



SPECIAL ISSUE: ORIGINAL STUDY

Enhancing Mortality Data Accuracy: Outcomes from a collaborative national workshop in Oman

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Advances in Knowledge

- The educational intervention significantly enhanced physicians' and medical coders' understanding of the importance of mortality data quality.
- The pre- and post-assessment design showed marked improvements in defining and sequencing causes of death, reducing certification errors and accurately documenting specific causes of death.

Application to Patient Care

- The improved accuracy in death certification achieved through educational interventions has significant implications for patient care. Accurate mortality data is essential for effective public health surveillance and healthcare planning. Enhanced data quality enables better assessment of health system performance, informing policy decisions and optimising resource allocation.

ABSTRACT

Objectives: Mortality data is essential for global health policy and sustainable development goals, yet errors in death notifications, often exceeding 50%, challenge its accuracy. This is largely due to the lack of formal training among physicians and medical coders in issuing death notifications. This study conducting a national educational intervention and aimed to assess the outcomes of the intervention **Methods:** A 2-day workshop was held in Oman in June 2023 for physicians and medical coders, employing a pre- and post-assessment design. The training, developed by both international and national experts, covered aspects of mortality data quality, based on the International Form of Medical Certificate of Cause of Death and validated by the World Health Organization. The curriculum focused on correctly defining and sequencing the causes of death and identifying common certification errors. **Results:** A total of 39 individuals, including doctors (59%) and medical coders (41%), participated in the workshop. A comparison of pre- and post-workshop assessments revealed significant enhancements in understanding mortality data. The doctors generally outperformed the coders in these improvements. Participant feedback was overwhelmingly positive, with approximately 80% strongly agreeing on the clarity and relevance of the content, as well as the engaging nature of activities and exercises. **Conclusions:** The intervention significantly improved the quality of mortality data by enhancing the accuracy of death certifications. This success was achieved through a collaborative effort, highlighting the model's potential for future online modules to extend its reach. This study underscores the importance of structured training in enhancing the utility of mortality data, contributing to better health system evaluation and policy-making.

Keywords: Mortality; Cause of Death; Death Certificates; Vital Statistics; Health Education; Oman

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1. Introduction

Cause of death in death notifications is the cornerstone of mortality data that holds immense importance and widely affects different aspects of the health system.¹ Mortality data is essential in any health information system as it is a very important public health indicator that significantly impacts global, regional and national health policies.² Mortality data provide direct and indirect inputs for calculations to monitor almost 50% of sustainable development goals.³ These data also play a crucial role in public health surveillance and assist in planning and evaluating healthcare systems.⁴ Furthermore, mortality data is a fundamental tool for researchers in disease prevention and control studies and provides a valuable resource for epidemiological research.⁵

Poor quality of mortality data is a well-recognised challenge that affects all health systems. Up to 95% of death notifications contain at least 1 or more errors, and more than 50% have major errors.⁶ Moreover, inaccuracies in the underlying cause of death (UCOD) constitute a significant burden of low quality in mortality data ranging from 2.6% to 98.7%.⁷ In the Arab region, ill-defined causes of death ranged between 3% to 60%.⁸ Different factors contributed to the poor quality of mortality data, and the main factor was the lack of training in issuing death notifications and identifying the cause of death. The majority of physicians who issued death notifications had not received formal training.^{7,9}

The lack of proper training can lead to errors in diagnosing and determining the cause of death, impacting the reliability of mortality data. This makes it critical to ensure that physicians are well-trained in death certification to improve the accuracy of death certificates and the quality of health data.^{7,10–12} Educational intervention through formal training had a positive impact and improved the quality of mortality data by increasing the completion of death notification and decreasing the inaccuracies in the cause of death.^{13–16} An interactive workshop was superior and more effective compared to the printed handout.¹⁴

In Oman, a recent study highlighted the high rate of inaccurate UCOD documented in death notifications, which was strongly linked to a lack of training.⁷ Based on this, an educational intervention was recommended as an evidence-based intervention to improve the overall quality of mortality data and safeguard against the consequences of inaccurate mortality data.

This study shares the experience of conducting a national educational intervention through a 2-day workshop targeting physicians from various specialties, along with medical coders. The workshop

provided formal training on improving the quality of mortality data. This intervention reflects the collaboration between different national and international institutions including the World Health Organization (WHO), the Ministry of Health in Oman, the Oman Medical Specialty Board and Sultan Qaboos University Hospital which is located in Muscat, Oman. This study aimed to present the systematic way of conducting the training programme and reflect on the assessment before and after the intervention.

2. Method

A quasi-experimental interventional study design for the before and after assessment was used. The workshop in this study was conducted at a meeting room in Avani Hotel, Muscat, Oman on the 11th and 12th of June 2023. The target population were from all the governorates across Oman. The target group consisted of medical coders and doctors. The doctors were from different levels, with 50% comprising interns and residents and 50% comprising specialists and consultants. Physicians from different specialities were involved, including internal medicine, family medicine, emergency medicine, surgery orthopaedics, intensive care, paediatrics and gynaecology.

Educational material contained scientific content presented in the workshop designed to cover the most important topics concerning the quality of mortality data. An extensive literature review was done, and the content was selected considering the diversity of the audience. The introduction highlighted the importance of mortality data, the burden and consequences of low-quality data and the factors contributing to low-quality mortality data. This was followed by clinical documentation and its impact on mortality data as well as the role of medical coders in the process. All details about the International Form of Medical Certificate of Cause of Death and the sequence of events were included and illustrated with practical examples. Moreover, the researchers explained the rules for selecting specific conditions in the cause of death and the recent WHO recommendations for conducting an external inspection of a body. The ethical and legal concerns were addressed as well. Finally, a group-based discussion was done to analyse different case scenarios and learn to complete the death notifications for these scenarios. All the educational materials were reviewed and validated by the WHO experts as well as local experts.

The workshop was designed to ensure all the participants attended 2 full working days. Different relevant topics were discussed and the theme was group-based discussion and interactive sessions.

Assessment tools comprised structured questions presented before and after the workshop and this assessment was reviewed and validated by experts within the group. The assessment tool covered the most vital educational goals and the important aspects of death certifications. The questions in the assessment tool were distributed as follows: 2 questions about the basic definitions of the cause of death (immediate and underlying); 2 questions about selecting the appropriate sequences in the International Form of Medical Certificate of Cause of Death; 3 case scenarios to determine the sequence of events and highlight the immediate and UCOD and recognise part II on the form; and 3 questions about certifying rules in specific causes of death, including malignancy, diabetes and hypertension [Supplementary].

In addition, the researchers conducted another assessment using different case scenarios and completing the International Form of Medical Certificate of Cause of Death within the groups. This was followed by discussion and the learning points from each response were highlighted.

The assessment tool was rigorously evaluated to ensure its validity. The validation process involved expert reviews by professionals from the WHO and local experts in the field. Initially, the assessment tool was reviewed by a panel of WHO experts who provided critical feedback on the survey items' relevance, clarity and comprehensiveness. Following the review, local experts with experience in death certification practices and health education further evaluated the tool, ensuring it was contextually appropriate and addressed local nuances. Feedback from these experts was incorporated to refine the survey, ensuring it accurately measured the intended outcomes. Before the main study, the assessment tool was pilot-tested with a small group of participants comparable to the study sample. The pilot test results were analysed to identify and address any ambiguities or issues in the final version of the survey.

Statistical analysis involved descriptive analysis used for the absolute and relative frequencies in the univariate analysis. Differences between doctors and coders in pre-workshop test performances were compared using Pearson's χ^2 tests (or Fisher's exact tests for expected cells < 5). McNemar's test was employed to evaluate the significance of changes in the proportions of correct answers for each test item before and after the workshop. The association between the proportions of change in the overall improvement attributable to the educational intervention was expressed by relative risks (RRs) with 95% confidence intervals. Statistical significance was defined by a 2-sided P value of < 0.05 . A subgroup analysis assessed the impact of the intervention across different target population groups. Statistical calculations were

performed using the Stata software, Version 18.0 (StataCorp LLC, Texas, USA).

3. Results

A total of 39 participants were included, consisting of 59% doctors ($n = 23$) and 41% medical coders ($n = 16$). Notably, 83.8% of the participants had no prior formal training in mortality data. The participants were from various medical specialties including internal medicine, family medicine, emergency medicine, surgery orthopaedics, intensive care, paediatrics and gynaecology. At baseline, there was no significant difference in pre-workshop knowledge assessment scores between doctors and medical coders [Table 1].

Knowledge assessment before and after the workshop—the analysis of pre- and post-workshop assessments—demonstrated significant improvements across multiple areas of mortality data knowledge. The RR for correct answers post-intervention increased notably in several key areas.

Overall, the number of correct responses increased significantly among workshop participants in multiple areas. The most substantial improvement was seen in the 'Sequences (Q3)' and 'Underlying Causes (Q6)' sections, where correct responses increased from 38.5% to 89.7% and 48.7% to 89.7%, respectively. Additionally, significant progress was noticed in the 'Definitions (Q1)' section, with accuracy improving from 28.2% to 66.7%. Doctors generally showed a more significant improvement compared to coders [Table 2].

Subgroup analysis involved the analysis of both doctors and coders. The intervention showed varying impacts on both groups. While these groups improved significantly in most areas, the improvement percentages among doctors were slightly higher across several domains compared to coders [Table 2].

Feedback was obtained from the participants about the different aspects of the workshop. Up to 80% of the participants strongly agreed that the workshop objectives were clearly stated and met, the content was relevant and informative and the activities and exercises were engaging and interactive. In addition, 77% agreed that facilitators were knowledgeable and effectively conveyed the information and that the workshop materials (handouts, slides, etc.) were helpful. In general, more than 90% of the participants were likely to recommend this workshop to others.

4. Discussion

To the best of the authors' knowledge, this is the first report of its kind from Oman and one among the limited number of such reports from the Middle East.

Table 1. Comparison of pre-workshop knowledge assessment performance between doctors and medical coders (N = 39).

Questions	n (%)			P value
	Pre-workshop test All (n = 39)	Pre-workshop test Doctors (n = 23)	Pre-workshop test Coders (n = 16)	
1 (definitions)	11 (28.2)	7 (30.4)	4 (25.0)	1.00
2 (definitions)	32 (82.1)	19 (82.6)	13 (81.3)	0.913
3 (sequences)	15 (38.5)	8 (34.8)	7 (43.8)	0.57
4 (sequences)	23 (59.0)	16 (69.6)	7 (43.8)	0.107
5 (immediate)	30 (76.9)	17 (73.9)	13 (81.3)	0.59
5 (part II)	19 (48.7)	11 (47.8)	8 (50.0)	0.89
6 (immediate)	21 (53.8)	12 (52.2)	9 (56.3)	0.802
6 (underlying)	19 (48.7)	13 (56.5)	6 (37.5)	0.242
7 (immediate)	23 (59.0)	13 (56.5)	10 (62.5)	0.710
7 (underlying)	27 (69.2)	18 (78.3)	9 (56.3)	0.143
7 (part II)	19 (48.7)	10 (43.5)	9 (56.3)	0.433
8 (neoplasm)	37 (94.9)	22 (95.7)	15 (93.8)	0.791
9 (hypertension)	37 (94.9)	21 (91.3)	16 (100)	0.226
10 (common errors)	26 (66.7)	17 (73.9)	9 (56.3)	0.250
11 (diabetes)	18 (46.2)	11 (47.8)	7 (43.8)	0.802

The strengths of this intervention include its systematic establishment; involvement of medical doctors of various levels and specialities alongside medical coders; and collaboration between different national and international institutions and organisations.

In this study, the researchers described their approach to conducting an intensive training programme aimed at enhancing the quality of mortality data. This involved assessing the knowledge of participants before and after the educational intervention. By and large, reports on such educational interventions remain scarce in developing countries.¹³

The training intervention was proven to improve the accuracy of death certification and significantly reduce the different types of errors related to it.¹⁵

A study of 200 internal medicine residents in the USA revealed poor proficiency in death certificate completion. Post-intervention, competency significantly improved in both those participating in an interactive workshop and those receiving printed material. However, the interactive workshop proved more effective in improving death certificate accuracy.¹⁴ In a study involving Spanish medical residents, 71.1% made errors when completing death certificates, often listing the mechanism of death instead of the cause. After a 90-minute seminar designed to improve the accuracy of death certification, the error rate dropped to 9%. The most common error was incorrectly listing respiratory or cardiac arrest as the immediate cause of death. Post-intervention, none of the participants made this mistake. This suggests that even a brief educational intervention can significantly improve the accuracy of death certificate completion among medical residents.¹⁷ Another educational initiative aimed at improving medicine residents' death certificate accuracy led to substantial

improvements. Initially, 32.9% of death certificates had major errors. Post-intervention, this dropped to 15.7%. Particularly, the mechanism of death without a valid underlying cause and improper sequencing errors significantly decreased.¹⁸

Development of the training curriculum is widely variable as reported in previous studies despite the importance of standardising and harmonising it to achieve the best results.¹³ The Education Committee of the WHO Family of International Classifications Network suggested a minimum cluster requirement for the international core curriculum for guiding the development of training for certifiers of causes of death. These clusters include basic medical knowledge related to ascertaining; principles of certifying the cause of death based on the International Form of Medical Certificate of Cause of Death recommended by the WHO; legal and ethical issues; and the use of mortality data and quality assurance.¹⁹ The current study covered the main clusters in the training materials along with the addition of an important step—the validation and review of the content by international experts from the WHO. The researchers believe that validation of the materials is a very vital step that needs to be included and highlighted when developing training material.

Targeted groups reported in previous studies were junior doctors and were usually from a single speciality.^{13,15} The study targeted a broader group of participants, including medical doctors from various levels and specialities along with medical coders. The researchers hypothesise that this combination would have a positive outcome due to the sharing of experiences between people from different levels and educational backgrounds. This will facilitate communication and bidirectional feedback in the process of death notification.

Table 2. Comparison of differences between performance in pre- and post-workshop knowledge assessment for all participants (i.e., doctors and medical coders) (N = 39).

Questions	Pre-workshop test, n (%)	Post-workshop test, n (%)	Difference in %	Relative risk	95% CI	P value
1 (definitions)						
All	11 (28.2)	26 (66.7)	38.5	2.36	1.39–4.02	0.001
Doctors	7 (30.4)	18 (78.3)	47.8	2.57	1.37–4.82	0.002
Coders	4 (25.0)	8 (50.0)	25.0	2.00	0.75–5.33	0.290
2 (definitions)						
All	32 (82.1)	37 (94.9)	12.8	1.16	0.97–1.37	0.096
Doctors	19 (82.6)	22 (95.7)	13.4	1.16	0.93–1.43	0.180
Coders	13 (81.3)	15 (93.8)	12.5	1.15	0.87–1.52	0.625
3 (sequences)						
All	15 (38.5)	35 (89.7)	51.3	2.33	1.53–3.55	<0.001
Doctors	8 (34.8)	20 (87.0)	52.2	2.50	1.40–4.46	0.001
Coders	7 (43.8)	15 (93.8)	43.8	2.14	1.17–3.92	0.022
4 (sequences)						
All	23 (59.0)	34 (87.2)	28.3	1.48	1.12–1.94	0.005
Doctors	16 (69.6)	23 (100.0)	30.4	1.44	1.10–1.88	0.008
Coders	7 (43.8)	11 (68.8)	25.0	1.57	0.83–2.96	0.29
5 (immediate)						
All	30 (76.9)	37 (94.9)	17.9	1.23	1.01–1.50	0.034
Doctors	17 (73.9)	21 (91.3)	17.4	1.24	0.92–1.66	0.157
Coders	13 (81.3)	16 (100.0)	18.8	1.23	0.97–1.56	0.250
5 (part II)						
All	19 (48.7)	33 (84.6)	35.9	1.73	1.20–2.51	0.003
Doctors	11 (47.8)	20 (87.0)	39.1	1.82	1.10–3.03	0.020
Coders	8 (50.0)	13 (81.3)	31.3	1.63	0.98–2.70	0.124
6 (immediate)						
All	21 (53.8)	35 (89.7)	35.9	1.67	1.21–2.30	0.001
Doctors	12 (52.2)	22 (95.7)	43.5	1.83	1.21–2.78	0.004
Coders	9 (56.3)	13 (81.3)	25.0	1.44	0.87–2.41	0.29
6 (underlying)						
All	19 (48.7)	35 (89.7)	41.0	1.84	1.29–2.63	<0.001
Doctors	13 (56.5)	21 (91.3)	34.8	1.61	1.07–2.44	0.021
Coders	6 (37.5)	14 (87.5)	50.0	2.33	1.18–4.59	0.022
7 (immediate)						
All	23 (59.0)	37 (94.9)	35.9	1.61	1.23–2.10	<0.001
Doctors	13 (56.5)	22 (95.7)	39.1	1.7	1.19–2.40	0.003
Coders	10(62.5)	15 (93.8)	31.3	1.50	0.98–2.29	0.125
7 (underlying)						
All	27 (69.2)	33 (84.6)	15.4	1.22	0.96–1.56	0.109
Doctors	18 (78.3)	19 (82.6)	4.3	1.10	0.80–1.40	1.00
Coders	9 (56.3)	14 (87.5)	31.3	1.56	0.98–2.47	0.125
7 (part II)						
All	19 (48.7)	27 (69.2)	20.5	1.42	0.97–2.09	0.073
Doctors	10 (43.5)	17 (73.9)	30.4	1.70	1.08–2.67	0.020
Coders	9 (56.3)	10 (62.5)	6.3	1.11	0.56–2.20	1.00
8 (neoplasm)						
All	37 (94.9)	36 (92.3)	2.6	0.97	0.86–1.10	0.655
Doctors	22 (95.7)	22 (95.7)	0	1.00	0.88–1.13	1.00
Coders	15 (93.7)	14 (87.5)	–6.3	0.93	0.74–1.18	1.00
9 (hypertension)						
All	37 (94.9)	37 (94.9)	0	1.00	0.93–1.08	1.00
Doctors	21 (91.3)	22 (95.7)	4.3	1.05	0.97–1.15	1.00
Coders	16 (100)	15 (93.8)	–6.3	0.94	0.83–1.06	1.00
10 (common errors)						
All	26 (66.7)	34 (87.2)	20.5	1.31	1.02–1.67	0.033
Doctors	17 (73.9)	23 (100)	26.10	1.35	1.06–1.72	0.031
Coders	9 (56.3)	11 (68.8)	12.5	1.22	0.70–2.13	0.723
11 (diabetes)						
All	18 (46.2)	28 (71.8)	25.6	1.56	1.01–2.39	0.041
Doctors	11 (47.8)	15 (65.2)	17.4	1.36	0.80–2.31	0.388
Coders	7 (43.8)	13 (81.3)	37.5	1.86	0.91–3.78	0.146

The duration of the training programme in the intervention was two full working days, amounting to a total of 14 hours, which was significantly longer than what was reported in previous interventions ranging from 30 minutes to half a day.^{13,15} This longer duration and splitting of the content into two days allowed sufficient time for participants to comprehend the materials and provided a better opportunity for group-based discussions.

Improvement was significant regarding the knowledge and ability to accurately select the sequence of events in death certificates as per the International Form of Medical Certificate of Cause of Death for specific cases. The improvement reported is in-line with the previously reported pool of results suggesting that certification errors decreased between 15% and 33% after the training.¹⁵

This study demonstrated that doctors exhibited marginally higher improvement percentages across some domains compared to medical coders. Indeed, the initial competency levels of participants can influence the effectiveness of the training. For instance, resident physicians displayed significant improvements in death certificate completion after training, suggesting that their baseline knowledge was low and thus more receptive to enhancement through educational intervention.²⁰

The researchers acknowledge several limitations in this study. First, while the sample size was drawn from the entire geographical area of Oman, it was relatively small, potentially limiting the generalisability of the study findings. Second, this study lacked a long-term follow-up to assess knowledge retention post-educational intervention. Additionally, it did not directly evaluate the impact of enhanced death certification practices on health policy and outcomes. Addressing these limitations in future research requires larger sample sizes, long-term follow-up assessments and broader evaluations of impact on health policy and outcomes.

5. Conclusion

The educational intervention highlighted the critical role of high-quality mortality data and precise death certifications. Using structured and validated content, the interactive workshops manifested considerable enhancements in post-intervention assessments. Evidence showed that doctors exhibited slight but noticeable improvements across certain domains, outperforming medical coders.

Authors' Contribution

Salim Al-Busaidi: Investigation, Writing - Original Draft, Writing - Review & Editing. **Eman Aly:**

Validation, Project administration. **Mohammed Al-Abri:** Validation, Project administration. **Salim Al-Salmi:** Validation, Project administration. **Abdullah Al-Hinai:** Validation, Project administration. **Omar Al-Naqabi:** Validation, Project administration. **Jawaher Al-Maskari:** Validation, Project administration. **Marwa Al-Mahroqi:** Validation, Project administration. **Alaa Hashish:** Supervision, Validation. **Henry Doctor:** Supervision, Validation. **Arash Rashidian:** Supervision, Validation. **Jean Jabbour:** Supervision, Validation. **Abdullah Al-Alawi:** Formal analysis, Writing - Original Draft, Writing - Review & Editing.

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Ethics Statement

Ethical approval was obtained as an extension from the Medical Research Ethics Committee of the College of Medicine and Health Sciences at Sultan Qaboos University (SQU-EC/124/19). All participants agreed to include the assessment findings during the workshop in future publications.

Conflict of Interest

The authors declare no conflicts of interest.

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Data Availability

Data is available upon reasonable request from the corresponding author.

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