

***Vibrio vulnificus* infection reporting on death certificates: the invisible impact of an often fatal infection**

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SUMMARY

This study assessed accuracy of (a) recording *Vibrio vulnificus* infection on death certificates and (b) International Classification of Disease (ICD)-9 codes for *V. vulnificus*. Patients with microbiologically confirmed *V. vulnificus* infection were identified as part of co-ordinated surveillance in four USA Gulf Coast states between 1989 and 1993. Of 60 deaths, 51 death certificates were reviewed and *V. vulnificus* was recorded as the immediate cause of death on 11 (22%). There was no ICD-9 code for *V. vulnificus* infection, thus no patients had an ICD-9 code indicating *V. vulnificus* infection. Of 23 certificates where *V. vulnificus* was recorded on the death certificate, only 5 (22%) were coded for Gram-negative, septicæmia. This study highlights the importance of teaching physicians how to provide epidemiologically meaningful data on death certificates and the need for accurate ICD mortality codes.

INTRODUCTION

Vibrio vulnificus, a Gram-negative bacterium, was first described as a cause of catastrophic bacteremia, gastroenteritis and wound infection in 1979 [1]. In 1988, a regional surveillance programme in four states along the Gulf Coast was established [2]; data from this surveillance suggested an annual rate of *V. vulnificus* infections of 0·6 per million persons and a case-fatality rate of 22% (4/18, 95% confidence interval = 6–48%). Persons with pre-existing liver

disease or compromised immune systems have a higher case-fatality rate [2]. The typical fulminant nature of fatal *V. vulnificus* infection means that deaths occurring in association with *V. vulnificus* infection are highly likely to be the immediate cause of death. However, data concerned with *V. vulnificus* deaths as reported on the death certificate may be different.

To date, data concerning *V. vulnificus* deaths have been obtained almost exclusively from surveillance studies. However, vital statistics obtained from the coding of death certificates are often used as a proxy for disease burden and it is therefore important to ascertain the accuracy of such data. Death certificates are often an imperfect record of these causes of death because they may not include the results of peri-

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mortem diagnostic studies and because they are often filled out by persons unfamiliar with the patients. In addition, there may be under-enumeration for conditions that have only recently been described in the medical literature.

The aim of this study was to assess the accuracy of death certification for persons known to have died with *V. vulnificus* infection, and in those cases where *V. vulnificus* was recorded accurately, determine the allocated ICD-9 codes. Linkage of *V. vulnificus* surveillance records to death certificate and coding data enables an estimate of the accuracy of mortality data based on death certification and ICD-9 codes in patients dying of *V. vulnificus* infection.

METHODS

Persons who died with culture-confirmed *V. vulnificus* infection between 1989 and 1993 who were reported to Florida, Alabama, Louisiana, and Texas state health departments were included in the study. Clinical and epidemiologic data were obtained from these four state health departments, where microbiologically proven *V. vulnificus* infections are registered as part of the Gulf Coast Surveillance System through microbiology laboratories both ante and post-mortem [2].

For those patients who died, death certificates were obtained. The four states issue death certificates that differentiate between Part Ia; 'the immediate cause of death (the final disease or condition resulting in death)', Parts Ib–d; 'conditions if any, leading to immediate cause of death and includes the underlying cause (disease or injury that initiated events resulting in death)', and Part II; 'other significant conditions contributing to death but not resulting in the underlying cause of death'. Death registrations are coded manually. Where *V. vulnificus* infection was recorded on the certificate, the allocated ICD-9 code for *V. vulnificus* infection was obtained [3].

The following factors were assessed for possible association with the omission of *V. vulnificus* on the death certificate: age, gender, year of death, state where the certificate was written. In addition, potential predisposing factors to *V. vulnificus* infection such as hepatic, diabetic, neoplastic, gastrointestinal, renal, cardiac, haematologic and immunology disease were examined as possible risk factors for the omission of *V. vulnificus* on the death certificate. Data were entered and analysed using Epi-Info [4]. Chi squared test, Fishers exact test and χ^2 test for trend were used as appropriate.

RESULTS

From 1989 to 1993, 60 deaths occurred among the 178 cases of *V. vulnificus* infection reported to the four state health departments (34%, 95% confidence interval = 27–41%). Death certificates were available for 51 (85%) of these patients.

Among the 51 certificates reviewed, 36 different medical conditions were listed on the death certificates (Table 1). Four of these 36 conditions referred to vibrio infection and appeared on 29 (57%) of 51 certificates: *V. vulnificus* ($n = 23$, 45%), *Vibrio cholerae* (1 certificate, 2%), *Vibrio parahaemolyticus* ($n = 2$, 4%) and *Vibrio*, type unspecified ($n = 3$, 6%). On the 23 certificates where *V. vulnificus* infection was recorded, 19 (83%) of the *V. vulnificus* entries were assigned a total of eight different ICD-9 codes (Table 2).

In total 11 different medical conditions were recorded for Part Ia of the certificate. On 29 (57%) of 51 certificates an infectious aetiology was described as the immediate cause of death (*V. vulnificus* infection, $n = 11$; sepsis [organism not specified], $n = 11$; Gram-negative septicaemia, $n = 7$).

Recent deaths were more likely to have *V. vulnificus* recorded on the death certificate than deaths occurring earlier in the surveillance programme (1988: 44% [7/16], 1989: 0% [0/4], 1990: 17% [1/6], 1991: 43% [3/7], 1992: 55% [6/11] and 1993: 86% [6/7] [χ^2 trend = 4.6, $P = 0.03$]). This trend was not statistically significant when only the immediate cause of death was considered. *V. vulnificus* was recorded more frequently on the death certificates of men than women (23/46 vs. 0/5, $P = 0.06$). There was no association between the age of the patient or the state where the certificate was written and recording of *V. vulnificus*. None of the following factors were associated with the omission of *V. vulnificus* on the certificate: hepatic, diabetic, neoplastic, gastrointestinal, renal, cardiac, haematologic and immunology disease.

Death certificates not included in the study were mostly a result of insufficient patient identifying data to enable location of the certificate. Access was not denied for any of the certificates.

DISCUSSION

In this study, linkage of *V. vulnificus* surveillance records to death certificate and coding data enabled us to estimate the accuracy of mortality data based on death certification and ICD-9 codes. *V. vulnificus* was

Table 1. Immediate cause of death, underlying cause of death and other significant conditions leading to death recorded on death certificates of 51 persons with microbiologically determined *V. vulnificus* infection

Cause of death	Immediate cause of death (Part Ia) No. (%)	Underlying cause of death (Part Ib–d) and other significant conditions contributing to death but not resulting in the underlying cause of death (Part II). No. (%)	Total No. (%)
<i>V. vulnificus</i> sepsis/infection	11 (22)	12 (24)	23 (45)
Sepsis (not specified)	11 (22)	4 (8)	15 (29)
Cardiopulmonary arrest	10 (20)	0 (0)	10 (20)
Gram-negative septicaemia	7 (14)	2 (4)	9 (18)
Liver failure/cirrhosis	5 (10)	23 (45)	28 (55)
Renal failure or disease	2 (4)	4 (8)	6 (12)
Cerebrovascular accident	1 (2)	0 (0)	1 (2)
Metabolic acidosis	1 (2)	0 (0)	1 (2)
Multi-organ failure	1 (2)	0 (0)	1 (2)
Stephens–Johnson Syndrome	1 (2)	0 (0)	1 (2)
Adult respiratory distress syndrome	1 (2)	0 (0)	1 (2)
Cardiac disease (ischaemic)	0 (0)	7 (14)	7 (14)
Non-vulnificus vibrio infection*	0 (0)	6 (12)	6 (12)
Alcoholism	0 (0)	6 (12)	6 (12)
Diabetes mellitus	0 (0)	4 (8)	4 (8)
Oesophageal varices	0 (0)	3 (6)	3 (6)
Gastrointestinal bleed	0 (0)	2 (4)	2 (4)
Anaemia†	0 (0)	2 (4)	2 (4)
Other‡	0 (0)	15 (29)	15 (29)

Percents do not add to 100 because of rounding.

* *Vibrio*, unspecified ($n = 3$), *V. parahaemolyticus* ($n = 2$), *V. cholerae* ($n = 1$).

† Aplastic anaemia, sideroblastic anaemia (1 each).

‡ AIDS, candidemia, cardiac disease (other), immunodeficiency (type not specified), lymphoma, necrotising fasciitis, necrotising enterocolitis.

Table 2. ICD diagnosis allocated to the 23 death certificates recording *V. vulnificus* infection

Diagnoses	No.
Gram-negative septicaemia, not otherwise specified	5
Other specified septicaemias	5
Unspecified infections and parasitic diseases	2
Shock, unspecified	2
Food poisoning secondary to <i>V. parahaemolytic</i>	2
Other specified bacterial infection	1
Other bacterial food poisoning (subset <i>Bacillus cereus</i>)	1
Toxic effect of noxious substance, eaten as food: fish and shellfish	1
No code	4
Total	23

not recorded anywhere on 55% of death certificates, and misclassification of *Vibrio* species occurred in an additional three (6%) cases. Increasing awareness of *V. vulnificus* during the surveillance period was illustrated by the increased recording of *V. vulnificus* on the death certificate over the five years studied.

Although death certificates are an important source of data for determining disease burden, the limitations of mortality statistics may result in substantial biases in epidemiological studies. Studies have concluded that for certain conditions death certificates may be a useful source of epidemiological data [5, 6] while for

other pathologies this may not be so [7, 8]. Future studies on death associated with *V. vulnificus* infections may use death certification as an epidemiological measure and it is thus important to determine the reliability of death certificates in order to evaluate the use of mortality data in such epidemiological analyses.

Certification for persons who died with *V. vulnificus* infection is difficult because these persons usually have underlying disease and the cause of death is often multifactorial. Article 23 of the World Health Organisation constitution defines the cause of death as 'the disease or injury which initiated the train of events leading directly to death' [9]. Although this definition might bias the cause of death to represent acute conditions, chronic conditions are often recorded for patients dying with *V. vulnificus* infections and Table 1 illustrates how frequently chronic conditions such as liver failure and cirrhosis were recorded as the cause of death for patients dying with *V. vulnificus* infection. When an acute condition was recorded, the diagnosis was often inappropriate, for example cardiopulmonary arrest.

Deaths attributable to recently recognized aetiologies may provide unreliable statistics, as they are likely to be recorded less often than well-established conditions. *V. vulnificus* infection was described only 15 years ago. It is highly likely that a number of deaths from *V. vulnificus* infection are not diagnosed, and when diagnosed, only a small proportion are recorded on the certificate.

When peri-mortem diagnostic studies are not available at the time of death, the death certificate is less likely to be completed accurately. Death from *V. vulnificus* often occurs within 48 h of onset of infection, before the results of microbiologic cultures may be available. Improved certification and coding will not improve mortality data on *V. vulnificus* infections when the cause of death at the time of completing the certificate is unknown.

Certificates are often completed by physicians unfamiliar with the patient's medical history. This may bias certification either toward recording the acute, or the long-standing condition. An example is a patient with chronic liver disease who dies of *V. vulnificus* infection with a cardiopulmonary arrest as the terminal event. In our opinion the primary diagnosis of greatest epidemiologic value is *V. vulnificus* infection. A physician may include *V. vulnificus* as the cause of death, but may also record the cause of death as chronic liver disease or

cardiopulmonary arrest, neither of which fulfil the WHO criteria as the cause of death.

Mortality statistics rely on the specificity and sensitivity of the ICD system and the ability of coders to accurately classify cause of death from death certificates. Because there was no ICD-9 code available for *V. vulnificus* infection during the period of the study, all death certificates recording *V. vulnificus* as the cause of death were misclassified with respect to ICD-9 coding. We are currently lobbying The World Health Organisation to provide a specific ICD mortality code for *V. vulnificus* infection. In the meantime, in the USA, National Center for Health Statistics, Washington DC has allocated *V. vulnificus* a specific ICD-9 clinical modification code (005.81) which allows accurate coding for hospital discharges.

Although *V. vulnificus* was mentioned on 45% of death certificates, the condition was documented as the immediate cause of death (Part Ia) on only 22%. Since vital statistics are derived from the coding of only Part Ia of the certificate, even with an ICD mortality code for *V. vulnificus*, the number of *V. vulnificus* deaths would be grossly underestimated. Extrapolating from this study, assuming all diagnoses were allocated the correct ICD code, 80% of deaths due to *V. vulnificus* would not appear on vital statistics.

This study highlights the importance of teaching physicians how to complete a death certificate that provides epidemiologically meaningful data. Even with the new ICD code, it remains unlikely that death certificates will allow a complete epidemiologic picture of the mortality associated with this infection. This highlights the importance of using other surveillance tools to provide more accurate data on *V. vulnificus* deaths.

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