The Spread of *Shigella dysenteriae* Type I in Africa

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**INTRODUCTION**

Since Shiga's bacilli were discovered 100 years ago, *Shigella dysenteriae* type I (SD1) has been implicated in large-scale epidemics world-wide with many thousands of deaths. Its infectivity and virulence, protean manifestations and propensity to develop multi-drug resistance, has meant that as a cause of disease it has not been conquered despite all advances. Epidemic Shigella has been termed a disease of wars (1). The historian Herodotus attributed the defeat of the Persian army in 380 BC to dysentery. It also follows droughts in arid climates, when contamination of meagre water sources can result in significant outbreaks. In other instances epidemics have followed the breakdown of waste disposal and sanitation as a result of flooding. Indeed, the history of SD1 and its spread through Africa closely parallels the story of human strife and suffering, of warfare and of climatic disasters in my troubled continent. It shows also how management policies impact on evolving patterns of drug resistance in what is rapidly becoming an untreatable infection in many parts of the world.

**Sporadic dysentery**

In Africa, the spread of SD1 can be tracked in several phases, whereby endemicity was established after an initial epidemic in previously unaffected areas. In most countries in Africa, SD1 appears to have been uncommon as a cause of sporadic dysentery till fairly recently. In an Egyptian follow-up study in 1955, Shigella was associated with 35% of the diarrhoea attacks, but no mention was made of SD1 (2). Similarly, a study in Johannesburg failed to identify SD1 in 200 children presenting with diarrhoea (3), and Bokkenheuser stated in 1959 that the isolation of *Shigella shiga* in South African laboratories was so rare that its existence in South Africa was being doubted (4). Twenty years later, a prospective
study in Nairobi also failed to identify SD1 as a cause of sporadic dysentery (5), though *Shigella dysenteriae* was identified in 3% and 14.1% of *Shigella* isolates in Cape Town (6) and Zaria, northern Nigeria (7) respectively.

**Epidemic spread**

The earliest known epidemic occurred in 1928-1932 in the Great Lakes region of the eastern part of the Congo. It is likely that endemicity was established there at that time, but little information is available. The first well-described epidemic occurred in the Giohar district of Somalia in 1963-1964 (8). This is a semi-arid scrub area with a narrow strip of irrigable land alongside the Uebi Scebelli river. When the semi-annual monsoon failed in that year, the nomadic population migrated closer to wells near the river. In this population of 150,000, an attack rate of 10% was seen with a case fatality rate of 10-15%.

While this epidemic remained localised to that particular district, approximately 1,500 cases were seen and treated with Streptomycin, Sulphonamides or Erythromycin with uncertain effect.

Subsequently, SD1 appears to have become endemic in Somalia and Ethiopia. Between 1974 and 1982, isolates from Ethiopia showed fairly uniform plasmid profiles, but after 1980, another distinct pattern was seen, identical with that of strains isolated from north-eastern Congo (9), where a new outbreak was recorded at that time.

The central African countries of eastern Congo, Rwanda and Burundi in the Great Lakes region including Lake Kivu and Lake Tanganyika have borne the brunt of hyperendemic and seasonal SD1 outbreaks since 1979. A high population density of 400-600/km² was conducive to an estimated attack rate of 524 per 100,000 in the Ruhengeri district of Rwanda in 1983. In another north Rwandan district of 160 km² with a population density of 720/km², a further epidemic occurred over a 7 week period in early 1985, showing that even in an endemic situation, epidemic outbreaks can occur (10). Annual epidemics were observed in Rwanda and Burundi in the wet season September to March; these increased in magnitude with time (11) to involve 75,741 cases in 1992 and even 91,179 cases in 1993. A number of tropical climatic, geographical and social factors contributed to this state.

Indeed, it had been predicted on the basis of social and nutritional research findings showing severe socio-economic underdevelopment and a rapid population growth rate leading to a doubling of the population
every 22-23 years, that societal structures might collapse completely in the early nineteen-nineties in the absence of co-ordinated development aid (12).

The southern African pandemic

This was the social background to the spread of SD1 beyond the initial focus in central Africa. In June 1990, an outbreak of SD1 dysentery was reported in a prison in western Zambia; by December 1991 a total of 24,774 cases had been recorded with a case fatality rate of 10.2% (13), and the infection had spread to Caprivi and Angola. By 1992, large numbers of cases were being seen in Zimbabwe and Malawi. A large epidemic affected Mozambique from 1993, when 47,483 cases were reported in the first year. The incidence rates in the provincial capitals ranged from 59.6 to 4381.9/100,000 (14). Zimbabwe reported 83,033 cases in 1994 and 77,368 cases in 1995 in an ongoing epidemic. By 1995, 46 southern African countries were reporting epidemics. The table below illustrates the magnitude of the problem in Malawi, Zimbabwe and Mozambique, as reported to WHO (15) for the first half of 1995:

<table>
<thead>
<tr>
<th></th>
<th>Zimbabwe</th>
<th>Malawi</th>
<th>Mozambique</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>10,385</td>
<td>4,072</td>
<td>3,955</td>
<td>18,412</td>
</tr>
<tr>
<td>February</td>
<td>8,286</td>
<td>3,433</td>
<td>5,118</td>
<td>16,837</td>
</tr>
<tr>
<td>March</td>
<td>7,393</td>
<td>1,786</td>
<td>6,058</td>
<td>15,237</td>
</tr>
<tr>
<td>April</td>
<td>4,944</td>
<td>1,134</td>
<td>4,192</td>
<td>10,270</td>
</tr>
<tr>
<td>May</td>
<td>5,050</td>
<td>654</td>
<td>4,005</td>
<td>9,709</td>
</tr>
<tr>
<td>June</td>
<td>6,839</td>
<td>775</td>
<td>4,655</td>
<td>12,269</td>
</tr>
<tr>
<td>Total</td>
<td>42,897</td>
<td>11,854</td>
<td>27,983</td>
<td>82,734</td>
</tr>
</tbody>
</table>

The South African epidemic was initially recognized through an increasing number of patients presenting with post-dysenteric haemolytic uraemic syndrome (HUS) (16, 17). In one teaching hospital in Durban, the number of paediatric HUS cases increased from 3 - 5 per year prior to 1994, to 24 in 1994 and 57 in 1995, while the number of SD1 isolates increased from 257 in 1994 to 537 in the first half of 1995. A lack of a functioning surveillance and notification system severely hampered a co-ordinated official response to the epidemic, which involved most of the eastern provinces of South Africa.
Epidemics due to mixed or multiple infections

This pandemic spread of SD1 throughout the whole of south central Africa coincided with large scale refugee migrations due to the massive political instability of the early 1990's. In a refugee camp of 60,000 Mozambicans in Malawi there were 772 cases of haemorrhagic colitis traced to contaminated food from a market; there was a suggestion that both SD1 and enterohaemorrhagic Escherichia coli could have been involved in this outbreak (18).

After the death of the Rwandan and Burundi presidents in an air crash in April 1994, a human tragedy of unheard of proportions unfolded in Central Africa. Following profound civil disturbances in Rwanda, an estimated 500-800,000 ethnic Hutus fled into the north Kivu region of the then Zaire and arrived in 3 refugee camps between July 14 and 17, overwhelming all services and relief agencies. In the following month, an estimated 6-10% of the total refugee population died, 85-90% of them associated with sequential epidemics of cholera and dysentery (19).

Besides the catastrophic societal disruption due to war, natural disasters have also played a role in epidemic spread of dysentery in Africa. A simultaneous outbreak of cholera and dysentery occurred in Kenya during May to August 1994, when flooding after heavy rains resulted in overflow of latrines and large scale environmental contamination (20).

During the last months of 1997 and into 1998, severe flooding was once more reported in Kenya and Somalia with, again, the occurrence of epidemic diseases.

Characterisation of epidemic strains and resistance

By means of molecular epidemiologic techniques, it could be shown that strains originating in Central America were genetically distinct from African and Asian strains (21). Plasmid characterisation showed that strains of SD1 cultured in Ethiopia before 1980 were different from those identified in Somalia and Ethiopia subsequently. These were all epidemiologically related to the Zairean strains after 1979 and showed a high rate of plasmid transfer coding for multidrug resistance. The influence of antibiotic policy on the pattern of drug resistance was evident in a study showing rapid acquisition of trimethoprim resistance within a few months of introducing a standard cotrimoxazole treatment policy for dysentery in 1981 (22). Subsequent studies in all southern African epidemics have emphasised the propensity of SD1 to acquire multidrug resistance at high levels, so much so that strains tested in Burundi in 1990
were 100% resistant to standard drugs and uniformly sensitive only to the newer quinolones and ceftriaxone (11). Nalidixic acid resistance occurred in 8-83% of sentinel sites with an overall rate of 57%.

**Risk factors for spread**

In the developing countries of Africa, collective societal and individual factors have been identified which increase the risk of transmission.

At the society level, the lack of infrastructure such as safe water and waste disposal, as well as poverty, a high population density and environmental degradation play a part. Once a rare infection in Africa, SD1 has now become endemic or hyperendemic in many countries and can easily erupt into epidemic spread by the vagaries of climate and political turmoil.

At the individual and household level, a number of risk factors have been identified by case-control studies. Failure to wash hands with soap and water before preparing food and after defecation had the strongest attributable risk, but in addition close contact with persons having had dysentery, sharing latrines and using cloth rags after defecation, and obtaining drinking water by hand-dipping a cup into wide-mouthed vessels rather than pouring from narrow-mouthed containers were all found to be significant risk factors (23, 24).

**Conclusion and lessons to be learnt**

The high virulence and infectivity of SD1 places vulnerable populations at extreme risk of epidemics. Many hundreds of thousands of Africans have been affected in the last decade alone; thousands have died and many more have suffered from acute malnutrition and the protean complications of this disease. This points to the prime need for sustained social, economic and infrastructure development to prevent infection.

The lessons to be learnt from these African experiences include the need for rapid inexpensive field identification of toxin-producing enterohaemorrhagic infections in order to be able to introduce early appropriate antibiotic therapy. The rapid development of multi-drug resistance of SD1 underlines the importance of a suitable reference laboratory to monitor and advise on suitable antibiotic policies. Without a functioning surveillance system, official responses to epidemics are delayed, haphazard and poorly directed.
One hundred years after Shiga, it is clear that much fundamental and applied public health research still needs to be done.

REFERENCES