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Review Article

**VACCINES FOR ADULTS; A REVIEW OF RECENT
LITERATURE**

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Abstract:

Introduction: Vaccinations in adults and older patients are of special importance due to two main reasons: physiological and anatomical alterations in the body as it ages, making diseases more serious and possibly fatal, and so that adult individuals have a decreased immunological response when they are exposed to infections. Major adult vaccination includes influenza, pneumococcal pneumonia and meningitis, pertussis, tetanus, diphtheria, and hepatitis. **Aim of the work:** In this study, our aim was to understand the recent updates on adult immunization and their efficacy in disease prevention. **Methodology:** we conducted this review using a comprehensive search of MEDLINE, PubMed and EMBASE from January 1994 to March 2017. The following search terms were used: adult vaccination, adult immunization, influenza, pneumococcal pneumonia and meningitis, pertussis, tetanus, diphtheria, preventive measures, infection prevention. **Conclusion:** Several communicable diseases that affect the elderly population which can cause significant morbidity and mortality along with excessive costs on the health care system are easily preventable with the use of vaccination. Therefore, using vaccines to prevent these diseases should be updated and encouraged by all family health care practices.

Keywords: adult immunization, adult vaccination, preventive health measures

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INTRODUCTION:

From communicable diseases in adults older than 65 years, we can count four major common diseases that widely affect this population and can be prevented using vaccines. These four are influenza, pneumococcal pneumonia and meningitis, pertussis, and herpes zoster. These four affect a large proportion of adults in the United States leading to significant burden on both individuals and health care system. Other less common vaccine-preventable diseases include tetanus and diphtheria, which, however, are of less importance due to relatively low prevalence. Hepatitis is also a vaccine-preventable disease. However, vaccines for hepatitis are not routinely recommended and administered, especially in the elderly, where no sufficient data is present. In total, over forty thousand individual older than 65 die annually in the United States from a communicable disease that could have been prevented with vaccination, with influenza being responsible for the larger portion of cases [1].

Vaccinations in adults and older patients are of special importance due to two main reasons. The first reason is physiological and anatomical alterations in the body as it ages, making diseases, which may be normal or mild in younger patients, more serious and possibly fatal. For example, older individuals have a higher residual volume of the lung, reduced efficiency of mucociliary escalation, and a decline in the force of cough, leading to significant impairment in the eradication of the pathogenic organism from the respiratory tract [2]. The second reason is that adult individuals have a decreased immunological response when they are exposed to infections. This is mainly because of reduced activity of both T-cells and B-cells. Moreover, cytokines levels also decrease with age. This decrease in cytokines will lead to significant impairment in systemic responses to infection, like fever. Malaise, anorexia, and other systemic manifestations may be different in adults leading to atypical presentations of the disease, making diagnosis more challenging, and causing possible delay in the diagnosis [3]. The presence of other chronic co-morbidities is another major factor that causes higher risk of complications among this population [4].

Therefore, the best way to decrease morbidity and mortality associated with such diseases, is achieving primary prevention of them using vaccination. Vaccines achieve high cost-effectiveness with significant improvements in health status and quality of life of elderly. That is why the government of the United States launched the Healthy People 2020 initiative, in which their priority was to increase

awareness of vaccine-preventable diseases among adults [5]. Despite all efforts, and despite being recommended to elderly, the rate of vaccination among this population remains relatively low and unsatisfactory. For example, it has been estimated that in the year 2015, pneumococcus vaccine and influenza vaccine were administered to only 64% and 74% of eligible adults, respectively. Moreover, in the year 2014, only 28% of adults received the vaccine for herpes zoster [6]. In addition, racial disparities in vaccines rates are still present and increasing [1].

METHODOLOGY:

We did a systematic search for blunt abdominal trauma and imaging using PubMed search engine [<http://www.ncbi.nlm.nih.gov/>], EMBASE, and Google Scholar search engine [<https://scholar.google.com>]. All relevant studies were retrieved and discussed. We only included full articles. The following search terms were used: adult vaccination, adult immunization, influenza, pneumococcal pneumonia and meningitis, pertussis, tetanus, diphtheria, preventive measures, infection prevention.

The study was approved by the ethical board of King Abdulaziz University.

Influenza vaccination:

Among communicable diseases, influenza remains to be one of the most common causes of morbidity and mortality in adults older than 65 years, with being responsible for more than 75% of vaccine-preventable diseases in this population and causing over 4 million infections annually [7]. Moreover, it leads to significantly high costs, with being accounting for more than 50% of costs of communicable diseases. Generally, individuals older than 65 years have higher incidence of influenza, higher mortality from influenza, and higher risk of developing strokes and heart attacks following influenza infection [8]. A previous report by Nichol *et al*, concluded that in a larger population of veterans, administration of the influenza vaccine was associated with a significant decrease in the incidence of pneumonia, cardiovascular diseases, and cerebrovascular diseases by 29%, 19%, and 23%, respectively [9]. The main limitation of this study was the assumption that the group that received the vaccine had already been healthier than the other group. However, later studies in different areas around the world have shown similar outcomes. For example, another study was conducted in 2011 on male patients older than 65 years who were diagnosed with acute coronary syndrome, has found that the administration of influenza vaccine led to a

30% decrease in the incidence of a cardiovascular event [10].

Despite the presence of this evidence, the issue of influenza vaccine remains to be a debatable issue, especially as individuals become older, with no solid evidence supporting its high efficacy and cost-effectiveness in very old individuals. In fact, it is a fact that the antibody response caused by the vaccine is weaker in the elderly when compared to young adults. Therefore, efforts aim to develop better vaccines that can provoke higher immunological response in older individuals. Approaches to achieve this can include using adjuvants, different methods of delivery, and adjusted doses [11]. A clinical trial was published in 2014, in which researchers studied over 31,000 patients older than 65. Authors grouped patients into a group receiving standard low-dose of the influenza vaccine, and a group receiving the experimental high-dose of the influenza vaccine. They concluded that the group with the high dose achieved higher titers of the influenza antibody, and less rates of developing influenza than the other group [12]. Several later studies found similar conclusions, which led to the recommendation of administering higher doses of the vaccine to this population as an attempt to improve protection and decrease hospitalization from influenza [13].

In 2015, the use of an adjuvant vaccine among elderly was approved by the FDA after it had been shown to achieve higher titers of the influenza vaccine when compared to the standard vaccine with no adjuvant [14]. The FDA has approved the use of several types of the influenza vaccine over the last years. One of these new types is a recombinant vaccine that is egg-free, which is of special importance as it can be used by elderly who has allergy to eggs [15]. Another addition to the influenza vaccine is the addition of protection against influenza B strain, which has been observed to show increased prevalence and incidence recently [15].

Influenza vaccines that are approved for the elderly in the United States are all administered through the intramuscular route, with none of them containing living strains of the virus. Despite having proven efficacy, many types of these vaccines have not been tested in trials or patients older than 65 years [16]. The influenza vaccine is recommended for all individuals starting from the age of six months, and without exceptions, except for who have an absolute contraindication to the vaccine. It is ideally administered in October, before the onset of influenza, but can be administered until March [17]. Health care personnel are another population of

special importance when making guidelines and recommendations on vaccines use. The term 'health care personnel' includes any individuals who works in a health care setting, and has potential exposure to patients, whether being a paid worker or a volunteer. Generally, all health care personnel are highly recommended to receive the influenza vaccine annually. When dealing with health care personnel who are younger than 65 years, several options of the vaccine are available, which include the intranasal vaccine and the intradermal vaccine [15]. In the population of health care personnel, the importance of the influenza vaccine is not only the improvement of health status among this population, but also the prevention of infection spread to their patients, especially the elderly, who are more prone to serious complications. Previous reports have estimated that the rate of influenza vaccine among health care personnel can be as low as 63%. Therefore, the Health People 2020 initiative aimed for influenza vaccination in at least 90% of health care personnel [5].

Highest vaccine rates of health care personnel are found in hospitals where the vaccination of this population is obligatory. However, it is still debatable whether it is ethically acceptable to mandate workers to receive the vaccination, and whether they have the right or not to accept/reject being vaccinated. Generally, all the present evidence in the literature favors the use of vaccines to protect both the health care provider and the patient [18].

A published study has concluded that the vaccination of health care personnel in a hospital will lead to a significant decline in mortality of elderly patients in this hospital [19]. These studies along with other studies all favor the direct benefits of vaccinations to health care providers. Several strategies can be implemented to increase the rates of influenza vaccine in health care personnel. These strategies include applying universal vaccination policies, establishing multiple sites for free vaccines, designing electronic systems that allow the review and update of workers' vaccination status, giving recognition or even awards for those who receive the vaccine within time, and applying punishments for health care personnel who do not receive their vaccine, unless there is a valid medical reason for this [20]. Policies for vaccination of health care personnel should be continuously reviewed and updated.

Pneumococcal disease and pneumococcal vaccination:

Pneumonia from pneumococcus infection, which sometimes occurs following an influenza infection,

has the highest mortality rate when compared to any other vaccine-preventable communicable disease; it is estimated that over 40,000 patients die to pneumococcal pneumonia annually in the United States [15]. The most common presentation of a pneumococcal vaccine is pneumonia. However, complications like bacteremia and meningitis can also occur, especially in children and older patients [15]. A recent concern regarding pneumococcal infection treatment is the emerge of newer strains that are resistant to antibiotics treatment [21].

The incidence and severity of pneumococcal pneumonia depends on several factors. The most important factor is having another underlying comorbidity, with over 20% of patients infected with pneumococcus having comorbidity. A systematic review and meta-analysis assessed pneumococcal infection in individuals older than 65 years and found that coronary heart disease, diabetes mellitus, and chronic obstructive pulmonary disease, were all associated with significantly higher risk of acquiring a pneumococcal infection [22].

The strain of the pneumococcus organism is another important factor that affects disease's severity and clinical picture. For example, the development of bacteremia and meningitis, and the resistance to antibiotics treatment can be observed with certain strains of the organism higher than others [23]. It has been estimated that bacteremia following a pneumococcal infection can cause an annual number of 12,000 hospitalizations. Moreover, it has a mortality of over twenty percent, and over fifty percent of patients will develop meningitis. Other less severe complications of pneumococcus infection include acute otitis media and pneumonia. Previous reports suggest that streptococcus pneumonia alone is responsible for up to 400,000 hospitalizations every year, and more than 35% of pneumonia in adult individuals. Moreover, it has been associated with a 7% mortality risk, which increases as individuals age [15].

To complicate the issue, pneumococcal organisms' strains can change over times depending on environmental and host factors. Researchers have been able to recognize thirty streptococcus pneumonia strains that are capable of causing pathology in humans. Currently, two types of vaccines are available in the United States against pneumococcal infections. These two are the 13-valent conjugate vaccine [pneumococcal conjugate vaccine] [PCV-13], and the 23-valent vaccine [polysaccharide pneumococcal] [PPSV-23]. These two vaccines have been proven to target the most common strains of

pneumococcal organisms [24].

When assessing the vaccines against pneumococcus infection, it is quite challenging to determine exact efficacy of the vaccine as these vaccines do not work directly, making antibodies levels that are associated with protection unclear [24]. Despite being extremely important, rates for adults' vaccinations against pneumococcal infections have remained relatively low [about 64%] and is even lower in minority ethnic and racial groups [25]. In fact, recent reports have suggested that vaccination rates against pneumococcal infection in African Americans, Asians, and Hispanics are 48.7%, 45.3%, and 39.2%, respectively [25]. The Healthy People 2020 initiative has set a target to reach 90% rate by the year 2020 [5].

The 23-valent vaccine [polysaccharide pneumococcal] [PPSV-23] includes antigens against 23 strains which are the most common causing both invasive and non-invasive pathology. However, the efficacy of this vaccine is mainly in the reduction of bacteremia rather than pneumonia. This insufficient efficacy against pneumococcal pneumonia made it necessary to develop another newer type of the vaccine that is capable of efficiently reducing the risk of pneumonia [PCV]. Currently, the dual administration of both PCV and PPSV is recommended to maximize immunity and protection of older individuals against pneumococcal infection and diseases [15].

Current guidelines recommend the administration of PPSV to all adults who are older than 65 years. In addition, it is recommended to individuals who are chronic smokers or those who suffer from a chronic disease. The PPSV vaccine works by inducing an immune response that is B-cell dependent.

The PCV vaccine against pneumococcal infection was first introduced and approved for children in the year 2000. By then, it provided protection against 7 strains of streptococcus pneumoniae. The PCV vaccine was shown to work by inducing an immune response that is dependent on both T and B cells. In contrast to the PPSV, the PCV vaccine was proven efficient against both invasive and non-invasive pathologies caused by pneumococcal infection. In fact, it was found efficient against pneumonia, otitis media, and organism carriage [26]. The use of PCV in children was estimated to decrease the incidence of pneumococcal infection from 80 cases per 100,000 persons, to only one case for 100,000 persons. This significant decline in incidence and prevalence of the disease in children was indirectly reflected in adults. Later in 2010, the newer PCV-13 vaccine was

introduced and induced protection against 13 common strains of pneumococcus. This latest PCV type was associated with a 93% decrease in the risk of pneumococcal bacteremia and pneumonia [27].

Most recent guidelines have recommended the administration of both PCV and PPSV vaccines in older adults. The recommendations are as following: any adult individual who is 65 years or older, and who has not received any vaccination against pneumococcus previously, should receive one dose of the PCV-13 vaccine. Six to twelve months after the administration of the PCV dose, another dose of PPSV-23 is administered. Then, a second dose of PPSV-23 is administered after five years. For patients aged 65 years who had already received a PPSV dose before reaching 65 years, a dose of PCV should be administered after passing of at least one year from the dose of PPSV. For patients aged 65 years who had already received a PCV dose before reaching 65 years, no additional PCV doses are administered [28]. After complete administration of the vaccine, most individuals will develop sufficient immunity within three weeks or less. However, some adults may still show a delay in the response, especially those who are very old or have other comorbidities.

Patients who have chronic comorbidities, and health care personnel have similar guidelines to the general population. However, different guidelines are applied for patients who are immunocompromised, chronic kidney disease patients, patients with nephrotic syndrome, and asplenia. In these patients, PCV vaccine is administered regardless of age, and followed by a first dose of PPSV after two months and a second dose of PPSV after six months [28].

Tetanus, diphtheria, and pertussis:

Incidence of tetanus is relatively low in the United States. However, it is still considered a serious health issue especially when dealing with elderly. Tetanus disease occurs due to exposure to the spores of *Clostridium tetani*, which will produce the toxin. Tetanus can also develop in individuals who have no immunization against the toxin. Incidence of tetanus significantly increases, and even doubles, in individuals older than sixty years. Mortality from tetanus also increases as individuals age. Tetanus vaccine is considered the gold standard in preventing the disease and decreasing its incidence [29].

Diphtheria, which caused by an infection with *Corynebacterium diphtheriae*, also has a relatively low incidence and prevalence in the United States with a very small number of cases occurring annually. Diphtheria vaccine is considered the gold standard in preventing the disease and decreasing its

incidence [29].

Whooping cough, also known as pertussis, is caused following an infection with the *Bordetella pertussis* organism. Despite being common in infants, it can affect any age. Due to the administration of the pertussis vaccine to both children and adults, the incidence and prevalence of the disease has been declining significantly [30].

Vaccinations against tetanus, diphtheria, and pertussis are administered all together in what is known as the tetanus-diphtheria toxoids and acellular pertussis vaccine [TDaP]. TDaP vaccine is considered to be one of the most commonly used vaccines in adults, with efficacy that can reach 100% in healthy individuals. The use of the TDaP vaccine is crucial in adults to improve their health status, and to prevent the reemergence of diphtheria and pertussis. Since 2012, the recommendations have been to administer the TDaP vaccine for all adults older than 65 years unless there is an absolute contraindication [30].

CONCLUSION:

A large portion of communicable diseases that affect the elderly population can be prevented by vaccines. These diseases cause significant morbidity and mortality along with high costs on the health care system. Therefore, using vaccines to prevent these diseases will lead to significant improvements of the health care status of individuals, and will decrease the costs of care on the society. Influenza and pneumococcal pneumonia are considered to be the most common infectious diseases that could be prevented using vaccines. Both diseases are responsible for high mortality among the elderly. Influenza vaccine is given annually as an intramuscular injection. Vaccination against streptococcal pneumonia infection follows a more complicated protocol, with the administration of both PCV-13 and PPSV-23 vaccines. Other significant preventable diseases include tetanus, diphtheria, and pertussis. However, the incidence of the last three has been decreasing in the United States.

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