# Epidemiology of Diabetes among Cases of Invasive Bacterial Infection, New Mexico, 2004–2012

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According to the Centers for Disease Control and Prevention, approximately 117 million adults in the United States had one or more chronic conditions in 2012. Among chronic diseases, diabetes is of particular concern as it affects an estimated 29.1 million individuals annually in the United States. Diabetes results from inadequate secretion of insulin or the inability of tissues to respond to insulin, which causes an excess of glucose in the bloodstream. This chronic condition can cause severe complications including heart and blood vessel disease, nerve damage, blindness, kidney disease, lower-extremity amputation, and an increased susceptibility to infection. Infectious agents can complicate chronic diseases, such as diabetes, by damaging organs and tissues, causing permanent disability, and predisposing an individual to other chronic conditions.

Examining the relationship between chronic and infectious diseases is a complex undertaking. However, many surveillance systems collect information regarding the burden of chronic disease, including diabetes among those with infectious conditions. The New Mexico Active Bacterial Core Surveillance Program (ABCs) conducts surveillance for five bacterial pathogens of public health importance among New Mexico residents: *Neisseria meningitidis* (*N. meningitidis*), *Haemophilus influenzae* (*H. influenzae*), group B *Streptococcus* (GBS), group A *Streptococcus* (GAS), and *Streptococcus pneumoniae* (*S. pneumoniae*). Through this surveillance program, demographic information, risk factors for disease and co-morbidities, such as chronic conditions, are collected to better understand the epidemiology and impact of these pathogens.

Found in the nose, throat, respiratory and gastrointestinal tracts of many healthy individuals, the five bacterial pathogens are of concern when they invade normally sterile body sites such as the blood and cerebrospinal fluid and cause invasive infection. Common risk factors for invasive bacterial infection include, age greater than 65 years and presence of certain co-morbidities including chronic disease. As rates of diabetes increase in NM and nationally it is important to assess the relationship between invasive bacterial infections and diabetes.

The epidemiology of diabetes has not been previously explored among NM residents with invasive bacterial disease, as defined by the NM ABCs Program. Therefore, we seek to: 1) compare the frequency of diabetes among ABCs cases with frequencies of diabetes among the general population of NM as reported through the Behavior Risk Factor Surveillance System (BRFSS); and 2) describe the frequency of diabetes among ABCs cases. We hypothesized that NM ABCs cases will have a higher frequency of diabetes compared to the general population of NM given that chronic diseases often predispose individuals to specific invasive bacterial infections.

**Methods**
NM BRFSS is a phone-based survey that uses statistical methodologies to make estimates of count data. In 2011 BRFSS methodology changed nationally. Prior to 2011, BRFSS surveys were administered to landline phone users only. In 2011, cell phone users were added to this population. As landline and cell phone users differ with respect to age, income, and other demographic factors, data collected prior to 2011 cannot be directly compared to data collected since 2011. Therefore, for the purposes of this analysis, data was split into two time-periods, 2004–2010 (T1) and 2011–2012 (T2).

A case was defined as an invasive bacterial infection with one of the five pathogens under ABCs surveil-

lance, among residents of NM from 2004–2012. Data from the ABCs surveillance database were obtained including information regarding patient demographics, diabetes status, and pathogen. The NM ABCs program has received Institutional Review Board (IRB) approval; use of the data for this analysis did not require additional IRB approval.

A descriptive epidemiologic analysis was conducted to compare frequencies of diabetes among NM ABC cases to frequencies of diabetes in the general population of NM from 2004–2012. All participants included in the analysis were aged ≥18 years. Frequency of diabetes for the general population of NM was obtained from the NM BRFSS.

## Results

Overall, the prevalence of diabetes increased from the first time interval to the second time interval. During T1, 7.8% of adults, or approximately 113,219 adults, were estimated to have diagnosed diabetes, by the BRFSS. Approximately, 7.8% of adult males and 7.8% adult females in NM were estimated to have diagnosed diabetes. The highest prevalence of diagnosed diabetes was estimated to occur among Blacks, 11.0%, followed by American Indians/Alaska Natives, 10.8%, Hispanic/Latino, 9.2%, Whites, 6.4%, and Asian/Pacific Islanders, 6.1%. During T2, 10.1% of adults, or 157,664, were estimated to have diagnosed diabetes by the BRFSS, with 10.3% of adult males and 9.9% of adult females in NM estimated to have diabetes. American Indians/Alaska Natives had the highest prevalence of diabetes with 16.4%, followed by Hispanic/Latinos, 11.6%, then Blacks, 9.0%, Whites, 7.6%, and Asian/Pacific Islanders 7.0%.

From 2004–2012 there were a total of 5,002 cases of invasive bacterial disease in New Mexico. The most common infection was *S. pneumoniae,* with 2,593 (51.8%) cases, followed by GBS 1,172 (23.4%), then GAS 954 (19.1%), *H. influenzae* 251 (5.0%), and *N. meningitidis* with 32 (0.6%) cases. Seven hundred cases were fatal. Fifty-six percent of invasive bacterial cases occurred in males. Cases ranged from 18–105 years of age, with a mean age of 59 years. Most cases occurred among Whites, 2,075 (41.5%), followed by unknown race, 1,752 (35.0%), American Indian/Alaska Native, 1,037 (20.7%), Blacks, 128 (2.6%), Asian, 19 (0.4%), and Native Hawaiian 10 (0.1%). Approximate

ly 1,495 (30.0%) cases occurred among Hispanics or Latinos.

Among cases of invasive bacterial disease during T1 and T2 (2004–2012), cases of GBS had the highest frequency of diabetes (52.0%). Cases of GAS infection had the second highest diabetes frequency (Table). Among all NM ABCs cases, the lowest frequency of diabetes occurred in 2008, when 24.5% of cases had diabetes (Figure). During subsequent years (2009–2012) frequencies of diabetes among NM ABCs cases were >30%.

Across all years, NM ABCs cases had higher frequencies of diabetes compared to the general population of NM. Twenty-nine percent of NM ABCs cases had diabetes during T1, compared to 7.8% of the general population of New Mexico. Frequency of diabetes was also higher among NM ABCs cases during T2, with 37.1% compared to 10.1% of individuals in the general population of NM (Figure).

## Discussion

Individuals with GBS had the highest frequency (52.0%) of diabetes compared to other invasive pathogens during 2004–2012. Similar studies suggest that among cases of GBS, diabetes is present in approximately 20–25% of cases. The findings of this analysis also indicate that among GBS cases in NM, the frequency of diabetes is much higher than the prevalence of diabetes in the NM population. Diabetics are more likely to have a GBS infection as complications from diabetes can reduce skin integrity due to poor circulation and changes in tissue structure. Lack of natural defenses in the skin allows for invasive disease from GBS. Similarly, immune system dysfunction and dyslipidemia caused by diabetes might predispose diabetics to develop other invasive infections and explain why high frequencies of diabetes were found among the other pathogens of interest.

The frequency of diabetes among NM ABCs cases was also higher compared to the general population of NM, in all years, from 2004–2012. If current trends of high incidence and low mortality continue, moderate estimates suggest that by 2050, the prevalence of diabetes may increase by approximately 25% to 28%, translating into an additional 18 million diabetics in the United States. These estimates have significant economic implications for NM as more than $2 billion dollars is

spent annually on diabetes in NM. Furthermore, with increased prevalence of diabetes, NM could also see additional cases of invasive bacterial disease in the coming years, adding to the costs of diabetes-associated care.

Differences in database methodologies between NM ABCs and NM BRFSS are limitations of this analysis. NM ABCs uses count data to assess the total burden of disease in NM, while NM BRFSS relies on survey methodologies to make estimates of count data. The collection of diabetes status is another limitation of this analysis.  Surveillance officers for the NM ABCs program collect information on cases from hospital records. Therefore, information provided for diabetes status only indicates whether an individual had diabetes noted in the medical record, at the time of the invasive bacterial infection. Confirmation of diabetes status or the duration of the disease prior to infection cannot be assessed with data currently available.  Additionally, the BRFSS relies on self-reported history of diagnosed diabetes and so may underestimate the true prevalence of diabetes in the adult population.

As the prevalence of diabetes is only expected to increase in the coming years, it is imperative that populations most at risk for diabetes in NM are educated regarding potential risk of infectious disease. By determining individuals at risk, support through diabetes management education, clinical care, and potentially vaccination against certain invasive pathogens of interest could help reduce the frequency of invasive infections among this population.

**Table. Frequency\* of diabetes by invasive pathogen, New Mexico, 2004 - 2012**

| Pathogen | Frequency n (%) |
|---|---|
| *N. meningitidis* | 4 (12.5) |
| *H. influenzae* | 61 (24.3) |
| GBS | 609 (52.0) |
| GAS | 286 (30.0) |
| *S. pneumoniae* | 607 (23.4) |

\*NM ABCs

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**Figure. Frequency of diabetes among ABCs cases compared to the estimated frequency of diabetes among residents aged >18 years, New Mexico, 2004–2012**