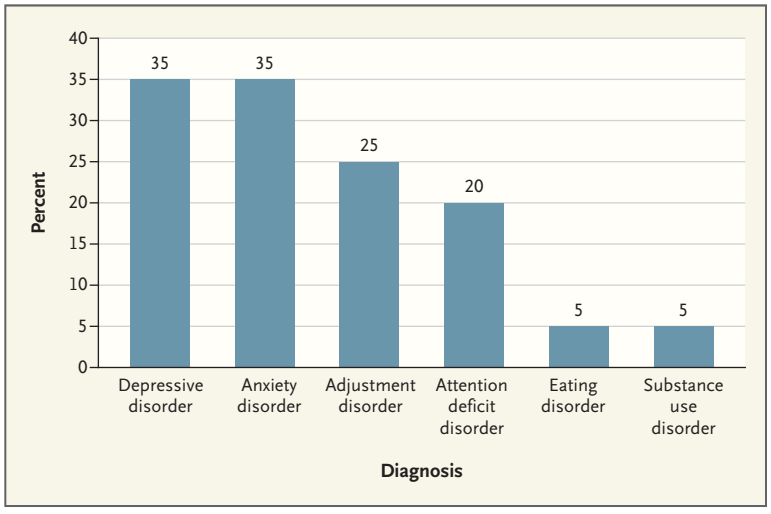


**Diagnoses of 150 Medical Students Seen by the Mental Health Care Team.**

ers at our medical school have determined that supporting the salary of in-house mental health professionals for students is a good investment, but such support may not be feasible at all programs, and other options must be considered. Creative solutions at other medical schools include appointing faculty "wellness advisors," sponsoring wellness initiatives to promote self-care, and bringing university counseling center staff on site for regular clinics. The University of California, San Diego, implemented the Healer Education Assessment and Referral (HEAR) program to educate medical and pharmacy students, house staff, faculty, trainees, and hospital staff about burnout, depression, and suicide and to provide confidential assessments related to these issues. Participants in this convenient, online program receive personalized referrals to local mental health clinicians and other community resources.

Other resources available to medical schools include free materials developed by the American Foundation for Suicide Prevention (afsp.org) to prevent burnout, depression, and suicide among health care professionals. Medical schools can also more closely align with hospital-based initiatives, which may have incentives to address physician well-being and mental health, in part to reduce costs and improve patient safety. Working closely with the physician-services divisions of large hospital systems may help schools and hospitals leverage resources and provide shared opportunities to improve the care of students, trainees, and faculty and staff physicians.

Disclosure forms provided by the authors are available at NEJM.org.

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# Outbreaks in a Rapidly Changing Central Africa — Lessons from Ebola

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West and Central Africa are experiencing explosive growth in urban populations, economic activities, and connectivity. The recent Ebola virus epidemic in West Africa demonstrated the vulnerability of the local health care infrastructure to newly emerging infectious diseases. Two key factors contributing to the epidemic's unprecedented size were growth-related: large urban populations that overwhelmed the public health infrastructure of these resource-poor countries and the extensive spatial and technological connectivity of the population.[1] These factors portend an increased risk in Central Africa of emerging infectious diseases caused by both known and unknown patho-



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**Outbreaks of Ebola Virus Disease in Central Africa, 1976–2018.***

| Year of Onset | Country | Epicenter or Epicenters | No. of Cases (Case Fatality Rate [%]) |
|---|---|---|---|
| 1976 | Zaire (current DRC) | Yambuku | 318 (88) |
| 1977 | Zaire (current DRC) | Tandala | 1 (100) |
| 1994 | Gabon | Mékouka, Ogooué-Ivindo Province | 52 (60) |
| 1995 | Zaire (current DRC) | Kikwit | 315 (81) |
| 1996 | Gabon | Mayibout, Ogooué-Ivindo Province | 37 (57) |
| 1996 | Gabon | Booué, Ogooué-Ivindo Province | 62 (75) |
| 2001 | Gabon and ROC | Mékambo, Ogooué-Ivindo Province (Gabon) | 65 (82) |
| 2001 | ROC and Gabon | Mbomo, Kéllé, Cuvette Ouest Region (ROC) | 59 (73) |
| 2002 | ROC | Mbomo, Kéllé, Cuvette Ouest Region | 143 (89) |
| 2003 | ROC | Mbomo, Cuvette Ouest Region | 35 (83) |
| 2007 | DRC | Luebo, Kasai Occidental Province | 264 (71) |
| 2008 | DRC | Mweka and Luebo, Kasai Occidental Province | 32 (47) |
| 2014 | DRC | Ikanamongo Village, Equateur Province | 69 (71) |
| 2017 | DRC | Kagbono, Likati, Bas Uélé Province | 8 (50) |
| 2018 | DRC | Ikoko-Impenge, Bikoro, Equateur Province | 54 (61) |
| 2018* | DRC | Mangina and Beni, North Kivu Province | 74 (46) |

* This outbreak was ongoing as of mid-August. Reported case numbers and case fatality rates are provisional. DRC denotes Democratic Republic of Congo, and ROC Republic of the Congo.

gens. Such unwelcome side effects of rapid growth can be mitigated only by strengthening the health care infrastructure, including diagnostic and clinical capacity, to meet the health care needs of the population; investment in the training of health care workers and African scientists; expansion of research capacity; development of disease-surveillance programs focused on humans, livestock, and wildlife; and rapid deployment of control measures when outbreaks occur.

A review of past outbreaks of Ebola virus (Zaire ebolavirus, EBOV) in Central Africa (Gabon, Republic of the Congo [ROC], and Democratic Republic of Congo [DRC]) is instructive. Before 2013, EBOV outbreaks consisted of relatively small numbers of cases (see table) and were effectively contained by basic public health, quarantine, and containment measures. The largest EBOV outbreak before 2013 occurred in the DRC in 1976 and comprised 318 cases. These outbreaks occurred predominantly in remote regions, where they had limited opportunity to spread over wide geographic areas. In the 2014 and 2017 EBOV outbreaks in the DRC, for instance, the initial zoonotic introduction from a wildlife reservoir in a remote area resulted in limited human-to-human transmission and rapid containment. Only 66 cases were detected in humans in the 2014 outbreak and 8 in the 2017 outbreak.

In stark contrast, 28,646 cases of EBOV were reported during the 2013–2016 epidemic in West Africa. That outbreak dispersed rapidly over large geographic areas in Africa, including major urban centers, and there were several cases of nosocomial infections in Europe and the United States. Among the West African casualties were more than 500 health care workers, whose loss further decimated an already extremely thin workforce. Rapid spread contributed to the inability to control the outbreak for more than 2 years, and the extended epidemic resulted in an estimated $2.2 billion loss in the gross domestic products of Liberia, Sierra Leone, and Guinea. The overall costs of the international response exceeded $3.9 billion.[2]

The unprecedented scale of the West African epidemic has been attributed to a combination of factors: large urban populations, minimal public health infrastructure, a slow response from international partners, and extensive connectivity of the populations. The recently contained outbreak of Ebola virus disease in the Equateur Province of the DRC appeared to be unusual for the



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region, in part because of such connectivity, with major waterways connecting the epicenter of the Bikoro region with major population centers including Kinshasa (population, 11.8 million) and Kisangani (1.6 million) in the DRC and Brazzaville (1.8 million) in the ROC; although the outbreak did not reach those cities, cases were reported in the regional capital of Mbandaka (1.2 million). These circumstances were alarmingly similar to those surrounding the West African epidemic, but the rapid response of the DRC ministry of health and international partners, including the likely benefit from the deployment of the VSV-Ebola vaccine, managed to block further spread.

However, only 7 days after that Ebola outbreak was declared over, a new outbreak was declared in the Mabalako health zone, territory of Beni in the DRC province of North Kivu. Mabalako is a challenging area, given its political instability, several large population centers — Goma (population, 1 million), Butembo (670,000), and Beni (230,000) — and substantial cross-border movement into Uganda and Rwanda. In light of the increase in frequency of Ebola outbreaks in DRC and their relatively rapid detection, it seems that it would be well worth the relatively small cost of investing in diagnostic capacity and training to avert the cost of containing any large outbreak. We believe that a similar return on investment could be expected from financial and educational support for improving and expanding the clinical care infrastructure.

Even if the ongoing outbreak in the DRC can be rapidly curtailed, the demographic data clearly indicate how the advance of the human footprint across Central Africa has exacerbated the risk of large outbreaks. Over recent decades, Central Africa has undergone profound changes in population structure. A rapid decline in death rates, in particular among children less than 5 years of age, has contributed to rapid population increases, combined with a demographic shift toward large numbers of working-age people.[3] In addition, Central Africa is experiencing the world's fastest rate of urbanization, with 50% of the Central African population expected to live in urban areas by 2030; and rural cities with populations exceeding 1 million, such as Mbandaka and Goma in DRC, are becoming more common throughout Central Africa.

One important factor in the potential rapid geographic spread of emerging infectious diseases is road construction for logging, mining, and hydroelectric activities that continues to open access to remote locations in Central Africa, facilitating movement between previously isolated communities (see map).[4] Road construction and other anthropogenic disturbances directly alter ecosystems in which pathogens reside.[5] These activities not only open previously pristine areas, but also reduce traveling times to and from highly urbanized areas such as Kinshasa and Brazzaville, both of which are increasingly hubs for global connectivity from which Asia, South and North America, and Europe can be reached in less than 12 hours. Large infrastructure programs such as the Program for Infrastructure Development in Africa will soon facilitate even greater connectivity among African countries and regions.

Clearly, Central Africa is rapidly approaching a tipping point. Africa's economic development is a positive change that cannot and should not be stopped. At the same time, rapid economic and demographic transitions bring the challenges of emerging infectious disease outbreaks of increased frequency, size, and global impact. Yet there is an alternative to this foreboding narrative of development-associated infectious diseases: rather than pose a risk, continuing population growth and increasing income and education levels can help spur greater demand for infrastructure to support sustainable economic development, including implementation of basic health services.

A substantial proportion of economic gains associated with extractive or road-building activities could be used to strengthen public health preparedness for emerging diseases. In addition, rather than spending exorbitant amounts reactively for control operations, international donors could invest in long-term public health and prevention infrastructure. Directed and sustained investment is urgently needed, before ongoing demographic and economic changes conspire to cause major outbreaks of both national and international consequence. This investment could include training and education of health care workers, especially in rural areas, to identify, report, and properly handle cases of unknown emerging diseases, as well as increases in diagnostic capacity and access to clinical care in both urban and rural areas. In addition, the region will need well-trained African scientists who can strengthen the much-needed clinical research infrastructure for testing new vaccines and therapeutics.

Recent economic gains in sev-



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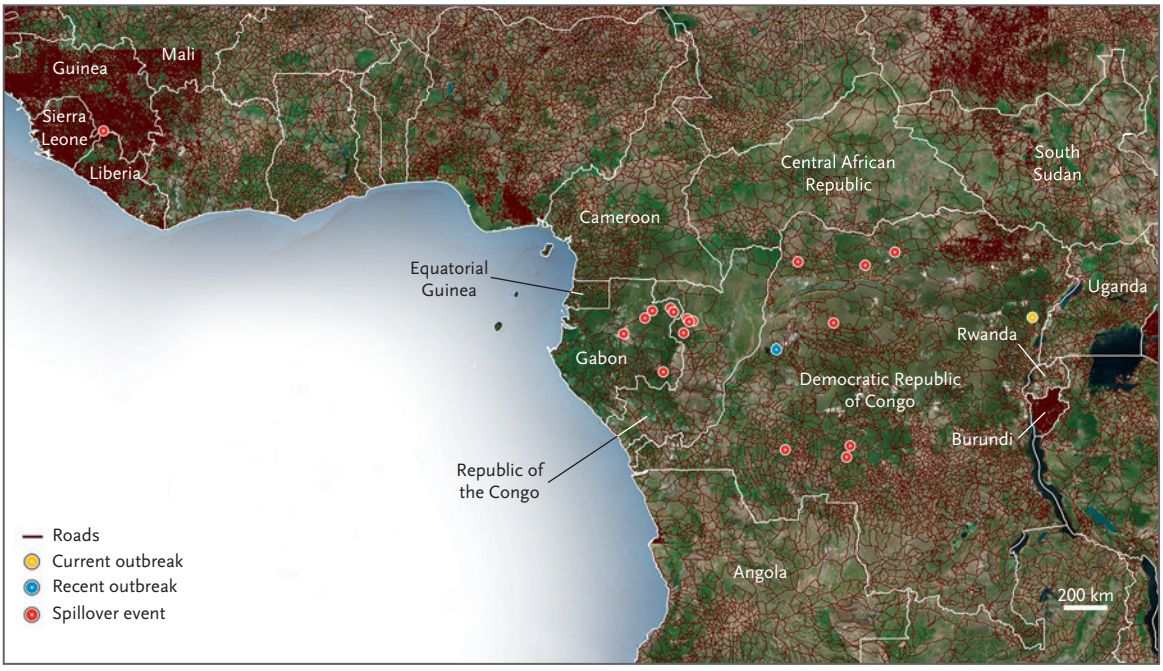


**Ebola Infections and Outbreaks in West and Central Africa.**

Red circles indicate areas of primary human infections of Zaire ebolavirus; the blue circle indicates the recently contained outbreak with its epicenter in the Bikoro region; and the yellow circle indicates the ongoing outbreak in the North Kivu region of the DRC. The density of road construction is shown in red. This map was generated with ArcGIS 10.4.1, and the coordinates of outbreak locations were compiled from information gathered from the World Health Organization and the U.S. Centers for Disease Control and Prevention. The roads layer was downloaded from the Center for International Earth Science Information Network based on data generated by the National Aeronautics and Space Administration.

eral Central African countries have not yet resulted in increased investments in health care infrastructure. Thus, strong international commitments of donor funds will be necessary to prevent devastating infectious disease outbreaks. World Bank trust funds, such as the Pandemic Emergency Financing Facility, can provide rapid surge financing during the initial stages of a severe outbreak. But we believe that long-term funding programs should also be made available for direct investment in the strengthening and sustaining of general health systems. This strategy will not only enable a better and faster response to emerging infectious diseases, but will also result in permanent improvements in quality of life through better access to care.

The views expressed in this article are those of the authors and do not necessarily reflect those of their respective organizations.

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