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Research Article

Evaluation of a health systems strengthening intervention to improve Ebola Virus Disease infection prevention and control in the Democratic Republic of the Congo

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Background

The Democratic Republic of Congo declared their tenth outbreak of Ebola in North Kivu in 2018, which was the second-largest in the world and took place in an active conflict zone. Transmission of Ebola occurs by direct contact with infected bodily fluids and can occur within facilities when infection prevention and control (IPC) precautions are not strictly practised.

Methods

To develop infection prevention and control (IPC) standards in health facilities, 45 medical students were trained and placed in 101 health facilities to mentor healthcare workers and support IPC practices between February and October 2019. A mixed-methods retrospective evaluation of quality improvement in North Kivu was conducted in October and November 2019 to capture key lessons from such a pilot IPC project. Five focus groups (N=49) and 42 key-informant interviews were conducted in addition to a secondary analysis of surveillance and programmatic data collected during the intervention.

Results

The intervention contributed 1.83 times (95% confidence interval, CI=1.10-3.06) to increased the likelihood of health facilities achieving an IPC score of 80% or above compared with facilities that did not receive the intervention. Overall, we found the odds of Ebola cases declining three times more likely in Butembo and Katwa (odds ratio, OR=3.00, 95% CI=1.87-5.62) relative to ten health zones in the region that were not reached by the intervention.

Conclusions

The results are difficult to attribute to any one type of intervention, given the number of other interventions implemented concurrently during the outbreak response. Further evaluations should be conducted to assess the cost-effectiveness of using medical students in conflict resolution and IPC, and to assess the suitability of scaling these approaches to other settings and diseases.

The Democratic Republic of the Congo (DRC) recently declared the end of the world's second-largest Ebola epidemic on record, with a total of 3481 cases (3323 confirmed and 158 probable).[1] These figures include 2299 deaths and 1162 survivors as of July 3 2020.[1] The outbreak occurred within a wider humanitarian emergency characterised by active armed conflicts, displaced populations, community resistance, and other disease outbreaks.[2,3] Furthermore, it was the first outbreak in North Kivu and Ituri Provinces with high population density (6,655,000 and 3,650,000, respectively), large population movements, and cross-border activity, particularly with Uganda and Rwanda (Figure 1).

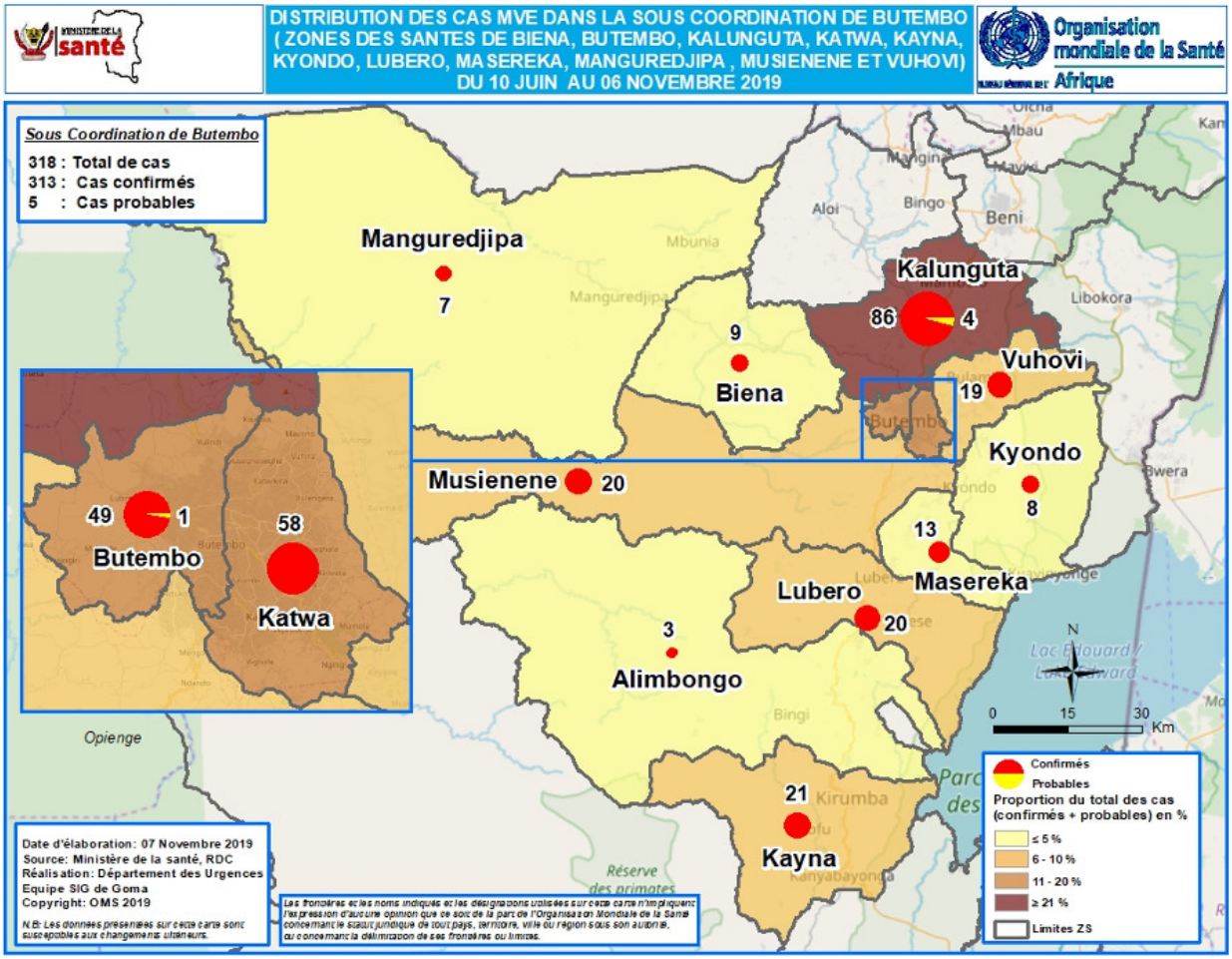


Figure 1. Map of distribution of Ebola Virus Disease cases in Butembo region of North Kivu from June 10 - November 6 2019 during the program implementation period.

INFECTION PREVENTION AND CONTROL IN DRC

Ebola Virus Disease (EVD) is caused by a filamentous RNA virus belonging to the filoviridae family, genus Ebolavirus.[4] Transmission occurs by direct contact with infected blood or bodily fluids. Infection prevention and control (IPC) measures aim to ensure the protection of those who might be vulnerable to acquiring an infection, both in the general community and while receiving care due to health issues, in a range of settings.[5] Transmission to health care workers (HCWs) can occur within facilities when IPC precautions are not strictly practised.[6] IPC measures are critically important in stopping the transmission of EVD, and other infectious diseases such as COVID-19.

IPC interventions during EVD outbreaks are comprised of (1) standard precaution measures (hand hygiene and personal protective equipment (PPE)), (2) case detection and triage strategies, (3) suspected case isolation, (4) waste and linen management and (5) safe and dignified burial (SDB) (see Table S1 in the Online Supplementary Document).[6] In March 2019, an operational review was carried out by WHO to analyse the strengths and weaknesses of the IPC pillar of the DRC Ebola Response prior to the implementation of several Paul G Allen Family Foundation (PGAF) funded projects.[7]

Firstly, the review identified IPC interventions in Butembo and Katwa were not well accepted by local communities. Isolation facilities were being burned down, and IPC teams conducting interventions such as household decontamination were being attacked. People were afraid of IPC interventions, including screening and triage for Ebola, and feared that HCWs were poisoning them with chlorinated cleaning solutions.

Secondly, individuals arriving at health facilities often met the EVD case definition, but HCWs were not reporting them as potential cases, instead of admitting them to wards for treatment of common illnesses like malaria and typhoid.[7] Staff frequently did not practice safe IPC standards and were putting themselves and other patients at risk. Prior to the implementation of these projects, approximately 40% of new Ebola cases were estimated to have a nosocomial link.[7] Since the start of the outbreak and prior to the project implementation, by March 2019 77 HCWs had been infected with Ebola and 26 had died.[7] The instability in the local area also restricted the ability of the response to provide consistent supervision and support to health facilities. Finally, the Ebola Response had a limited number of staff to support IPC in health facilities and was prioritising their deployment based on limited data and analysis of infection risk.

In the context of these challenges to the IPC pillar, a partnership between WHO and PGAF was established to pilot an innovative project focusing primarily on IPC and community engagement. The overall project goal was to achieve a reduction in new cases of Ebola transmission in Butembo and Katwa Zones de Santé with three core objectives: (1) reduction in the number of attacks on IPC workers while performing interventions in the community; (2) reduction of nosocomial transmission of Ebola; (3) reduction of HCW Ebola infections.

METHODS

In the context of these challenges to the IPC pillar, a partnership between WHO and PGAF was established to pilot an innovative project focusing primarily on IPC and community engagement. The overall project goal was to achieve a reduction in new cases of Ebola transmission in Butembo and Katwa Zones de Santé with three core objectives: (1) reduction in the number of attacks on IPC workers while performing interventions in the community; (2) reduction of nosocomial transmission of Ebola; (3) reduction of HCW Ebola infections.

Specifically, a partnership with the Medical School of the Université Catholique du Graben in Butembo, WHO, and the DRC Ministry of Health was created to train 45 medical student mentors to build IPC capacity in high-risk health facilities. The sixth-year medical students were trained by WHO and the Ministry of Health in IPC practices, community engagement techniques, leadership, and change management between February 11 and June 9 2019. They were then placed in health facilities near their communities of origin to improve acceptance by the community as they often spoke the local dialect. The medical students mentored HCW and supported IPC and health promotion in their local health facilities (including IPC supply management & active case finding of Ebola cases) between June 10 and October 6 2019. The students generally worked in their assigned health facilities for a minimum of 21 days and then were redeployed to a different high-risk health facility. The project evaluators (independent of the students) used digital tablets to document IPC improvement using a previously standardised IPC scorecard (see Table S2 in the Online Supplementary Document). The project evaluators (independent of the students) used digital tablets to document IPC improvement using a previously standardised IPC scorecard (see Table S2 in the Online Supplementary Document).

STUDY DESIGN

A mixed-methods retrospective evaluation was conducted to capture key lessons from the pilot intervention. Methods included qualitative interviews and focus groups, site observations and retrospective secondary analysis of programmatic and surveillance data. We have reported our findings in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies (see Table S3 in the Online Supplementary Document).

STUDY POPULATION

The evaluation was conducted in October and November 2019 in the two zones of the intervention: Butembo and Katwa. As a comparator, we used the other 10 "Zones de Santé" for the Emergency Operations Centre (EOC) of Butembo. For some indicators, we also used a pre/post design.

Both a pre/post-intervention and geographic comparison approach were used to develop as full a picture as possible of the impact of the interventions during a very dynamic and complex operating environment. For geographic comparisons for medical student mentoring interventions, we compared relevant KPI indicators (see Table S4 in the Online Supplementary Document) within the 12 Zones de Santé for the Butembo EOC to minimise confounding by the natural epidemiology of EVD and security, economic, and cultural differences. We compared the two zones of intervention, Butembo and Katwa (n=2), with the other ten zones in the Butembo region also under the supervision of the Butembo EOC: Kalunguta, Kyondo, Lubero, Alimbongo, Kayna, Masereka, Vuhovi, Biena, Mangurejipa, Musienene (n=10). Note that Butembo refers both to a large geographic region that encompasses all 12 zones (referred to throughout as Butembo EOC) and to one of the smaller health areas, known as "Butembo Zone de Santé." The evaluation period spans 34 weeks (17 weeks prior, from February 11 to June 9 2019, and 17 weeks during project implementation, from June 10 to October 6 2019).

Statistical AnalyseProcess variables of interest included numbers of medical students trained, a number of facilities reached, and a number of community plans developed. For outcome measures, we used key performance indicators (KPIs) developed by the WHO and partners and outlined in Table S4 of the Online Supplementary Document, including the number of newly infected health staff; percentage of health facilities with an IPC score card that is more than or equal to 80%; and percentage of cases resulting from possible nosocomial exposure. The IPC score card measure, described by Ousman and colleagues,[6] is a validated IPC dashboard tool collected by trained IPC specialists, different from those who provided training and IPC mentoring for this intervention, which is assessed at baseline and after the mentoring intervention. Twelve key IPC priority areas were combined to get an aggregate health facility score of up to 100% compliance. The IPC scorecard assesses the availability of the following parameters: the presence of a focal point and hygienic committee, medical triage, an isolation facility, hand wash stations, availability of personal protective equipment (PPE), presence of waste sorting and waste discharge, IPC capacity building, reporting of EVD internal alerts, sterilisation, bio-cleaning of the patient environment, and healthcare workers knowledge of EVD (see Table S2 in the Online Supplementary Document).

Quantitative methods included the retrospective secondary analysis of surveillance data sets available to the WHO, including the Epi Info Viral Haemorrhagic Fever Application, the line list of EVD cases, a p-cloud dataset monitored by the surveillance team, and KPI data captured by the central monitoring and evaluation team. Process sta-

tistics were also gathered by the grant recipients and summarised weekly to the EOC. Data quality was monitored externally by WHO staff with support from supervisors and mentors of the projects, including quality audits and external input from multiple partners and consultants.

STATISTICAL ANALYSES

Baseline descriptive statistics were calculated, stratified by areas covered by the intervention and areas not covered by the intervention, and compared using Pearson's chi-squared test (or Fisher's exact test for small cell counts) for categorical variables and the Wilcoxon rank-sum test and Mann-Whitney U test for continuous variables. Logistic regression was performed, and two-sided P values and unadjusted odds ratios (OR) with 95% confidence intervals (95% CI) are reported. All statistical analyses were performed using R software (Release V.1.67-7152).

To analyse the impact of medical student mentoring, logistic regression was performed comparing the IPC score card results before and after the mentorship intervention using the key performance indicator cut-off of 80% or above over 34 weeks of the evaluation period. We also compared the mean IPC scores of the baseline evaluation to the mean scores at follow-up evaluation. A proportion test was used to assess if there was a statistically significant difference in IPC scores between healthcare facilities mentored and those not mentored in the Butembo region.

QUALITATIVE METHODS

Qualitative methods included five focus groups (n=49) and 42 key informant interviews in North Kivu and remotely by videoconference. Focus groups were conducted with project participants, beneficiaries, community members, project staff, partners, and stakeholders. Focus groups with youth and community members were primarily conducted in Swahili by the national evaluator with translation provided by the international evaluator. Interviews were primarily conducted in French, with some in Swahili and some in English. It was not possible to record and transcribe the interviews and focus groups due to security and privacy concerns. Key themes were summarised using the Systematic and Reflexive Interviewing and Reporting Method and findings were validated with the local team to triangulate the data.[8] Non-English focus groups and interviews were initially summarised in French and then translated using DeepL software (DeepL GmbH, Cologne, Germany) and reviewed by experts with full professional proficiency in English for accuracy and meaning.

Prior to the field visits, a desk review was conducted, which included a review of key documents, including the proposal, logical framework, terms of reference, and project implementation documents. During the field visits, a review of health facility evaluations, databases, and key indicators (attacks on IPC staff, number of cases, HCW infections, etc.) was conducted to gather both qualitative and quantitative data for secondary analysis.

ETHICS

This work is defined as routine public health activities not constituting research and therefore did not require independent ethics review, but still proceeded with due attention to ethical considerations, as outlined in the WHO's Guidelines on Ethical Issues in Public Health Surveillance and in conformity with the principles embodied in the Declaration of Helsinki.[9,10]

RESULTS

QUANTITATIVE FINDINGS

Overall, 45 medical students intervened at 101 healthcare facilities in total across Butembo and Katwa, DRC, from June 1 to November 1 2019, with near gender parity achieved across the students (51% male and 49% female). All process objectives were met in terms of the number of students trained and deployed, with the exception of a number of health facilities reached. The target was hampered by significant security concerns in the region, which meant that students were not always able to travel to new health facilities if a serious security alert was raised.

In terms of impact outcomes, declines were observed in EVD cases associated with supported health facilities, EVD cases among HCWs and total cases during the medical student mentoring intervention (Table 1). Given the range of interventions piloted across the response targeting these particular KPIs at the same time, we did not calculate tests of statistical significance for this association but overall, the trend is positive. Three facilities did not receive a baseline evaluation prior to the intervention and were therefore excluded from the analysis. Similarly, since the evaluation was conducted in mid-October, data for the 5th deployment of follow up was not yet available.

IPC Scorecards may be a more accurate measure of the medical students intervention as they were completed at baseline and post-intervention at the facilities where the medical students were deployed and collected by an independent IPC specialist employed by the DRC Ministry of Health. A statistically significant median increase of 11.05% in IPC scores (P <0.001) was observed when comparing pre and post-intervention at healthcare facilities in Butembo and Katwa (Table 2), suggesting an overall positive effect of the medical students with an interquartile range of 29.5.

Similarly, Table 3 demonstrates IPC scores showing a statistically significant improvement in the 98 health facilities within the two geographic zones receiving the mentorship intervention when compared with 160 other health facilities in the ten zones within Butembo EOC.

In addition, using bivariate regression analysis, we found that having the medical student intervention resulted in 1.83 times (95% confidence interval, CI=1.10-3.06) increased likelihood of health facilities achieving an IPC score card of 80% or above when compared with facilities that did not receive the intervention in the Butembo EOC (Table 4).

Overall, a positive trend was observed in all of the IPC key performance indicators for the Ebola response before

Table 1. Nosocomial infection outcomes before and after medical students deployments in Butembo and Katwa, DRC from February 11 to October 6 2019 (17 weeks pre and post intervention)

Characteristic	Pre-Intervention	Post-Intervention
Health Facilities with IPC Score above 80%	33/98 (33.67%)	52/98 (53.06%)
N of nosocomial cases*	9 (IQR = 4.5)	1 (IQR = 2)
N of cases among HCWs**	1 (IQR = 1)	0.23 (IQR = 0)
N of cases***	32 (IQR = 22.5)	6 (IQR = 5)

*mean value - weekly data from the Master Line List database
** mean value - referring to new cases per week in KPI database
***mean value - referring to new cases per week in KPI database

Table 2. Average IPC scorecard before and after medical students deployments in Butembo and Katwa (n=98)

Characteristic	Median % change	Pre-Intervention % (Median)	Post- Intervention % (Mean)	p-value*
IPC Score	+11.05 (IQR = 29.5)	72 (IQR = 31)	80·75 (IQR = 16.75)	<0.001

Table 3. Unadjusted odds ratio with 95% confidence intervals (95% CI) for decreasing EVD cases in North Kivu in intervention zones compared to non-intervention zones between July 1 and October 1 2019 (n=289)

	Odds Ratio (OR)
Characteristic	Unadjusted OR (95% CI)
Intervention Zone de Santé	3.00 (1.87 – 5.62)

Table 4. Logistic regression with unadjusted odds ratio with 95% confidence intervals (95% CI) for association between reaching an IPC scorecard of 80% or above in health facilities that have receiving the medical mentoring student intervention compared to facilities that did not in North Kivu between July 1 and October 1 2019 (n=258)

	Odds Ratio (UOR)	
Characteristic	Adjusted (95% CI)	p-value
IPC Scorecard of 80% or above	1.83 (1.10-3.06)	0.01

and after the medical student intervention and for most of the key indicators when comparing rates within the two geographic zones with the intervention to the ten similar control zones outside the intervention's reach (Figure 2). Figure 2 demonstrates the temporal trend of new EVD cases in healthcare settings in the two intervention zones of Butembo and Katwa (noted in green) when compared with the overall in twelve zones (including the two with medical students and youth interventions) in Butembo EOC (noted in red). Before the interventions (March and early April 2019), we can see that new EVD cases in healthcare settings had an increasing trend, and almost all were coming from Butembo and Katwa. With the interventions, new healthcare-related EVD cases decreased in the intervention zones compared to other zones without the medical student mentoring and community youth leadership interventions.

Similarly, we found the odds of EVD cases 3 times (95% CI=1.87-5.62) more likely to decline in Butembo and Katwa compared with the other ten zones not reached by the medical student mentoring and youth projects. Clearly, this is not only attributable to the two interventions but to an incredible amount of effort and work by all partners in the affected zones. Similarly, one can't discount the issue of confounders such as the natural history of an EVD outbreak, increasing violence in other zones, and other sociodemographic differences between regions such as mobility, poverty, and underlying social and cultural factors.

QUALITATIVE FINDINGS

Key informant interviews and focus group respondents reported significant improvements in IPC practices in facilities reached by the intervention in Butembo and Katwa. Before entering a facility, it was viewed as essential that local leadership supported their deployment and that the students benefited from the patronage of local health leaders who conveyed to each facility that the students had a clear mandate and role in the Ebola response. This allowed for a more junior, younger student to have some authority when mentoring more senior clinicians in the facility, as they were viewed as an extension of the authority of the national public health agency. Each facility also designated a core IPC person to be the main staff person in charge of IPC, which was beneficial for the students to have a clear mentoring focal point during their deployment. The mentoring primarily occurred over 21 days. Students noted the first week was about building rapport and trust with the health facility staff, the second week was about diagnosing problems, and the final week was devoted to problem-solving and training. When asked if they should

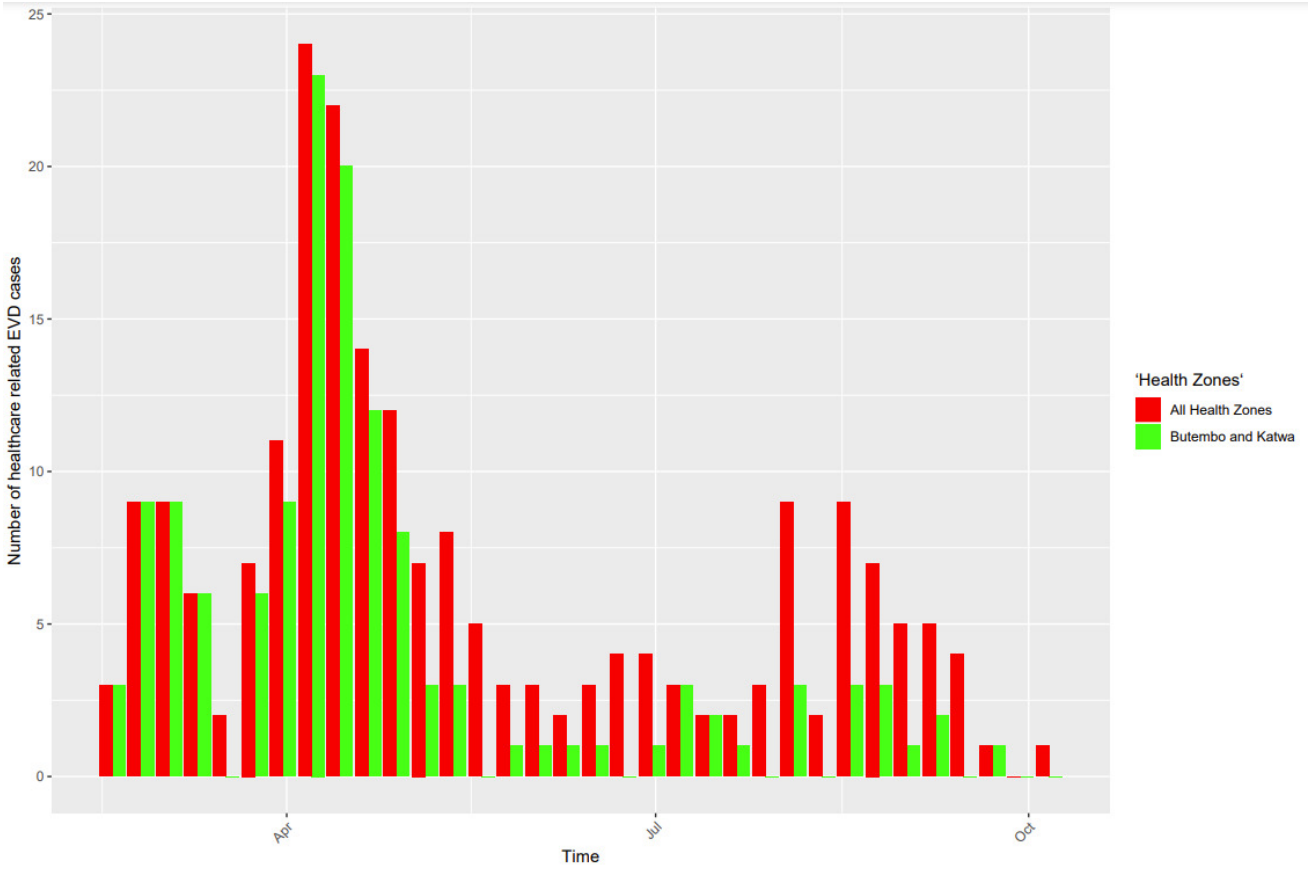


Figure 2. Health care related Ebola Virus Disease (EVD) cases in intervention zones in Butembo and Katwa (green) compared to all health zones (HZs) in North Kivu, DRC (red) between April 1 and October 1 2019.

have longer deployments, students raised the concern that a longer deployment may cause more harm as facilities may give up control and expect the student to take charge of IPC in their facility, as opposed to the short-term model which focused on the student mentoring the local facility level IPC champion and helping them to solve problems to build a sustainable IPC plan. Practically, students became involved in supporting facilities to gather needed IPC supplies and, where possible, set up sustainable supply chains with larger health facilities for personal protective equipment and other supplies. In some facilities, students found needles and syringes being reused and strewn on the floor with no sharps disposal system in place. They were able to conduct training on safer injection practices and arrange for safe disposal systems. In other settings, they described working with water, sanitation and hygiene (WASH) partners to set up handwashing, laundry, and lavatories, although it was noted that this area could have been better integrated with the pilot.

Overall, the intervention clearly benefited from intensive support from local IPC specialists from the DRC Ministry of Health and the WHO IPC team and EOC leadership, who were available to help students with conflict resolution and troubleshoot supply chain issues and challenging ethical cases. Students did note that it may be useful for future expansions of the project to offer refresher training to both the IPC Specialists and surveillance teams supervising students so that, as much as possible, everyone was working to the same core standards.

Students also noted various financial challenges related to communities' poverty, including when members had no cell phone credits or transport for case transfer. Other challenges included a lack of overall resources in the health system, which meant that some clinicians' salaries were unpaid and many sites required significant investments to improve overall IPC and WASH standards, such as lavatories and new facilities.

In terms of occupational health and safety, the medical students received extensive training in protecting themselves from infections and were offered the Ebola vaccine. Given the violence against the response, security strategies were also developed, including using radios, a security WhatsApp group, and redeployment to areas with lower security risk during the conflict.

Many respondents noted that the overall reduction in EVD cases in the region is difficult to attribute to any one intervention, but the impression was that the medical student mentoring project helped and should be scaled up. Similarly, it was noted as an innovative health systems strengthening project using quality improvement techniques in a very complex outbreak and security situation that could have a lasting impact for generations of future medical leaders.

DISCUSSION

In low-resourced settings with poor health systems, infectious diseases can spread rapidly, with poor IPC as a major contributor.[11] The WHO's 2018 Call for Action, following the 2014-2016 West African Ebola outbreak, laid out the need for comprehensive IPC capacity building and it's integration as a key pillar in the health system.[12,13]

Lessons learned from the West African outbreak for rapidly improving IPC have been extensively documented,[14,15] with the Liberian example demonstrating that clear strategy (e.g. ring IPC)[16] and government buy-in can lead to significant improvement from a very low baseline.[17] These lessons were critical, as the DRC's health care services also suffered similar challenges, including previously documented low handwashing rates.[18]

The IPC mentorship programme described in this paper aimed to learn from the West African outbreak by supporting IPC at the health facility level and ensuring that IPC skills and importance were emphasised for the next generation of medical leaders.[12] This evaluation has identified several areas of improvement that should be taken on board for this outbreak, future health systems strengthening projects, and future outbreaks of infectious disease with nosocomial transmission, including COVID-19.

The medical student cadre of HCWs could potentially be expanded to support other pillars of the response beyond IPC, i.e. vaccines and surveillance. This would allow the medical students to leave the EVD response with a more well-rounded training to be deployed in future outbreaks as part of a systematic plan to build up the national workforce. Other areas of the health care workforce could also be supported, including nursing students, midwives, and HCWs. The intervention may also be useful for other infectious disease outbreaks, including measles, cholera, yellow fever, and COVID-19. Similarly, the curriculum developed for the intervention should be shared with the large range of academic institutions across DRC and developed into a standardised train-the-trainer curriculum, which could become a core component of medical, nursing, and other health care sector foundational training.

The program could also offer more flexibility in implementation and tailor deployments to the facility size and baseline IPC score. For instance, very large low-performing facilities could have longer mentoring periods and one student assigned per department as opposed to one student for a very large hospital. Similarly, one student may be able to support several small, rural facilities in the same neighbourhood (with adequate transportation subsidies).

STRENGTHS AND LIMITATIONS

Several other strategies and partners were implementing key interventions concurrently, making it difficult to establish clear causality of impact and to limit confounders. Consequently, results observed were related to a collective effort and should not be attributed to one project or one partner. The findings described above aim to explore if changes were occurring in a positive direction in the zones of intervention and before and after the intervention or if they were worsening. In order to minimise confounding factors, we have attempted to present both pre and post-data as well as comparator data with ten other sub-regions where the interventions were not piloted, but that had similar culture and security situations and similar rates of EVD (i.e. the ten other regions of Butembo EOC). Similarly, these findings represent a very small sample size of a rare outbreak of viral haemorrhagic fever (VHF) and findings may not be generalisable beyond the North Kivu VHF context. Overall, it was also difficult to find data disaggregated by gender, ethnicity, and/or age.

CONCLUSIONS

This four-month health system strengthening and community engagement project to support IPC efforts achieved its aims to reduce community resistance, increase the capacity of HCWs and engage communities in preventive actions to prevent the spread of Ebola. These results occurred in North Kivu, a highly mobile province with nearly 7 million people well-known for being an area of conflict for over 25 years, with more than 100 active armed groups.[3] Within this incredibly challenging context, the medical student mentoring intervention represents a promising quality improvement initiative which aligns with the recommendations by multiple partners to focus the next phase of the Ebola response on building the capacity of the existing health care system in DRC.[7,19] Sacks and colleagues argue that explicit attention to community-level services, actors, and partnerships is necessary to strengthen health systems and provide primary healthcare for all.[20]

The Ebola outbreak was not new in DRC; thus, healthcare workers and the public knew lreadyy some clinical symptoms and prevention measures of the disease. However, the insecurity, economic and social-cultural context was unique, and made the response difficult. Mistrust of the general population, and healthcare workers with limited knowledge made the outbreak more difficult to contain. However, community-based lead interventions contributed immensely to fight the outbreak. One of aspect of that response approach was this project of training medical students and deploy them in healthcare facilities within their communities for IPC interventions.

The intervention has the potential for long-term capacity building, offering both an immediate IPC impact and potentially a longer-term health systems strengthening impact. Such gains are already evident, with lessons from the Ebola response being applied to the current COVID-19 response in multiple jurisdictions.[21–23] Given the importance of IPC to any COVID-19 response, this promising intervention could be easily adapted to have medical students provide similar training and capacity building during the current outbreak. Qualitative interviewees noted that medical students represent the future of the country and by targeting youth who will remain in the country long after the international agencies, the Ebola response hopes to leave a lasting impact for the people of the Democratic Republic of the Congo.

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DECLARATIONS

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position, decisions, policy or views of institutions where authors are affiliated.

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AUTHORSHIP CONTRIBUTIONS

The first author named is lead and corresponding author and guarantor. All other authors are listed in order of contribution with the last author being the senior author. We describe contributions to the paper using the CRediT taxonomy (Brand et al. (2015), Learned Publishing 28(2)). Conceptualisation: KO, MT, GM, DMO, LK, BH, PMN; Funding Acquisition: KO, GM, LK, BH; Investigation: MT, DN, DMO, PMN, LK, BH; Methodology: KO, MT, GM, DN; Formal Analysis: MT, DN, DMO, PMN; Writing – Original Draft: MT, DN, GM, PMN; Writing – Review & Editing: KO, MT, GM, DMO, BB, SM, RT, PMN, AT, LK, BH, MK, AB; Project Administration: KO, DN, DMO, BB, SM, RT, PMN, AT, LK, BH, MK, AB. All authors have read, and confirm that they meet, ICMJE criteria for authorship.

COMPETING INTERESTS

The authors completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available upon request from the corresponding author), and declare no conflicts of interest.

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SUPPLEMENTARY MATERIALS

Online Supplementary Document

Download: https://www.joghr.org/article/36558-evaluation-of-a-health-systems-strengthening-intervention-to-improve-ebola-virus-disease-infection-prevention-and-control-in-the-democratic-republic-o/attachment/92956.docx