**Review**

**Clostridium difficile: A healthcare-associated infection of unknown significance in adults in sub-Saharan Africa**

Alexander J. Keeley¹, Nicholas J. Beeching¹,²,³, Katharine E. Stott¹, Paul Roberts⁴, Alastair J. Watson⁵, Michael B.J. Beadsworth¹,²

1. Tropical and Infectious Disease Unit, Royal Liverpool University Hospital, Liverpool, United Kingdom
2. Department of Clinical Sciences, Liverpool School of Tropical Medicine, Liverpool, United Kingdom
3. National Institute for Health Research Health Protection Research Unit in Gastrointestinal Infections, University of Liverpool, Liverpool, United Kingdom
4. Department of Infection and Immunity, Royal Liverpool University Hospital, Liverpool, United Kingdom
5. National Institute for Health Research Health Protection Research Unit in Gastrointestinal Infections, Norwich Medical School, University of East Anglia, Norwich Research Park, Norwich, United Kingdom

Correspondence to: Michael B.J. Beadsworth (Mike.Beadsworth@rlbuht.nhs.uk)

**Abstract**

**Background**

*Clostridium difficile* infection (CDI) causes a high burden of disease in high-resource healthcare systems, with significant morbidity, mortality, and financial implications. CDI is a healthcare-associated infection for which the primary risk factor is antibiotic usage, and it is the leading cause of bacterial diarrhoea in HIV-infected patients in the United States. Little is known about the disease burden of CDI in sub-Saharan Africa, where HIV and healthcare-associated infections are more prevalent and antibiotic usage is less restricted. This article reviews published literature on CDI in sub-Saharan Africa, highlighting areas for future research.

**Methods**

English language publications since 1995 were identified from online databases (PubMed, Medline, Google Scholar, and SCOPUS), using combinations of keywords “*C. difficile*”, “Africa”, and “HIV”.

**Results**

Ten relevant studies were identified. There was considerable variation in the methodologies used to assess for carriage of toxigenic *C. difficile* and its associations. Eight studies reported carriage of toxigenic *C. difficile*. Three (of three) studies found an association with antibiotic usage. One (of four) studies showed an association with HIV infection. One study showed no association with degree of immunosuppression in HIV. Two (of three) studies showed an association between carriage of toxigenic *C. difficile* and diarrhoeal illness.

**Conclusions**

While the carriage of toxigenic *C. difficile* is well described in sub-Saharan Africa, the impact of CDI in the region remains poorly understood and warrants further research.

**Introduction**

*Clostridium difficile*, an anaerobic gram-positive spore-forming bacterium, was first described following isolation from neonatal intestinal tissue in 1935, and was initially presumed to be a commensal organism.² *C. difficile* was later recognised to cause pseudomembranous colitis via toxin production, and it has since emerged as a major enteric pathogen.² Its clinical significance ranges from asymptomatic carriage to life-threatening colitis, with significant morbidity and mortality. *C. difficile* colonises the large bowel following ingestion of spores, which are heat and acid resistant.³ The spores can be found in most healthcare settings and in the general environment.²⁴ Gut damage in susceptible individuals results from production of the enterotoxin TcdA, which damages the intestinal epithelium, and the cytoxin TcdB, which has broader cellular tropism.² The emergence of the 027/BI/NAP1 strain, with dramatically increased cytoxin production, is responsible for the observed increased prevalence and virulence of *C. difficile* in recent years.⁸¹⁰ This strain emerged in North America and Western Europe and rapidly disseminated worldwide.¹¹

The primary risk factor for *C. difficile* infection (CDI) is antibiotic usage. CDI is known to be the cause of up to 25% of antibiotic-associated diarrhoea.¹² CDI was originally described following clindamycin use but is now known to complicate the use of many broad-spectrum antibiotics, particularly cephalosporins, co-amoxiclav, and fluoroquinolones.¹³ Following antibiotic usage, there is an imbalance in the normal gut flora and *C. difficile* overgrowth can lead to pseudomembranous colitis in susceptible individuals.¹⁴ Other described risk factors for CDI include hospital admission, exposure to an infected carrier, advanced age, and immunosupression.¹⁵ The importance of proton pump inhibitors and of other interventions that reduce the gastric acid barrier in increasing susceptibility to CDI remains controversial.¹⁶¹⁷ There is a described relationship between CDI and HIV, wherein *C. difficile* is known to be the leading cause of bacterial diarrhoea among HIV-infected populations in the United States, but it is not clear how much this reflects increased exposure to healthcare compared to HIV-negative individuals.¹⁸¹⁹ Only two studies show a convincing association between CDI and low CD4 count, and interpretation of these results is difficult given the high rates of *C. difficile* colonisation in HIV-infected populations.¹⁹²²

While CDI has been extensively researched in well-resourced health systems, there are few published studies about CDI in sub-Saharan Africa. Healthcare-associated infections cause a greater disease burden in healthcare systems with fewer resources.²¹ Furthermore, in sub-Saharan Africa there is widespread availability of broad-spectrum antibiotics and fewer controls on their usage.²⁴ Finally, HIV is far more prevalent in sub-Saharan Africa than in the United States or Europe. It is, therefore, possible that CDI plays an important role in diarrhoeal illness in sub-Saharan Africa, yet there are few published data on the subject. Published infection rates vary greatly, with some authors describing 0% toxigenic *C. difficile* detection in Kenya and Zambia, while the highest

http://dx.doi.org/10.4314/mmj.v28i2.8
published rate is from Nigeria at 43%. The nature of the relationship between HIV and CDI in sub-Saharan Africa remains poorly understood.

The aims of this review are to describe current published literature regarding CDI in adults in sub-Saharan Africa, and to highlight areas warranting further research.

**Methods**

In order to identify English-language publications since 1995 assessing CDI in adults in sub-Saharan Africa, online databases (PubMed, Medline, Google Scholar, and SCOPUS) were searched, using combinations of keywords “C. difficile”, “Africa”, and “HIV”. All relevant papers, in English, from 1995 onwards were included in the review, and their bibliographies were reviewed for relevant papers. Papers that looked for C. difficile in children were excluded. Papers looking at adults and children were only included if it was possible to distinguish between the two populations. In total ten relevant studies were found. Data were extracted from relevant papers using a standardised pro forma.

**Results**

Ten studies looked for toxigenic C. difficile carriage in sub-Saharan Africa. Of these, eight described toxigenic C. difficile carriage. Two studies from Kenya (1998) and Zambia (2000) did not find carriage of toxigenic C. difficile. There was considerable variation in laboratory methodology used to identify C. difficile and in the populations studied. Furthermore, there was wide variation in the methodology used to assess the association of CDI with recent antibiotic usage, HIV, diarrhoea, and degree of immunosuppression. Table 1 summarises current published studies of CDI in adult populations in different countries in sub-Saharan Africa.

**Discussion**

The majority of published studies, and all studies after the year 2000, describe carriage of toxigenic C. difficile in adult populations in sub-Saharan Africa. In three studies, which assessed recent antibiotic usage, there was a significant association between antibiotic usage and CDI; however, no studies were designed to implicate individual antibiotics, nor to describe the nature of antibiotic usage. These findings are consistent with the well-described risk factor of antibiotic usage in high-resourced healthcare systems. In three of four studies that assessed association with HIV status, no association was found. The only study claiming an association between HIV status and CDI in adults was from Nigeria. However, it compared toxigenic C. difficile carriage in an entirely HIV-positive sample from an urban teaching hospital, with a control population from a different geographical region, wherein HIV status was presumed to be negative if unknown. A study of adults and children in Tanzania found a significant difference in toxigenic C. difficile carriage between HIV-positive and HIV-negative individuals. It was not possible, however, to distinguish between adults and children in this analysis, and the number of adults in the study was low. The lack of association between CDI and HIV status in adults differed from observations in high-resource healthcare systems in the United States and Europe. The only study to assess the association between degree of immunosuppression in HIV and CDI was from Malawi. This study showed no significant association between carriage of toxigenic C. difficile and severe immunosuppression (CD4+ cell counts less than 50 × 10^9/L), although numbers in this group were small. This warrants assessment in a larger study population.

A further area of uncertainty is the role that C. difficile plays in diarrhoeal illness, as opposed to asymptomatic infection and incidental detection, in populations studied in sub-Saharan Africa. Table 1 shows that a wide variety of laboratory methods have been used to detect C. difficile in the different studies, with different sensitivities and specificities. Methods that use cytotoxicity or immunogenic assays to detect C. difficile toxin reliably detect invasive CDI but sensitivity is variable and dependant on laboratory technique, while methods based solely on polymerase-chain-reaction (PCR) assays probably result in overdiagnosis. Only one study used the two-step diagnostic algorithms currently recommended in many countries, using assays for faecal C. difficile glutamate dehydrogenase (GDH) as a screening test for presence of infection, followed by confirmatory PCR for cytotoxin genes to diagnose invasive disease potential. The majority of studies assessed C. difficile in patients with diarrhoea and did not compare these to non-diarrhoeal controls. However, the most robust study of CDI in sub-Saharan Africa showed a clear association between detection of toxigenic C. difficile and symptomatic diarrhoeal illness in South Africa. Another study of adults and children in Tanzania detected toxigenic C. difficile in 9 of 141 subjects with diarrhoea, compared to none in the stools of 109 symptom-free controls. While asymptomatic carriage has been well documented and has been demonstrated to contribute to ongoing transmission of C. difficile in well-resourced healthcare systems, its significance in sub-Saharan Africa is uncharacterised.

Only one study on CDI in South Africa described complications (other than diarrhoea) and prognosis. There was an observed 66.7% mortality rate for patients with CDI and diarrhoea. However, there was no statistical difference in mortality between patients with or without C. difficile, nor in length of stay and intensive care admission. Twelve percent of patients with CDI required colectomy, a finding that was significantly associated with the presence of toxigenic C. difficile. The presence of toxigenic C. difficile has been described in sub-Saharan Africa, but its disease burden and clinical significance, particularly in areas of high HIV prevalence, remain poorly understood.

**Conclusions**

There are relatively few studies on CDI in sub-Saharan Africa, but toxigenic C. difficile has been detected in the majority of studies designed to look for it in the region, where it has been consistently associated with antibiotic usage. Further in-depth research is needed to define the epidemiology of CDI in sub-Saharan Africa in order to clarify the extent of colonisation within communities and among hospitalised populations, the extent to which CDI is associated with HIV and CD4 count, and its role in contributing to morbidity and mortality.

**Acknowledgements**

NJB and AW receive support from the National Institute for Health Research Health Protection Research Units (NIHR HPRU) in Gastrointestinal Infections at the University of Liverpool and the University of East Anglia, respectively, in partnership with Public Health England (PHE), the University of Oxford, and the Institute of Food Research. The views expressed are those of the authors and not necessarily those of the National Health Service (NHS), the NIHR, the Department of Health, or Public Health England.
### Table 1: Published studies on CDI in adults in sub-Saharan Africa, 1995 to present

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>Setting</th>
<th>Controls</th>
<th>Diagnostic test for CDI</th>
<th>Sample size (adults)</th>
<th>CDI detection rate (adults)</th>
<th>Antibiotic association</th>
<th>HIV association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mwachari25</td>
<td>1998</td>
<td>Kenya</td>
<td>HIV positive adult inpatients with chronic diarrhoea</td>
<td>n/a</td>
<td>Cytotoxicity assay</td>
<td>75</td>
<td>0%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Germani28</td>
<td>1998</td>
<td>Central African Republic</td>
<td>Adults presenting to hospital with diarrhoea</td>
<td>HIV positive and negative non-diarrhoeal adult inpatients</td>
<td>Cytotoxicity assay</td>
<td>430</td>
<td>0.7%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Zulu26</td>
<td>2000</td>
<td>Zambia</td>
<td>HIV positive adult inpatients</td>
<td>n/a</td>
<td>ELISA for toxin A</td>
<td>68</td>
<td>0%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Samie29</td>
<td>2008</td>
<td>South Africa</td>
<td>Adults and children in hospital and community with diarrhoea</td>
<td>HIV positive and negative non-diarrhoeal adult in hospital and community</td>
<td>PCR for cytotoxin gene</td>
<td>135</td>
<td>17.8%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Onwuema27</td>
<td>2011</td>
<td>Nigeria</td>
<td>Adults and children in hospital and community with diarrhoea</td>
<td>HIV negative (or unknown) adults in the community</td>
<td>EIA for toxin A and B</td>
<td>140</td>
<td>4.3% (community) to 43.5% (inpatient)</td>
<td>Yes</td>
<td>n/a</td>
</tr>
<tr>
<td>Rajabally30</td>
<td>2013</td>
<td>South Africa</td>
<td>Adult inpatients with diarrhoea</td>
<td>n/a</td>
<td>EIA for toxin A</td>
<td>643</td>
<td>9.2%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Beadsworth31</td>
<td>2014</td>
<td>Malawi</td>
<td>Adult inpatients with diarrhoea</td>
<td>HIV positive and negative non-diarrhoeal adult inpatients</td>
<td>ELISA for toxin A and B</td>
<td>206</td>
<td>13.6%</td>
<td>n/a</td>
<td>No</td>
</tr>
<tr>
<td>Simango32</td>
<td>2014</td>
<td>Zimbabwe</td>
<td>Adults and children in community with diarrhoea</td>
<td>n/a</td>
<td>Culture and EIA for toxin A and B</td>
<td>159</td>
<td>6.9%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Kullin33</td>
<td>2015</td>
<td>South Africa</td>
<td>Adults in hospital and community with diarrhoea</td>
<td>n/a</td>
<td>PCR for cytotoxin genes</td>
<td>156</td>
<td>16%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Seugendo34</td>
<td>2015</td>
<td>Tanzania</td>
<td>Adults and children inpatients with diarrhoea</td>
<td>Non-diarrhoeal adults in community</td>
<td>Rapid test for GDH and PCR for cytotoxin genes</td>
<td>33</td>
<td>9.1%</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

CDI = *Clostridium difficile* infection; ELISA = Enzyme-linked immunosorbent assay; PCR = polymerase chain reaction; EIA = Enzyme immunoassay; n/a = not assessed; GDH = glutamate dehydrogenase (*Clostridium difficile*-specific)

### References

http://dx.doi.org/10.4314/mmj.v28i2.8


