



Conceptualizing Ebola Virus Disease (EVD) Infection Prevention and Control (IPC) Program in the Context of Democratic Republic of the Congo (DRC) During the 2018-2020 EVD Outbreak: Pilot Study

Boniface Hakizimana^{1,2*}

¹Academic Unit for Infection Prevention and Control, Faculty of Medicine and Health sciences, Stellenbosch University, PO Box 19063, Tygerberg 7505, Cape Town, South Africa

²Infection Prevention and Control Unit, WHO Health Emergencies Program, EVD Response, Democratic Republic of the Congo

Abstract

Background: The 2018 to 2020 Ebola Virus Disease (EVD) outbreaks in the eastern Democratic Republic of the Congo (DRC) was declared by the Ministry of Health on 01 August 2018. It is the DRC largest ever EVD outbreak and the second biggest Ebola epidemic recorded behind the West Africa outbreak of 2014 to 2016. The weak health systems in DRC, mistrust of the populations to healthcare facilities and insecurity in eastern part of the country constituted big amplifiers of EVD outbreak. We conceptualized infection prevention and control took into account the DRC context and we piloted it in twenty five healthcare facilities to contribute to ensure healthcare facilities are able to effectively prevent and/or respond to EVD cases and avoiding propagation within healthcare facilities and in the communities.

Materials and Methods: This quasi experimental intervention pilot study was conducted in twenty five (25) healthcare facilities of Goma EVD sub coordination, North-Kivu province between December 2018 and March 2019. IPC program was tailored to DRC context and IPC approach developed and implemented to strengthen Infection Prevention and Control (IPC) activities in priority HCFs. The study was composed by three phases: Pre-intervention IPC assessment conducted in January 2019, intervention phase in February 2019 and post intervention assessment which we conducted in March 2019. The activities conducted during intervention phase were: Training of healthcare workers and hygienists, donation of HCF with IPC kits, supportive supervision with coaching and mentoring of healthcare workers and hygienists on how perform IPC practices. Pre and post assessment data was analyzed using Ms Excel.

Results: Before intervention, the average score of IPC was 37% and 9% of triage and isolation section. After intervention, the average score of IPC increased to 61% and 81% of triage and isolation section. Eighty percent (20/25) healthcare facilities had the IPC score below 50% before intervention, while 20% (5/25) of the HCF their IPC score was between 50% and 79%. There was no HCF with acceptable IPC score ($\geq 80\%$). After intervention, 12% (3/25) of HCF had acceptable IPC score ($\geq 80\%$). 72% (18/25) of the HCF had IPC score between 50% and 79%. The IPC score of 16% (4/25) of HCF remained below 50%. There was an improvement of 24% in terms of IPC and 72% in terms of triage and isolation section.

Conclusion: This pilot study demonstrated how is feasible to setup a comprehensive program such as infection prevention and control as part of improving health systems and maintain readiness level prevent or contain outbreaks such as Ebola Virus Disease. Capacity building including training, coaching and mentoring of healthcare workers is a key for effective implementation of IPC program. Building trust between communities and healthcare facilities should be strengthened. More efforts, resources and expertise are needed for community mobilization and community engagement. Community infection prevention and control program should be developed and supported.

Keywords: Infection prevention and control; Health systems strengthening; Infection prevention and control assessment; IPC score; Alcohol based hand rub; Ebola virus disease, Ebola virus disease outbreak; Healthcare facilities; Healthcare associated infections; Community engagement

OPEN ACCESS

*Correspondence:

Boniface Hakizimana, Academic Unit for Infection Prevention and Control, Faculty of Medicine and Health Sciences, Stellenbosch University, PO Box 19063, Tygerberg 7505, Cape Town, South Africa. Telephone number: +250788594903; E-mail: bonihak@yahoo.fr

Received Date: 05 Mar 2020

Accepted Date: 20 Mar 2020

Published Date: 24 Mar 2020

Citation:

Hakizimana B. Conceptualizing Ebola Virus Disease (EVD) Infection Prevention and Control (IPC) Program in the Context of Democratic Republic of the Congo (DRC) During the 2018-2020 EVD Outbreak: Pilot Study. *Int J Fam Med Prim Care.* 2020; 1(1): 1005.

Copyright © 2020 Boniface Hakizimana. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

The 2018 to 2020 Ebola Virus Disease (EVD) outbreak in eastern Democratic Republic of the Congo (DRC) was declared by the Ministry of Health on 1 August 2018 and it is the tenth epidemic of EVD and the DRC's largest ever Ebola outbreak [1-3]. This EVD outbreak is also known to be the second biggest Ebola epidemic recorded behind the West Africa outbreak of 2014 to 2016 [1-3]. On 14 July 2019, the first case of Ebola was confirmed in Goma, the capital of North Kivu, and a city of one million people. On 30 July 2019, a second person in Goma was diagnosed with Ebola, he died the next day and two more cases were announced. In reaction to the first case found in Goma, on 17 July 2019, the World Health Organization (WHO) announced that the current Ebola outbreak in DR Congo represents a Public Health Emergency of International Concern (PHEIC). In mid August 2019, the epidemic spread to neighboring South Kivu province exactly in Mwenga and becoming the third province in DRC to record cases in this outbreak. On the 7th August 2018, the national laboratory (INRB) confirmed that the current outbreak is of the Zaire Ebola Virus, the most deadly strain and the same one that affected West Africa during the 2014 to 2016 outbreak.

The weak health system in the DRC as a major amplifier of the most frequent disease outbreaks in the country

The health status of the population is alarming. The seven principal causes of Disability Adjusted Life Years (DALY) lost are malaria, diarrheal diseases, protein energy malnutrition, lower respiratory tract infections, HIV, preterm birth complications and tuberculosis. Non-communicable diseases associated with epidemiological transitions account for 21% of the national burden of disease, although this proportion is rising [4]. The health system of the DRC is organized in three levels. At the implementation level there are 516 health districts, where a district team manages a network of health centers and a district hospital. Districts typically cover a population of 100000 to 200000. The intermediate level, responsible for technical and logistic support, is managed by provincial health departments, the number of which has recently increased from 11 to 26. The central level has a normative role. Expenditure on health in the DRC is low at US\$ 12 to 13 per capita per year between 2008 and 2012. Total health expenditures were US\$ 876 million in 2009, declining to US\$ 830 million in 2010, with a partial recovery to US\$ 843 million in 2012 [5]. Households are the largest contributors to total health expenditure, closely followed by multilateral aid. Central government contributes 11%. There have been 10 outbreaks of the Ebola Virus Disease in the Democratic Republic of the Congo. Additionally, polio, cholera, and measles are the overlapping outbreaks in some part of the country, while tuberculosis is an increasingly serious health concern in the DR Congo [6].

The community mistrusts and attacks on EVD responders

The engagement of the community constitutes the cornerstone of successful response and a key to defeating the Ebola outbreak [7,8]. Fighting Ebola in the environment where members of the community don't support the response team, where people continue to deny the existence of Ebola outbreak, where no trust between the communities to the EVD response team increases the vulnerability of response team and amplifies the spread of the disease in different health areas and health zones. The mistrust and violent attacks against the Ebola response show no signs of abating; as recently as mid September, violence was reported and around 30 houses and a part of the health centre were burnt down in Lwemba, Ituri province, following the

death of a local health worker from Ebola [9]. In late June, angry crowds hurled rocks at a driver working with an Ebola response team in Beni and set his vehicle on fire. WHO and Ministry of Public Health (MSP) field staff continue to be affected by those attacks and some of them have been assassinated.

Weak health system and lack of Infection Prevention and Control (IPC) program in healthcare facilities leads to the propagation of Ebola Virus Disease (EVD) within healthcare facilities and in the communities

Lack or deficit of well-trained IPC practitioners and frontline healthcare providers continue to amplify the transmission of EVD in HCFs and in the community. Insufficiency or inadequate resources such as personal Protective Equipment (PPE), hand hygiene consumables (soap, alcohol based hand rub, clean running water) as well as training materials such comprehensive training modules, reminders at workplace is a major and challenge problem in healthcare facilities. Lack of community engagement to support and synergize the response team continues to aggravate EVD propagation in the community (Table 1).

Materials and Methods

IPC Program was tailored to DRC context and IPC approach was developed and implemented in Goma priority Healthcare Facilities (HCFs) [10-14]. The new approach was developed and introduced in priority healthcare facilities to strengthen Infection Prevention and Control (IPC) activities in the priority HCFs at the beginning of December 2018. This approach involves the deployment of IPC supervisors in the HCFs capacitate the health staff using coaching and mentorship methods. Supervisors work together with healthcare facility managers, frontline healthcare providers, staff responsible for activities such as screeners, hygienists, laundry officers, waste management, etc. and fill the identified gaps (knowledge, skills to perform certain actions, IPC assessments, IPC operational action plan, organization of the various services like triage, healthcare unit, in patient wards, etc). The initiated program aimed to improve the quality of care, patient safety and the safety of health personnel. It also aimed to put in place prevention and control measures against the intra healthcare facility Ebola Virus Disease (EVD) transmission by improving and strengthening early detection, isolation and notification of EVD suspected cases to the centre of EVD alerts management, the unit of EVD response coordination [15]. The safety of patients, health personnel and anything that uses health facilities is non-negotiable (DUTY OF CARE). The priority activities of this project include: Conduct the HCF first IPC assessment, developing IPC action plan based on the identified gaps, providing IPC kit, IPC training to the healthcare facility personnel (managers, healthcare workers, hygienists, etc), support supervision by IPC supervisors, organizing the second or further IPC assessment, discuss on the sustainability plan. Commitment of the HCF leadership and ownership of the program by the health staff are the foundation of the success of this program.

Description of the program

1. IPC assessment and identification of the weaknesses or gaps
2. Developing IPC operational action plan
3. Implementation of IPC operational action plan:
 - Make available the necessary resources: IPC kit and consumables, setting up/construction of triage and isolation unit,

construction of sanitary facilities where needed, setting up healthcare facility IPC structures such as IPC committee and IPC focal point

- IPC training of healthcare facility personnel (Teaching on best practices)
 - establishing supportive supervision of the facility (coaching/mentoring)
4. Monitoring and evaluation of IPC activities in the healthcare facility (joint and integrated team): A monitoring and evaluation plan to be developed (considering the implementation plan)
 5. Assure the sustainability of performance/achievements through the promotion of the best practices, encouraging leadership from the HCF managers and ownership of IPC program by the frontline healthcare providers and engaging the community (patients, nurses, visitors, surrounding community, etc.) in IPC activities.

Healthcare facility rapid IPC assessment using scorecard – kobo collect

- Steps: 1. Conduct the initial (first) HCF IPC assessment
2. Developing HCF operational IPC action plan based on the identified gaps
3. Implementation the HCF operational IPC action plan (different interventions)
4. Follow-up/supportive supervision and continue supporting the facility with coaching and mentoring methods. It takes between 1 to 3 times a week depending on the results of IPC assessment
5. A second IPC assessment is conducted three weeks after the validation of the HCF operational IPC action plan.

Procedure for conducting IPC assessment in the healthcare facility

HCF IPC assessment must be joint and integrated: Use the validated rapid IPC assessment tool known as scorecard. This was the IPC assessment tool developed by the ministry of health in collaboration with World Health Organization, UNICEF and implementing partners and it was recommended to be the sole tool to be used when conducting IPC assessment in healthcare facilities during EVD response in the affected or high-risk health zones in DRC.

- The assessment team should be composed by IPC supervisor representing IPC commission for coordination of EVD response,

Health Zone Supervisor(s), HCF IPC/WASH committee members or HCF IPC/WASH and a representing of the HCF Implementing partner in case of the facility is supported by implementing partner.

- Develop HCF operational IPC action plan and obtain its validation. The validation of the plan took one to three days;
- Implement HCF operational IPC action plan (different interventions) immediately after the validation of the plan;
- Conduct the second assessment two to three weeks after the validation of the plan.

Interpretation of HCF IPC assessment results

- When the score was \geq (greater than or equal to) 80%: This was an acceptable score. The risk of transmission of nosocomial infections or healthcare-associated infections was low. It was recommended to maintain this level of performance, even improve further and it was classified as low risk.
- When the score was between 50% to 79%: It was recommended to improve the score to the acceptable level. The risk of contamination, transmission or propagation of nosocomial infections or healthcare associated infections was still there and it was classified as medium risk.
- When the score was (less than) $<50\%$: this was an unacceptable score. The risk of contamination or transmission of nosocomial infections or healthcare associated infections was very high and it was classified as high risk. It was recommended to put more effort to improve the score to the acceptable level.

Seventy six priority healthcare facilities in Goma have been identified for better Ebola Virus Diseases (EVD) preparedness, readiness and response

Activating the response mode in Goma aimed to secure its population of around a million and its surrounding areas. The vulnerability of Goma was the migration of people including EVD high risk contacts from infected areas such as Beni and Butembo. The roadmap developed in November 2018 highlighted 76 healthcare facilities to focus on with EVD response interventions whereby 42 healthcare facilities were identified to be attached to the points of entry or points of control (PoE/PoC), and 34 most frequented healthcare facilities in Goma city (Figure 1).

IPC program in Goma and its domains of intervention

Study design to introduce this paragraph: This quasi

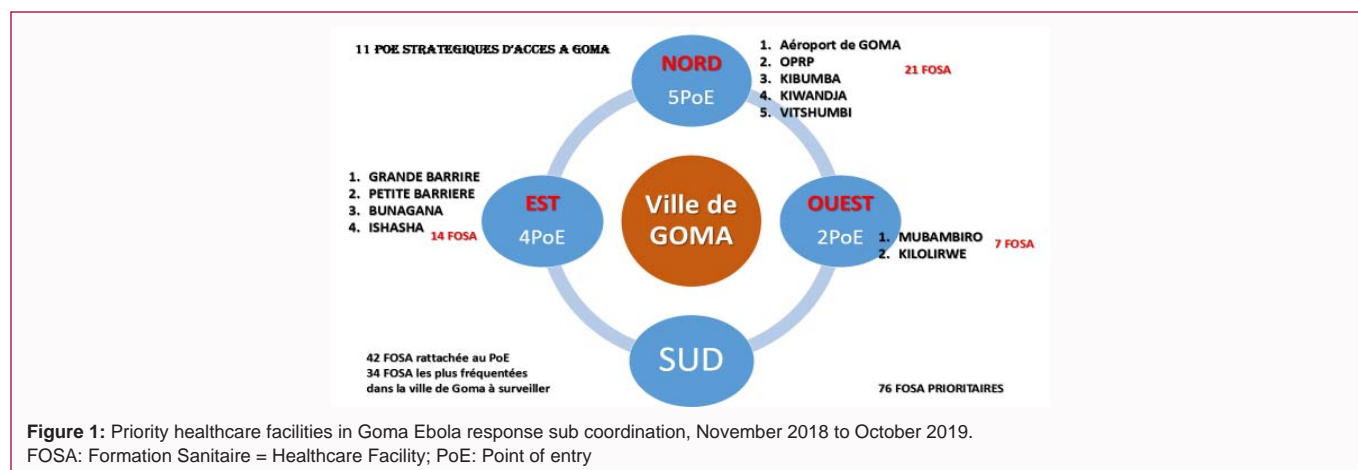


Table 1: Timeline of Ebola outbreaks in the Democratic Republic of the Congo (formerly Zaire).

Date	Country	Major location	Outbreak information				Source
			Species	Cases	Deaths	CFR	
Aug-76	Zaire	Yambuku	EBOV	318	280	88%	7
Jun-77	Zaire	Tandala	EBOV	1	1	100%	8-9
May-Jul 1995	Zaire	Kikwit	EBOV	315	254	81%	10
Aug-Nov 2007	Democratic Republic of the Congo	Kasai-Occidental	EBOV	264	187	71%	11
Dec 2008-Feb 2009	Democratic Republic of the Congo	Kasai-Occidental	EBOV	32	14	45%	12
Jun-Nov 2012	Democratic Republic of the Congo	Orientale	BDBV	77	36	47%	8
Aug-Nov 2014	Democratic Republic of the Congo	Tshuapa	EBOV	66	49	74%	13
May-Jul 2017	Democratic Republic of the Congo	Likati	EBOV	8	4	50%	14
Apr-Jul 2018	Democratic Republic of the Congo	Bikoro	EBOV	54	33	61%	15
Aug 2018-present	Democratic Republic of the Congo	Kivu	EBOV	3,432	2,253	ongoing	16

experimental intervention study was conducted in twenty five (25) healthcare facilities of Goma EVD sub coordination, North Kivu Province between January and March 2019 as a pilot study. The main activities were: Conducting a pre and post intervention assessments to measure the impact of the intervention. The assessment tool used was the Infection Prevention and Control including Water Sanitation and Hygiene (WASH), EVD surveillance and communication components which developed and validated by the ministry of health of DRC in collaboration with World Health Organization, UNICEF and other many implementing partners. The assessment tool was composed by nine sections: Triage and isolation, organization of IPC, standard precautions including hand hygiene, Personal Protective Equipment (PPE), decontamination and sterilization of medical devices and decontamination of hospital linen. Apart from standard precautions, the tool looked at environmental decontamination, waste management and surveillance of suspected cases during admission. During the intervention phase we conducted the following activities: Setting up hospital infection prevention and control committee and nomination of hospital infection prevention and control focal point, briefing of the IPC committee members and IPC focal point on their roles and responsibilities, a 5 day IPC training workshop for hospital senior managers, IPC committee members and IPC focal point. The training emphasized on basic IPC, leadership and management of IPC program. At the end of the training, the medical director of each hospital signed a pledge to own and sustain IPC program. We also organized a five (5) day IPC training workshop for frontline healthcare workers focusing on basic infection prevention and control considering both Ebola and usual contexts. We then organized a three (3) day infection prevention and control training workshop for healthcare facility hygienists. The training took into account three contexts (usual, Ebola and Cholera). The first day is devoted to theory; the second day focuses on practical sessions. The third day is devoted to internships in healthcare facilities. Each hospital received IPC kit composed by IPC equipment, materials and supplies including consumables. A supportive supervision with well trained IPC supervisors was established where by coaching and mentorship methods were used to help trained healthcare workers translate their knowledge into practice. Two (2) infection prevention and control supervisors were assigned to accompany each hospital and they work with hospital managers, IPC committee members and IPC Focal Point every day from Monday to Saturday to effectively implement IPC program at a hospital level. To speed up the implementation process, each hospital has been assigned to at least

one implementing partner who provided both technical and financial support to the hospital. We organized and held two review meetings a month with IPC supervisors each the second and the fourth Sunday to review the progress of IPC activities in their respective healthcare facilities. Each supervisor had a chance to share with others his successes, weaknesses and challenges through one day review meeting workshop organized twice a week. Those meetings were also attended by EVD response senior managers from the ministry of public health, heads of health zones, World Health Organization, UNICEF and implementing partners. Based on the gaps identified, recommendations were formulated and served as the roadmap for the next two weeks implementation plan. A quarterly retreat workshop was organized to bring together all IPC implementing partners, IPC supervisors, healthcare facility managers, EVD response IPC commission leaders, EVD Goma sub coordination coordinator, World Health Organization and UNICEF [16]. The aim of the retreat was to evaluate the IPC implementation progress, to appreciate the successes and identify the weaknesses and gaps. The retreat helps to align interventions to the ministry of public health priorities and share key information with partners. After intervention phase, we conducted a post intervention assessment and data was analyzed using Ms Excel (Table 2).

Result

The results from pre intervention assessment of the minimum IPC requirements to prevent or contain EVD in HCF demonstrated the low level of preparedness (Figure 2). The average score of IPC in 25 HCF was 37% which was far below the acceptable score of at least 80% (Table 3). None of 25 HCF with acceptable level of preparedness 80% (20/25) of the HCF had IPC score below 50% while 20% (5/25) their score was between 50% to 79% (Figure 3). When looking at triage and isolation section, the average score was 9% and none of the HCF with acceptable score of at least 80%. Triage and isolation were inexistent in 68% (17/25) of the facilities (Figure 3). The results from post intervention assessment of the minimum IPC requirements to prevent or contain EVD in HCF demonstrated an improvement in terms of preparedness almost in all HCF. The average score of IPC in 25 HCF increased from 37% to 61% (Table 3) and there were 12% (3/25) HCF with acceptable score of at least 80% and 72% (18/25) of HCF had the score between 50% and 79% while 16% (4/25) their score remained below 50% (Figure 4). The triage and isolation section improved significantly as well. The average score of triage and isolation improved from 9% to 81% and 80% (20/25)

Table 2: Infection Prevention and Control programme tailored in line with Goma context to defeating Ebola virus disease.

IPC programme in Goma, DRC	
Structure of IPC programme	Domain of intervention
Infection Prevention and Control (IPC) in Healthcare facilities	IPC in modern healthcare facilities known as IPC FOSA
	IPC for traditional healing facilities known as IPC TRADI
Community Infection Prevention and Control (IPC)	IPC at the point of entry (PoE) and point of control (PoC)
	IPC in schools
	Decontamination of households during outbreaks
Event Infection Prevention and Control (IPC)	IPC measures during a recognised event where many people meet together during outbreak

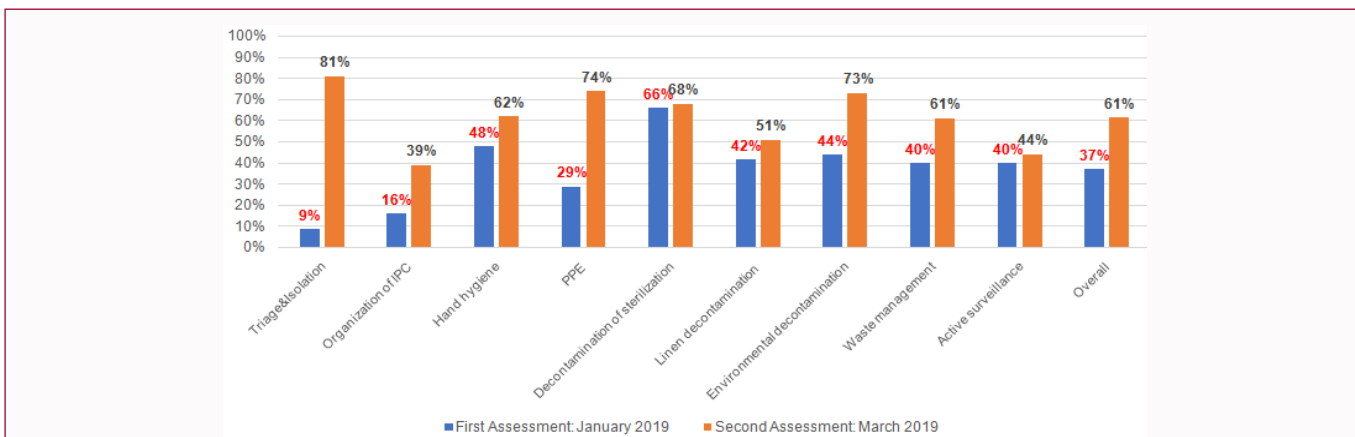


Figure 2: Comparison of the results from pre- and Post-assessments of IPC in 25 HCF of Goma EVD sub-coordination conducted from December 2018 to March 2019.

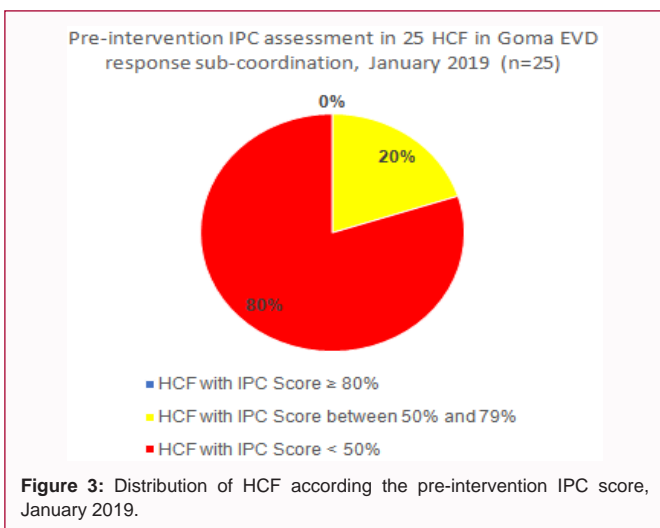


Figure 3: Distribution of HCF according the pre-intervention IPC score, January 2019.

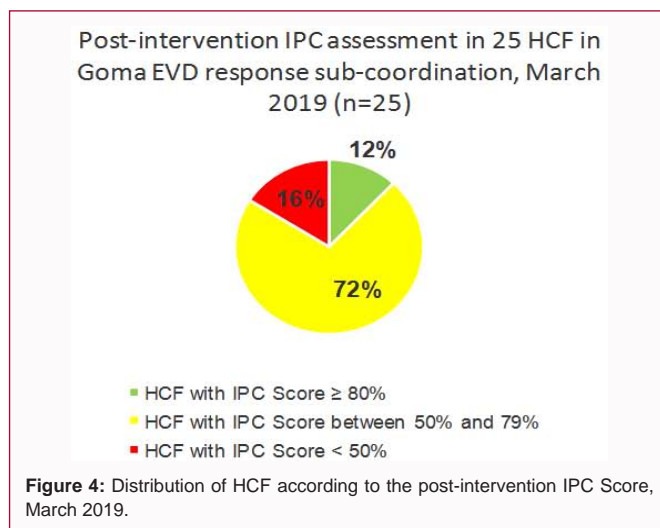


Figure 4: Distribution of HCF according to the post-intervention IPC Score, March 2019.

of the facilities had a unit of triage and isolation responding to IPC requirements (Figures 5). There were other IPC sections that came up with notable improvement such as PPE that improved from 29% to 74%, environmental decontamination that improved from 44% to 73% and waste management that improved from 40% to 61% (Figure 2). Some IPC sections needed more attention and more technical and financial support to achieve the acceptable level. Those sections were: Organization of IPC improved from 19% to 39%, hand hygiene slightly improved from 48% to 62%, decontamination and sterilization of medical devices which the situation remained the same 68% compared to 66% of pre-intervention, linen decontamination of 51% compared to 42% of pre intervention and active surveillance of

EVD suspected cases of 44% compared to 40% of pre intervention (Figure 2).

Discussion

The International Health Regulation (2005) gives significant weight to Infection Prevention and Control as a central strategy for dealing with public health threats of international concern [17].

The results of this study demonstrated the importance of infection prevention and control during emergency preparedness and response in healthcare facilities. The findings from the pilot study conducted in 25 HCF in North-Kivu province demonstrated an overall improvement of 24% (34% to 61%) in terms of IPC and

Table 3: Pre and Post intervention IPC assessment in 25 HCF of Goma EVD Sub-coordination from December 2018 to March 2019.

No	Healthcare facility (HCF)	Pre-intervention IPC assessment: January 2019	Post-intervention IPC assessment: March 2019
1	HOPITAL Heal Africa	73%	85%
2	HOPITAL PROVINCIAL DU NORD-KIVU (HPNK)	63%	80%
3	HGR Nyiragongo	60%	65%
4	CS KINGARAME	58%	65%
5	CS MUGUNGA	55%	70%
6	CM MUYISA	45%	65%
7	CS KASIKA	45%	60%
8	Disp TULIZENI	45%	58%
9	CS BUHUMBA	43%	70%
10	CS KASIZI	43%	68%
11	CS KANYARUCYINYA	40%	58%
12	CSR KAHEMBE	35%	68%
13	HGR KIROT SHE	35%	85%
14	CM BONJOUR	33%	53%
15	CM Siloé	33%	73%
16	CS CASOP	30%	58%
17	CSR SAKE	30%	53%
18	CS KIBATI	28%	60%
19	HGR Charité Maternelle	25%	73%
20	PS DE SAKE	25%	38%
21	Disp Maendeleo	23%	33%
22	CSR MAPENDO	18%	53%
23	CH SHIFAA	15%	40%
24	Disp la Confiance	15%	55%
25	PS MUNIGI	13%	33%
	AVERAGE	37%	61%

HGR: Referral General Hospital; CSR: Referral Health Center; CS: Health Center; PS: Health Post; CM: Medical Center; CH: Hospital Center; Disp: Dispensary

an improvement of 72% (9% to 81%) in terms of triage and isolation section. Some IPC sections improved significantly such as PPE with an improvement of 45% that means from 29% to 74%, environmental decontamination with an improvement of 29% that means from 44% to 73%, hand hygiene with an improvement of 14% that means

from 48% to 62% and waste management that came up with an improvement of 21% that means from 40% to 61% (Figure 2). The rest of IPC sections such as organization of IPC, decontamination and sterilization of medical devices, linen decontamination and active surveillance of EVD suspected cases within in patients needed

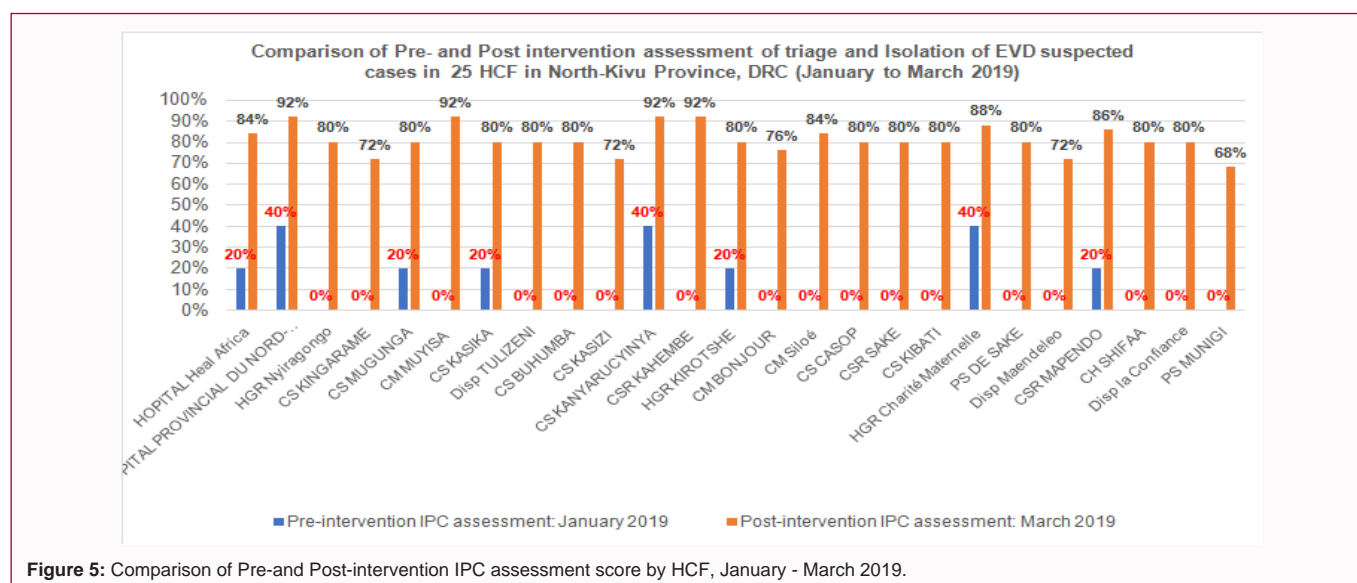


Figure 5: Comparison of Pre-and Post-intervention IPC assessment score by HCF, January - March 2019.

more efforts and both financial and technical support. This study contributed in raising awareness of HCF managers and healthcare workers to actively participate in EVD preparedness and response, particularly by improving screening and isolation and notification of suspected EVD cases as well as setting up minimum IPC requirements to prevent transmission of EVD within healthcare facilities.

Conclusion

Setting up infection prevention and control in the healthcare facilities and definition of minimum requirements such as triage and isolation, standard precautions including hand hygiene, personal protective equipment and environmental decontamination increase the level of preparedness to respond to any outbreak. HCF managers, frontline healthcare workers and hygienists should be trained and basic IPC resources such as soap and water, alcohol based hand rub solutions, personal protective equipment including examination gloves, domestic gloves, surgical mask, N-95 respirators, plastic aprons and plastic boots be available at the facility level. Some equipment such as plastic tables, plastic chairs, and thermo flash should be available to improve triage and isolation of suspected cases. Patients and communities should be gaged and encouraged to report any sign and symptom that they may have or previously had when reported to the HCF. They should also be encouraged to regularly perform hand hygiene to prevent propagation of EVD and other pathogenic organisms.

References

1. Congo declares new Ebola outbreak in eastern province. Reuters. August 2018.
2. Congo announces 4 new Ebola cases in North Kivu province
3. Cluster of presumptive Ebola cases in North Kivu in the Democratic Republic of the Congo. World Health Organization (WHO).
4. World Health Organization. Improving aid coordination in the health sector Democratic Republic of the Congo case study.
5. Institute for Health Metrics and Evaluation. Global burden of disease database.
6. Ministère de la Santé Publique. Comptes nationaux de la Santé 2010 et 2011 RDC. Programme National des Comptes de la Santé. Kinshasa; 2013.
7. Report of an International Commission. Ebola haemorrhagic fever in Zaire, 1976. *Bulletin Bull World Health Organ.* 1978;56(2):271-93
8. CDC. Years of Ebola Virus Disease Outbreaks.
9. Heymann DL, Weisfeld JS, Webb PA, Johnson KM, Cairns T, Berquist H. Ebola Hemorrhagic Fever: Tandala, Zaire, 1977–1978. *J Infect Dis.* 1980;142(3):372-6.
10. Khan AS, Tshioko FK, Heymann DL, Le Guenno B, Nabeth P, Kerstiëns B, et al. The reemergence of Ebola hemorrhagic fever, Democratic Republic of the Congo, 1995. *Commission de Lutte contre les Epidémies à Kikwit. J Infect Dis.* 1999;179:S76-86.
11. Outbreak news. Ebola virus haemorrhagic fever, Democratic Republic of the Congo--update. *Wkly Epidemiol Rec.* 2007;82(40):345-6.
12. WHO. End of Ebola outbreak in the Democratic Republic of the Congo. Retrieved 22 May 2018.
13. Congo declares its Ebola outbreak over. Reuters.
14. Democratic Republic of the Congo Ebola virus". World Health Organization. Retrieved 22 May 2018.
15. Ebola virus disease – Democratic Republic of the Congo: Disease outbreak news, 25 July 2018.
16. Operations Dashboard for Arc GIS. who.maps.arcgis.com. Retrieved 17 November 2019.
17. International Health Regulations. 3rd ed. Geneva: World Health Organization; 2005.