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Community-Based Crisis Response: Evidence from Sierra Leone's Ebola Outbreak†

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In September 2014, the World Health Organization (WHO) described West Africa's Ebola epidemic as "the most severe acute public health emergency seen in modern times. Never before in recorded history has a biosafety level four pathogen infected so many people, so quickly, over such a broad geographic area, for so long."[1] At that point, fewer than 7,000 individuals had been infected. The Centers for Disease Control and Prevention (CDC) estimate that by the end of the crisis in early 2016, there were more than 28,000 confirmed, suspected, or probable cases; 11,300 deaths; US$3.5 billion spent on response efforts; and US$2 billion lost in economic activity.[2] Sierra Leone accounts for roughly half of those cases and just under 4,000 deaths.

Ebola containment efforts emphasize early isolation and treatment. Yet during the West Africa epidemic, the WHO assumed that many cases were never reported (Enserink 2014). Distrust deterred symptomatic individuals from visiting health facilities: "local communities were suspicious of efforts to test, treat, and isolate patients with Ebola symptoms and engaged in practices of hiding sick family members, running away from local communities, or attempting to manage the course of Ebola within local households and communities" (Abramowitz et al. 2016, p. 24).

Postmortems on the crisis stress that "robust community engagement" helps to build trust and encourage reporting (Kruk et al. 2015, p. e1910). To assess this oft-repeated claim, we evaluate a large-scale policy effort that involved the construction of Community Care Centers (CCCs) across Sierra Leone in the midst of the country's Ebola outbreak. CCCs were designed to alleviate fears about Western medicine and to encourage reporting. Using a difference-in-differences research design and geocoded data on the number of reported cases (including individuals who test negative for Ebola) in a given week and section,[3] we find that CCCs roughly tripled the increase in reported cases, relative to sections without CCCs. We find substantial increases in both the total number of cases and the number of cases that eventually test positive for Ebola (i.e., confirmed cases). This suggests that CCCs increased the isolation of infected patients, a necessary step for containing the outbreak.

These results are consistent with Christensen et al. (2019), which evaluates two randomized accountability interventions that were implemented across government-run clinics in Sierra Leone roughly one year before the Ebola crisis. Its medium-run results from before the crisis

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[1] WHO, "Experimental Therapies: Growing Interest in the Use of Whole Blood or Plasma from Recovered Ebola Patients (Convalescent Therapies)," September 26, 2014, https://www.who.int/mediacentre/news/ebola/26-september-2014/en/.

[2] CDC, "Cost of the Ebola Epidemic," March 8, 2019, https://www.cdc.gov/vhf/Ebola/outbreaks/2014-west-africa/cost-of-Ebola.html.

[3] Sections are small administrative units in Sierra Leone with a median area of 40 square kilometer. Figure A1 maps total reported cases in the Viral Hemorrhagic Fever database by section.

show improvements in clinic utilization and the perceived quality of care; amid the subsequent Ebola crisis, these treated areas also saw a large increase in Ebola reporting.

More broadly, our findings contribute to recent findings that fear and distrust deter patients from using health facilities (Alsan and Wanamaker 2018; Blair, Morse, and Tsai 2017; Vinck et al. 2019; Lowes and Montero 2018).[4]

I. Community Care Centers

The initial response to the Ebola outbreak envisioned large-scale facilities, accommodating over 100 patients and capable of enforcing strict biosafety control procedures. Yet would-be patients viewed these treatment centers with suspicion and refused to report, instead hiding their symptoms and potentially prolonging the epidemic (Mokuwa and Maat 2020).

To allay fears and encourage reporting, UNICEF and Sierra Leone's Ministry of Health and Sanitation (MoHS) started to implement the CCC model in mid-October 2014 and built facilities through January 2015. According to estimates from the UK Department for International Development, a typical CCC cost about £1 million, which funds an eight-bed unit staffed by individuals who were often recruited from nearby communities and then trained in infection prevention and control.[5] CCCs employed community liaisons and social mobilizers to raise awareness in surrounding areas, resolve misconceptions, and refer patients. According to Abramowitz et al. (2016, p. 16), the typical message from the liaisons and social mobilizers was, "CCC is where you and your loved ones who are sick with Ebola symptoms can receive safe care closer to your home and community."

Ebola prevalence fell from early 2015 in areas outside of the capital, Freetown. The decommissioning of CCCs started in March 2015.

In case studies and field reports, CCCs have been heralded as a success. Michaels-Strasser et al. (2015, p. e361) conducts an early "rapid cross-sectional [qualitative] assessment" of 11 CCCs in December 2014 and reports that CCCs were very quickly established, delivered the expected services, and maintained essential safety measures. Abramowitz et al. (2016) assesses CCCs toward the end of the crisis and concludes that "CCCs were an effective community-based mechanism to screen for Ebola, triage persons exhibiting signs of illness, and isolate Ebola suspects" (p. 10). And the authors specifically address the issue of reporting, writing that "by making Ebola care available at the community-level, fear was reduced and communities were more likely to seek care" (p. 11). This finding is echoed in interviews presented in Pronyk et al. (2016) and Mokuwa and Maat (2020).

II. Data and Research Design

We employ two sources of data. First, we use data on the locations of 41 CCCs from the UN Mission for Ebola Emergency Response (UNMEER) (see Figure A1). Second, we construct panel data on the number of reported cases—including cases that will return both positive and negative lab tests for Ebola—in every week and section from August 2014 through February 2015. These case counts are derived from the Epi Info Viral Hemorrhagic Fever (VHF) database, which was the primary data management system for case and contact tracing during the outbreak, implemented and maintained by the MoHS with support from the CDC.[6] Officers employed (even prior to the crisis) by the MoHS oversaw teams of case investigators charged with following up on suspected cases. Investigators learned about cases through walk-ins at health centers, active surveillance (e.g., contact tracing), and outreach to communities (Owada et al. 2016). For each reported case, they completed a Case Investigation Form

[4] They also relate to Bandiera et al. (2019), which finds that an empowerment program for young women in Sierra Leone increased their capacity to cope with disruptions caused by the Ebola crisis.

[5] CCC staff received three days of classroom and practical training in infection prevention and control, on-site training, and two weeks of 24-hour mentorship after the CCC opened. CCCs were then monitored three times per week. Cost estimates are drawn from the UK Department for International Development's Development Tracker (International Aid Transparency Initiative Identifier GB-1-204896; https://devtracker.dfid.gov.uk/projects/GB-1-204896).

[6] We use deidentified data (where patient names and characteristics have been redacted) from the Njala University Ebola Museum and Archive.

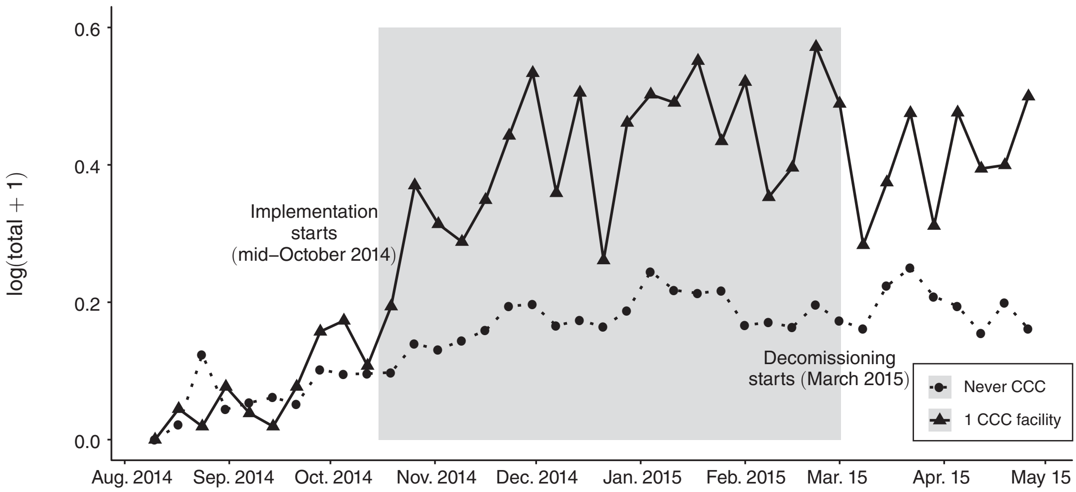

Figure 1. Trends in Total Cases by CCC Presence

Notes: Using UNMEER data, we identify those sections that eventually contain one CCC. We then compute the average number of total cases (logged) in sections that do and do not receive a CCC in each week from August 10, 2014, to May 1, 2015. The gray area starts with CCC implementation in mid-October 2014 and ends with the initial decommissioning of CCCs in March 2015.

(CIF), which included demographic (including district, chiefdom, and village) and health information. Completed CIFs were brought back to District Ebola Response Centers and entered by data managers in the local VHF database. Each observation in our data represents one of these CIFs.

We geocode cases by using information on individuals' residence included in the VHF database (typically district, chiefdom, section, and village or parish). We use a fuzzy matching algorithm (to permit alternative spellings) to search gazetteer files of place names in Sierra Leone, using Open Street Map (see full geocoding protocol in the online Appendix). Below we use data from 1,316 sections over 30 weeks.[7] Our main dependent variables are the counts of reported cases, either all cases or confirmed cases that test positive for Ebola.

Exploiting this panel data, we employ a difference-in-differences design, estimating the differential change in reported cases in sections that do and do not host CCCs, before and after the start of CCC implementation. Specifically, we estimate two models:

$$(1) \quad y_{st} = \alpha + \kappa\, CCC_s + \delta\, Post_t + \beta D_{st} + \varepsilon_{st},$$

$$(2) \quad y_{st} = \alpha_s + \gamma_t + \beta D_{st} + \varepsilon_{st},$$

where $s \in \{1,2,\ldots,1{,}316\}$ indexes sections, $t \in \{1,2,\ldots,30\}$ indexes weeks, and D_{st} $(\mathrm{CCC}_s \times Post_t)$ is an indicator for whether a section contains a CCC after October 15, 2014, which we use to approximate the start of implementation in mid-October. Equation (1) is a simple two-group-two-period model; in equation (2), we include section fixed effects (α_s) and week fixed effects (γ_t). We employ several functional forms as a robustness check, logging the counts (adding one to avoid dropping section-weeks with no cases), using a inverse-hyperbolic sine transformation, and running a linear probability model for whether any cases were reported (see online Appendix Table B1). Across models, we cluster our standard errors at the section level.

The key identifying assumption is that trends in the sections that do and do not host CCCs would have remained parallel absent implementation. We bolster this assumption through

[7] We use the date when a case first appears in the VHF database to determine the week interval. Data exclude Waterloo Rural in the Western Area, a periurban section that received three larger CCCs with over 50 total beds.

Table 1—Effect of CCC on Confirmed and Total Cases

	Total cases		Confirmed cases	
	(1)	(2)	(3)	(4)
Cases				
CCC × Post (D_{st})	0.544	0.544	0.129	0.129
	(0.173)	(0.176)	(0.058)	(0.06)
$log(cases + 1)$				
CCC × Post (D_{st})	0.237	0.237	0.041	0.041
	(0.056)	(0.057)	(0.02)	(0.02)
Section fixed effects		1,316		1,316
Week fixed effects		30		30
Observations	39,480	39,480	39,480	39,480

Notes: Standard errors clustered on section are shown in parentheses. Models 1 and 3 estimate equation (1) using ordinary least squares; models 2 and 4 estimate equation (2), which includes section and week fixed effects. Each row corresponds to a different transformation of the dependent variable: raw case counts and log case counts (plus one).

a series of placebo tests that employ data prior to implementation and look for differential pretreatment trends in reporting (see online Appendix Table B2).

III. Results

Our main result is apparent in Figure 1: while trends are parallel prior to CCC implementation, we see a large uptick in (log) reported cases in sections hosting CCCs relative to control sections.[8] Prior to implementation, the average number of cases in sections that eventually hosted a CCC was 0.14, compared with 0.28 in control sections. Between October 15, 2014, and the end of February 2015, the average jumps to 0.94 in sections hosting CCCs but increases to only 0.54 in control sections. That represents a close to sevenfold increase in sections with CCCs, compared with just a doubling in control sections. When we focus our attention on confirmed cases—which are of special interest for containment—we find the same divergent increase following the implementation of CCCs (see Figure 1). Yet there is a falloff in confirmed cases across all sections in early 2015, as Ebola prevalence fell across rural Sierra Leone and concentrated in the capital, Freetown.

Table 1 presents our estimates from equations (1) and (2) using both total and confirmed cases as outcome measures. We find that CCCs substantially increase reported cases, both total and confirmed. This holds for both outcomes, across equations, and when different functional forms are used. In raw numbers, while the number of confirmed cases actually falls by 13 percent in control sections, reports of confirmed cases increase by over 140 percent in sections with CCCs.

We run a series of placebo tests to assess whether trends in the two groups of sections are parallel prior to treatment (see online Appendix Table B2). The results of these tests are consistently small in magnitude: our actual estimate is four times larger than the maximum placebo coefficient. Field reports indicate that CCCs were not sites of nosocomial transmission; the increase in cases reflects greater reporting, not a heightened incidence of Ebola. Pronyk et al. (2016) argues that CCCs reduced the reproduction rate of the virus by between 13 and 32 percent.

IV. Discussion

A recent report by the Lancet Global Health Commission argues that patients' trust in providers contributes to the resiliency of health systems. "Trust is essential for maximizing outcomes because it can motivate active participation in care—i.e., adherence to recommendations and uptake of services, including in emergencies" (Kruk et al. 2018, p. e1201). Effectively responding to public health crises requires not just international coordination of humanitarian resources but also localized efforts to engage and build confidence in the communities most directly affected by a crisis.

While this claim has been featured among "lessons learned" from the West African Ebola crisis, it has not been rigorously evaluated. To help fill that gap, we evaluate the impacts of CCCs—a new model of crisis response that stressed community engagement, recognizing the need to overcome fears and build trust. CCCs did not boast the equipment or specialized personnel of larger treatment centers; the model, instead, employed local staff and community liaisons to close the physical and social distance between patients and providers.

[8] CCCs are not colocated with other specialized treatment facilities (e.g., Ebola Treatment Units) in the UNMEER data. Our results are robust to dropping the one section in our sample that contains a CCC and another type of facility.

While CCCs have been heralded as a success, existing qualitative work and field reports do not consider or attempt to estimate how the outbreak might have progressed absent the intervention. Employing new panel data on reported cases and a difference-in-differences design, we find that CCCs dramatically increased reporting, including by infected patients.

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