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Review

Healthcare providers as sources of vaccine-preventable diseases

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ABSTRACT

Vaccine-preventable infectious diseases may be introduced into the healthcare setting and pose a serious risk to vulnerable populations including immunocompromised patients. Healthcare providers (HCPs) are exposed to these pathogens through their daily tasks and may serve as a reservoir for ongoing disease transmission in the healthcare setting. The primary method of protection from work-related infection risk is vaccination that protects not only an individual HCP from disease, but also subsequent patients in contact with that HCP. Individual HCPs and healthcare institutions must balance the ethical and professional responsibility to protect their patients from nosocomial transmission of preventable infections with HCP autonomy. This article reviews known cases of HCP-to-patient transmission of the most common vaccine-preventable infections encountered in the healthcare setting including hepatitis B virus, influenza virus, *Bordetella pertussis*, varicella-zoster virus, measles, mumps and rubella virus. The impact of HCP vaccination on patient care and current recommendations for HCP vaccination against vaccine-preventable infectious diseases are also reviewed.

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1. Introduction

In 2011, close to 12 million people were employed in healthcare, making this one of the fastest growing employment sectors in the US [1]. These healthcare personnel or providers (HCP) especially in certain settings are exposed to infectious diseases, including those that are preventable by vaccination. Some of these vaccine-preventable diseases encountered in healthcare settings produce significant illness while in some cases the HCP can be asymptomatic. Although rare, HCPs may be exposed to and serve as a source of transmission of vaccine-preventable diseases to their patients. The vaccine preventable diseases most commonly encountered include the hepatitis B virus, influenza virus, *Bordetella pertussis*, varicella-zoster virus, and less commonly measles, mumps and rubella virus infections. One of the principal methods of protection from work-related infection risk is vaccination that protects the individual HCP from communicable disease for which vaccines are available. Equally, importantly, vaccination of HCP can prevent transmission of communicable diseases to patients who may have compromised immune systems. Hence, maintaining immunity in HCPs to vaccine-preventable diseases and assuring that the population is immune (herd immunity) is imperative to prevent transmission to and from HCPs. Because of these issues, individual HCPs and healthcare institutions must balance the ethical and professional responsibility to protect their patients from nosocomial transmission of preventable infections with the autonomy of HCPs to make their own decisions. This article reviews known cases of HCP-to-patient transmission of the most common vaccine-preventable diseases, the impact of HCP vaccination on patient care, current recommendations for HCP vaccination and associated barriers to vaccine coverage and transmission prevention.

For the purposes of this review, HCP refers to all employees, students, faculty, and volunteer staff working in healthcare settings who have the potential for exposure to patients and/or infectious materials such as body fluids, contaminated medical supplies, contaminated environmental surfaces and contaminated air [2].

2. Hepatitis B virus

2.1. Background and importance

Hepatitis B virus (HBV) infection is endemic worldwide serving as a major cause of morbidity and mortality. The prevalence of HBV varies geographically from 0.1% to greater than 20% [3]. The prevalence of past or present HBV infection in the United States is 4.9% [3,4], and higher outside of North America with variation

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depending on geographic location and patient population. The spectrum of HBV infection spans asymptomatic infection to fulminant hepatic failure [5]. Acute infection may progress to chronic infection, leading to increased risk of cirrhosis and hepatocellular carcinoma (HCC) [5].

Confirmed transmission of HBV from HCPs to patients is rare. Since HBV testing became available in the early 1970s, 53 HBV-infected HCPs have been linked to HBV transmission to more than 500 patients [6–22]. There has been only one report of HCP to patient transmission of HBV in the United States since 1994 [7]. This case involved an orthopedic surgeon who was unaware he was infected with HBV and definitively transmitted to two cases and possibly to another six patients. The surgeon had a high HBV viral load (>17.9 million IU/mL) and was hepatitis B e antigen (HBeAg) positive [7].

The highest reported rates of transmission involve surgeons and dentists who perform invasive procedures with significant risk of blood and body fluid exposure because of blind suturing, restricted anatomic spaces and poor visualization [9,23]. The stage and infectivity of the HCPs HBV infection are also related to the risk of transmission. Risk of transmission increases if the HCP is HBeAg positive and most reported cases have involved HCPs with high HBV viral loads [7,9,23]. Although rare, seven HBeAg-negative HCPs have been implicated in transmission of HBV to patients [13,14,16,17]; the majority of these HCPs were infected with a pre-core variant of HBV that prevented production of the e antigen [24].

2.2. Vaccine impact

The decline in reported cases of HCP to patient transmission of HBV in the last 20 years while multifactorial can likely be attributed to the widespread implementation of HBV vaccination beginning in 1982 [6–22]. Since that time the United States and Canada have implemented universal vaccination programs for HBV [25,26] and, the Advisory Committee on Immunization Practices (ACIP) and consensus groups in Canada, the United Kingdom and Europe recommend HBV vaccination of HCPs who are HBV surface antibody (anti-HBs) negative and at risk of contact with blood and/or body fluids [2,26–28]. In the US, the Occupational Safety and Health Administration (OSHA) mandates employers provide HBV vaccination for all HCPs with potential exposure to blood or bodily fluids [23,29]. Vaccination campaigns have led to a stunning 95% decline in the incidence of HBV infection among HCPs [25].

While vaccination campaigns, widespread adoption of standard precautions, implementation of safer work practices and engineering controls, and improved surgical techniques have all likely contributed to decreased transmission of HBV in healthcare settings, additional recommendations for the management of HBV-infected HCPs have been issued in many developed countries [23,26–28,30]. In addition to HBV vaccination of all HCPs and screening for chronic HBV infection in select individuals (vaccine non-responders, those at risk of HBV infection, and providers performing exposure-prone procedures), updated CDC guidelines recommend all healthcare institutions and medical and dental schools establish written policies and procedures for the identification and management of HBV-infected HCPs and students [23].

2.3. Recommendations in healthcare

The ACIP in the US recommends all healthcare personnel with potential exposure to blood and body fluids should receive the three-dose HBV vaccine series, generally administered at zero, one and six month intervals (Table 1) [2]. Within two months of the 3rd dose, anti-HBs should be measured [2]. If the anti-HBs level is not above 10 million IU/mL, a second, three dose series is administered [2]. Again, the HCP should be tested for immunity [2]. If these personnel do not achieve an anti-HBs level of 10 million IU/mL and they are core antibody negative they are considered non-responders [2]. In those who are previously vaccinated but anti-HBs were not measured, no follow up levels are needed except in the setting of exposure to blood or body fluids [2].

3. Influenza

3.1. Background and importance

Annual influenza epidemics are responsible for significant morbidity, mortality and carry an enormous economic burden. In the US between 1976 and 2007, the estimated annual rate of influenza-associated deaths ranged from 1.4 to 16.7 deaths per 100,000 persons, with fluctuations likely due to variations in circulating virus types [31]. The World Health Organization (WHO) estimates that 15% of the population develops influenza annually with an associated 250,000 to 500,000 deaths worldwide [32]. Based on 2003 data, the CDC estimates annual influenza epidemics in the United States lead to 31.4 million outpatient visits, 3.1 million hospitalized days and a total economic burden of $87.1 billion including direct medical costs ($10.4 billion) and lost productivity [33].

Significant amounts of influenza virus are present in respiratory secretions of those infected, with subsequent transmission resulting from close contact to respiratory droplets generated via coughing, sneezing or speaking [34,35]. Viral shedding from the respiratory tract may be detected up to two days prior to symptom onset and typically lasts 4 days in healthy adults; however, prolonged shedding up to several weeks can be detected in the young, elderly and those with chronic and/or immunocompromising conditions [36–38]. Infectious influenza viruses may also persist on inanimate surfaces for up to 48 h and on hands for up to 5 min, potentially facilitating transmission through direct contact [39,40].

Visits to healthcare facilities peak during influenza season [33,41,42], bringing many potentially infected with influenza together with those who are susceptible, facilitating nosocomial transmission [43]. Even asymptomatic, yet infected, HCPs and visitors contribute to influenza transmission [44]. In addition, HCPs often continue to work despite symptoms of influenza, further increasing the risk of nosocomial transmission to vulnerable populations [45,46]. Proper infection control measures are often delayed for patients with influenza in whom the diagnosis is not entertained, potentially leading to virus transmission to other patients. Some evidence suggests unvaccinated HCPs are the predominant source of nosocomial influenza [43,47–50]. A surveillance program to detect respiratory infections in both inpatients and HCPs found that HCPs accounted for half of all cases of acute respiratory infection during influenza season, underscoring the role unvaccinated HCPs can play in nosocomial influenza transmission [51].

Nosocomial outbreaks of influenza have been reported in multiple settings including adult intensive care units (ICUs), neonatal intensive care units (NICUs), general medical and surgical wards, transplant units and geriatric units [43,49,52]. Attack rates in one community hospital experiencing a nosocomial influenza outbreak were upwards of 50% among patients and 18% among HCPs [53]. Finally, in addition to attributable morbidity and mortality, nosocomial influenza disrupts healthcare services and increases medical costs due to staff shortages, bed closures, need for additional diagnostic evaluation and treatment, prolonged hospitalization and ward closures to control outbreaks [54–56].

3.2. Vaccine impact

Inactivated influenza vaccines (IIVs) are 50–70% efficacious and 60% effective at preventing influenza-like illness (ILI) in healthy