td>
<td>Randomised controlled trial</td>
<td>2000 †, France</td>
<td>Providing guidelines in addition to examples on death certificates to intervention group</td>
<td>Two groups each of general practitioners and specialists</td>
<td>Scoring of death certificates filled out using 10 case scenarios by each group</td>
<td>In the intervention group (compared to control group),</td>
<td></td>
</tr>
<tr>
<td>Death certification: production and evaluation of a training video</td>
<td>Randomised controlled trial</td>
<td>1995*, UK</td>
<td>A video (in addition to the usual lecture on death certification) for intervention group; usual lecture only for control group</td>
<td>First year medical students assigned to one of two groups using random numbers</td>
<td>A test of knowledge and skills in completing death certificates using case scenarios (under examination conditions) in both groups 1 week after the intervention.</td>
<td>The intervention group performed slightly better than the control group (only about 5% better overall score)</td>
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*Year(s) the evaluation conducted or covered. †Year the article published.
Training programmes

Interactive workshops are probably the most effective form of education in improving the quality of death certification, as borne out from several before–after comparison studies (two in Canada \(^29\) \(^30\) and six in Spain \(^31\)–\(^33\) \(^35\)–\(^37\) ). Five of these studies evaluated interactive workshops or seminars with theoretical and practical components \(^29\)–\(^33\) while the other three evaluated seminars which only had a theoretical component \(^35\)–\(^37\). Overall, seven studies reported statistically significant improvements in the quality of death certification. The remaining study also reported improvement, but without any statistical measures \(^30\). In summary, all the educational interventions identified in our review improved certain aspects of death certification, and the statistical significance of evaluation results for each type of intervention is shown in figure 2.

Timing of education

The review provided useful insights into the issues regarding the appropriate stage of medical education at which the principles and practices of death certification should be taught. For example, several authors observed that despite education on death certification as part of traditional undergraduate medical training and the availability of guidelines on death certificate completion, inaccuracies in death certification persisted \(^26\) \(^42\)–\(^46\). Pain et al reasoned that students at an early stage of medical training may find it difficult either to see the relevance of death certification to themselves, or to understand the clinical scenarios outlined \(^41\). This is substantiated by findings from a university teaching hospital in the UK, where inaccurate completion of the death certificates by junior doctors occurred despite most of them having graduated from the same university, where death certification was part of their course \(^46\). According to comments made by house officers and general practitioners in a study by Maudsley et al, undergraduate training on death certification was regarded as too early and not reinforced subsequent to graduation \(^49\). This suggests that merely teaching undergraduate medical students without follow-up training during their residency is not effective in improving the accuracy of death certification. This statement was supported by a number of authors. Weeramanthri et al rationalised the need to target medical residents for proper death certification training, in view of the opportunity for practical experience in completing death certificates and the expected persistence of good practices learnt during residency \(^59\). Similarly, Pritt et al stated the need for gaining death certification experience throughout one’s residency, and recommended an annual course in death certification for all resident staff, to avoid acquiring bad habits without proper training and reinforcement \(^50\). Kircher et al also indicated the need for education of medical students through teaching, self study and examination questions as well as the importance of providing proper guidance in completing death certificates during their residency \(^51\). However, given the competing demands faced by residents, optimal use of the time available for teaching on completion of death certificates is important \(^42\).

Content of educational interventions

Regarding curriculum, the review identified that instruction and training on this subject is widely perceived to be inadequate, and that there is a need for evidence based, well designed and organised education on cause-of-death certification \(^52\)–\(^70\). In particular, several articles identified and classified major errors in death certification, and highlighted major topical areas in which doctors need to be trained \(^26\) \(^46\) \(^50\) \(^71\)–\(^74\). In this regard, death certification training curricula or guidelines have been published by a number of countries, and are widely accessible through the internet \(^75\)–\(^81\). To achieve greater harmonisation in death certification among European countries, the Statistical Office of the European Communities (Eurostat) conducted a regional survey on training practices in cause-of-death certification, and the results were used in developing a basic common training package on good death certification procedures \(^60\).

In the international context, the Education Committee of the World Health Organization Family of International Classifications (WHO-FIC) Network has developed a core curriculum for guiding the development of training for certifiers of causes of death, key elements of which are listed in table 3 \(^82\). While providing guidance for standardised curriculum, these knowledge clusters are sufficiently broad to permit country specific...
adaptable to meet local education needs. Indeed, standardisation in training of certifiers of causes of death and procedures for the collection of cause-of-death data has been recommended to improve the comparability of epidemiological data.\(^5\) Quality assurance of data through reliability assessments of certification and/or coding, supported by validation studies comparing death certificate diagnoses with those from medical records, are also necessary to improve the utility of cause-specific mortality data, and these are additional aspects that could be touched upon during training programmes.

**DISCUSSION**

Certifying causes of death is a technical matter that requires specific knowledge to meet the legal, clinical and epidemiological purposes of this function. The use of information on causes of death has evolved over time, and changes in legislation have generally increased the need for proof of the cause of death. This is particularly relevant to exclude the possibility of foul play, or where present, to aid forensic inquiry into the circumstances resulting in death. However, the latter instances comprise only a small proportion of all deaths. Knowledge of disease processes leading to death has continued to grow with technological improvements in diagnostic abilities, and appropriate documentation of the chain of events in chronological and pathophysiological sequence requires attention to identify specifically the underlying cause of death used for tabulation, reporting and comparative purposes. Hence, adequate education in these aspects is essential, as well as ongoing orientation to changes in certification requirements. The key challenges in the provision of such education are: first, the need to provide fresh medical graduates with an understanding of principles of death certification from legal and epidemiological perspectives in addition to the clinical aspects; and second, to update knowledge among a wide pool of certifiers periodically, in the form of refresher training. In this regard, Maudsley and Williams declared that exploring alternative methods of providing instruction on death certificate completion was required.\(^{49}\) This article reviews the state of the art in interventions for providing education on cause-of-death certification, and provides a platform for developing suitable options to serve such a variety of educational needs.

The review provides useful insight into the variety of methods used to impart knowledge on this subject to a range of recipients including interns, specialists, community physicians, and even funeral directors, who do not hold formal responsibilities for death certification but often have an important role to play in this process in many countries. Although the number of studies conducted to evaluate the impact of specific training interventions formally is few, a common theme that emerges from the review is that interactive workshops are the most effective form of education. This has been consistently observed from different study designs (before—after comparisons and randomised controlled trials), for different professional groups (interns, general practitioners, specialists), and for different durations of training (45 min to half-day sessions). However, while interactive workshops can be organised for students or hospital staff, engaging community or remote area physicians in a similar manner could pose significant challenges. Therefore, the findings from the review that other training methods such as videos and different types of printed materials are also useful methods, although their effectiveness ranks lowest among the studies, are encouraging. European initiatives in developing self study tools and interactive training websites have broadened the range of methods for disseminating information and providing education on cause-of-death certification.\(^{65}\)

Another limitation from the review is that all the 14 articles that report quantitative evaluations of educational interventions are from developed countries. In fact, only six of the 58 articles from the initial search were from developing countries, and all of these six articles only stated the urgent need for education without discussing the effectiveness of educational interventions. However, given the universality of problems with death certification, it is possible that there are similar articles from developing countries in medical or public health journals that are not indexed in PubMed, or are not accessible through the other search engines employed in this review. In summary, there is a need for studies comparing different instructional methods in various settings to identify and implement suitable and cost effective interventions.

Apart from direct educational interventions, there are other approaches to improve the quality of cause-of-death certification. For example, the Australian Bureau of Statistics implements a mechanism to raise queries on certificates that include inconsistent or questionable data, requiring the certifier to verify or expand on the diagnoses provided, with subsequent correction of the coding from the original certificate.\(^{34}\) Periodic audit of death certificates with feedback to certifiers has also been proposed as a method for improving the quality of information on causes of death.\(^{19}\) However, the primary purpose of such querying or audit processes is to verify reported causes of death with a view to refining mortality statistics, rather than to actually imparting knowledge on death certification, and therefore such processes do not fall directly in the sphere of formal education. On the other hand, audit processes with feedback given to certifiers may have educational value and the evidence suggested giving feedback individually to the certifiers as well as during a clinical meeting was beneficial.\(^{34}\) The effectiveness of such interventions (especially in settings where formal training is difficult or not feasible) should be scientifically evaluated in further research.

### Table 3 Minimum requirements for the content of training in certifying causes of death\(^{12}\)

<table>
<thead>
<tr>
<th>Knowledge Cluster</th>
<th>Content</th>
</tr>
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<tbody>
<tr>
<td>1. Medical science related to ascertaining cause(s) of death</td>
<td>Concept of aetiology and risk factors</td>
</tr>
<tr>
<td></td>
<td>Pathophysiology</td>
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<tr>
<td></td>
<td>Forensic medicine</td>
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<td></td>
<td>Postmortem examination and autopsy</td>
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<td></td>
<td>Structure of WHO medical certificate of cause of death (parts I and II)</td>
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<tr>
<td></td>
<td>Concept of underlying cause of death</td>
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<td></td>
<td>Importance of best medical opinion</td>
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<td></td>
<td>Appropriate exercises in death certification</td>
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<tr>
<td>2. Principles for certifying causes of death</td>
<td>External causes of death—for example, suicides, drowning, alcohol related deaths, drug overdose, poisoning</td>
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<td></td>
<td>Guidelines for reporting perinatal deaths</td>
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<td></td>
<td>Certifying deaths from cancers, diabetes, asthma,</td>
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<tr>
<td>3. Certification rules for specific causes of death</td>
<td>Legal requirements regarding death certification</td>
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<td>General privacy and confidentiality principles</td>
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<td>Professional ethics</td>
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<td>4. Legal/ethical issues</td>
<td>Clinical education</td>
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<td>Medical and epidemiological research</td>
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<td>Statistical outputs for health situation and trend analysis</td>
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<td>5. Uses of data on causes of death</td>
<td>Health programme evaluation and planning</td>
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Education for certifiers of deaths should be recognised as a fundamental requirement for high quality mortality statistics. Education in the form of interactive workshops is recommended as the most effective method for providing instruction on completion of death certificates. Provision of feedback regarding the quality of death certification to individual certifiers, including queries from the statistics office, leads to improvements in quality. Education regarding death certification needs to be provided both to new medical graduates and then periodically to practising clinicians to reinforce knowledge. Training certifiers using the standardised curriculum from the WHO-FIC Network has the potential to improve the consistency in death certification practices and subsequently the comparability of epidemiological data.

CONCLUSIONS
The need for accuracy in the recording of causes of death on medical death certificates cannot be overemphasised. Good education on best practice for cause-of-death certification is a basic step required to ensure production of high quality mortality statistics. The challenges in imparting suitable education on this important aspect to medical certifiers in many countries located in Africa, the Middle East, Asia-Pacific and Latin American regions are considerable. Even in developed countries, there is room for improvement in cause-of-death certification by new medical graduates as well as by practising medical personnel. This review has identified that a range of educational interventions exist, and have potential benefit in varying circumstances. Therefore, suitable needs assessment research should be conducted to tailor educational delivery to meet the requirements of medical personnel operating in different environments. Judicious use of electronic media and self study materials supported by interactive education and audit/feedback processes is necessary to achieve the wide range of coverage required for overall improvements in the accuracy and reliability of cause specific mortality data.

MULTIPLE CHOICE QUESTIONS (TRUE (T)/FALSE (F); ANSWERS AFTER THE REFERENCES)
1. The optimal source of information on causes of death is:
   A. Hospital statistics
   B. Demographic surveys
   C. Civil registration and vital statistics systems
   D. Disease specific registers/registries

2. The quality of mortality statistics is directly affected by:
   A. Coverage of national survey on behavioural risk factors
   B. Timeliness of vital registration data
   C. Completeness of vital registration data
   D. Accuracy of cause-of-death information on death certificates

3. In the reviewed literature, which of the following is the most common approach used to evaluate educational interventions on death certification?
   A. Randomised controlled trials
   B. Non-randomised controlled trials
   C. Post-intervention feedback mechanisms
   D. Before and after comparisons

4. Overall outcome of educational interventions on death certification:
   A. Can be improved by proper combination of different educational methods
   B. Is independent of skills and experience of participants
   C. Is influenced by timing and duration of the intervention
   D. Is evaluated for all interventions

5. Which of the following is/are useful method(s) for imparting knowledge on death certification in different circumstances?
   A. Printed educational materials
   B. Educational videos
   C. Data audit and feedback on certification performance
   D. Formal face-to-face training

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ANSWERS
1. A (F); B (F); C (T); D (F); 2. A (F); B (T); C (T); D (T); 3. A (F); B (F); C (F); D (T); 4. A (T); B (F); C (T); D (F); 5. A (T); B (T); C (T); D (T)
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Eindra Aung, Chalapati Rao and Sue Walker

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