



The Challenges of Pregnancy and Childbirth Among Women Who Were Not Infected with Ebola Virus During the 2013–2015 West African Epidemic

Regan H. Marsh, Katherine E. Kralievits,
Gretchen Williams, Mohamed G. Sheku,
Kerry L. Dierberg, Kathryn Barron,
and Paul E. Farmer

3.1 Introduction: The Story of Aminata

Aminata's story is the story of thousands of women who lost their lives during the West African Ebola epidemic that began in 2013. It brings into relief the impact of the Ebola epidemic not on just one woman and her family, but on millions of women and theirs.

In late December 2014, Aminata became one of the many counted (and uncounted) maternal deaths that occurred during the epidemic. She was a 37-year-old mother of two and pregnant for a third time. She had not received antenatal care during this pregnancy, as health services were limited during the peak of the outbreak in Sierra Leone. She went into labor at full-term at home, but recognized, as did

R. H. Marsh · P. E. Farmer
Partners In Health, Boston, MA, USA

Division of Global Health Equity, Brigham and Women's Hospital, Boston, MA, USA
Department of Global Health and Social Medicine, Harvard Medical School, Boston, MA, USA

K. E. Kralievits (✉) · G. Williams
Partners In Health, Boston, MA, USA

Department of Global Health and Social Medicine, Harvard Medical School, Boston, MA, USA
e-mail: katherine_kralievits@hms.harvard.edu

M. G. Sheku
Koidu Government Hospital, Koidu, Sierra Leone

K. L. Dierberg
Partners In Health, Boston, MA, USA

Division of Infectious Diseases and Immunology, New York University, School of Medicine,
New York, NY, USA

K. Barron
Partners In Health, Boston, MA, USA

those attending her, that there was a problem a day later. Her delivery was not progressing in the same way as the previous two pregnancies had.

Her family took her to the local district hospital for care only to find it closed due to active Ebola virus transmission occurring within it. It had been shuttered a week earlier on the advice of the U.S. Centers for Disease Control and Prevention (CDC) and by order of the Sierra Leone Ministry of Health and Sanitation. A local nurse saw her privately. Following this visit, Aminata's family raised money for her to take an hour-long taxi ride to the district's other public hospital, which she reached in the early afternoon with a note from the nurse in hand, documenting a likely obstructed labor.

On arrival, she was met only by a volunteer nurse and cleaner. Three of the hospital's four midwives on staff had been reassigned to work in Ebola treatment units (ETUs), and the fourth was not available in the hospital that afternoon. The hospital's two doctors were also actively engaged in the Ebola response and unavailable. Aminata was brought into the delivery room and laid on the delivery bed; there were no mattresses on the labor ward beds, as they had been burned as an infection-control precaution.

About 10 minutes later, before a midwife could be summoned, Aminata had a seizure, likely due to eclampsia (diagnosis of the syndrome requires evidence of elevated blood pressure and proteinuria, which were not obtained). Aside from Aminata's brother, who had traveled with her, the maternity ward was empty. There was no skilled provider available; no intravenous lines to place; no diazepam or magnesium available to stop her seizure; no oxygen or suction (and in fact, no power at the hospital); no resuscitation equipment; and no surgeon to try to save her or the baby. Still unconscious, Aminata then vomited, aspirated, and died—unattended—of one of the most common causes of maternal mortality.

Aminata did not have Ebola.

With access to routine care, early signs of eclampsia (hypertension and protein in the urine) might have been detected; even if they had not, standard maternity care, basic intravenous medications, oxygen, and access to safe, urgent treatment and delivery might have saved her life. And while eclampsia was the immediate and proximate cause of death—the cause noted in the records and registers—the true root etiology of Aminata's death was that of a dysfunctional and under-resourced health system, stripped even further of resources by the Ebola epidemic.

3.2 Partners In Health

In September 2014, as Ebola virus disease spread rapidly across West Africa, Partners In Health—a nonprofit dedicated to providing quality healthcare to those living in poverty—made a commitment to respond and began working in Liberia and Sierra Leone (Partners In Health 2016a). Founded in 1987, PIH was initially established as a community health project based in a rural squatter settlement in central Haiti. Today, Partners In Health (PIH) works in ten countries: Haiti, Rwanda, Malawi, Lesotho, Mexico, Russia, Peru, the Navajo Nation, Liberia, and Sierra Leone. At the heart of PIH's work is its mission to provide a preferential option for the poor in healthcare by forging long-term relationships with Ministries of Health and local sister organizations that work in solidarity with poor communities. This work is built on a foundation of integrated service delivery, training, and research.

In Haiti, PIH pioneered the use of *accompagnateurs*—community health workers that offer direct medical, social, and economic support to patients—to treat the poorest and hardest to reach patients; this model continues to guide PIH's work at each of its sites. Critically, PIH works within the public sector, working with governments and other local organizations to support and strengthen health systems, making long-term commitments to the communities served. This model has proven that it is possible to prevent and treat complex and difficult illnesses, including

cancer, AIDS, and multidrug-resistant tuberculosis, among impoverished populations. It has also sought to prevent unplanned or undesired pregnancies and to deliver facility-based obstetrics and surgical care. Now with 18,000 staff members (most of them community health workers), PIH programs reflect local needs and seek to strengthen health systems in order to increase their ability to respond effectively to unforeseen problems.

In 2010, PIH was among the organizations that responded to the earthquake in Haiti, which devastated much of the country's medical and other infrastructure. Although not explicitly an emergency-response organization, PIH felt a moral imperative to provide relief in the immediate aftermath, which ended or indelibly impacted the lives of many long-time PIH colleagues and their families, and soon became a leader in the fight against cholera, which began explosively seven months after the quake. PIH operated 11 cholera treatment centers, recruited and trained community health workers, and later provided cholera vaccinations in partnership with the Ministry of Public Health and Population; this work continues today as cholera remains a threat in the wake of Hurricane Matthew and other storms. After the earthquake, the government of Haiti asked PIH to aid in post-disaster reconstruction by building an academic teaching hospital outside of Port-au-Prince. In 2013, PIH opened the 300-bed teaching hospital, Hôpital Universitaire de Mirebalais, in Haiti's Central Plateau. In partnership with the Government of Rwanda, PIH has also undertaken significant projects in that country, including the opening of Butaro Hospital in 2011, the Butaro Cancer Center of Excellence (the first of its kind in rural Africa) in 2013, and most recently and at the same site, the University of Global Health Equity in 2015. Amid this work in Haiti, Rwanda, and elsewhere—and with equity in mind—PIH and its partners undertook similar, long-term endeavors in one of the great clinical deserts of the twenty-first century, Upper West Africa.

3.3 The Ebola Epidemic and the Partners In Health Response

Eight months after Ebola virus disease was retrospectively alleged to have claimed the life of a toddler in eastern Guinea—"Patient Zero" of the 2013–2015 outbreak—the World Health Organization (WHO) declared the Ebola outbreak a "public health emergency of international concern" (World Health Organization 2014). The already beleaguered—and, in many cases, nearly nonexistent—health systems in these countries were no match for the disease, which targeted caregivers (healthcare professionals, family members, and traditional healers) and required diagnostic, preventive, and supportive therapeutic capabilities not readily available in these settings.

Earlier, in March 2014, the WHO announced that the previously unidentified febrile illness that had been causing deaths in Guinea—and across its borders—was in fact Ebola virus disease (EVD). Within a week and a half of this diagnosis, Médecins Sans Frontières (MSF) opened and staffed Ebola isolation wards in three locations in Guinea, where it had already been working. The organization expressed serious concerns about the continued escalation of the epidemic, which was spreading undiagnosed in multiple regions, including within Sierra Leone and Liberia. On June 21st, MSF announced the epidemic to be "out of control," which stood in contrast to earlier assessments by other responders and global institutions that the epidemic was waning (Sack et al. 2014).

By August 6th, when the WHO did declare the epidemic as a public-health emergency, the disease had already severely disrupted healthcare delivery, caused widespread panic across West Africa, and taken 936 lives, although this likely underrepresented the true burden of disease due to underreporting (Garrett 2015; WHO 2014). In September, the region experienced the epidemic's peak incidence, with significant variations between the three countries (WHO Ebola Response Team 2015). That same month, as the United Nations Security Council and the CDC issued dire warnings regarding the scope and potential trajectory of the disease, members of the United States and British militaries were

deployed to West Africa (Garrett 2015). The UN Mission for Ebola Emergency Response was also established, with the aim of coordinating efforts across the region (United Nations 2016).

Among the quickest to respond to the outbreak—beyond the West African healthcare providers that were on the frontlines from the beginning—were large nongovernmental organizations (NGOs), which primarily relied on the deployment of expatriate clinicians and other responders. Such organizations included MSF, the International Federation of the Red Cross and Red Crescent Societies, International Medical Corps, and GOAL. These organizations faced some level of distrust in the local communities, which were skeptical of the motivations of the governments and outside responders and as an epidemic of fear gripped the region and others largely untouched by the Ebola outbreak itself (Sack et al. 2014). Those working to stem the epidemic faced immense challenges amid weak existing health systems, poor coordination among responding bodies, inadequate and slow responses from the global community, and insufficient resources to address the spread of the disease and save lives. MSF reports caring for 35% of all confirmed Ebola cases in the region; their six-pronged approach included caring for the sick, providing training for and conducting safe burials, raising awareness about how Ebola is spread, disease surveillance, contact tracing, and providing some healthcare services separate from efforts to curb Ebola (Médecins Sans Frontières 2017).

In September 2014, as the disease incidence mounted in Sierra Leone and plateaued in Liberia, PIH began working with these countries' Ministries of Health and local partners (most notably, Wellbody Alliance in Sierra Leone and Last Mile Health in Liberia). By then, most recognized the profound impact of weak health systems on disease surveillance and the quality of clinical services for those with Ebola. Patients needing routine care were, however, often forgotten amid the crisis.

For those working in Haiti, Rwanda, and many other settings, the framing of this epidemic as an “acute-on-chronic” process that overwhelmed already weak health systems was a familiar dynamic. PIH's early response focused on stemming the acute epidemic by treating cases, employing active case finding, and operating Ebola treatment units in partnership with district and national systems, while also delivering healthcare services for illnesses and conditions other than Ebola. PIH deployed nearly 200 expatriate clinicians, logisticians, and support staff to operate these units, while also recruiting and training 2,000 local people as community health workers, drivers, data collectors, clinical aides, and sundry other jobs (Partners In Health 2016a). Working closely with the Ministry of Health and Social Welfare in Liberia, PIH targeted its response in the southeast, including Maryland County, a 20-hour drive from the capital city of Monrovia. There, PIH supported care in two Ebola treatment units (ETUs) and three community care centers—clinics designated for suspected cases of Ebola with confirmed cases transferred to ETUs, when possible. Even before the onset of the epidemic, the region's foremost problem was already the collapse of primary care and delivery of care to the critically ill and injured, impacting the ability to respond to this crisis.

At the request of the Ministry of Health and Sanitation in Sierra Leone, PIH focused its efforts in three districts: Freetown (the capital city), Port Loko (about two hours outside the capital), and Kono (in the eastern part of the country). In Freetown, we worked at the Princess Christian Maternity Hospital (PCMH), the country's only referral hospital for pregnant women facing serious complications. In collaboration with PCMH, our team established formal Ebola screening for all patients and visitors entering the hospital, and an Ebola triage and isolation unit, where women with symptoms of Ebola could receive diagnostic testing and care. From December 2014 to December 2015, over 42,000 women were screened for symptoms of Ebola; 610 met case definitions for isolation and 29 tested positive for Ebola (Garde et al. 2016).

In Port Loko, PIH helped to operate and staff the Port Loko Government Hospital (PLGH), Maforki Ebola Treatment Unit, and seven other community care centers (CCCs). In many cases, responders relied on temporary, makeshift isolation centers to manage the overwhelming caseload. PLGH itself was filled with Ebola patients (and corpses) upon our arrival. Given the overwhelming need and to

support government efforts, PIH partnered with the District Health Management Team, which was utilizing an abandoned vocational school as an ETU at Maforki; construction of a new purpose-built unit would have taken too long to complete. Upon initiation of our clinical and logistical support, the Maforki ETU was the only Ebola care unit operational in the district—an Ebola hotspot which would go on to manage 1,884 admitted patients in the ETU and have 978 cases in the district—and was operating at 100% capacity with extremely limited government resources. In Kono District, PIH supported operations and clinical care at Koidu Government Hospital (KGH), Wellbody Clinic, and four CCCs. At both district hospitals (PLGH and KGH), our teams worked to establish screening and triage procedures, as well as to provide direct clinical services to care for the thousands of patients needing usual services and to restore community trust in the public hospitals. By January 2015, PIH supported a total of 21 health facilities across Liberia and Sierra Leone (Partners In Health 2016a). Community health workers, many of whom were Ebola survivors, were instrumental to these efforts, as they helped to identify cases and connect the sick to healthcare while dispelling stigma surrounding Ebola survivorship. Responders to the epidemic, including local healthcare workers, faced a paucity of the staff, staff, space, and systems essential to strong health systems. Compounded by the Ebola emergency, which demanded and diverted the scant resources available, pregnant women had limited access to essential care, causing an escalation of otherwise preventable maternal deaths.

In January 2016, the WHO declared that all known chains of transmission of Ebola in West Africa had been halted, although sporadic cases continued in Guinea and Liberia until April 2016. Finally, the WHO announced the end of transmission in those locations in June 2016 (U.S. Centers for Disease Control and Prevention 2016; WHO 2016a). There were more cases and deaths during this epidemic than in all previous Ebola virus outbreaks combined (WHO 2016b). While likely an underestimate due to weaknesses in surveillance and reporting—and the presence of minimally symptomatic cases of infection—there had been 28,616 recorded cases of and 11,310 deaths from Ebola reported across Guinea, Sierra Leone, and Liberia. There were a further 36 locally acquired or imported cases and 15 deaths in seven countries: Nigeria, Senegal, Spain, United States, Mali, United Kingdom, and Italy (WHO 2016b).

Multiple studies conducted during the course of the epidemic indicated that, despite the complex challenges presented by the spread of the disease in urban areas, Ebola epidemics are preventable, provided there is an immediate response aimed at interrupting transmission and limiting spread, including active case finding and rapid diagnosis, as well as prompt hospitalization with adequate care (WHO Ebola Response Team 2015). However, while international emergency responses to infectious or natural disasters typically prioritize rapid mobilization and relief, they are rarely linked to long-term strategies for disease surveillance and control, which are essential in strengthening health systems and preventing future outbreaks. They are even more rarely linked to the provision of quality clinical care, further compounding distrust of health services and of disease-control efforts.

This epidemic was characterized by the collision of a highly contagious virus with weak health systems—overwhelmed and unable to adequately respond—and a sluggish international response. The unprecedented spread of Ebola in Upper West Africa was itself a symptom of such dysfunction. This epidemic also highlighted the many ways that Ebola differentially affects women, given their roles as caregivers in the health system and at home; indeed, women accounted for 75% of the deaths early in the epidemic prior to implementation of public-health measures, and 51% of laboratory-confirmed cases overall (Luginaah et al. 2016, WHO 2016c). This gender divide has been mirrored in previous outbreaks of the disease in Uganda and Sudan (Hogan 2014).

However, the second story—often less reported—is the impact of the epidemic on women who did not have Ebola; women like Aminata, who needed access to both routine and emergency care, but could not access these services because of the devastation to an already weak health sector as a secondary result of the epidemic.

3.4 The Health System in West Africa Prior to Ebola

The healthcare systems in Sierra Leone, Liberia, and Guinea were weak, allowing Ebola to explode rapidly across the region in 2014. The social, economic, and political history of West Africa is complex (and outside the scope of this chapter), including centuries of exploitation of resources (both human and physical), colonialism, and more recently civil war. The civil wars in Liberia (1989–2003) and Sierra Leone (1991–2002) were characterized by brutal violence, weakening of the government, and destruction of infrastructure and systems. While relatively more stable, Guinea has faced coups and intermittent military rule. Left in the wake of these disruptions were some of the weakest healthcare systems in the world. During the Ebola emergency, these underfunded and understaffed health systems were challenged—and often unable—to maintain routine health services, especially for children and pregnant women, even those not infected with the disease.

Maternal mortality is often used as a metric to evaluate the overall state of a health system. Sierra Leone had one of the highest maternal mortality ratios (MMRs) in the world prior to the Ebola epidemic, with an adjusted maternal mortality ratio of 1,100 maternal deaths per 100,000 live births and lifetime risk of maternal death for all women of childbearing age of 1 in 21 (WHO 2016b). Guinea had shown a great improvement in maternal mortality, reducing their maternal mortality from 1,040 maternal deaths per 100,000 live births in 1990 to 679 maternal deaths per 100,000 live births in 2015, but still representing stark excess mortality. For reference, the maternal mortality ratio in the United States was 23.8 maternal deaths per 100,000 live births in 2013, which is more than triple the rate of Canada—sparking a recent outcry in the public-health news (Tavernise 2016). As evidenced, the majority of maternal deaths worldwide occur in low-resource settings, like Sierra Leone, Liberia, and Guinea, and most of them can be readily prevented.

In an effort to reverse the trend of high maternal mortality, in 2010, the government of Sierra Leone launched the ambitious “Free Healthcare Initiative,” which offers free health services in public facilities to pregnant women, lactating mothers, and children under five years old, as well to those needing HIV/AIDS and tuberculosis care. In theoretically eliminating the cost barrier for services, the government of Sierra Leone saw a doubling in utilization of services upon implementation of this program. However, there still remained several barriers to the program’s objectives, including an insufficient healthcare workforce and infrastructure in place for women and children to receive care, and patients still having to pay despite the promise of “free” care (Pieterse and Lodge 2015). At the same time, other barriers remained unaddressed, including distance to facilities and limited options for transport (Sharkey et al. 2016).

As in Sierra Leone, Liberia had made improving maternal health a national priority after the civil war, before Ebola reached the country. In 2007, the Liberian government launched the “Emergency Human Resources Plan” to rebuild the healthcare workforce after its civil war ended. As a result, the number of working nurses doubled, and the country saw a substantial increase in facility-based deliveries, from 38% to 56% between 2007 and 2013. And, although still one of the highest in the world, maternal mortality had improved from 1,200 maternal deaths per 100,000 live births to 640 maternal deaths per 100,000 live births from 1990 to 2013 (Ly et al. 2016).

Even further, in 2013, and just before the Ebola outbreak, Liberia initiated the “Accelerated Action Plan to Reduce Maternal and Newborn Mortality.” This plan aimed to further invest in a robust health workforce by training skilled birth attendants (SBAs); increasing coverage of and access to emergency obstetric care (EmOC) and essential maternal and newborn healthcare; increasing access to and utilization of family planning services; expanding and strengthening outreach and community-based services; and improving management of maternal and newborn health services. The country saw progress with this plan—in 2013, the Liberia Demographic and Health Survey reported that 96% of women received at least one antenatal care visit, and 61% gave birth with a skilled provider, with almost all of these

encounters taking place in health facilities (Liberia Institute of Statistics and Geo-Information Services (LISGIS) et al. 2014). However, across Liberia, an overall disparity remained in the availability of care for those outside of Monrovia: 84% of poor women and 53% of rural residents reported little access to maternal health services (Luginaah et al. 2016). Similar trends were seen in Sierra Leone and Guinea.

Despite these ambitious national health initiatives, a variety of factors contributed to the frailty of the health system. The number of healthcare workers—defined as doctors, nurses, and midwives—available per population is a valuable metric to assess the strength (or weakness) of a health system. Prior to the Ebola epidemic, Guinea had only one health worker per 1,597 people, Liberia had one for every 3,472 people, and Sierra Leone had one per 5,319 people. This pales in comparison to the WHO's standard of one healthcare worker per 439 people (WHO 2016d). The statistics were even worse for specialist providers—in 2008, there were only 10 surgeons operating in government-run hospitals in Sierra Leone, and only seven obstetrician-gynecologists to serve the entire nation of six million people; in 2015, there were only three anesthesiologists nationwide (Ribacke et al. 2016). Data from Liberia, compiled just before the outbreak, revealed that there were only 51 doctors working in the entire country (WHO 2016d). Moreover, in all three nations, the healthcare workforce was unevenly distributed across the country, with the majority working in urban centers, inaccessible to the rural majority.

Of critical importance to pregnant women (who require Caesarean section in up to 10% of deliveries) and therefore maternal mortality, access to surgical care is another metric to evaluate the strength of a healthcare system. In a paper published prior to the Ebola epidemic, a Sierra Leonean surgeon, Dr. T.B. Kamara, revealed: “*Government hospitals in present day Sierra Leone lack the infrastructure, personnel, supplies, and equipment to adequately provide emergency and essential surgical care. In a comparison of present day Sierra Leonean and US Civil War hospitals, the US Civil War facilities are equivalent and in many ways superior*” (Crompton et al. 2010). This comparison illustrates the overall destitution of healthcare facilities in the country and the impact on its ability to deliver adequate health services. Beyond the limited number of trained surgeons to perform routine and emergency procedures, stockouts of essential surgical supplies, including sterile tools, suture kits, and oxygen, were commonly reported (Barden-O’Fallon et al. 2015). As expected, the Caesarean section rate in this region is low—in Sierra Leone, between 2.3 and 4.5% of all births are performed by Caesarean section. This is far below the WHO standard that a minimum of 10% of deliveries will require a Caesarean section (WHO 2017a). Further, with only 50% of deliveries occurring in a health facility, many women rely on traditional birth attendants (TBAs) or family members to assist in delivery, without any access to emergency obstetric and neonatal care (EmONC) (Ribacke et al. 2016). Even without an outbreak of epidemic disease, safe surgery, along with basic medical care, simply cannot be delivered where there is limited health infrastructure or a weak supply chain to procure and deliver medications, supplies, and necessary equipment.

The previously mentioned “symptoms” of a weak health system are in part due to a lack of adequate government funding for health services. The International Monetary Fund (IMF) recommends that governments spend a minimum \$86 USD per capita per year for basic health services. Prior to the Ebola epidemic, the three most affected countries spent far less on healthcare: \$9 USD in Guinea, \$20 USD in Liberia, and \$16 USD in Sierra Leone—shockingly representing a drastic increase from a decade earlier. Decades-old structural adjustment policies from the World Bank and IMF contributed to underinvestment in health and education. Through privatization of public goods, tax exemptions, and incentives given to private companies, NGOs, and embassies, it has been estimated that in Sierra Leone alone, the country lost approximately \$200 million USD annually in revenue from 2010 to 2012 (Save the Children 2015). In the same period, the country invested only \$20 million USD in the health sector annually (O’Hare 2015). This lack of capital and steady monetary support to establish and develop a functioning health system in these three countries contributed to the environment that allowed Ebola to explode rapidly across the region.

3.5 The Impact of Ebola on Health Systems

In any setting, the building blocks of a health system consist of the same essential components: staff, stuff, space, and systems. Each of these is essential to the provision of quality care, and without any one component, the health system—and the patients it serves—is vulnerable. In Upper West Africa, as described above, the three countries of Sierra Leone, Guinea, and Liberia had some of the weakest health systems in the world. And, in the words of the Medical Director of Koidu Government Hospital located in Kono District, “*the Ebola epidemic brought the health system in Sierra Leone to its knees*” (Marsh 2015).

In devastating fashion, the impact of the Ebola epidemic on the health system had its most significant impacts on those members of society who were the most vulnerable: women and children, people living with HIV and tuberculosis, and people with mental and physical disabilities. The impact on pregnant women—even those who did not have Ebola, like Aminata—was particularly profound (Strong and Schwartz 2016). In sub-Saharan Africa, nearly three quarters of maternal mortality is due to direct obstetric causes, such as prolonged and obstructed labor, hemorrhage, eclampsia and other hypertensive diseases, complications of abortion, and sepsis—conditions that can be averted with proper provision of emergency obstetric and neonatal care (O’Hare 2015).

Basic emergency obstetric and neonatal care is defined as seven essential “signal functions” that treat these major causes of maternal mortality: antibiotics to prevent puerperal infection; anticonvulsants for treatment of preeclampsia and eclampsia; oxytocics to reduce postpartum hemorrhage; manual removal of placenta; assisted or instrumented vaginal delivery; removal of retained products of conception; and neonatal resuscitation (UNFPA 2014). Basic EmONC should be provided at the health center level. Comprehensive EmONC is the addition of surgical delivery by Caesarean section, blood transfusion, and advanced neonatal resuscitation—usually available at the hospital level. To reduce maternal mortality, health centers and hospitals should be staffed, equipped, and organized to provide this care.

3.5.1 Staff

The Ebola epidemic had a devastating impact on the healthcare workforce across the region. The first of the three losses of staff that directly impacted maternal healthcare services was death of health workers. Ebola is a caregiver’s disease. While the majority of deaths occurred among families who cared for their sick loved ones and buried their dead, physicians and nurses—professional caregivers—were gravely affected. At the peak of the epidemic in Sierra Leone in 2014, the incidence of Ebola among healthcare workers was 103-fold higher than that of the general population, peaking in August 2014 (Kilmarx et al. 2014). Overall, healthcare workers were 21–32 times more likely to be infected than the general population across the three countries (Elston et al. 2017). Over the course of the Ebola epidemic, 881 confirmed infections and 513 deaths were reported among healthcare workers in total in the three countries—a particularly striking number when compared against the paucity of healthcare workers at the start of epidemic (WHO 2015a). As of late May 2015, Guinea, Liberia, and Sierra Leone, respectively, had lost 78, 83, and 79 doctors, nurses, and midwives to Ebola, which translates to 1.5%, 8.1%, and 6.9%, respectively, of the healthcare workforce that died (Evans et al. 2015). Tragically, prior to the outbreak, Liberia had only 12.8 physicians, midwives, and nurses per 10,000 people (far below the WHO benchmark of 23 per 10,000) and reported 175 healthcare worker deaths by the end of 2015 (Iyengar et al. 2015). To reach the minimum 80% health coverage targeted by the Millennium Development Goals (MDGs), 43,565 doctors, nurses, and midwives would need to be hired across the three countries—a likely impossible feat, but one that demonstrates the sheer magnitude of the fragility of the health system.

Another significant loss to the healthcare workforce was as a result of diversion into the Ebola response. Physicians, nurses, and midwives who would normally provide maternal health services were recruited to oversee operations and provide clinical service delivery in response to the outbreak. This happened as part of the national Ministries of Health strategy, as the health leadership of each country redirected its public employees to staff its public Ebola centers, but also occurred in an unplanned fashion, as NGOs responding to the epidemic hired trained workers to staff their facilities (Elston et al. 2017). While many NGOs tried to minimize hiring staff who were already employed in the public sector, given the profound lack of human resources, it was often unavoidable and ability to verify other employment was difficult. This meant that the few healthcare staff available were drawn out of public facilities into (higher-paying) jobs as part of the Ebola response. As a result, routine antenatal, delivery, and emergency obstetric care were reduced, as fewer doctors, surgeons, nurses, and trained birth attendants were available to provide care. For Aminata, three of the four midwives at the government hospital were engaged in the Ebola response, leaving her unattended when she presented for care.

Finally, though not as prominent as the previous two, another loss to the healthcare workforce was from fear of infection and subsequent “flight” from the health system. Healthcare workers reportedly abandoned posts for fear of infection or the stigma attached to caring for infected patients. This effect was particularly severe in maternity wards—as delivery is notable for significant loss of blood and other potentially Ebola-infected bodily fluids—exacerbating both risk and fear. This loss led to the abandonment of patients on wards by both family members and healthcare providers. Similarly, there were reports of staff refusing to care for patients, which unfortunately and disproportionately affected laboring women, for whom the risk to staff was perceived to be higher (Elston et al. 2017). Even where deliveries were still being performed, *“The few staff were demoralized and people lost faith in the healthcare system”* (Sheku 2018).

Sadly, as noted, there was a profoundly negative outcome of these staffing losses: *“In the context of the Ebola epidemic, the absence of healthcare providers offering relevant services, the inability to differentiate between Ebola and other febrile diseases at onset, and the fear of contracting Ebola at a health facility can also prevent pregnant women from seeking reproductive health services”* (Davtyan et al. 2014; Menendez et al. 2015; Walker et al. 2015).

3.5.2 Staff

An efficient health system simply cannot function without adequate supplies—or “stuff”—including medications, consumable items, biomedical equipment, and laboratory necessities. Similar to the human resources, the supply chain was diverted into the Ebola response. This shift meant stockouts of essential drugs, such as antimalarial medications and antiretroviral treatment, and of supplies, including gloves, gowns, soap, and chlorine, as well as vehicles and the fuel required for these vehicles and generators. This diversion of supplies into the response resulted in an inability to continue routine services, which were already limited and insufficient prior to the beginning of the Ebola epidemic.

In Sierra Leone, public hospitals are provided quarterly distributions of medications and supplies from a national centralized supply. Many facilities reported baseline stockouts of essential medications prior to the epidemic (Barden-O’Fallon et al. 2015). While there is a possibility to purchase supplies from the private sector, hospitals have limited budgets with which to do so and, therefore, limited ability to manage stockouts locally. Additionally, inventory systems are both limited technologically and understaffed. When emergency supplies were delivered to hospitals, they were often limited in their ability to receive, inventory, and then dispense these items.

One of our colleagues in Liberia offered the following example during the peak of the epidemic: “*In one health center in Liberia, nurses complained of shortages of all drugs, except oral rehydration salts, for many months preceding the Ebola crisis.*” These stockouts persisted during the epidemic. In neighboring Sierra Leone, prior to the Ebola outbreak, a 170-bed capacity hospital, serving a catchment area of over 500,000 people, never had a connected X-ray machine and had just two doctors on staff.

Also with respect to access to EmONC, there remained a notable lack of oxygen and blood. Essential for maternal and neonatal resuscitation, oxygen can be delivered via oxygen cylinders or bedside concentrators. Oxygen cylinders must be filled at a central source; in Sierra Leone, there was only one oxygen plant in the public sector, at the teaching hospital in Freetown, which was unable to supply the country. Smaller bedside oxygen concentrators—while more available—require electricity, a variable resource from expensive fuel-dependent generators and limited national grids.

Access to safe transfusion is essential for EmONC, as hemorrhage is one of the leading causes of maternal mortality. While still extremely limited, all three countries had made significant progress in improving their blood supplies prior to the Ebola epidemic. However, this access plummeted during the epidemic. In Sierra Leone, voluntary donation was suspended, limiting the supply. In Guinea, the Director of the National Blood Service noted a drop in voluntary donations, citing fear of Ebola dissuading potential donors; and in Liberia, the Assistant Minister of Health stated that “*the blood service completely ceased up [sic]*” during the epidemic. Regulatory oversight dropped in all three countries (WHO 2017b). In many cases, family members were asked to donate for emergency cases or recruit other donors, increasing the risk for infection transmission and coercion (Raykar et al. 2015). Overall, blood became less available—or at least less readily available—in emergency cases, reducing EmONC and increasing risk of death for women with obstetric complications.

3.5.3 Space

Decades of poverty, structural adjustment policies that disincentivized investment in public infrastructure, followed by a decade of civil war in Sierra Leone and Liberia left the health infrastructure among the worst in the world. Road networks, telecommunications, hospitals, and laboratory systems were weak to nonexistent, particularly in rural areas. These gaps contributed to delays in recognition of the epidemic initially and then to delays in management and treatment (WHO 2015b).

At the request of the respective ministries of health, PIH worked to support public hospitals in two rural districts in Sierra Leone and in southeastern Liberia. At each facility, our experience was similar: power was available only intermittently; piped water was rare and none was potable; and general infrastructure (including roofs, windows, doors) had not been updated significantly in decades. No hospital had a functional X-ray machine, and laboratory capacity was minimal. Compounded by concern about nosocomial Ebola transmission, communities generally feared the hospitals. Unsurprisingly, these facilities were minimally prepared to perform the essentials of disease surveillance or control the spread of the epidemic.

Worsening the baseline limitations in infrastructure, hospital and health center closures due to hospital-based transmission of Ebola, and infectious risk further undermined access for women to preventative and therapeutic treatment, including family planning, antenatal, and delivery needs (Ly et al. 2016). Due to essentially nonexistent infrastructure for isolation at the start of the outbreak, even those hospitals that remained open were forced to convert functional wards into quarantine spaces—limiting access to care and heightening concern within the community. The situation was likely the worst in Liberia, where the WHO reported that two thirds of health services ceased functioning by August 2014 and that 62% of health facilities closed by September 2014. Additionally, the three largest hospitals in Monrovia—the site for the majority of clinical teaching and referral care—were all closed (Iyengar et al. 2015).

3.5.4 Systems

Delivery of quality healthcare relies on innumerable systems, including communications, WASH (water, sanitation, and hygiene), supply chain, triage, referral, financing, and many others. With the dramatic diversion of human, financial, and supply resources into the Ebola response, those (already weak) systems that were designed to care for pregnant women and their children were undermined by this further loss of inputs.

3.5.5 Referral Systems and Ambulances

Even before the epidemic, referral systems and ambulances for pregnant women were limited. In the hypothetical design of the health system, pregnant women would present to health centers for delivery; in cases of emergency, they would be transported to district hospitals for blood transfusion or surgical delivery—the two defining features of comprehensive EmONC. With the onset of the Ebola outbreak, referral became even more difficult. The few ambulances and other vehicles in the ministries of health's fleets were diverted into the response. Women with hemorrhage, eclampsia, or obstructed labor (like Aminata) had few options to access the care they needed. Families were often left to raise funds to pay for private transportation.

3.5.6 Travel and Movement Restrictions

Further challenging access to EmONC were Ebola-related travel restrictions. Travel between districts on major roads was often limited to daytime only and for those carrying special passes allowing travel. Between villages, movement was also often restricted, and community members were encouraged to report any unknown people for fear of disease. These restrictions—while important for EVD control—impacted access to non-Ebola care, particularly for women with complications of delivery, who needed care at Basic EmONC-capacitated health centers or at hospitals (for Caesarean section and blood transfusion).

3.5.7 Communication and Messaging

The nature of the Ebola epidemic demanded widespread communications systems to ensure public safety; this was especially the case due to the infection's rapid transmission across national borders involving multiple countries, as well as the occurrence of widespread infections not only in rural areas but also, for the first time, in large cities. However, it was often difficult to ensure messages were reaching the communities most in need. While ubiquitous, radio messaging is often expensive. Additionally, phone and the emergency call numbers were limited by the existing communications infrastructure in Upper West Africa. Initial communication around the Ebola outbreak further undermined communities' trust in government and public facilities. While early posters and billboards emphasized "ABC" (Avoid Bodily Contact) messaging, many focused on less common forms of EVD transmission (i.e., by the consumption of bushmeat and wild animals). With emphasis there (and not on infection prevention), these messages missed the opportunity to prevent infections among caregivers, and therefore, may have contributed to the early facility-based transmission of Ebola virus disease—ultimately resulting in significant fear of hospitals, deterring necessary women's healthcare. Further, much of the messaging around caring for people at home who were sick, as well as methods for burying the dead, were not matched with the enabling systems to do so. Families were left to manage the ill and deceased through usual means, further increasing risk.

3.5.8 Cost

Prior to 2013, in an effort to reduce their high maternal and neonatal mortalities, Sierra Leone and Liberia both implemented programs to eliminate user-fees and costs for pregnant women. The 2010 Free Healthcare Initiative (FHCI) in Sierra Leone made it illegal to charge fees for services for pregnant and lactating women. There were many successes of the FHCI, including significantly increased facility-based deliveries. However, even before the Ebola-related shortages, many facilities were routinely stocked out of essential free supplies provided by the government, and then charged women to purchase medications and necessary consumables (Pieterse and Lodge 2015). In a country where more than 60% of the population lives in absolute poverty (<\$1.25/day), these costs created a real barrier to care (UNDP 2017). At PIH, we heard these concerns from patients. One woman said: *“I might be given a receipt to go the drug store, but I cannot afford these medicines. We are told medicines should be available, but they are not”* (personal communications with community members in Sierra Leone and Liberia, 2015).

3.5.9 Ebola Screening

The system for Ebola screening itself—while essential to the epidemic response—undermined critical maternity care for pregnant women who did not have Ebola. Ebola virus disease during pregnancy is associated with extremely high maternal mortality and nearly uniform fetal demise. Miscarriage and hemorrhage are common. Particularly early in the epidemic, treatment of Ebola in pregnancy was largely considered futile and high risk (Médecins Sans Frontières 2017). The WHO/CDC case definition (and therefore screening criteria) for Ebola virus disease included both (1) fever with any bleeding and (2) fever associated with any three other symptoms, including vomiting, diarrhea, abdominal pain, malaise, fatigue, anorexia, headache, muscle and joint pain, and respiratory difficulty. Many women with known and routine complications of pregnancy such as ante- or postpartum hemorrhage, miscarriage, eclampsia, or chorioamnionitis met these screening criteria, but did not have Ebola infections. When arriving at health facilities, they were therefore isolated for EVD polymerase chain reaction (PCR) confirmatory testing. Patients were required to have symptoms for at least 72 hours to ensure necessary sensitivity, and laboratory testing itself took a minimum of a day to receive results (and longer at the beginning of epidemic).

As such, many women with treatable obstetric conditions were held for several days in Ebola isolation units, where minimal care was available for the true etiology of their symptoms. Access to blood transfusion was rare and surgical delivery nonexistent. One study estimated that even at the peak of the epidemic, as many as 98.5% of women admitted to isolation would likely test negative for EVD, based on prevalence of EVD relative to the prevalence of other obstetric conditions, which would also meet this case definition. In this setting, in which treatment was largely withheld due to perceptions of futility and risk, these non-EVD-infected women—in a region with some of the highest maternal mortality rates in the world—were offered limited care for the true cause of their (often very treatable) presentations. While the policy of delaying obstetric interventions until Ebola was excluded was well-intentioned, it likely led to the death of many women without EVD (Deaver and Cohen 2015).

Additionally, in many hospitals, it was often the (formal or informal) policy that women who needed surgical delivery—even those who were well and did not meet the screening criteria for Ebola case definition—were required to have a negative EVD PCR test prior to Caesarean section, leading to delays in care for mother and neonate.

During the epidemic, these various systems—finance, communication, referral/transportation, and Ebola screening (among others)—left gaps in the ability of health systems to provide care for pregnant women, likely contributing to rise in maternal mortality and decline in routine services delivered during the epidemic (VSO 2015).

3.6 Impact of the Ebola Epidemic on Women Without Ebola Infection

3.6.1 The Story of Fatmata

Fatmata was fortunate. Born in Sierra Leone, she had a university education and a steady job at a bank in Freetown. Her husband worked as the executive director of a Sierra Leonean healthcare nonprofit and earned a respectable salary. It was early 2014; Fatmata was 22 years old and expecting her first child.

Concurrently, the Ebola epidemic was starting its spread across West Africa. As Fatmata's pregnancy progressed, the private clinics in Freetown where she was planning to seek care started to close—she was unable to receive any antenatal care. She and her husband became increasingly concerned about where she would go for a safe delivery once she went into labor.

As she reached full term, Fatmata's husband made increasingly worried calls to his various clinical colleagues, who were eventually able to secure her access to a free clinic in Freetown—one that usually provided care only to the poorest of women. Although her and her husband's economic status essentially disqualified them from receiving care there, she was promised admission once she went into labor.

However, in early August 2014, when she went into labor, Fatmata and her husband went to the clinic only to find “almost no staff there.” They learned that there had been an Ebola case in the clinic, and fear of infection spread rapidly among the staff: many doctors and midwives were too afraid to come to the clinic to provide care for the patients. With persistence, eventually Fatmata was screened for Ebola and, since she did not meet case definition, she was allowed access into the clinic. Her husband and their family were asked—or forced—to remain outside and waited across the street. Her husband continually called his colleagues, who called the staff at the clinic for updates on Fatmata's progress. No one knew if a midwife or physician came to take care of her, while she labored inside. For a first pregnancy, it was a difficult and long delivery, and eventually she was delivered by one of the few nurses working at the time.

At 5 a.m., Fatmata was finally able to call her anxious family who had been waiting 24 hours to hear from her. After a long night, and without an intravenous line or any medications, she had successfully delivered a healthy baby girl. The nurse then spoke to her husband and asked him to come inside to take her home, as there were “no staff to take care of her.” Inside the clinic, other women were laboring—and delivering—largely unattended. Having fortunately had an uncomplicated labor without the need for emergency obstetric care, and having the significant personal resources necessary to find even this basic care, Fatmata, her husband, and their new baby girl went home together, leaving the other women behind.

3.7 Impact on Maternal Health Services

A side effect of the Ebola epidemic itself, these profound disruptions to healthcare provision—including the staff, staff, space, and systems—impacted women without Ebola (like Aminata and Fatmata) and their ability to access both routine preventative care and emergency treatment. This

was exacerbated by fear and stigma, which further undermined relationships between communities and health facilities. As a result, there was a significant drop in attendance at facilities, and it is widely presumed that these women went unattended (Elston et al. 2017).

3.7.1 Maternal Mortality

Estimates suggest that during the peak of the epidemic, maternal mortality increased by as much as 38%, 74%, and 111% in Guinea, Sierra Leone, and Liberia, respectively. With a maternal mortality rate (MMR) of 1,100 deaths per 100,000 live births prior to the epidemic, Sierra Leone's maternal mortality reached 1,916 deaths per 100,000 live births, levels not seen since the civil war and erasing the progress that had been made since that time (Evans et al. 2015). Over the entire duration of the epidemic, it is estimated the Sierra Leone's maternal and neonatal mortality rates increased by 30% and 24%, respectively (VSO 2015).

3.7.2 Facility-Based Deliveries

Facility-based deliveries declined by 20–23% in Sierra Leone during the epidemic; with reductions of 40–50% reported in the most heavily affected regions during the peak of the epidemic (Ribacke et al. 2016).

Evidence is similar in Liberia. In one study of two Liberian counties from March 2014 (first case reported in Liberia) to December 2014 (worst month), total health facility deliveries dropped to less than 33% compared to March 2014 (Iyengar et al. 2015). In a different study in Liberia, Lori and colleagues also found that facility-based deliveries and use of maternity waiting homes dropped by 77% (from 500 to 113 deliveries per month) during the peak of the Ebola epidemic in a high-burden county (Lori et al. 2015).

Even in an area of rural southeast Liberia, where there were very few Ebola cases detected, there was a 30% decrease in odds of a facility-based delivery. Likelihood of facility-based delivery was associated with belief in the safety of health facilities: the odds of facility-based delivery were 41% lower in women who believed that facilities were a site of Ebola virus disease transmission versus those who did not share this belief (Ly et al. 2016).

There was a similar impact in Guinea, where prior to the epidemic, only 41% of deliveries were facility-based (Barden-O'Fallon et al. 2015). At the Matam maternity hospital in Conakry, there was a dramatic drop in utilization from 904 to 123 patients per quarter from July to September 2014 (Delamou et al. 2014). In Conakry and N'Zerekore overall, the number of women giving birth in a facility with a skilled birth attendant fell by 87% (Barden-O'Fallon et al. 2015).

Across all three countries, changes in facility-based deliveries were more notable at the hospital level when compared to health centers, suggesting that hospital services suffered more from Ebola-related stigma than did services at health centers (Barden-O'Fallon et al. 2015).

3.7.3 Surgical Delivery

Maternal and neonatal mortality increase when Caesarean sections rates fall below 10% (WHO 2017a). It has been noted that the rate of Caesarean sections remained approximately the same before and after the Ebola outbreak; however, the number of noninfected women seeking care at a health facility was dramatically lower. A similar reduction was seen in the private sector; Médecins Sans

Frontières performed fewer Caesarean section procedures during the Ebola outbreak and closed their large referral center in the southern province of Sierra Leone.

As mentioned above, the Caesarean section rate in Sierra Leone had increased steadily prior to 2013, likely due to the impact of the national Free Healthcare Initiative, but remained far below WHO recommendations. An analysis of all 61 public and private facilities that offered surgical care in Sierra Leone found a 20% decrease in Caesarean sections during the epidemic, reversing the gains of the previous decade (Ribacke et al. 2016). In 2014, only 5,025 Caesarean sections were reported in Sierra Leone, leaving as many as 17,000 women with an unmet need for surgical delivery (Elston et al. 2017).

In Guinea, national Caesarean section rates fell by 16% during the epidemic when compared to the previous year; in EVD-affected prefectures, the rates fell by as much as 90% during the peak of the epidemic (Elston et al. 2017). Ebola virus disease-affected districts in Sierra Leone also experienced similarly striking reductions in surgical delivery capacity. The Kenema Government Hospital had no one to provide surgical delivery care in summer 2014 and no viable place to transfer women with emergencies. At the Koidu Government Hospital, the operating theaters closed for three months without any documented surgical care.

3.7.4 Antenatal Care

As for Aminata and Fatmata, access to and utilization of preventive services, including antenatal care (ANC), also declined during the epidemic. In September 2014, in two counties in Liberia, ANC uptake fell to less than 9% of previous peak utilization and to 4% for intermittent preventive treatment for malaria (Iyengar et al. 2015). Overall in Sierra Leone, ANC fell by 18% and postnatal care by 22% (Jones et al. 2016). In Guinea, there was a 51% reduction in HIV testing at ANC during the six peak months of the epidemic. Sierra Leone experienced a 23% decline in HIV testing at ANC overall (Elston et al. 2017).

3.7.5 Economic Impact on Women

Women were disproportionately affected by the economic impact of the Ebola epidemic. The World Bank estimated that across the three economies of Sierra Leone, Liberia, and Guinea, \$1.6 billion USD was forgone in 2015 due to EVD. Households experienced increased prices for necessary goods, as well as decreased employment. Job losses predominantly affected the informal and agricultural sectors in which more women are employed. Food insecurity also increased, with more significant direct impacts on pregnant women, lactating mothers, and young children (Elston et al. 2017).

3.7.6 Stigma and Mistrust

In addition to the direct impacts of the Ebola epidemic on maternal mortality, access to Caesarean sections, and utilization of antenatal care, there is concern that the outbreak indirectly contributed to increased stigmatization of pregnancy and delivery, even for women without Ebola (Strong and Schwartz 2016, 2019). In addition to the many barriers to supervised deliveries in West Africa, contributing to poor maternal and neonatal outcomes even prior to the Ebola epidemic, there was evidence that women “feared” seeking care at facilities due to the perceived risk of surgical intervention and the belief that “normal” deliveries occur in the village (Treacy and Sagbakken 2015). Given the high-risk nature of pregnancy during Ebola, the epidemic worsened stigmatization of pregnant women

and delivery as a driver of the epidemic, and a service that was particularly risky for healthcare providers. This stigma likely contributed to reduced access to care for women. In addition to stigma imposed externally, Luginaah and colleagues argue that the underutilization of healthcare services may have been due to internal stigma, as pregnant women felt associated with Ebola, and therefore, missed necessary care to avoid feeling labeled (Luginaah et al. 2016).

Given the lack of human resources, reliable infrastructure or supplies, and robust systems for care, coupled with frequent out-of-pocket costs, there was often a profound lack of faith and mistrust in the health systems in Upper West Africa. These gaps were present well before the recent Ebola epidemic and widened during the epidemic, further undermining community trust. As a result, people sought care elsewhere—in private clinics, at pharmacies, and with traditional healers (Lori et al. 2015). High levels of transmission of Ebola virus disease occurred at the community level. Household members frequently took care of their sick loved ones, cleaning vomit, disposing of diarrhea, and sleeping in the same rooms with infected family members. By the time patients sought treatment in the formal healthcare sector, their condition was often very advanced. These fears were exacerbated by actual nosocomial transmission of Ebola between infected patients to staff, caregivers, and other patients (Dunn et al. 2016). In the Bombali district of Sierra Leone, nosocomial transmission of EVD occurred in a hospital maternity ward in which several mothers and their newborn infants became infected (Connolly et al. 2017; Connolly and Young 2019).

In the Kenema district in Sierra Leone, a qualitative study of healthcare workers found that there had been a perceived decrease in women presenting for antenatal care, preventative services, and delivery. The healthcare workers perceived that women were afraid of contracting EVD in hospital or outpatient settings, feared the presence of foreigners (who were perceived by some as having brought Ebola to the country), and feared that hospital staff were experimenting on the community (Dynes et al. 2015).

3.8 The Way Forward

As cases of Ebola declined across West Africa, PIH transitioned our response in Sierra Leone and Liberia to match the changing needs of the local communities and to build the staff, staff, space, and systems needed to strengthen the health systems and promote resilience in the health sector. Building robust local health systems will help to prevent further Ebola infections, while also promoting primary care, maternal and child health, and the effective diagnosis and treatment of other infectious and chronic diseases—all of which had been largely neglected during the epidemic as Ebola demanded the health systems' already scant resources. In both countries, community health workers—many of whom are Ebola survivors—now serve as a crucial link between community members and new health, social, and economic resources. PIH has prioritized the remodeling of health facilities to ensure that they are equipped to deliver quality care; this has included installation of generators to prevent disruptions in electricity, fixing plumbing, stocking pharmacies, and updating patient wards.

In Liberia, PIH is now working in Grand Gedeh and Maryland counties. In the latter, we have refurbished and operate a hospital and a clinic, improving the space for healthcare delivery. At the PIH-supported J.J. Dossen Hospital, the emergency room, operating theaters, and maternity ward were renovated, along with the updating of a laboratory and blood bank. The electrical system has also been overhauled. Remarkably, in December 2016, triplets were successfully delivered there via Caesarean section (Partners In Health 2017a). PIH also rebuilt Pleebo Health Center in southeastern Liberia, which had fallen into severe disrepair. In the reconstruction of this center, the maternity ward was made a priority and the center now delivers approximately 100 babies per month, representing nearly 85% of those expected in its catchment area (Partners In Health 2017b). PIH is also working in

neighboring districts to repair clinics and has begun planning in Maryland County to build a new national referral hospital for the underserved southeast region of the country.

It has also been critical to ensure that the necessary “stuff” is available to healthcare practitioners. In PIH-supported facilities, there are now fewer stockouts of essential medications and supplies; there is also new laboratory, sterilization, and biomedical equipment, as well as a new oxygen generator. At the J.J. Dossen Hospital, a new digital X-ray machine arrived in September 2016—the first X-ray machine at the hospital in 35 years. Beyond improving patient diagnosis and care, the machine provides a valuable teaching tool for student nurses and other clinicians; previously, the nearest X-ray machine was eight hours by road (Partners In Health 2016b).

To help build local human resources capacity (the “staff”), PIH is working alongside Harvard faculty members to provide mentorship at Tubman University, which houses Liberia’s only public nursing program. In Monrovia, PIH has helped to renovate and staff a tuberculosis hospital. We are also working closely with the Ministry of Health and Social Welfare to provide training and staffing support (including Liberian nationals and expatriates), with priority placed on maternal and child health (e.g., hiring midwives and nurse anesthetists) (Partners In Health 2017c). Further, PIH has worked with our partners to develop a variety of systems, including supply chains, ambulance coordination, and health facility transfers, among others.

In Sierra Leone, PIH has been similarly engaged in efforts to bring the necessary staff, stuff, space, and systems to the communities in which we work. PIH is promoting access to healthcare largely neglected during the epidemic (e.g., treating malaria, malnutrition, HIV, and tuberculosis, and encouraging safe births) and continuing to support health facilities in Port Loko and Kono. At Port Loko Government Hospital (PLGH) and Koidu Government Hospital (KGH, in Kono District), PIH has rebuilt facility infrastructure: painting wards, installing new roofs, providing generators to prevent power disruption, fitting new plumbing for potable water, and improving driveways and walkways for patient and staff safety. In both facilities, PIH updated the operating rooms, including improved lighting and new operating tables. At the Wellbody Clinic in Kono, PIH helped to improve clinic infrastructure and has opened a maternity waiting home on the clinic campus.

In these PIH-supported facilities, there have been improvements made to the laboratories and laboratory equipment for faster and more accurate diagnostic testing and to ensure constant availability of blood. As they did in Liberia, PIH has installed the first X-ray machines in both Port Loko and Kono Districts. At KGH, PIH has installed the first functioning anesthesia machine since the war, which helps ensure safe Caesarean sections, among other surgical procedures. PIH has also purchased and installed biomedical equipment for its supported facilities, including pulse oximeters, ultrasound machines, electrocardiography machines, and a large oxygen concentrator, which can provide reliable oxygen both for the hospital and health centers in the district. Working closely with the Ministry of Health and Sanitation and the Central Medical Supply, PIH has ensured that the districts have an improved supply chain, particularly for essential medicines, including those used for antiretroviral therapy and treating tuberculosis.

PIH has supported public sector human resources for health by hiring key staff to fill essential gaps that are crucial to improving maternal and child mortality, such as midwives and nurse anesthetists. Nurse educators from PIH support the hospital nursing directors and clinical staff, work collaboratively with nurses on the wards, and teach and support emergency obstetric care and neonatal resuscitation. Physicians and mid-level clinical officers have been hired to care for admitted patients and perform essential surgery, including Caesarean sections. A laboratory manager was recruited to support service delivery and teaching in the laboratory and blood bank. Additionally, PIH has supported regular teaching for all cadres at the hospitals in which it works. In an effort to build durable systems to guide and buttress this work, PIH has worked with the Ministry of Health and Sanitation to support

District Health Management Team activities, held trainings on HIV/AIDS and tuberculosis in the districts, and led training on emergency obstetric care at the health center level. Each of these activities contributes to strengthening the health system in order to promote improved maternal and neonatal outcomes, while also building capacity to quickly identify Ebola or other infectious diseases so that a rapid, effective response may be initiated.

We have also continued to support Ebola survivors. In the wake of the epidemic, Ebola survivors have experienced a range of clinical sequelae—from joint pain to depression—associated with the disease that may require ongoing medical care following recovery from the acute illness. Among such complications, about 18% of survivors have developed uveitis, an inflammation of the eye that can cause blindness. The National Survivor Eye Care Program, which emerged from PIH's work in Port Loko, has screened over 4,000 Ebola survivors in Sierra Leone for uveitis and other related complications. To achieve comprehensive screening of survivors, PIH partnered with the Ministry of Health and Sanitation, local organizations, NGOs, clinics, mobile health clinics, and community health workers. By March 2016, 3060 survivors had been screened, with 379 people treated for uveitis (Partners In Health 2017d). PIH also continues to support routine care for Ebola survivors in Kono and Port Loko.

3.9 Conclusions

In the aftermath of the 2013–2015 Ebola epidemic that swept across Sierra Leone, Liberia, and Guinea, many often ask “Why these three countries and not others?” While Ebola made its way into several countries—including the United States and other “high-income” countries in Europe—the magnitude of the outbreak in Upper West Africa was uniquely profound, and the international response was highly focused on containment of the disease instead of comprehensive care of the Ebola-stricken. Following a decade of civil conflict in the region, and for a variety of reasons, little investment was made by the governments and international organizations to rebuild—or rather, build for the first time—functioning health systems. The lack of staff, stuff, space, and systems in these three countries allowed a preventable and treatable disease like Ebola to take so many lives of the poor and vulnerable.

Among the most vulnerable in such low-resource settings are pregnant women, as they are unable to access or receive the proper care they need to have a healthy pregnancy and safe delivery. The stories of Aminata and Fatmata have illustrated the adverse outcomes that can result across circumstances and social strata when a health system lacks the fundamental components to deliver adequate care for women and their newborns. Whenever the next epidemic or emergency happens—whether Ebola or Zika or a hurricane or earthquake—responders must consider and make long-term commitments to addressing the root causes of such losses. As Elston and colleagues note, “*the greatest benefit to populations is likely to come from slow but sustained health systems strengthening and public health development, both to prevent epidemics from happening in the first place, and to limit the deeper consequences of them afterwards*” (Elston et al. 2017). In such settings with the highest maternal mortality rates in the world, efforts to build a health system that can withstand turmoil—from epidemic disease to war to natural disasters—must be a local, national, and international priority.

References

- Barden-O’Fallon, J., Barry, M. A., Brodish, P., & Hazerjian, J. (2015). Rapid assessment of Ebola-related implications for reproductive, maternal, newborn and child health service delivery and utilization in Guinea. *PLoS Currents*, 4, 7. Retrieved December 22, 2017, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4542265/>.

- Connolly, A., Bayor, F. A., Edgerley, S., Sessay, T., & Jamieson, D. J. (2017). *An Ebola virus cluster linked to a hospital maternity ward in Bombali District, Sierra Leone: Implications for mother, infants and the community*. Presented at the annual meeting of the American Anthropological Society, Washington, DC.
- Connolly, A.M., & Young, A.J. (2019). Ebola virus disease surveillance in two high-transmission districts of Sierra Leone during the 2013–2015 outbreak: Surveillance methods, implications for maternal and child health, and recommendations. In: D.A. Schwartz, J.N. Anoko, & S.A. Abramowitz (Eds.), *Pregnant in the time of Ebola: Women and their children in the 2013-2015 West African epidemic*. New York: Springer. ISBN 978-3-319-97636-5.
- Crompton, J., Kingham, T. P., Kamara, T. B., Brennan, M. F., & Kushner, A. L. (2010). Comparison of surgical care deficiencies between US civil war hospitals and present-day hospitals in Sierra Leone. *World Journal of Surgery*, 34(8), 1743–1747.
- Davtyan, M., Brown, B., & Foday, M. O. (2014). Addressing Ebola-related stigma: Lessons from HIV/AIDS. *Global Health Action*, 7. <https://doi.org/10.3402/gha.v7.26058>. Retrieved December 20, 2017, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4225220/>.
- Deaver, J. E., & Cohen, W. R. (2015). Ebola virus screening during pregnancy in West Africa: Unintended consequences. *Journal of Perinatal Medicine*, 43(6), 649–655.
- Delamou, A., Hammonds, R. M., Caluwaerts, S., Utz, B., & Delveaux, T. (2014). Ebola in Africa: Beyond epidemics, reproductive health in crisis. *Lancet*, 384(9960), 2105. Retrieved December 20, 2017, from [http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(14\)62364-3/fulltext](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)62364-3/fulltext).
- Dunn, A. C., Walker, T. A., Redd, J., Sugerman, D., McFadden, J., Singh, T., et al. (2016). Nosocomial transmission of Ebola virus disease on pediatric and maternity wards: Bombali and Tonkolili, Sierra Leone, 2014. *American Journal of Infection Control*, 44(3), 269–272.
- Dynes, M. M., Miller, L., Sam, T., Vandi, M. A., Tomczyk, B., & Centers for Disease Control and Prevention (CDC). (2015). Perceptions of the risk for Ebola and health facility use among health workers and pregnant and lactating women—Kenema District, Sierra Leone, September 2014. *MMWR. Morbidity and Mortality Weekly Report*, 63(51), 1226–1227. Retrieved December 22, 2017, from <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6351a3.htm>.
- Elston, J. W., Cartwright, C., Ndumbi, P., & Wright, J. (2017). The health impact of the 2014–15 Ebola outbreak. *Public Health*, 143, 60–70.
- Evans, D. K., Goldstein, M., & Popova, A. (2015). Health-care worker mortality and the legacy of the Ebola epidemic. *The Lancet Global Health*, 3(8), e439–e440.
- Garde, D. L., Hall, A. M. R., Marsh, R. H., Barron, K. P., Dierberg, K. P., & Koroma, A. P. (2016). Implementation of the first dedicated Ebola screening and isolation for maternity patients in Sierra Leone. *Annals of Global Health*, 82(3), 418. Retrieved December 19, 2017, from [http://www.annalsofglobalhealth.org/article/S2214-9996\(16\)30191-6/fulltext#sec3](http://www.annalsofglobalhealth.org/article/S2214-9996(16)30191-6/fulltext#sec3).
- Garrett, L. (2015). Ebola's lessons: How the W.H.O. mishandled the crisis. *Foreign Affairs*. Retrieved December 22, 2017, from <https://www.foreignaffairs.com/articles/west-africa/2015-08-18/ebolass-lessons>.
- Hogan, C. (2014). Ebola striking women more frequently than men. *Washington Post*. Retrieved November 17, 2017, from https://www.washingtonpost.com/national/health-science/2014/08/14/3e08d0c8-2312-11e4-8593-da634b334390_story.html?utm_term=.660dc6b7fb83.
- Iyengar, P., Kerber, K., Howe, C. J., & Dahn, B. (2015). Services for mothers and newborns during the Ebola outbreak in Liberia: The need for improvement in emergencies. *PLoS Currents*, 16, 7. Retrieved December 22, 2017, from <http://currents.plos.org/outbreaks/article/services-for-mothers-and-newborns-during-the-ebola-outbreak-in-liberia-the-need-for-improvement-in-emergencies/>.
- Jones, S. A., Gopalakrishnan, S., Ameh, C. A., White, S., & van den Broek, N. R. (2016). ‘Women and babies are dying but not of Ebola’: The effect of the Ebola virus epidemic on the availability, uptake and outcomes of maternal and newborn health services in Sierra Leone. *BMJ Global Health*, 1(3), e000065. Retrieved December 20, 2017, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5321347/>.
- Kilmarx, P. H., Clarke, K. R., Dietz, P. M., Hamel, M. J., Husain, F., & McFadden, J. D. (2014). Ebola virus disease in healthcare workers—Sierra Leone, 2014. *MMWR. Morbidity and Mortality Weekly Report*, 63(49), 1168–1171. Retrieved December 19, 2017, from <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6349a6.htm>.
- Liberia Institute of Statistics and Geo-Information Services (LISGIS), Ministry of Health and Social Welfare [Liberia], National AIDS Control Program [Liberia], & ICF International. (2014). *Liberia demographic and health survey 2013*. Monrovia: Liberia Institute of Statistics and Geo-Information Services (LISGIS) and ICF International.
- Lori, J. R., Rominski, S. D., Perosky, J. E., Munro, M. L., Williams, G., Bell, S. A., et al. (2015). A case series study on the effect of Ebola on facility-based deliveries in rural Liberia. *BMC Pregnancy and Childbirth*, 15, 254. Retrieved December 20, 2017, from <https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-015-0694-x>.
- Luginaah, I. N., Kangmennaang, J., Fallah, M., Dahn, B., Kateh, F., & Nyenswah, T. (2016). Timing and utilization of antenatal care services in Liberia: Understanding the pre-Ebola epidemic context. *Social Science and Medicine*, 160, 75–86.

- Ly, J., Sathananthan, V., Griffiths, T., Kanjee, Z., Kenny, A., Gordon, N., et al. (2016). Facility-based delivery during the Ebola virus disease epidemic in rural Liberia: Analysis from a cross-sectional, population-based household survey. *PLoS Medicine*, 13(8), e1002096. Retrieved December 22, 2017, from <http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002096>.
- Marsh, R. (2015). Partners In Health. Personal communication.
- Médecins Sans Frontières. (2017). *Ebola*. Retrieved December 22, 2017, from <http://www.doctorswithoutborders.org/our-work/medical-issues/ebola>.
- Menendez, C., Lucas, A., Munguambe, K., & Langer, A. (2015). Ebola crisis: The unequal impact on women and children's health. *Lancet Global Health*, 3(3), e130. Retrieved December 19, 2017, from [http://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(15\)70009-4/fulltext](http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(15)70009-4/fulltext).
- O'Hare, B. (2015). Weak health systems and Ebola. *The Lancet Global Health*, 3(2), e71–e72. Retrieved December 20, 2017, from [http://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(14\)70369-9/fulltext](http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(14)70369-9/fulltext).
- Partners In Health. (2016a). *Ebola*. Retrieved January, 2017, from <http://www.pih.org/blog/partners-in-health-ebola-response>.
- Partners In Health. (2016b). *An X-ray machine that inspires devotion*. Retrieved November 17, 2017, from <http://www.pih.org/blog/x-rays-help-inspire>.
- Partners In Health. (2017a). *Three boys, three joys: Triplets born in Liberia*. Retrieved November 17, 2017, from <http://www.pih.org/blog/triplets-born-at-j.j.-dossen-hospital-in-liberia>.
- Partners In Health. (2017b). *Pleebo*. Retrieved November 17, 2017, from <http://www.pih.org/pages/pleebo>.
- Partners In Health. (2017c). *Liberia*. Retrieved November 17, 2017, from <http://www.pih.org/country/liberia>.
- Partners In Health. (2017d). *Blindness*. Retrieved November 17, 2017, from <http://www.pih.org/blog/blindness-uveitis-partners-in-health-sierra-leone-eye-care>.
- Pieterse, P., & Lodge, T. (2015). When free healthcare is not free. Corruption and mistrust in Sierra Leone's primary healthcare system immediately prior to the Ebola outbreak. *International Health*, 7(6), 400–404.
- Raykar, N. P., Kraljevićs, K. E., Greenberg, S. L., Gillies, R. D., Roy, N., & Meara, J. G. (2015). The blood drought in context. *Lancet Global Health*, 3(Suppl 2), S4–S5. Retrieved December 22, 2017, from [http://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(14\)70351-1/abstract](http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(14)70351-1/abstract).
- Ribacke, K. J. B., van Duinen, A. J., Nordenstedt, H., Höjjer, J., Molnes, R., Froseth, T. W., et al. (2016). The impact of the West Africa Ebola outbreak on obstetric healthcare in Sierra Leone. *PLoS One*, 211(2), e0150080. Retrieved December 22, 2017, from <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0150080>.
- Sack, K., Fink, S., Belluck, P., & Nossiter, A. (2014). How Ebola roared back. *New York Times*. Retrieved November 17, 2017, from www.nytimes.com/2014/12/30/health/how-ebola-roared-back.
- Save the Children. (2015). *A wake-up call: Lessons from Ebola for the world's health systems*. Retrieved November 17, 2017, from <https://www.savethechildren.net/sites/default/files/libraries/WAKE%20UP%20CALL%20REPORT%20PDF.pdf>.
- Sharkey, A., Yansaneh, A., Bangura, P. S., Kabano, A., Brady, E., Yumkella, F., et al. (2016). Maternal and newborn care practices in Sierra Leone: A mixed methods study of four underserved districts. *Health Policy and Planning*, 32(2), 151–162.
- Sheku, M. (2018). Koidu Government Hospital. Personal communication.
- Strong, A., & Schwartz, D. A. (2016). Sociocultural aspects of risk to pregnant women during the 2013–2015 multinational Ebola virus outbreak in West Africa. *Health Care for Women International*, 37(8), 922–942. <https://doi.org/10.1080/07399332.2016.1167896>.
- Strong, A., & Schwartz, D. A. (2019). Effects of the West African Ebola epidemic on health care of pregnant women—Stigmatization with and without infection. In D. A. Schwartz, J. N. Anoko, & S. Abramowitz (Eds.), *Pregnant in the time of Ebola: Women and their children in the 2013–2015 West African Ebola epidemic*. New York: Springer. ISBN 978-3-319-97636-5.
- Tavernise, S. (2016). Maternal mortality rate in U.S. rises, defying global trend, study finds. *The New York Times*. Retrieved November 17, 2017, from <https://www.nytimes.com/2016/09/22/health/maternal-mortality.html>.
- Treacy, L., & Sagbakken, M. (2015). Exploration of perceptions and decision-making processes related to childbirth in rural Sierra Leone. *BMC Pregnancy and Childbirth*, 15, 87. Retrieved December 21, 2017, from <https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-015-0500-9>.
- U.S. Centers for Disease Control and Prevention. (2016). *CDC's ongoing work to contain Ebola in West Africa*. Retrieved November 17, 2017, from <https://www.cdc.gov/vhf/ebola/pdf/cdcs-ongoing-work.pdf>.
- United Nations. (2016). *Global Ebola Response. UN Mission for Ebola Emergency Response (UNMEER)*. Retrieved November 17, 2017, from <http://ebolaresponse.un.org/un-mission-ebola-emergency-response-unmeer>.
- United Nations Development Programme (UNDP). (2017). *About Sierra Leone*. Retrieved December 22, 2017, from <http://www.sl.undp.org/content/sierraleone/en/home/countryinfo.html>.
- United Nations Population Fund (UNFPA). (2014). *Setting standards for emergency obstetric and newborn care*. Retrieved November 17, 2017, from <http://www.unfpa.org/resources/setting-standards-emergency-obstetric-and-newborn-care>.

- VSO. (2015). *Exploring the impact of the Ebola outbreak on routine maternal health services in Sierra Leone*. Retrieved December 22, 2017, from <https://www.vsointernational.org/news/press-releases/higher-maternal-and-newborn-death-rates-sierra-leone-due-ebola-fears>.
- Walker, P. G., White, M. T., Griffin, J. T., Reynolds, A., Ferguson, N. M., & Ghani, A. C. (2015). Malaria morbidity and mortality in Ebola-affected countries caused by decreased health-care capacity, and the potential effect of mitigation strategies: A modelling analysis. *Lancet Infectious Diseases*, 15(7), 825–832. Retrieved December 22, 2017, from [http://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(15\)70124-6/abstract](http://www.thelancet.com/journals/laninf/article/PIIS1473-3099(15)70124-6/abstract).
- WHO Ebola Response Team. (2015). West African Ebola epidemic after one year—Slowing but not yet under control. *New England Journal of Medicine*, 372, 584–587. Retrieved December 22, 2017, from <http://www.nejm.org/doi/full/10.1056/NEJMc1414992#t=article>.
- World Health Organization. (2014). *Statement on the 1st meeting of the IHR Emergency Committee on the 2014 Ebola outbreak in West Africa*. Retrieved November 17, 2017, from <http://www.who.int/mediacentre/news/statements/2014/ebola-20140808/en/>.
- World Health Organization. (2015a). *Ebola situation report—30th September 2015*. Retrieved November 17, 2017, from <http://apps.who.int/ebola/current-situation/ebola-situation-report-30-september-2015>.
- World Health Organization. (2015b). *Factors that contributed to undetected spread of the Ebola virus and impeded rapid containment*. Retrieved November 17, 2017, from <http://www.who.int/csr/disease/ebola/one-year-report/factors/en/>.
- World Health Organization. (2016a). *Latest Ebola outbreak over in Liberia; West Africa is at zero, but new flare-ups are likely to occur*. Retrieved November 17, 2017, from <http://www.who.int/mediacentre/news/releases/2016/ebola-zero-liberia/en/>.
- World Health Organization. (2016b). *Ebola virus disease. Fact sheet*. Retrieved November 17, 2017, from <http://www.who.int/mediacentre/factsheets/fs103/en/>.
- World Health Organization. (2016c). *Ebola data and statistics: Situation summary by sex and age group, 11 May 2016*. Retrieved November 17, 2017, from <http://apps.who.int/gho/data/view/ebola-sitrep/ebola-summary-latest-age-sex>.
- World Health Organization. (2016d). *Global Health Observatory data repository*. Retrieved November 17, 2017, from <http://apps.who.int/gho/data/>.
- World Health Organization. (2017a). *WHO Statement on Caesarean Section Rates*. Retrieved on 17 November 2017, http://apps.who.int/iris/bitstream/10665/161442/1/WHO_RHR_15.02_eng.pdf.
- World Health Organization. (2017b). *Ebola virus disease brings opportunities for improved blood systems in West Africa*. Retrieved November 17, 2017, from http://www.who.int/medicines/ebola-treatment/ebola_improved_bs_wa/en/.