Chapter 3

Impact of Hurricane Katrina on the Louisiana HIV/AIDS Epidemic: A Socio-Ecological Perspective

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Additional information is available at the end of the chapter

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1. Introduction

Emergency preparedness is an important issue and public health professionals seek to plan for and anticipate the effect of large scale disasters. The chief concern may be the impact of disasters on infection and infection control, or in some cases the impact of the public's health is a direct result of the disaster itself. For example cholera outbreaks such as seen in Haiti following the 2010 earthquake, or radiation sickness as a result of damage to the Fukushima plant. However, the effect of disasters on other epidemics, including more chronic diseases such as HIV/AIDS, may also be felt.

Hurricane Katrina and the failure of the federal levee system remains one of the largest and costliest natural or man-made disasters in U.S. record. In all Katrina is estimated to have cost over 100 billion dollars in damage and recovery costs [1] with nearly 2000 people dead or presumed dead [2]. While Katrina had impacts across the Gulf South, the city and metropolitan area of New Orleans Louisiana sustained the most devastation, which resulted in a near total evacuation of the city that continues to be felt seven years later. Crouse-Quinn [3] have remarked that Katrina was both a social as well as a public health disaster.

Like the rest of the South, Louisiana and New Orleans have high concentrations of people living with HIV/AIDS as well as high rates of newly infected cases. In 2005 there were 21,062 persons living with HIV/AIDS in the Alabama, Mississippi and Louisiana Gulf Coast area [4] and 7068 people living with HIV/AIDS in the New Orleans metropolitan area [5]. According to the CDC, the state ranked 5th and the metropolitan area ranked 7th in new AIDS cases in 2005, with 21.2 and 30.3 cases per 100,000 residents, respectively [6].

Thus the intersection of a disaster such as Katrina and the resultant long lasting effects of the storm and flood may have particular relevance to the large population living with HIV/AIDS

or those who may be at risk for HIV in Louisiana. Given that in many ways this can be seen as a vulnerable population who may be disproportionately affected, it was critical to examine the impact of the storm on the epidemic.

One cannot, however, describe the impact of a single event such as Katrina on the entire epidemic without considering its effects on the individual as well as the various social and environmental contexts. It is increasingly recognized that explanations for determinants of health that operate solely on the individual level are inadequate [7]. Models of health and health behavior need to incorporate factors such as social and physical environments that nest individuals within these levels. The primary method of theorizing about health and health related behaviors from this multi-level framework has been the social-ecological approach [8, 9], that postulates a series of levels or strata at which these health-related risks and protective factors may operate. These strata often begin with the more proximal causes or moderators of disease, at the individual or intrapersonal level, and move towards the more distal interpersonal risks, social and cultural factors and ultimately societal, structural or environmental level factors. Several researchers have pointed to the importance of the ecological framework or inclusion of these multilevel factors in understanding the HIV/AIDS epidemic [8,10-12].

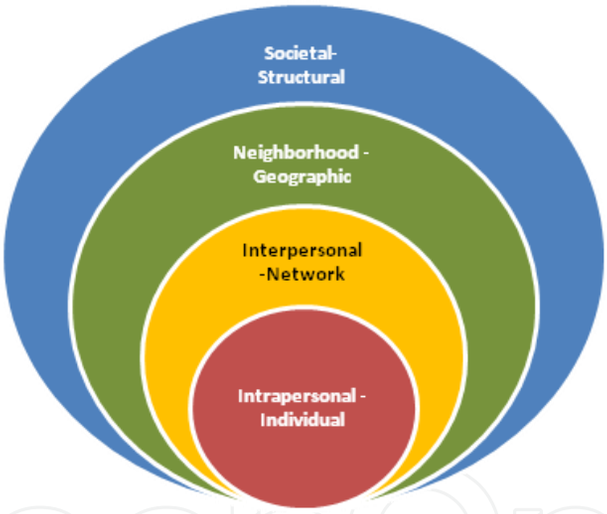

Figure 1. Socio Ecological Model of Health

Figure 1 presents an adaptation of the social-ecological model as one possible representation of levels of risk for HIV/AIDS. Following this model, Katrina might impact the way in which HIV acts at the individual level, such as influencing individual risk behaviors with unsafe sex or substance use practices. Social and interpersonal factors might be have been influenced by disruptions of networks or neighborhoods, and structural or policy level changes may have occurred at the system level such as the health care infrastructure.

Each of these levels embodies multiple research questions, often with multiple alternate hypothesized results. In order to best capture the possible ways in which the epidemic may have been affected by Katrina, the method of Strong Inference outlined by Platt [13] was used

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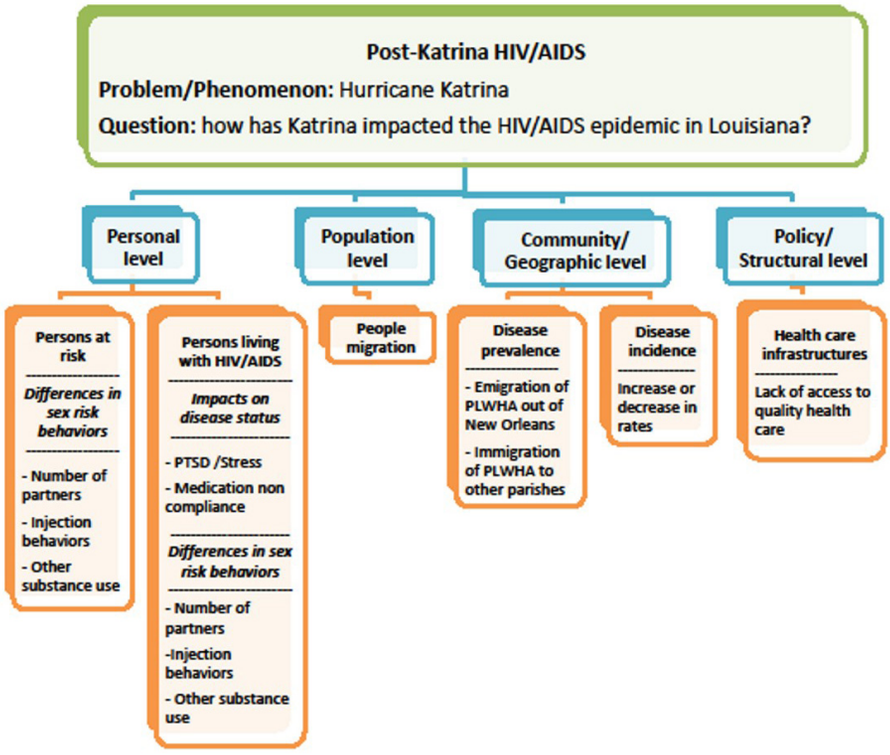

Figure 2. Logic tree conceptual diagram of potential Post Katina impact on the local HIV epidemic

to generate specific research questions and possible alternate hypotheses dealing with each of these levels.

Figure 2 represents the operationalization of these questions and the structure of their alternate hypotheses into a logic tree. These levels are explored in this chapter and the existing literature on HIV/AIDS and Hurricane Katrina is summarized and interpreted in this perspective.

2. Individual level

At the individual level, the primary changes that an event such as Katrina might have on the HIV epidemic are those of individual behaviors among those with or at risk for HIV/AIDS, and the impact that the disaster itself may have on the disease status of the individual living with HIV/AIDS.

2.1. Behavioral impact

The literature has pointed to changes in risk behaviors following natural and man-made disasters. While many of these changes may be moderated by the context of the event, increases in HIV specific risk behaviors, such as sexual or substance using practice, are common. Several studies specific to New Orleans have confirmed this effect after Katrina.

Morse [14] followed up with an existing cohort of New Orleans injection drug users 5 months after Katrina: 60% expressed that their risk behaviors had increased in the time since Katrina. Furthermore, among the injection drug users that had evacuated to other areas many had been incarcerated in other cities or had little or no difficulty in obtaining drugs. Kissinger [15] re-contacted a small sample of young women who had accessed clinical reproductive health services before the storm and found that many of them had stopped using birth control, contracted sexually transmitted infections or gotten pregnant after the storm. Similarly, she found high rates of risk behaviors among a sample of Latino migrant workers who had newly arrived after the storm [16].

Since 2003, New Orleans has participated in the *National HIV Behavioral Surveillance System* funded by the Centers for Disease Control and Prevention, an annual survey that assesses HIV risk behaviors and access to testing and prevention services among the three populations at highest risk for HIV a) men who have sex with men, b) injection drug users and c) heterosexuals living in areas at high risk for HIV and poverty. From 2006 to 2009, samples from over 500 respondents in each of these high risk groups were asked to self-report on their perceived change in HIV risk during the 12 month immediately after the storm. Overall, self-reports of increased risk - from 60% to 70% - were more commonly reported than reports of decreased risk (15%-20%). The most commonly reported reasons for why an individual's risk might have increased included increased or additional sexual partners, unsafe practices and increases in substance use or use of injection drugs and unprotected sexual practices. The most common reported reason for why a person's HIV risk might have decreases was a decreased number of sex partners.

These results cannot demonstrate a causal relationship between Katrina and change in risk. Furthermore they are self-report data and may be subject to recall or social desirability bias. However, they still do point to the fact that HIV risk behavior increased among many individuals in the time after Katrina.

2.2. Health status

The action of HIV is to compromise the human immune system by attacking the types of white blood cells (called CD4) that fight off many types of infection. Today, the primary disease management tool for HIV is the use of drugs including highly active antiretroviral therapy. Medication adherence, however, is critical in order to adequately manage the disease. Persons living with HIV on these regimens are able to live much longer and often control the disease to the point where its viral load is undetectable in the bloodstream. As a result the immune system may be less compromised and higher CD4 counts (a typical measure of the immune system t-helper cells) may be seen.

The impact of stress on the human immune response has been well documented [17]. Chronic stress can lead to reduction in the immune system's ability to fight off infection. Given that the mechanism for HIV is its effect on the immune system itself, it is no surprise that studies have demonstrated the relationship between stressful life events and the disease status of persons living with HIV/AIDS.

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Post-traumatic stress disorder (PTSD) is a chronic and long lasting stress related condition that is often triggered by specific psychological trauma. PTSD is common in post disaster environments and after Katrina, the entire population of New Orleans experienced trauma and levels of PTSD were shown to be highly prevalent in the city across many groups [18, 19] Wagner et al. [20] provide a synopsis of potential for PTSD, substance use, and HIV risk among youth subsequent to Katrina. Among persons living with HIV/AIDS, high levels of PTSD have been also shown following the experience of notification of a positive HIV diagnosis [21], and this has adverse impact on the disease progression.

In 2009, Reilly et al. [22] demonstrated high levels of PTSD (37%) in a sample of 145 persons living with HIV/AIDS in New Orleans one year after the storm. While high, these levels were consistent with other studies of the general population. By comparing the health status of those persons living with HIV/AIDS with PTSD to those who did not have clinical levels of stress, they found that persons living with HIV/AIDS with PTSD were less likely to have non-detectable viral load levels and were more likely to have weakened immune systems (CD4 counts) also two years after the storm. Thus, the disease status of the PTSD group was significantly worse than that of the group who showed low PTSD. It should be noted that this study was conducted on a clinic sample of persons living with HIV/AIDS who had already returned to and sought care in New Orleans, thus did not include people who were unable or unwilling to return.

Disease status of persons living with HIV/AIDS was examined to detect differences in the between Katrina evacuees who had returned to New Orleans and those who remained displaced outside the metropolitan area [23]. Laboratory records reported to the state Office of Public Health for 18 months prior to the storm and 18 months post storm were obtained and coded according to current residential status. It was found that those persons living with HIV/AIDS who had returned had overall CD4 counts comparable to residents from parts of the state unaffected by Katrina. Conversely, those persons living with HIV/AIDS who remained away from their homes showed both lower overall CD4 counts before and after the storm as well as showing a significantly greater decrease in CD4 in the time before to the time after the storm (Figure 3). While CD4 was used as the primary indicator of disease status in this study, similar results were found but not reported for increases in viral load laboratory results.

Other outstanding questions remain about the way in which an event such as Katrina might impact the disease progression of persons living with HIV/AIDS. While these increases in viral load and decreases in CD4 were found to be statistically significant 18 months out from the storm, studies are needed to examine the potential for longer term changes in these indicators. Furthermore, the extent to which these clinical indicators of disease status translate into other disease related outcomes is unknown. For example, do persons living with HIV/AIDS who were displaced or impacted by Katrina show shorter survival times from AIDS diagnoses to death? Similarly, reductions in time from HIV diagnosis to an AIDS diagnosis or AIDS diagnosing condition have not been established or investigated.

While stress, potentially in the form of PTSD, may be one explanation for these effects on disease status, other possible explanations are conceivable. For example, disruptions in medication regimen or adherence could also explain these results. This may be an intractable

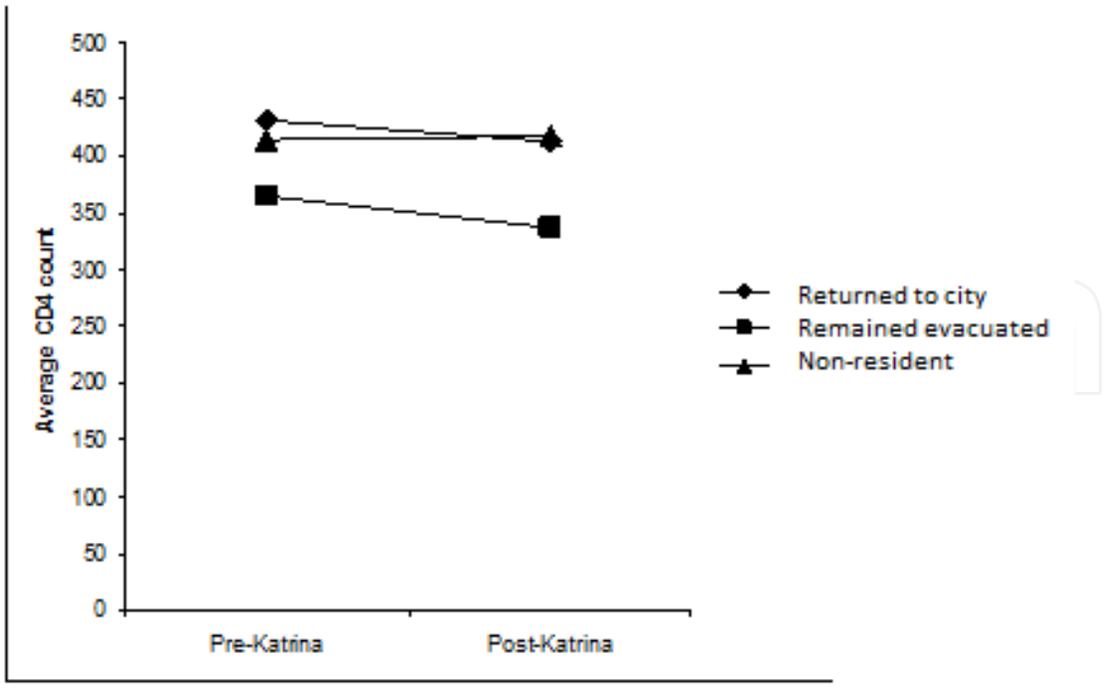

Figure 3. Average CD4 Counts Pre and Post Katrina for Evacuees, Returnees and Other state residents.

problem, however, given that PTSD itself has been shown to result in poor adherence [24,25]. Increases in viral load and decreased immune response at the individual level are certainly unfortunate, more problematic, however, may be the impact that this has on the epidemic itself. Recent studies have shown that individuals with high uncontrolled viral load, including those who are newly infected and may not know their status, are more likely to transmit the infection [26,27] and disruptions in medication can result in emergence of drug-resistant strains of the virus. Thus Katrina may have had a synergistic effect leading to increased risk behaviors and increased viral loads ultimately leading to increases in infections.

3. Social network and geographic levels

By far the most dramatic and long lasting effects of Katrina and the resulting failure of the federal levee systems was the widespread flooding and devastation of the city of New Orleans and surrounding communities. Many large areas of the city remained under over 10 feet of water for weeks after the storm. Furthermore, the city itself remained under a mandatory evacuation order with no critical services such as water or electricity for over a month until the New Orleans Mayor allowed a staged return to certain ZIP codes based on damage. Thus, people were unable to return to their, even undamaged, homes for long periods and those with significant damage were forced to relocate to other neighborhoods, cities or even states. Other large scale disasters may necessitate long or short term evacuation events. Flooding, radiation release, or damage, such as that observed in Katrina, Fukushima [28] or the 2010 Haiti

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Earthquake, may lead to significant population migration. In these cases, accurate data on current population estimates are critical to conduct public health and other important planning efforts, however, these data are often invalid or not available, such as in the case with Katrina.

3.1. Population data

Because of the lack of availability of this important information in the absence of the traditional measures of population (e.g. the US Census), several attempts were made to calculate estimates of the return of the general population of New Orleans and the surrounding areas. One of the first comprehensive published results was the New Orleans Emergency Operations Center's Rapid Population Estimate Project, a survey realized by CDC and the Census [29]. Later survey estimates based on neighborhood enumerations [30] or made available from commercial sources or marketing research firms such as Claritas/Neilsen were released [31]. Eventually the U.S. Census was able to provide standard mid-year estimates of the city population, however, these figures have been regularly disputed by state and city officials and annually amended.

Several problems and caveats with these data sources exist that make it very difficult to plan and conduct regular public health activities. Clearly the results of these studies are extremely time dependent especially given the rapid and ever changing pace of the population migrations in the months and years since Katrina. The results also lack a needed level of geographic specificity or resolution, that is to say they are often only available at the level of the entire parish. This is problematic when assessing smaller areas such as ZIP codes, neighborhoods or census blocks. Given the differences in damage to neighborhoods may differentially influence a person's ability to return to their home. Related to this is the disparity and disproportionate impact of Katrina on different racial, ethnic and socioeconomic groups. Only with the release of the complete 2010 Census will true and accurate data be available at the level of detail that is needed to conduct public health and planning activities.

Because of the absence of reliable population data, planning efforts had to be based on non-empirical or proxy measures for traditional data. For example postal service measures based on the proportion of households within a ZIP code or neighborhood who were receiving mail were used in some cases. Greater New Orleans Data Center [32] conducted regular estimates using these sorts of methods. Other efforts included an ethnographic mixed methods approach that was conducted as part of the National HIV Behavioral Surveillance System. This project involved both qualitative and quantitative descriptions of neighborhoods that were identified as high risk for HIV prior to Katrina, which documented the potential viability of survey research within those areas. These efforts targeted neighborhoods of greatest HIV risk based on pre-storm data.

These investigations included systematic social observations or windshield surveys followed by brief street interviews, focus groups and semi structured interviews with neighborhood residents. In all staff rated neighborhoods in terms of the appropriateness for survey activities and overall recovery based on these measures, which included over 16,000 direct observations of individual residential units and over 100 interviews with neighborhood residents [32]. Many

of these areas were among the most heavily damaged neighborhoods and some continued to be classified as non-livable months or years post-Katrina.

Figure 4. Katrina damage in Lower 9th Ward

Figure 4 and Figure 5 document damage to structures in the devastated Lower 9th Ward that was not atypical of the area. Other areas, however, such as the French Quarter and Uptown, remained relatively untouched and showed denser occupation than pre-Katrina levels.

Regardless of damage, the results of the qualitative and quantitative investigations showed clear disruption to peoples social and sexual network due to the changes in post-Katrina neighborhood level population. Interview results frequently referred to the splitting up of families, friends and social groups. In Brumsfa's Sociology of Katrina [33] the impact of the formal and informal social network is frequently mentioned. Under the socio-ecological model these are important potentially protective factors when one considers the potential roles of collective self-efficacy or the ability of a community to mobilize resources. When these ties are broken, the community suffers. These changes could represent possible risk factors as new, potentially HIV infected, partners enter fresh networks, or alternatively these disruptions could reduce the protective factors that social support has on decision making ability.

3.2. Prevalence

A more direct measure of community or geographic risk is the prevalence of disease within the areas that these networks are embedded within. Disease *prevalence* is often defined as the proportion of the population who have the disease or condition. While prevalence may be used

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Figure 5. Katrina damage in Lower 9th Ward

to assess the stage of an epidemic, it is also the key measure for planning for services to persons living with the disease or prevention interventions for those at risk.

For diseases such as HIV/AIDS, monitoring of local prevalence is often conducted by state or jurisdictional health departments through the use of registry or sentinel surveillance systems. Typical disease surveillance systems utilize either active or passive disease reporting of notifiable (legally reportable) conditions. In *active* systems the information usually is the result of field investigation conducted by epidemiologists or other trained staff. For example when an outbreak of foodborne illness triggers an active investigation of local restaurants. On the contrary, *passive* systems rely on information that is reported by medical providers or laboratories. In the U.S. HIV/AIDS, surveillance is conducted using the enhanced HIV/AIDS Reporting System, which is for the most part a passive system. Address at diagnosis is often initially reported and in many cases it is rarely updated. Because of this, calculation of geographic disease burden or local prevalence is based on this address at diagnosis, rather than last known address of the individual.

Under large scale migration or evacuation events, passive systems will *overestimate* the prevalence of the disease or condition because the system will not be updated: the address that was reported at the time of a person's HIV diagnosis will remain in place even after that person has evacuated. Two methods were developed to estimate the post-Katrina prevalence of persons living with HIV/AIDS [5] in the New Orleans region. One method, based on available population return data described above, applied the point estimates of the proportion of the general population to the number of pre-Katrina persons living with HIV/AIDS to compute estimated prevalence. A second method utilized available information from additional

secondary active surveillance or reporting systems, such as laboratory reports, to document the return or relocation of persons living with HIV/AIDS. Cases with any available information were used as a sample of all cases to impute return of all persons living with HIV/AIDS. Both of these methods were recomputed at regular intervals in order to inform and direct the state and local health department during this critical period.

Figure 6 shows the estimated return of *persons living with HIV/AIDS* (PLWH/A) to Orleans Parish at time intervals consistent with the available population data. The rate of return of persons living with HIV/AIDS, using the secondary surveillance estimates, consistently matches the return of the general population. Not shown here, however, are the group specific estimates, which again point to disproportionate return based on race, sex, and geographic area of residence. Surprisingly, mode of transmission was an important factor in the ability to return, with men who have sex with men returning much earlier and at higher rates. However, this may be confounded with the geographic and socioeconomic characteristics of where many of them resided.

3.3. Incidence

Disease rate is often calculated as the number of disease cases divided by the number of persons in the population. However, more formal definitions would introduce time and replace the number of persons in the population with number of person-years at risk in the population.

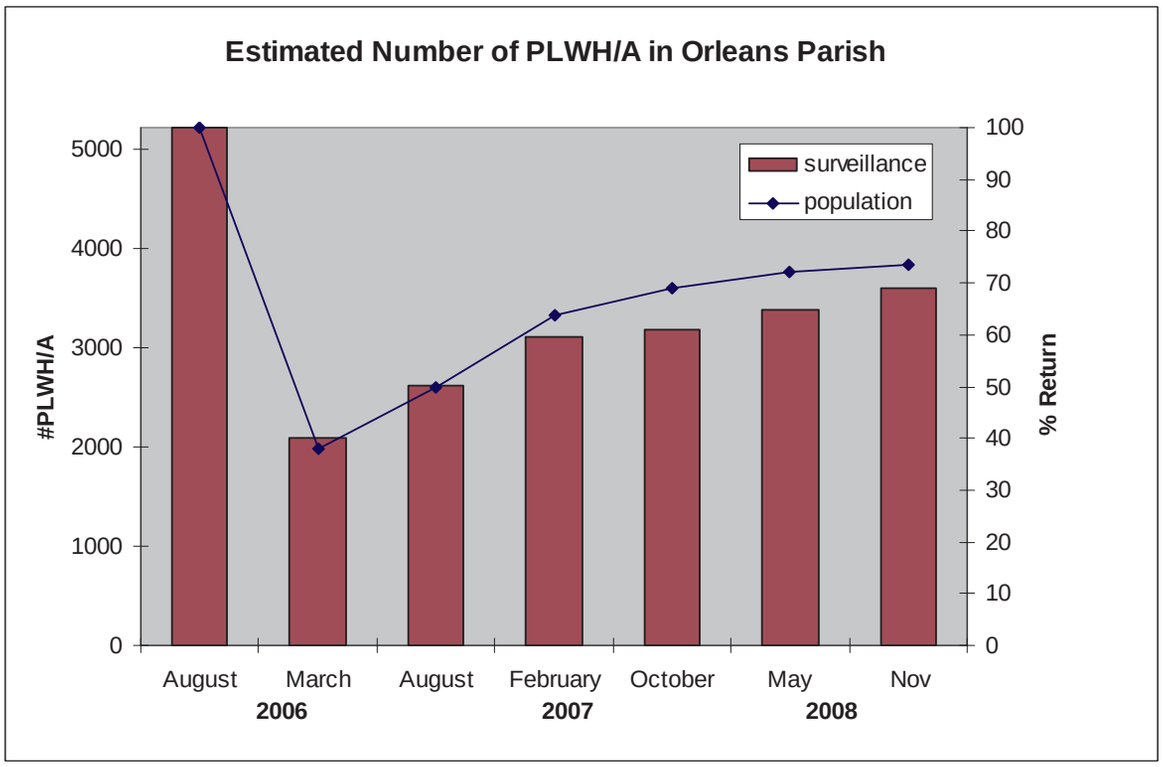

Figure 6. Estimated numbers of returning persons living with HIV/AIDS (PLWH/A)

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Under normal circumstances, these two numbers are equal and estimates of the # of persons living in an area at mid-year (as provided by the US Census) are equal to the actual number of person years at risk because any change over the course of the year is assumed to be consistent and therefore the midpoint reflects an average. However, in cases where the change in population is sudden this assumption is no longer valid and the mid-year no longer represents a true reflection of person years. It should be expected therefore that the mid-year estimate for New Orleans might violate this assumption since the entire city was under a mandatory evacuation order and only allowed a staggered and slow return to their homes.

Under large scale evacuation events, or other instances where the census does not accurately reflect the number of person years, disease rates will be drastically *underestimated*. Van Landingham [34,35] explained this phenomenon as applied to New Orleans murder rate. Due to the large population loss in the last months of 2005, there was an apparent drop in murders that was actually an artifact of calculations. After applying a corrected population estimate of the average person years at risk as a denominator the actual rate was similar to previous years.

Rates of HIV/AIDS calculated as those murder rates can produce incorrect estimates. In 2008 Robinson et al. [36] applied corrected estimates of the person years at risk to New Orleans HIV/AIDS diagnosis data and found that there was a dramatic spike in disease diagnosis rates in the year following Katrina (Figure 7).

4. Structural and policy level

We have already discussed how some persons living with HIV/AIDS and persons at risk may have had some difficulty in accessing needed programs services such as family planning or reproductive health needs [15] one year following the storm. Many of these interventions may have been traditionally sought at local public clinics, many of which remained closed until well after this time. This would be an example of one structural factor that could influence the epidemic as a result of Katrina. Thus, Katrina influenced the epidemic at a policy or structural level to the extent that clinic closures acted as a barrier to utilization of family planning services or other reproductive health needs that could've been used in the prevention of HIV or unplanned pregnancies.

Clearly one major concern following a natural disaster is in maintaining the infrastructure of the health care system. For those impacted with a disease such as HIV this is of vital importance and disruptions to the system can mean fluctuations in the delivery and availability of badly needed drugs or access to drug supplemental assistance programs. Several reports documented the recovery of the health care system and health care providers such as the Medical Center of Louisiana of New Orleans. One year after Katrina over 50% of professionals surveyed from the American College of Emergency Providers reported very little or no progress in the emergency care system [37]. Though improvements were marked and continue to improve to this day, a great deal of uncertainty existed well past that time [18] including the question of the future of the State's safety net health care system for indigent care.

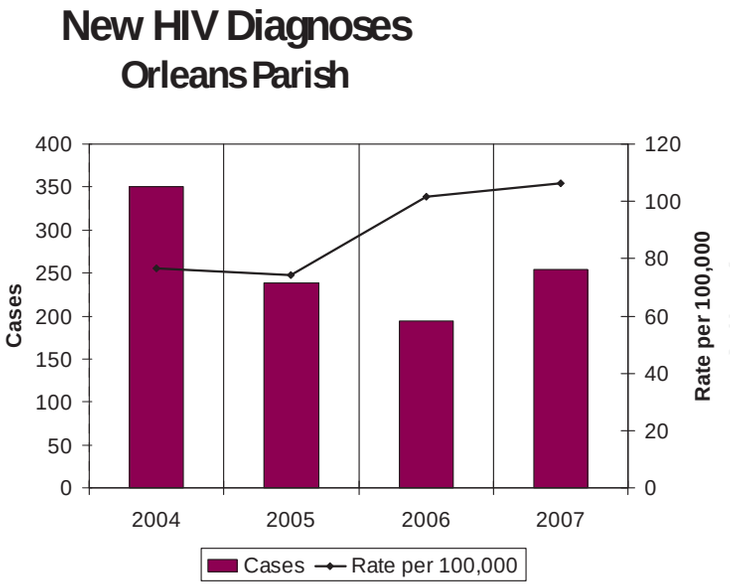

Figure 7. Corrected HIV rates in Orleans Parish 2004- 2007

Concerted efforts did take place to ensure quality care of persons living with HIV/AIDS. One example of that is the recovery of the Medical Center of Louisiana *HIV Outpatient* (HOP) clinic [38-41]. Approximately one month after the storm the New Orleans Mayor reopened areas of the city by selected ZIP codes. Immediately following this, HOP physicians and staff had established the means to provide medication and prescriptions to persons living with HIV/AIDS prior to reopening of their office space. Because of the importance of maintaining adherence, staff and social workers went so far as to advertise this service in local bars. By Summer 2006 staff had occupied a temporary space and restored many services, with some exceptions including laboratory testing.

Extensive efforts by state Office of Public Health personnel and social workers also resulted in minimal disruption to the state Ryan White Title II funded *AIDS Drug Assistance Program* (ADAP). These efforts included agreements with other states in order to preserve services for those persons living with HIV/AIDS who were dislocated to other states [42]. This strategy was successful in that the results of a collaborative needs assessment New Orleans persons living with HIV/AIDS who utilized services such as ADAP, relatively few (15%) reported not being able to access these services in the six months following Katrina [43]. Also, while there was a reduction in the number of statewide unduplicated ADAP clients in the quarter following Katrina, that number of quarterly clients remained stable in the three years following the storm, potentially reflecting the fact that a number of clients may have not returned.

Clark et al. [41] made several recommendations for increasing emergency preparedness capacity. Physicians and other health workers should reinforce patient responsibility in knowing about their health indicators and their own medication need. Systems should move towards electronic health records and plan for storage and backup of needed data. Disaster

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plans should be developed by staff that is tailored towards their client base and explains the need for and how to access services such as getting assistance with medication needs during these crises. Finally, providers should be aware that different funding mechanisms may be impacted by these events differentially and anticipate the results of that potential fiscal disruption.

Other policy level factors could easily influence disease or the way in which Katrina impacts the epidemic. For example, how recovery money is allocated to rebuild neighborhoods, or to rebuild the health care system itself. Staffing and health department decisions or capacity to compete for funding also may be important.

5. Summary

This chapter presents a summary of the numerous impacts that were observed after Hurricane Katrina on the population and individuals who are living with or at risk for HIV/AIDS in Louisiana and the New Orleans area. These findings are furthermore interpreted in accordance with the Socio-Ecological Model of Health in order to conceptualize how a major disaster like Katrina can have long reaching impacts on not just the individual but on entire communities and systems under which people live. It is hoped that this model will allow future researchers to more fully understand the impact of disasters in a new light, as well as provide valuable insight into the experience of public health professionals working in disaster recovery conditions.

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