Supporting Vulnerable Health Systems Improve Infection Prevention and Control to Fight the COVID-19 Pandemic

Guadalupe Bedoya and Amy Dolinger[1]

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Protecting healthcare workers and patients is critical to reduce the spread of the disease. In this brief we highlight three urgent actions:

1. Distribution of infection prevention and control (IPC) policies and guidelines to all health facilities;
2. Manufacturing and distribution of IPC supplies to health facilities; and
3. Mass media hand hygiene behavior change campaigns for health workers and the general population.

Leading epidemiological models show that, even with draconian suppression measures, COVID-19 rapidly overwhelms healthcare systems.[2] As more patients are hospitalized, healthcare workers at the frontline of delivering care are at the greatest risk of contagion. Worse, if infection prevention and control (IPC) systems are

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[2] Ferguson NM, Laydon D, Nedjati-Gilani G, Imai N, Ainslie K, Baguelin M, et. al. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID- 19 mortality and healthcare demand. Imperial College COVID-19 Response Team. 2020. https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf. [cited 20 March 2020].

not in place and IPC practices are not widely followed, health facilities can drastically speed up the spread of the virus.[3,4] In China's Wuhan city, where COVID-19 was first reported, an overwhelmed healthcare system contributed to a fatality rate of 5.8% versus 0.7% in the rest of the country, in spite of considerable centralized support to increase the city's healthcare capacity.[5] Italy's healthcare workers are facing high rates of infection at 5 times that of the general population. Similar levels were reported for Hubei's province, where Wuhan city is located.[6] In short, healthcare workers are disproportionately affected.

Those are the grim statistics for high-income and high-capacity countries. In low- and middle-income countries, the problem might be worse. In Africa, only a few countries have put in place national policies on safe healthcare practices and monitoring systems.[7] By the end of the last Ebola epidemic, the rate of infection among healthcare workers was 21 to 32 times that of the general population in the most affected countries. These were low-income countries in West Africa, with systems unprepared to face such an outbreak.[8] In the current pandemic, this could further overwhelm health care systems in regions such as Africa or the Eastern Mediterranean, reporting among the lowest healthcare worker densities worldwide at 2 and 5 per 1000 people, or 14% and 33%, respectively, of those available in Europe.[9] The source of vulnerabilities in low- and middle-income countries are not well studied, but a study by Bedoya et al. (2017) contributes to our understanding of such vulnerabilities through the largest data collection effort on IPC practices and patient safety in primary care settings in any low- and middle-income country.[10]

To understand their results, it is helpful to think of a patient journey through a primary care visit. They will first see a nurse, who must wash his/her hands before the examination. The nurse will then go through the examination, and will have to disinfect the thermometer with an alcohol-based solution. To conduct an invasive procedure, for instance, attending to an open wound, the nurse must wear personal protective equipment (PPE) such as gloves, and segregate infectious waste into appropriate containers. If the patient requires an injection or a blood draw, additional practices will be required. In IPC terminology, every action by a healthcare worker that should trigger an IPC action (washing hands, wearing gloves, segregating waste appropriately) is called an "indication." If the healthcare worker does not complete this action, it is recorded as a "violation." Building on WHO work, ***Bedoya et al. (2017) developed and deployed an observation tool that tracked 14,328 patients, recording and assessing 106,464 indications through their patient journeys in 935 facilities in Kenya.***[11]

IPC's Vulnerabilities in Two Figures

The analysis reveals a high ratio of IPC violations per indication across different procedures (Figure 1). There are an average of 5.1 safety violations out of 7.5 indications triggering a safety action during outpatient visits. Safety violations rapidly increase with the number of procedures per visit (examination, blood draws and injections). IPC standard provisions assume that each person is potentially infected or colonized with a pathogen that could be transmitted. Therefore, the importance of these violations

[3] IPC is "a scientific approach and practical solution designed to prevent harm caused by infection to patients and health workers. It is grounded in infectious diseases, epidemiology, social science and health system strengthening, which have been designed to reduce the spread of infections in healthcare settings." World Health Organization. Infection Prevention and Control. https://www.who.int/gpsc/ipc/en/. [cited 20 March 2020].

[4] As Peter Piot, co-discoverer of Ebola, stated: "Clinics that failed to observe this [safe injection practices] and other rules of hygiene functioned as catalysts in all additional Ebola outbreaks." Their mistakes, "drastically sped up the spread of the virus, or made the spread possible in the first place."

[5] WHO's estimated crude mortality rate as of February 20, 2020. China's efforts to support their healthcare system in Wuhan included 40,000 additional healthcare workers sent from other areas of the country to assist the city, the construction of two dedicated hospitals in a few days, and the rapid establishment of fever clinics that separated potential infected people from other patients. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). World Health Organization, 2020. https://www.who.int/publications-detail/report-of-the-who-china-joint-mission-on-coronavirus-disease-2019-(covid-19). [cited 20 March 2020].

[6] The rate of infection is estimated as the proportion of confirmed cases relative to the relevant population. Own estimates based on data from John Hopkins COVID-19 Situation Reports as of March 19, 2020 for Italy and WHO-China Joint Mission Report as of February 20, 2020 for Hubei, China. Healthcare worker infections are more likely to be confirmed than for the general population due to higher access to testing. Healthcare workers includes health service providers, health management staff and support workers in healthcare institutions. John Hopkins COVID-19 Situation Reports. http://www.centerforhealthsecurity.org/resources/COVID-19/. [cited 19 March 2020]. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). World Health Organization, 2020. https://www.who.int/publications-detail/report-of-the-who-china-joint-mission-on-coronavirus-disease-2019-(covid-19). [cited 20 March 2020]. Parameters on healthcare workforce are from WHO Health workers: a global profile. World Health Organization, 2006. https://www.who.int/whr/2006/chapter1/en/. [cited 20 March 2020].

[7] World Health Organization Regional Office for Africa. Guide for Developing National Patient Safety Policy and Strategic Plan. World Health Organization, 2014. http://www.who.int/patientsafety/guide-for-developing-national-patient-safety-policy-and-strategic-plan_final.pdf. [cited 20 March 2020].

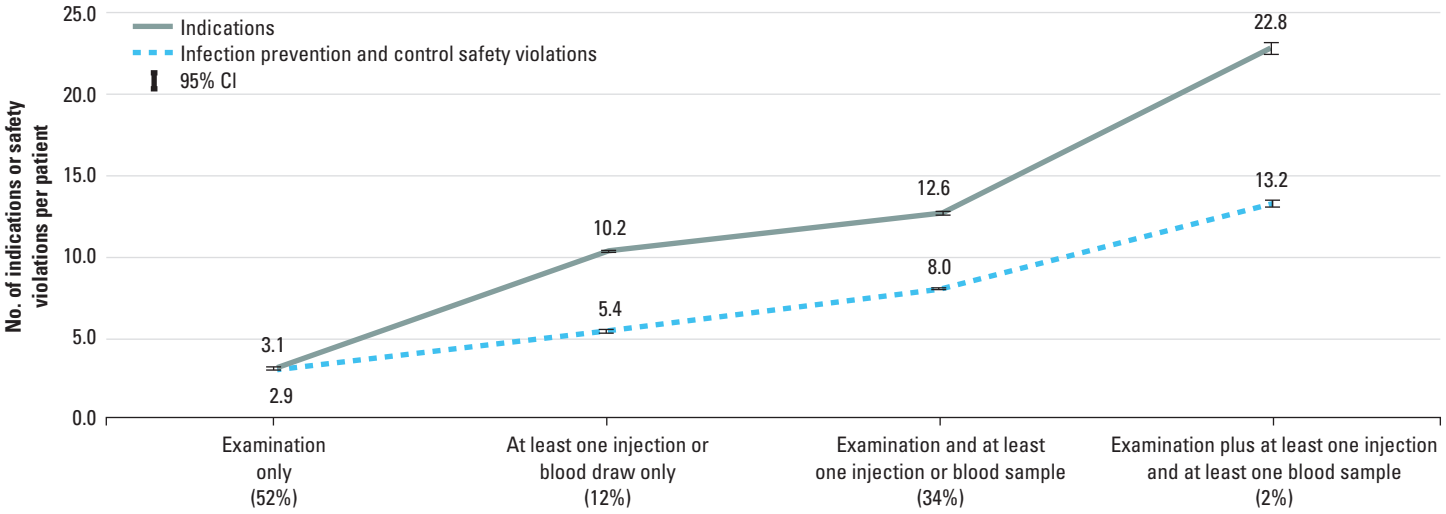
[8] World Health Organization. Health worker Ebola infections in Guinea, Liberia and Sierra Leone: Preliminary Report. World Health Organization, 2015. https://www.who.int/csr/resources/publications/ebola/health-worker-infections/en/. [cited 20 March 2020].

[9] World Health Organization. Global strategy on human resources for health: Workforce 2030. https://apps.who.int/iris/bitstream/handle/10665/250368/9789241511131-eng.pdf?sequence=1. [cited 20 March 2020]. The WHO Eastern Mediterranean region includes Afghanistan, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, and Lebanon, amongst others.

[10] Bedoya G, Dolinger A, Rogo K, Mwaura N, Wafula F, Coarasa J, et al. Observations of infection prevention and control practices in primary health care, Kenya. Bulletin of the World Health Organization. 2017;95:503–516. http://doi.org/10.2471/BLT.16.179499.

[11] The study uses direct observation of patients interacting with healthcare workers in all facilities of three regions in Kenya. Compliance with IPC practices to prevent harm caused by infection to patients and healthcare workers were assessed including hand hygiene, use of gloves, disinfection of reusable devices such as thermometers, segregation of infectious waste, and injection and blood draw safety.

Figure 1. Infection prevention and control indications and safety violations, infection prevention and control study, Kenya



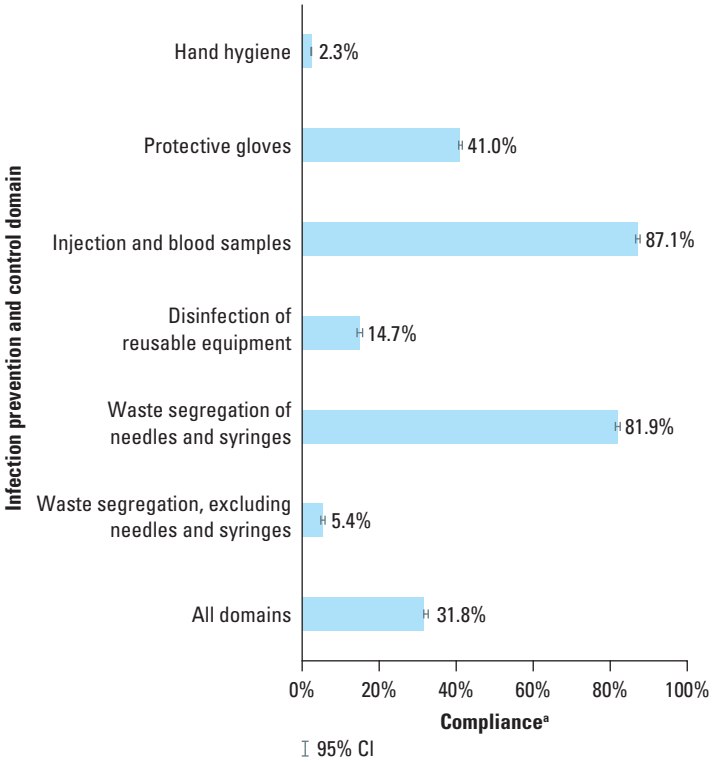
CI: confidence interval.
Notes: An indication refers to a situation in which an infection prevention and control practice must be undertaken to prevent the risk of a pathogen being transmitted from one surface to another. A safety violation occurred when the required action was not taken. The percentages in parenthesis give the proportion of patients who underwent the procedure or combination of procedures.
Source: Bedoya et al. (2017)

depends on the risk of the pathogens being transmitted from one surface to another in that setting. In a pandemic of a highly infectious disease like COVID-19, these violations become a significant means of transmission.

On average Bedoya et al. assess compliance with 20 IPC practices at only 32%, with notable successes in some domains and failures in others. Most troublingly, compliance with hand hygiene, the cornerstone of IPC—and a critical practice to fight COVID-19's spread—was assessed at only 2%, the lowest level across all practices (Figure 2).[12] Yet, safe practices in injections and blood draws (IBD) were followed for 87% of indications. Knowledge, supplies and practices are aligned in IBD; most likely this is associated with an increased HIV risk and intensive campaigns to prevent its transmission.[13]

We now turn to three areas of IPC with significant constraints that are critical to prepare for the current pandemic. The domains analyzed here are by no means comprehensive. IPC health facility preparedness resources for COVID-19 are available in the WHO's Coronavirus disease (COVID-19) technical guidance.[14]

Figure. 2. Compliance with infection prevention and control practices, by infection prevention and control domain, Kenya



CI: confidence interval.
[a]The compliance is the proportion of indications for an infection prevention and control practice for which the corresponding action was taken.
Notes: An indication refers to a situation in which an infection prevention and control practice must be undertaken to prevent the risk of a pathogen being transmitted from one surface to another. The data in the figure relate all 106,464 indications observed.
Source: Bedoya et al. (2017)

[12] The virus is surrounded by oily lipid molecules, which break apart on contact with soap.
[13] Reid S. Injection drug use, unsafe medical injections, and HIV in Africa: a systematic review. Harm Reduct J. 2009; 6: 24. https://doi.org/10.1186/1477-7517-6-24
[14] World Health Organization Coronavirus disease (COVID-19) technical guidance: Infection prevention and control. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control. [cited 20 March 2020].

1. **Immediate Provision of IPC Policies and Procedures to Health Facilities:** The WHO guidance includes, among others, triage assessment for early identification of cases among patients in admission, and safe operating procedures such as hand hygiene, disinfection, and use of appropriate personal protective equipment (PPE). What we learned in low-capacity contexts like Kenya is that triage assessment is weak and only 12% of facilities have skilled staff for coding patients at first point of contact and isolating those with suspected infections. Further, standard operating procedures on key IPC practices are ***absent*** overall with only 2% of facilities with a hygiene protocol and 5% with IPC guidelines. As a result, ***immediate provision of information and support to health facilities on minimum IPC requirements for IPC policies and protocols during the pandemic is critical***.

2. **Manufacturing and Provision of Critical IPC Supplies to Health Facilities:** The WHO recommends essential IPC supplies for safe practices, such as hand hygiene, disinfection and sterilization, and PPE for healthcare workers, including standard (gloves, gowns, masks) and specialized PPE like N95 masks and eye protection (e.g., goggles or face shields) for certain procedures. In Kenya, minimum supplies for hand hygiene were available in 70% of facilities—either running water and soap or alcohol-based hand-rub—but only 5% reported the stricter complete set including single-use towels, which is recommended to maximize the effectiveness of hand hygiene.[15] For outpatient services, 72% of facilities had gowns, 84% had gloves, 47% had disinfectant available, and only 15% of facilities had face masks.[16,17] The number of facilities without important supplies in key departments, such as admission and outpatient services, point to suboptimal capacity to protect healthcare workers and patients in the absence of a crisis. This is severely exacerbated during the pandemic–when potential infected patients must also wear a mask–and contributes to the spread of the disease, as well as to increased infection and potential death of health workers.[18] Based on the shortages reported in high-capacity countries such as the US and Italy, ***countries must redirect manufacturing capacity towards the production and delivery of needed supplies***. Supplies are critical to protect healthcare workers and patients, and reduce the spread of the disease. This requires tracking the number of healthcare workers and patient loads, infection rates, stocks and demand, as well as planning for the production and provision of timely, efficient access to the supplies required to fight the spread of the disease.

3. **Mass Media Hand Hygiene Behavior Change Campaigns**: There is real progress in some domains in IPC practice in Kenya, particularly in injections and blood draw safety with compliance reaching 100% for the action of "using new needles and syringes for injections and blood sampling." However, as Figure 3 shows, some basic practices like hand hygiene compliance remain extremely low even with availability of required supplies (3.2%) and supplies and knowledge (4.2%). Gaps are reported across several domains. This problem is common to many countries. Appropriate hand hygiene was performed in less than 1% of birth deliveries in a study in India.[19] In Australia 44% of healthcare workers performed hand hygiene before a national intervention.[20] How to engender behavior change—particularly hand hygiene—remains the single biggest challenge for patient safety and IPC everywhere, and of paramount importance in the pandemic. Improving hand hygiene practices in the whole population is also urgently required. Currently, there is no robust evidence of the impact of individual or packaged interventions recommended by the WHO (alcohol-based hand rubbing, education, reminders, performance feedback, and managerial support) on behavior and infections.[21] ***Mass media behavioral campaigns or edutainment (short for "entertainment education") delivered by professional mass media producers and distributors should be considered to impact behavioral change in the short- and long-term.*** These campaigns have been proven highly effective, for example, to change behavior and health outcomes outside of healthcare settings for campaigns targeting HIV prevention in

[15] According to Kenya National IPC Guidelines supplies include running water (in a sink or from a bucket with a tap or a bucket with a pitcher), soap (either bar or liquid soap), and availability of single-use towels. The standards set by the WHO and CDC are soap, water, and single-use towel or alcohol-based handrub. The study uses the more lenient indicator without single towels based on the main tools from the WHO and CDC. World Health Organization. *WHO Guidelines on Hand Hygiene in Health Care*. World Health Organization, 2009. https://www.who.int/gpsc/5may/tools/9789241597906/en/. [cited 20 March 2020]. Centers for Disease Control and Prevention. *Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care*. Atlanta, USA: CDC. 2014; 18–33. https://www.cdc.gov/hai/settings/outpatient/outpatient-care-guidelines.html. [cited 20 March 2020].

[16] This PPE is required at outpatient sites according to Kenya's IPC guidelines. Ministry of Health, Republic of Kenya. National Infection Prevention and Control Guidelines for Health Care Services in Kenya. Nairobi, Kenya: Government of Kenya. 2015.

[17] Figures related to availability of gowns, gloves, disinfectant, and face masks are from the Kenya Patient Safety Impact Evaluation Endline Survey, 2018.

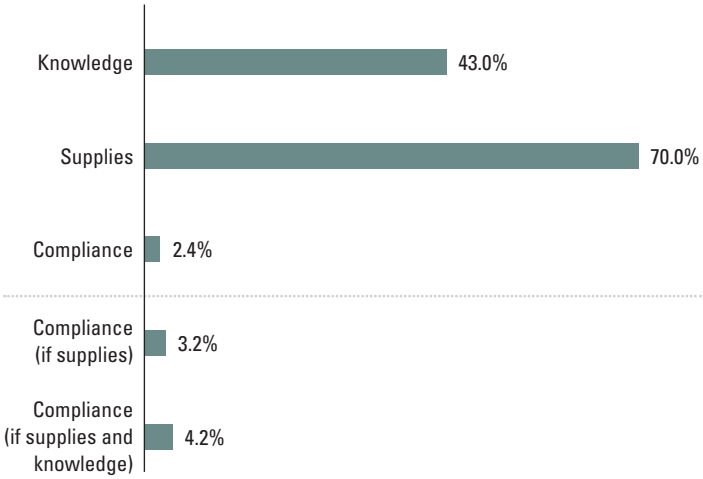
[18] In the last Ebola epidemic, healthcare workers' fatality rates were more than 70 times that of the rest of the population in the most affected countries. Evans DK, Goldstein M, Popova A. Health-care worker mortality and the legacy of the Ebola epidemic. The Lancet. 2015. https://doi.org/10.1016/S2214-109X(15)00065-0

[19] Semrau KEA, Hirschhorn LR, Delaney MM, Singh VP, Saurastri R, Sharma N, et al. Outcomes of a Coaching-Based WHO Safe Childbirth Checklist Program in India. The New England Journal of Medicine. 2017; 377: 2313–2324. https://doi.org/10.1056/NEJMoa1701075

[20] Grayson ML, Russo PL, Cruickshank M, Bear JL, Gee CA, Hughes CF, et al. Outcomes from the first 2 years of the Australian National Hand Hygiene Initiative. Med J Aust. 2011;195(10):615–9. https://doi.org/10.5694/mja11.10747 PMID: 22107015.

[21] Gould DJ, Moralejo D, Drey N, Chudleigh JH, Taljaard M. Interventions to improve hand hygiene compliance in patient care. Cochrane Database of Systematic Reviews. 2017;9:CD005186. https://doi.org/10.1002/14651858.CD005186.pub4

Figure. 3. IPC knowledge-supplies-practice gap: Hand hygiene, Kenya
Percent of healthcare workers that comply with practice, know the practice, and have access to the required supplies



Notes: Estimates are based on data from facilities in 3 countries—Kakamega, Kilifi and Meru—and for which healthcare workers' compliance, knowledge, and supplies were all non-missing (88,814 indications of the 106,464 indications). When conditioned on supplies, hand hygiene is conditioned on availability of running water and soap or an alcohol-based handrub solution.
Source: Bedoya et al. (2017)

Nigeria,[22] to increase awareness of vaccination in Indonesia,[23] and to improve school investments in Ethiopia.[24] Mass media campaigns are cost-effective and can have massive outreach potential with multiplier effects across news and social media.

The systems for prevention and control of infections that are critical for a well-functioning health system are indispensable during a pandemic of a highly infectious disease such as COVID-19. In the past, unprepared health systems across the world, even in high-income countries, contributed to disease transmission during the epidemics of Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS).[25] These episodes led some to improve their infection

surveillance, prevention, and control measures.[26] Surveillance and response measures to support IPC are often missing in low-resource settings and critical to fight the pandemic. South Korea's successful initial handling of the COVID-19 outbreak is in part due to strengthened surveillance and infection control response systems to contain the 2015 MERS outbreak and continued incidence of MERS cases thereafter.[27] South Korea's COVID-19 surveillance and infection control response includes early patient detection with rapid expansion of screening clinics and testing

[22] "Edutainment consists of media programs, usually radio, television or film aiming to change attitudes and behaviors by getting the viewer immersed into an entertaining narrative where the educational messages are presented as an integral part of a bigger story." Banerjee, A, La Ferrara, E, Orozco-Olvera, V. The Entertaining Way to Behavioral Change. Policy Research working paper; no. WPS 8998. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/518151568049461993/The-Entertaining-Way-to-Behavioral-Change-Fighting-HIV-with-MTV. [cited 20 March 2020].

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[25] Nuzzo JB, Meyer D, Snyder M, Ravi SJ, Lapascu A, Souleles J, et al. What makes health systems resilient against infectious disease outbreaks and natural hazards? Results from a scoping review. BMC Public Health. 2019;19(1310). https://doi.org/10.1186/s12889-019-7707-z

[26] Elkholy AA, Grant R, Assiri A, Elhakim M, Malik MR, Van Kerkhove MD. MERS-CoV infection among healthcare workers and risk factors for death: Retrospective analysis of all laboratory-confirmed cases reported to WHO from 2012 to 2 June 2018. J Infect Public Health. 2020;13(3)418–422. https://doi.org/10.1016/j.jiph.2019.04.011

[27] Cho HW. Effectiveness for the Response to COVID-19: The MERS Outbreak Containment Procedures. Osong Public Health and Research Perspectives. 2020;11(1): 1–2. https://doi.org/10.24171/j.phrp.2020.11.1.01

Young girl using alcohol-based hand rub for hand hygiene

and quarantining of suspected cases to reduce the possibility of contaminating healthcare institutions. Their IPC measures include providing Level-D protective gear,[28] masks for specialists, disposable waterproof gowns, and infection control guidelines.

They also recommend the designation of an infection control staff member at each healthcare institution to ensure infection prevention measures are reinforced and monitored.[29] Singapore and Hong Kong, which faced SARS outbreaks in the past have also had success in controlling the initial spread of the virus.[30] Their basic tactics at health facilities rely on wearing regular PPE for each patient (surgical masks and gloves), performing appropriate hand hygiene and disinfecting surfaces after each patient. They only use more specialized PPE (N95 masks, face protectors, goggles and gowns) for potential infected cases when procedures that could aerosolize respiratory secretions. They also rely on appropriate triage of suspected cases and social distancing in health facilities to limit exposure of healthcare workers.[31] Learning from countries that have invested in IPC and surveillance systems such as South Korea, Singapore and Hong Kong is essential to protect healthcare workers and patients, reduce risk at health facilities, and help slow down community spread. Providing significant support to low-capacity countries to strengthen their vulnerable systems is of primary importance to reduce the potentially devastating consequences they may face and as a protective action to limit the spread of COVID-19 worldwide.

[28] "Level D" refers to whole-body suits (including a full-length gown, goggles, N95 mask, gloves, shoe covers, and other components) that were defined in response to the 2015 outbreak of MERS in South Korea. Choi, JS, Kim, KM. Crisis prevention and management by infection control nurses during the Middle East respiratory coronavirus outbreak in Korea. American Journal of Infection Control. 2016;44(480–1). https://doi.org/10.1016/j.ajic.2015.10.032

[29] A complete list of measures can be found at the Korea Ministry of Health and Welfare, Central Disaster and Safety Countermeasure Headquarters: Current Status of Response to COVID-19 and Future Plans. March 9, 2020.

[30] National Academies of Medicine. Learning from SARS: Preparing for the Next Disease Outbreak. Workshop Summary, 2004. http://www.nap.edu/catalog/10915.html. [cited 20 March 2020].

[31] Gawande, A. Keeping the Coronavirus From Infecting Health-care Workers: What Singapore's and Hong Kong's success is teaching us about the pandemic. The New Yorker. March 21, 2020. https://www.newyorker.com/news/news-desk/keeping-the-coronavirus-from-infecting-health-care-workers. [cited 23 March 2020].

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