Epidemic Cholera in Guinea-Bissau: The Challenge of Preventing Deaths in Rural West Africa

Geir Gunnlaugsson, PhD;* Frederick J. Angulo, PhD;† Jónína Einarsdóttir, BA;§ Alberto Passa, RN;* and Robert V. Tauxe, MPH‡

ABSTRACT

Objectives: An epidemiologic investigation was conducted to identify factors associated with cholera mortality in a rural African setting and interventions likely to prevent deaths in future epidemics.

Methods: The authors reviewed surveillance data from rural Biombo, Guinea-Bissau, interviewed family members of persons who died of cholera, and conducted a case-control study in the catchment area of a health center with a high case:fatality ratio (CFR).

Results: Forty-three deaths occurred among the 1169 persons who reported to health centers with cholera during the epidemic (CFR = 3.7%). Delayed rehydration and over-hydration probably contributed to 10 of these deaths. An additional 19 cholera deaths occurred outside health centers. In the case-control study, persons with cholera who died were 5.4 times (95% CI = 1.0-53.4) more likely to be in poor health or intoxicated at illness onset than persons with cholera who survived. Fatal cases were 6.0 times (95% CI = 1.1-60.8) more likely to not attend the health center than survivors.

Conclusions: The low overall CFR in Biombo, compared to CFRs reported during other epidemics in sub-Saharan Africa, suggests that medical care provided at rudimentary rural health centers prevented numerous deaths. Additional deaths may be prevented by strengthening the infrastructure of health services in the rural areas and by enhanced public education regarding the need for persons with cholera to promptly seek medical care.

Key Words: Africa, developing country, epidemiology, mortality, surveillance, Vibrio cholerae O1


In its severe form, cholera results in profuse watery diarrhea, which, if untreated, leads to rapid dehydration, acidosis, circulatory collapse, and death. Prompt fluid therapy with adequate volumes of electrolyte solution to correct dehydration, acidosis, and hypokalemia is the cornerstone of cholera therapy.¹ If fluid replacement is delayed, the case:fatality ratio (CFR) among persons with cholera may exceed 50%.² With appropriate oral and intravenous rehydration,³ the CFR among persons with cholera may be reduced to less than 1%.⁴ Case:fatality ratio, therefore, often is used as a measure of the quality of care provided to cholera patients.⁵⁻⁷ Accurate interpretation of differences in CFRs requires an evaluation of the methods used for ascertaining cholera cases and deaths. Such investigations have not been reported from Africa, where surveillance for cases of infectious diseases often is incomplete, particularly in rural areas. In addition, although most cholera deaths in recent years have occurred in sub-Saharan Africa,⁸⁻⁹ factors associated with mortality have not been reported except during epidemics associated with famine or refugee camps.¹⁰⁻¹²

The 1994 cholera epidemic in Guinea-Bissau, the first in that country since 1987, was caused by Vibrio cholerae O1, serotype Ogawa, biotype El Tor, and resulted in 15,878 reported cases and 292 deaths among the one million inhabitants of that nation.⁶ During the epidemic, the region of Biombo had the highest recorded cholera incidence outside of the capital city of Bissau, partly as a result of high risk funeral practices.¹³ Marked differences in CFRs were reported among patients attending the various rural health centers in Biombo. Therefore, an epidemiologic investigation was conducted to identify
factors associated with cholera mortality in Biombo and to determine what interventions might best prevent future deaths.

PATIENTS AND METHODS

The rural region of Biombo (1994 population 61,522), with 73 inhabitants per square kilometer, is the most densely populated of the nine regions outside the capital of Bissau in the West African country of Guinea-Bissau (Figure 1). The 136 villages in Biombo have a median population of 316 inhabitants (range, 8-3557). The villages are arranged in compounds, in which extended family members live in thatched-roof huts. Few villages have latrines or electricity. Walking is the principal means of transportation. The population is predominately Papel (73%) or Balanta (19%) ethnic groups that adhere to traditional African religions.

Routine health services in Biombo are provided by nurses assigned to one of seven state-operated rural health centers; each health center is responsible for most medical services within a defined catchment area of 5 to 31 villages. Although 40% of the population of Biombo lives within 3 kilometers of a health center, 40% of Biombo residents live more than 5 km from a center and some residents live 20 km from a center. Individuals also may seek medical care at the general hospital in Bissau, but access to that facility is limited by transportation and economic constraints. None of the rural health centers in Biombo has electricity; only three have adequate access to water. Medicines and medical supplies are limited and often in short supply. Most centers have two beds and are normally staffed by two to four nurses.

In October 1994, when cholera was detected in Guinea-Bissau, the international community rapidly provided the Ministry of Public Health with supplies (including oral rehydration solution, lactated Ringer's solution, intravenous infusion sets, antibiotics, and bleach); limited supplies were distributed to the rural health centers in Biombo. Early in the epidemic, to reduce cholera transmission, the Ministry of Public Health mandated that the bodies of all persons dying of cholera be disinfected with bleach by health center personnel before burial. This policy was enforced by local police during the epidemic.

Following the standard World Health Organization case definition, a cholera case was defined as the acute occurrence of watery diarrhea in a Biombo resident 2 years of age or older who presented to a health center in Biombo during the period of the cholera epidemic. Health center nurses registered cholera cases and prospectively completed surveillance case report forms, which contained information on demographics and clinical outcome. For this study, a cholera death was defined as the death of a person with cholera-like illness (whether or not he or she had attended a health center). Although

Figure 1. Location of the Republic of Guinea-Bissau and Biombo region.
not considered cholera cases for surveillance purposes. Health center nurses also completed case report forms for cholera deaths that occurred outside of their health center but within their health center catchment area. Stool specimens were collected from selected patients with cholera-like illness and submitted in alkaline peptone water to the National Public Health Laboratory in Bissau for culture and antimicrobial sensitivity testing. Antimicrobial sensitivities to chloramphenicol, trimethoprim-sulfisoxazole, tetracycline, doxycycline, erythromycin, furazolidone, ciprofloxacin, nalidixic acid, ampicillin, sulfisoxazole, streptomycin, and kanamycin was determined at the Centers for Disease Control and Prevention (CDC) in Atlanta, USA, by disk diffusion.15,16

Cholera deaths were identified by reviewing health center case report forms. An attempt was made to ascertain unrecorded cholera deaths during frequent interviews with health center staff and visits to the villages. Only deaths among persons who presented to a health center were used to determine CFRs. Estimated village populations extrapolated from the 1991 census, were used to determine the health center-specific attack rates, and age- and sex-specific death rates. Extensive interviews, using a pretested, standardized questionnaire, were conducted with health center nurses and family members of all persons who died of cholera in the region during the epidemic. Following such interviews, researchers evaluated the quality of care provided at the health center for each person who presented and subsequently died with a cholera-like illness.

To determine factors associated with cholera deaths, a case-control study was conducted among persons who had a cholera-like illness (acute occurrence of watery diarrhea in a person >2 y of age) during the epidemic period and who resided in one of the villages served by a health center that, compared to other health centers in Biombo, had a high cholera case-fatality ratio. Cases were village residents who died with a cholera-like illness during the epidemic (regardless of whether or not they attended a health center). Numerous visits and interviews were conducted in the villages to ensure comprehensive ascertainment of cholera deaths. For each case, two age-matched (±5 years) controls (persons who had a cholera-like illness who survived) were sought from neighboring compounds in the same village. In this case-control study, cases and controls were ascertained and enrolled during visits and interviews conducted in the villages; importantly, although both cases and controls included persons with cholera, attending a health center was not a criterion for enrollment. Interviews with controls and family members of cases were completed with the assistance of a Papel translator, between March and June 1995, using a standardized questionnaire. Participants were asked about other illnesses or predisposing conditions, clinical courses of the cholera illness, treatment received at home and, if applicable, at the health center. Particular attention was paid to reasons for not seeking care, and the time sequence and chain of events from illness onset to presentation at the health center or death. Recall of participants was facilitated by the severity of cholera symptoms and the many associated deaths.

Univariate analysis of the data was performed with Epi Info (USD Inc., Stone Mountain, GA, USA). Statistical comparisons were done with the Mantel-Haenzel chi-squared test with Taylor series 95% exact confidence intervals (CI) calculated for the risk ratio (for surveillance data) and exact 95% confidence intervals (CI) were calculated for matched odds ratios (mOR) for the case-control study. Multivariate analysis was performed using conditional logistic regression (PHREG/SAS).

RESULTS

During the epidemic, between October 1994 and January 1995, 1169 cases of cholera were reported in Biombo (20.4 cases per 1000 population) (Table 1). The cholera incidence was higher among females (24.9 cases per 1000), and persons 45 years of age or older (38.4 per 1000). The incidence also was higher among persons living less than 5 km from a health center (28.0 per 1000). Among the health center catchment areas, the lowest incidence was in Ondame (12.2 per 1000), the highest was in Dorse (24.7 per 1000). Despite preparations for the epidemic, health center personnel and resources often were overwhelmed; on several days, dozens of cholera patients were treated at each of one or more health centers. Nevertheless, most patients who reported to the health center with a cholera-like illness received oral rehydration solution and antibiotics (tetracycline, ampicillin, or erythromycin). Most patients with moderate or severe dehydration also were treated with intravenous rehydration.

During the epidemic, 43 persons with cholera-like illness treated at a health center in Biombo died (CFR = 3.7%). The weekly CFR varied from 0% to 8.7%, and was 2.9% during the first 6 weeks of the epidemic and 4.7% during the last 6 weeks. For fatal cases, the median time from illness onset to presentation at a health center was 10 hours (range, 1-30 hr) and the median time from arrival at the health center to death was 18 hours (range, 7-110 hr).

The CFR was 1.9 times higher among males than females (95% CI = 1.1-3.4); the CFR among males with cholera was 5.3% (22/413) compared with 2.8% (21/756) among females. The CFR also increased with age: 6.6% (24/363) of cholera patients who were 45 years of age or older died, compared to 2.6% (17/648) of cholera patients between 15 and 44 years of age, and 1.3% (2/149) of patients between 2 and 14 years of age. The CFR among persons with cholera who lived 3 or more kilometers from a health center (3.6%) was not different from the CFR among those who lived closer (3.8%).
Table 1. Cholera Incidence per 1000 Population, Case:Fatality Ratio, and Relative Risk of Dying of Cholera, Biombo, Guinea-Bissau, October 1994-January 1995

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Population ≥2 y (n = 57,358)</th>
<th>Number of Cholera Cases* (n = 1169)</th>
<th>Incidence per 1000 Population (Mean 20.3)</th>
<th>Number of Cholera Deaths at Health Center (n = 43)</th>
<th>Case:Fatality Ratio (Mean = 3.7)</th>
<th>Relative Risk of Dying of Cholera</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26,985</td>
<td>413</td>
<td>15.3</td>
<td>22</td>
<td>5.3</td>
<td>1.9</td>
<td>1.1-3.4</td>
</tr>
<tr>
<td>Female</td>
<td>30,000</td>
<td>756</td>
<td>24.9</td>
<td>21</td>
<td>2.8</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Age† (y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-14</td>
<td>26,499</td>
<td>149</td>
<td>5.6</td>
<td>2</td>
<td>1.3</td>
<td>0.1</td>
<td>0.02-0.35</td>
</tr>
<tr>
<td>15-44</td>
<td>21,395</td>
<td>648</td>
<td>30.3</td>
<td>17</td>
<td>2.6</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>≥45</td>
<td>9,464</td>
<td>363</td>
<td>38.4</td>
<td>24</td>
<td>6.6</td>
<td>4.1</td>
<td>2.5-7.1</td>
</tr>
<tr>
<td>Distance to a health center†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3 km</td>
<td>21,756</td>
<td>609</td>
<td>28.0</td>
<td>23</td>
<td>3.8</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>≥3 km</td>
<td>35,602</td>
<td>551</td>
<td>16.0</td>
<td>20</td>
<td>3.6</td>
<td>1.0</td>
<td>0.8-1.2</td>
</tr>
<tr>
<td>Catchment area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorse</td>
<td>5,498</td>
<td>136 (174)</td>
<td>24.7</td>
<td>1</td>
<td>0.6</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Prabis</td>
<td>13,791</td>
<td>296 (296)</td>
<td>21.5</td>
<td>5</td>
<td>1.7</td>
<td>2.9</td>
<td>0.3-141.4</td>
</tr>
<tr>
<td>Quinhamel</td>
<td>8,381</td>
<td>204 (227)</td>
<td>24.3</td>
<td>5</td>
<td>2.2</td>
<td>3.8</td>
<td>0.4-181.2</td>
</tr>
<tr>
<td>Bijimita</td>
<td>4,719</td>
<td>115 (113)</td>
<td>24.4</td>
<td>3</td>
<td>2.7</td>
<td>4.6</td>
<td>0.4-248.1</td>
</tr>
<tr>
<td>Iffnumni</td>
<td>5,345</td>
<td>90 (70)</td>
<td>16.8</td>
<td>2</td>
<td>2.9</td>
<td>5.0</td>
<td>0.3-301.9</td>
</tr>
<tr>
<td>Ondame</td>
<td>11,278</td>
<td>138 (96)</td>
<td>12.2</td>
<td>10</td>
<td>10.2</td>
<td>17.8</td>
<td>2.7-857.9</td>
</tr>
<tr>
<td>Safim</td>
<td>8,346</td>
<td>190 (191)</td>
<td>22.8</td>
<td>17</td>
<td>8.9</td>
<td>15.5</td>
<td>3.6-710.4</td>
</tr>
</tbody>
</table>

*For health centers, numbers of cholera cases in catchment area and, in parenthesis, number of cases seen at the health center.
†Age and distance to health center unknown for 9 cases (none of whom died).

However, the CFR of persons with cholera who presented to a health center 12 hours or longer after diarrhea onset (5.1%, 13/253) although statistically not significant was 1.7 times higher (95% CI = 0.9-3.4) than the CFR for those who presented more rapidly (3.0%, 23/778).

There were marked differences in the CFRs by health centers. Dorse was the health center with the lowest CFR (0.6%); the CFRs of the health centers at Ondame (10.2%) and Safim (8.9%) were 17.8 (95% CI = 2.7-857.9) and 15.5 (95% CI = 3.6-710.4) times higher, respectively. Review of the clinical care provided at the health centers for the 43 cholera patients who died indicates that 110 patients were inadequately treated; 5 of these patients who died were apparently inadequately monitored during rehydration and were over-hydrated, and 5 received insufficient rehydration (3 did not receive intravenous fluids and 2 received fluids only after a delay of >10 h). Nine of the 10 inadequately treated patients died in Ondame (4 patients) or Safim (5) health centers.

The differences in health center-specific CFRs were not explained by differences in numbers of nursing staff; for example, Prabis, Bijimita, and Dorse, centers with the lowest CFRs, had among the highest case:nurse ratios during the epidemic (Table 2). The health center-specific CFRs also did not appear to be associated with the percentage of the population in the catchment area who lived 3 or more kilometers from the health center, or the percentage of cholera patients who reported to the health center 12 hours or longer after illness onset.

An additional 19 cholera deaths occurred outside of the health centers in Biombo and were reported to health center personnel: clinical case histories as recounted by relatives validated the diagnosis of cholera. Fifteen (79%) of these 19 deaths occurred among residents of Ondame and Safim catchment areas. Five (26%) of these deaths occurred at the general hospital in Bissau, and the remainder occurred at home or en route to seek care. No additional cholera deaths were detected during visits to numerous villages, suggesting that, in total, 62 persons died with a cholera-like illness during the epidemic in Biombo (1.1 deaths per 1000 population). The cholera death rate increased with age from 0.04 per 1000 for persons 2 to 14 years of age, to 1.0 per 1000 for persons 15 to 44 years of age, to 4.1 per 1000 for persons 45 years of age and older. The overall cholera death rates were similar for each of the health centers (0.2-0.6 per 1000) except for Ondame (1.4 per 1000) and Safim (3.1 per 1000). Among the 62 fatal cases, treatment was rarely initiated at home; only 5 cases (8%) were reported to have drunk oral rehydration solution at home. Although the cholera death rates were similar for males and females, among persons who died of cholera, males were four times more likely than females to be intoxicated at the time of illness onset (95% CI = 1.5-10.4).

*Vibrio cholerae* O1, serotype Ogawa, biotype El Tor was isolated from stool specimens collected from eight patients in Biombo, none of whom died. Four of four isolates collected early in the epidemic were resistant to trimethoprim-sulfisoxazole, furazolidone, sulfisoxazole, and streptomycin. Four of four isolates collected late in the epidemic were additionally resistant to tetracycline, doxycycline, and ampicillin.

A case-control study was conducted to further investigate the high CFR at the health center in Ondame.
Interviews were completed with family members of the 16 patients who died and 32 age-matched surviving cholera patients an average of 4 months following illness onset (range, 3–6 mo). One of the patients who died and four of the patients who survived reportedly drank oral rehydration solution before dying or attending the health center. Persons with cholera who died were 5.4 times (95% CI = 0.7–4.3) more likely to be in poor health or intoxicated at illness onset than persons with cholera who survived; among those for whom the information was available, 8 (53%) of the 15 persons with cholera who died were in poor health or intoxicated at illness onset compared to 5 (17%) of 29 persons with cholera who survived. Fatal cases were also 6.0 times (95% CI = 1.1–60.8) more likely to not attend the health center than the surviving cases; 6 (37%) of the 16 persons with cholera who died did not attend the health center compared to 2 (6%) of 32 persons with cholera who survived. All patients who sought medical care received antibiotics (tetracycline or ampicillin) and intravenous rehydration. In a multivariate model, not attending a health center (mOR 5.4; 95% CI = 0.7–43.2) and being in poor health or intoxicated at illness onset (mOR 6.4; 95% CI = 1.1–37.7) remained the most prominent risk factors for fatal outcome among persons with cholera.

DISCUSSION

The present study analyzes mortality in epidemic cholera in the region of Biombo in Guinea-Bissau, a rural region with existing, although rudimentary, health care services. Other studies during cholera epidemics in Africa were conducted during wars or famines when health care services were severely disrupted.5,6,10–12 The epidemic largely overwhelmed the local health care infrastructure of seven health centers, staffed with only 24 health care workers; during the 12-week epidemic period in late 1994, more than 2% of the population sought care for the treatment of cholera-like illness. Despite the large numbers of persons treated for cholera, the CFR (3.7%) in Biombo was low, particularly in five of seven health centers.

When using CFR as a quality-of-care measurement, it is important to evaluate the completeness of surveillance for cholera deaths and cases. It is unlikely that many additional cholera deaths occurred among Biombo residents during this epidemic. The mandatory disinfection of bodies of persons who died of cholera by health center personnel, which was enforced by police, makes it likely that most, if not all, cholera deaths were brought to the attention of health center personnel. This conclusion is supported by failure of researchers to identify unreported cholera deaths despite numerous visits to villages and health centers. In contrast, some under-reporting of cholera cases is likely. However, attack rates of 22 to 25 cases per 1000 population in all of the catchment areas except two give a rate similar to rates frequently reported in cholera epidemics,11 suggesting adequate registration routines. Taken together, these data suggest that the regional surveillance data used to determine the overall CFR of 3.7% probably contains most, if not all of the cholera deaths that occurred during the epidemic, but may have missed some of the cases. If all of the cases had been included, the overall CFR in Biombo may have been less than 2%. Despite severe lack of personnel and limited access to appropriate supplies, the regular regional health services coped well with the burden of the epidemic; the low CFR suggests that treatment at the health centers prevented perhaps hundreds of deaths during the epidemic and underscores the public health importance of functioning, simple health facilities located near the population.

Despite this low CFR, additional deaths may have been possible to prevent through better training of health center personnel. Clinical data on the 43 patients who died at health centers suggest that 10 (23%) of these patients died due to delays in rehydration or over-hydration; lack of experience in establishing intravenous infusions may have contributed to the outcome. Delays in rehydration may be reduced, in part, by additional emphasis on use of oral rehydration solution. Although oral rehydration solution may be used to hydrate most dehydrated patients rapidly and safely, it was under-utilized during


during the epidemic; the low CFR suggests that treatment at the health centers prevented perhaps hundreds of deaths during the epidemic and underscores the public health importance of functioning, simple health facilities located near the population.

Despite this low CFR, additional deaths may have been possible to prevent through better training of health center personnel. Clinical data on the 43 patients who died at health centers suggest that 10 (23%) of these patients died due to delays in rehydration or over-hydration; lack of experience in establishing intravenous infusions may have contributed to the outcome. Delays in rehydration may be reduced, in part, by additional emphasis on use of oral rehydration solution. Although oral rehydration solution may be used to hydrate most dehydrated patients rapidly and safely, it was under-utilized during
this epidemic. Adequate patient monitoring during rehy-
ddration prevents over-hydration. To assist in monitoring
of oral or intravenous rehydration, individual cholera treat-
ment records (which were not used during this epidemic)
might also help ensure quality care.

Antimicrobial resistance emerged among the *Vibrio chole-
rae* isolates in the course of this epidemic, becoming
resistant to doxycycline, tetracycline, and ampicillin,
antimicrobial agents that were widely dispensed during
the epidemic. Because only a limited number of isolates
were available for antimicrobial sensitivity testing, it is
not clear when the more resistant isolates became preva-
 lent, or whether this emergence of increased antimicro-
bial resistance was associated with increased mortality.
However, the CFR during the first 6 weeks of the epi-
demic was 2.9% and during the last 6 weeks was 4.7%.
In the case-control study, use of antimicrobials was nei-
ther positively nor negatively associated with mortality
among cholera cases.

Prevention of death in epidemic cholera is a com-
fendable challenge, even for countries with longstanding
experience with cholera, and rests upon two inter-
related mechanisms: appropriate health education and
proper treatment. Treatment facilities can help only those
who seek care. Further deaths may be prevented by edu-
cating the population to seek medical care rapidly fol-
lowing the onset of diarrhea during a cholera epidemic.
In this case-control study, even though it was conducted
at a health center where many patients died, failure to
seek medical care was the strongest risk factor for death
among cholera cases. Furthermore, the public should also
be informed that intoxicated or debilitated family mem-
bers who become ill with diarrhea during a cholera epi-
demic should be rapidly brought to health centers.

**CONCLUSION**

All cholera deaths that occurred during the 1994 epi-
demic in Biombo, a rural West Africa region, were inves-
tigated. Although health services were overwhelmed, the
overall CFR was relatively low: less than 3% in most of the
health centers. Persons 45 years of age and older were at
highest risk of death. Among patients with cholera-like
illness, failure to seek medical care was the strongest risk
factor for death. Results suggest that in a rural African
setting with an existing rudimentary health infrastruc-
ture, given appropriate medicines during epidemics, the
CFR can be 2% or lower. Strengthening the infrastructure
of health services in the rural areas may prove to be one
of the most cost-effective measures to prevent deaths in
future cholera epidemics.

**ACKNOWLEDGMENTS**

The authors thank Odete Felix for translation, village leaders for
their guidance, patients and family members of the patients who
died of cholera for their participation, and the health care workers
in Biombo for their hard work under difficult conditions. They also thank Lar Har Cheng for statistical support.

**REFERENCES**

1. Swerdlow DL, Ries AA. Cholera in the Americas: guidelines
2. Manson-Bahr PEC, Bell DR. Diarrhoea caused by vibrios. In:
Manson-Bahr PEC, Bell DR, eds. Manson’s tropical diseases.
3. Hirschhorn N. The treatment of acute diarrhea in children:
an historical and physiological perspective. Am J Clin Nutr
1980; 33:637-663.
4. Guthmann JP. Epidemic cholera in Latin America: spread and
5. Siddique AK, Salam A, Islam MS, et al. Why treatment cen-
tres failed to prevent cholera deaths among Rwandan
7. van Bergen JEAM. Epidemiology and health policy: A world
of difference? A case-study of a cholera outbreak in Kaputa
1995; 70:201-208.
73:89-96.
10. Tauxe RV, Holmberg SD, Dodin A, Wells JV, Blake PA. Epi-
demic cholera in Mali: high mortality and multiple routes of
transmission in a tamine area. Epidemiol Infect 1988;
100:279-289.
11. Moren A, Stefanaggi S, Antrona D, et al. Practical field epi-
demiology to investigate a cholera outbreak in a Mozambici-
12. Goma Epidemiology Group. Public health impact of Rwand-
an refugee crisis: What happened in Goma, Zaire, in July,
Passa A, Tauxe RV. Funerals during the 1994 cholera epi-
demic in Guinea-Bissau, West Africa: the need for disinfec-
tion of bodies of persons dying of cholera. Epidemiol Infect
15. Bauer AW, Kirby WMM, Sherris JC, Turck M. Antibiotic sus-
ceptibility testing by a standardized single-disk method. Am
16. Centers for Disease Control and Prevention. Laboratory
methods for the diagnosis of *Vibrio cholerae*. Atlanta, GA:
Centers for Disease Control and Prevention, 1995.