Original Research Article

Assessment of immune response to Hepatitis B vaccine by estimation of anti - HBs antibody titer among immunized health care workers

Badave G.K.[1], Puneriya P.[2]

[1]Dr. Gitanjali Kailas Badave: Associate Professor, Microbiology, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, [2]Ms Priyanka Puneriya, Third year MBBS student, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, India.

Corresponding Author- Dr. Gitanjali Kailas Badave, Associate Professor, Address: Department of Microbiology, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, India. Email: badve.gitanjali@gmail.com

Abstract

Background: Hepatitis B vaccination is recommended for all health care workers as they constitute a high-risk group for acquiring blood borne hepatitis B infection. Anti HBs level ≥10 mIU/ml at any time after vaccination is considered as a marker of sustained immunity, which provides protection against infection. Poor sero-protection rates to hepatitis B vaccine are recognized and some individuals do not develop sufficient levels of anti-HBs antibodies. Hence, it is necessary to identify the individuals who are non-protective responders to vaccination. With this background, the present study was undertaken to determine immune response to hepatitis B **v**accine amongst the health care workers. **Material and Methods:** The present cross-sectional study included 200 health care workers in a tertiary teaching hospital, who were immunized with three complete doses of hepatitis B vaccine. Quantitative determination of anti HBs levels was done by ELISA. The effect of gender, age, smoking, body mass index and duration after immunization on antibody levels were analyzed. **Results:** The association of anti-HBs status and gender was not statistically significant. Increase in age leads to decline of anti-HBs protective responders. Smoking and higher body mass index are significantly associated with less anti HBs titers (<10 mIU/ml). **Conclusion:** The highest number of protective responders is seen in initial 5 years post vaccination duration and least protective responders are observed in >10 years post vaccination duration, indicating decline in antibody response over a period of time.

Keywords: Hepatitis B vaccine, Health care worker, Anti-HBs titer, ELISA, CDC

Introduction

Hepatitis B virus (HBV) prevalence amongst the general population in India ranges from 2 to 8%, thus categorized as intermediate endemic zone for HBV [1]. The risk of contracting HBV by health care workers (HCW) is four-times greater than that of general population [2]. Blood infected with HBV carries the highest HBV load; making blood borne transmission as the most important mode in health-care setting [3]. Previous studies among HCWs in India had shown a high prevalence of Hepatitis B surface antigen (HBsAg) positivity (2–10%) [4,5] whereas recent studies have shown a relatively low prevalence (0.4–2%) [6,7].

Introduction of HBV vaccine in India was pilot-tested and later expanded to the entire country in 2011-12 [8]. Hepatitis B vaccine is safe, provides long lasting immunity and also indirectly protects against hepatocellular carcinoma [9,10]. Reports from India indicate that only 16-60% of HCWs have received complete HBV immunization. Paramedical staff has a greater risk of HBV transmission as occupational hazard, also the adherence of universal safety precautions is neglected among HCWs in developing countries [11,12].

Centre for Disease Control and Prevention (CDC) has recommended that all HCWs should receive Hepatitis B vaccination at 0, 1, and 6 months, administered intramuscularly [13]. Immunocompetent individuals having vaccine-induced anti-HBs titer of ≥10 mIU/mL after 1–2 months of complete dose of Hepatitis B vaccine are considered as seroprotected [14]. Vaccine induced seroprotection is a useful surrogate marker of vaccine efficacy [15]. Post vaccination seroprotection is achieved in approximately 95% of healthy individuals

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[16]. All HCWs, who are recently vaccinated should undergo anti-HBs testing, performed 1–2 months after administration of the last dose of the vaccine. Age, gender, obesity, smoking, immunity, and genetic factors may be responsible for reduced immune response to vaccination as documented in various Indian research studies [17, 18]. An anti-HBs titer less than 10mIU/ml is regarded as nonresponsive, levels between 10 and 100 mIU/ml are considered as hypo response and more than 100mIU/ml is considered as high level of immunity following vaccination.

Levels more than 10mIU/ml at any time after vaccination are considered as a marker of sustained immunity which provides protection against infection [14]. While the protective level of anti-HBs after primary vaccination has been shown to be 10 mIU/mL but the level of antibody necessary to provide long-term protect against HBV infection is still unknown [19].

The vaccination derived anti-HBs titers vanish over a period of time and the need for booster doses has long been a matter of argument. It seems reasonable that high-risk populations like HCWs may need boosters when their anti-HBs fall below the protective level.

According to CDC and the World Health Organization (WHO), there is no need to give boosters to individuals who acquired anti-HBs levels of ≥10 mIU/ml after completion of the HB vaccine schedule [14]. US Public Health Service do not recommend booster dose in HCW after completion of primary immunization with protective level of anti-HBs. However, HBV booster is recommended in immuno-compromised HCWs to maintain anti-HBs levels of more than10 mIU/ml [20].

Poor seroprotection rates to hepatitis B vaccine are documented in subjects of older age group, Body Mass Index (BMI) ≥ 25, smokers and poor nutritional status [17, 18].This makes it necessary to identify the individuals who are hypo responsive to vaccination thus taking necessary actions. The need for the present study is becoming increasingly important in Indian scenario to create awareness and ensure complete protection from Hepatitis B infection in high risk individuals particularly among health care workers. With this background the present study was undertaken to evaluate anti-HBs antibody levels among immunized health care workers in a teaching hospital.

Aims and Objectives

1. Estimation of anti-HBs antibody titer by Enzyme Linked Immune Sorbent Assay (ELISA) test in immunized health care workers.
2. Assessment of variation of anti-HBS titers with factors like gender, age, smoking, body mass index and post immunization duration.

Material and Methods

Place of study: Mahavir Institute of Medical Sciences, Vikarabad**,** Telangana State.

Type of study: Cross sectional

Study population: Health care workers in tertiary care hospital

Inclusion criteria

Health care workers (doctors, staff nurses, technicians) in tertiary care hospital who have been immunized against Hepatitis B with 3 complete doses.

Exclusion criteria

1. Health care workers in tertiary care hospital who are not immunized against Hepatitis B or immunized without completion of full course of vaccination.
2. Health care workers who are positive for HBsAg.

The current study included 200 healthcare workers who received full course of hepatitis B vaccine. Ethical clearance from the Institutional Ethical Committee and Informed consent from all individuals was obtained for the study. The demographic details like age, gender, height, weight, personal habits, medical history, and details of Hepatitis B immunization were recorded for each individual in case record form.

Under strict aseptic precautions, 3 ml of venous blood was collected by venipuncture from all subjects. Serum separation was performed by centrifugation of the blood sample at 2000 rpm for 20 minutes. Serum thus separated was stored at −20°C until anti-HBs test was undertaken. Commercially available HBsAb ELISA kit for quantitative determination of antibodies to Hepatitis B surface antigen, manufactured by DIA. PRO diagnostic (Italy) was used for quantitative assay of anti-HBs. ELISA was performed as per the manufacturer's instructions.

As per the assay procedure for quantitative analysis, 50µl of specimen diluent was added in all the micro-wells except the wells for blanking. Further, 100 µl of all the calibrators (0, 10, 50, 100, 250 mIU/ml) and 100 µl of control serum in duplicate was dispensed in the corresponding micro-wells as per the manufacturer protocol. The micro-plate was incubated at 37^0C for 60 minutes. Later five washing cycles (aspiration and dispensation of washing solution) were performed using wash buffer concentrate (350 µl / well). Then 100 µl of

enzyme conjugate was added in all the micro-wells except blank micro-wells. The micro-plate was again incubated at 37^0C for 60 minutes followed by washing cycles as done before. Then 100 µl of chromogen substrate (tetramethyl benzidine and hydrogen peroxide) was added in all the wells including blank wells. The micro-plate was again incubated at room temperature for 20 minutes followed by addition of 100 µl of sulphuric acid in each well. The color intensity was measured with micro-plate reader at 450nm and 620 nm. Anti-HBs antibodies were quantitated by means of standard curve calibrated against WHO reference preparation (1977) with concentrations of 0, 10, 50, 100, 250 mIU/ml. As per the results of post HBV immunization titer, health care workers were classified as follows:

1. A protective responder is a person with levels of anti-HBs ≥10 mIU/ml.
2. A non-protective responder is a person with levels of anti-HBs <10 mIU/ml.

Note:protective responder and non protective responder terminology used in the present study is strictly based on above mentioned anti HBs titer after primary series of complete hepatitis B vaccination.

Whereas, as per CDC guidelines subjects with anti-HBs level <10 mIU/ml after primary series of complete vaccination are advised to repeat the complete series of vaccination again.

Even after second series of complete vaccination, if subject continues to have anti-HBs level <10 mIU/ml, then they are considered as non-responders to vaccination.

Statistical analysis: Analysis of results was carried out by Statistical Package for the Social Sciences (SPSS). Chi-square test was used for significance of difference in various groups. p value <0.05 was considered significant.

Results

A total of 200 subjects participated, of which 160 (80%) were protective responders and 40 (20%) were non protective responders, post immunization. Anti-HBs status in relation to gender is as mentioned in Table 1.

Table-1: Gender and anti-HBs status

Anti-HBs status	Male	Female	Total
Protective responder	88 (75.9%)	72 (85.8%)	160 (80%)
Non-protective responder	28 (24.1%)	12 (14.2%)	40 (20%)
Total	116 (100%)	84 (100%)	200 (100%)

p value by Chi square test is 0.08 (not significant as P value is more than 0.05)

Although the percentage of female protective responders was greater (85.8%) compared to male protective responders (75.9%), the association of anti-HBs status and gender was not statistically significant (p value 0.08)**.** As seen in Figure-1, increase in age leads to decline of anti-HBs protective responders. The lowest number of non-protective responders (03/40) is seen in age group less than 20 years. Whereas, highest number of non-protective responders (18/40) is seen in age group of more than 60 year.

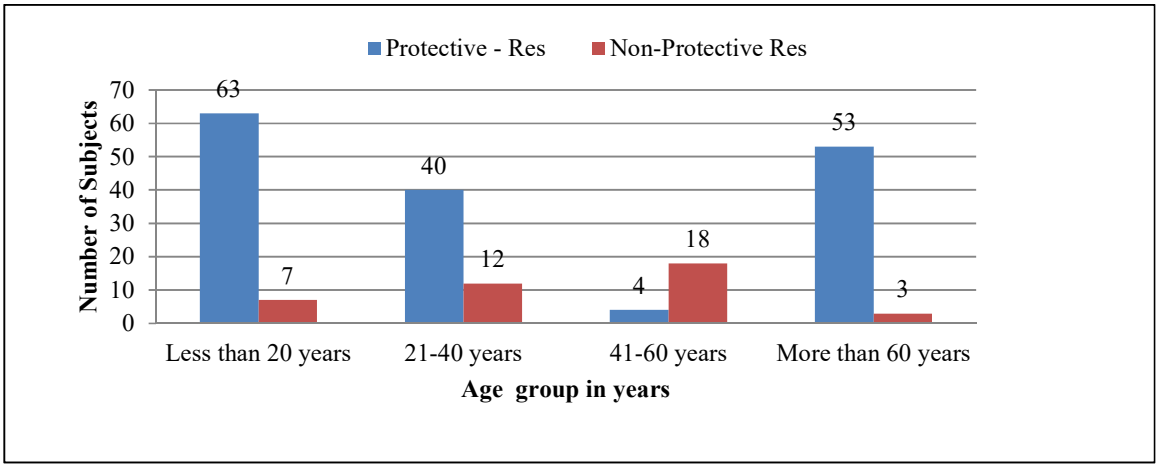

Figure-1: Age wise distribution of protective responders/non-protective responders of anti-HBs status.

Table-2 shows comparison of anti-HBs status among smokers and non-smokers. Smokers has less protective responders as compare to non-smokers and this is statistically significant (p value less than 0.0001).

Table-2: Smoking and anti-HBs status

Anti-HBs status	Smokers	Non-smokers	Total
Protective responder	19 (11.9%)	141(88.1%)	160
Non protective responder	29 (72.5%)	11 (27.5%)	40
Total	48 (100%)	118 (100%)	200 (100%)

p value by Chi square test is less than 0.0001

Table-3 depicts relationship of BMI with anti-HBs status. Higher BMI is associated with greater number of non-protective responders, which is statistically significant (p value less than 0.0001).

Table-3: Body mass index and anti-HBs status.

Anti-HBs status	BMI < 25	BMI >25	Total
Protective responder	142 (88.7 %)	18 (11.3 %)	160
Non protective responder	04 (10%)	36 (90%)	40
Total	146 (100%)	54 (100%)	200 (100%)

p value by Chi square test is less than 0.0001

Figure-2 shows highest number of protective responders in initial 5years of post vaccination duration and least protective responders are observed in >10 years post vaccination duration, indicating decline in antibody response over time.

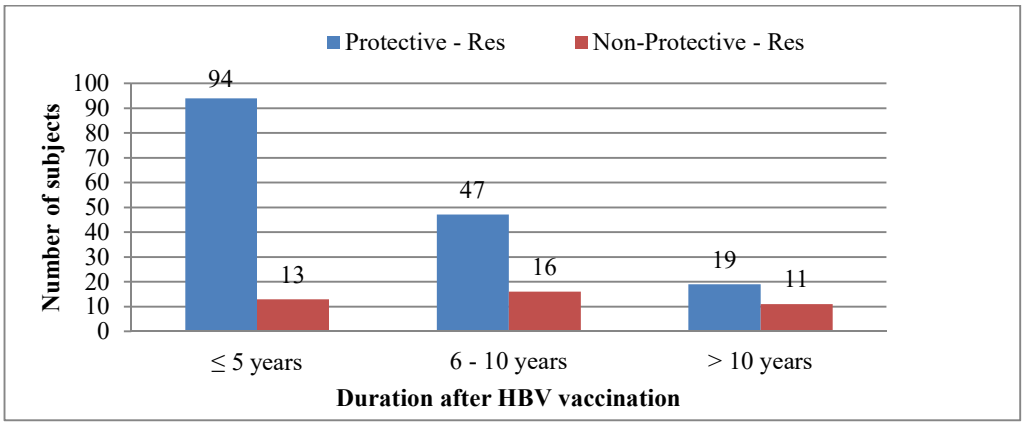

Figure-2: Duration after HBV vaccination and Anti-HBs status.

Discussion

Vaccination is the most effective prevention method for Hepatitis B. Since the 1980s, primary HBV immunization has been implemented to reduce HBV transmission and has shown high efficacy [21]. Sero-protection against HBV infection is defined as having an anti-HBs level of ≥10 mIU/mL after having received a complete immunization schedule [14]. Immunity against HBV provides protection against infection which is directly related to the peak production of anti-HBs after primary vaccination. Additionally, protection against disease is offered by immune memory cells, which persists even after disappearance of anti-HBs [21]. In the present study, out of total 200 subjects, 160 (80%) were protective responders and 40 (20%) were non protective responders, post HBV immunization. Although the percentage of female protective responders was greater (85.5%) compared to male protective responders (75.9%), the association of anti-HBs status and gender was not statistically significant. Ashmaki et al, Chaudhari et al observed that anti-HBs titer due to gender factor was not statistically significant [22,23]. Also research studies have reported increased

percentage of non-protective responders among males as compared to females [24,25]. Smoking and certain genetic factors have been proposed as probable reasons for a poor immune response to HBV immunization in men [17,18]. In the present study, maximum non-protective responders were constituted by subjects above 60 years age group, whereas least by less than 20 years age group.

Maximum positive responders were seen in age group of 21-40 years. Similarly, Aghakhani et al studied persistence of anti-HBs among vaccinated children and concluded that vaccine-induced anti-HBs titer decline or remain undetectable with increase in age [26]. Age associated changes in humoral and cellular immune function is a determining factor for poor immune response to vaccination. Sero-protection declines among individuals above 40 years compared to those less than 40 years [27]. This underlines the importance of HBV vaccination at the earliest for better immunogenicity and protection for high risk group especially among health care workers.

In the current study, 60.4% (29/48) smokers showed antibody titer <10mIU/mL. This association of smoking with reduced anti HBs titer is statistically significant. This present finding is consistent with decreased antibody titer observed in smokers as compared to non-smokers in various research studies [28,29]. Cigarette smoking is associated with range of alterations in immune function. It is well-accepted that nicotine leads to weakening of immune system[30,31].

Winter et al found that smokers who received hepatitis B vaccines at 0, 1, and 6 months had lower antibody levels than nonsmokers after 3, 7, and 13 months [32]. Nejad et al also identified smoking as a significant factor associated with decreased sero-protection after HBV vaccination in Iranian healthcare workers [33]. Shaw et al also established a harmful effect of cigarette smoking on antibody response after hepatitis B vaccination. [29] Wood et al. also linked smoking as an independent risk factor for vaccine non-response [25].

In the present study, 66.6% subjects of BMI >25 has anti HBs titers less than 10mIU/ml, this association of higher BMI with low titer is statistically significant. Weber et al observed that antibody responses to hepatitis B vaccine were significantly reduced in obese individuals as compared with non-obese people [34]. Dinelli et al reported that the obese women who did not response to 6 doses of recombinant hepatitis B vaccine, showed sero-conversion subsequent to weight reduction [35].A suggested mechanism causing inappropriate immune responses in obese individuals may be leptin-induced systemic inflammation and alterations in innate and adaptive immune responses [36].

In the present study, highest number of protective responders (58.8%) is seen in 0-5 years post vaccination and least protective responders (11.9%) are observed more than 10 years post vaccination indicating decline in antibody response over a period of time. Floreani A et al evaluated the long-term persistence of sero-protection after HBV vaccination and concluded that rate of persistence of anti-HBs declines with increase in the duration of post vaccination period [37]. In adults, anti-HBs concentrations decrease rapidly within the first year after primary vaccination and more slowly thereafter.

A decline of titer to a level of 10mIU/mL is seen in 7%–50% of vaccinated adults within 5 years after vaccination was observed [38]. Regardless of low or undetectable antibody titers years after vaccination, immune memory was confirmed in various studies [39, 40]. Therefore, CDC advised that a booster dose no longer be administered to fully vaccinated healthy subjects [14].

Limitations of present study: In the present study, the response of revaccination (second three dose schedule) was not analyzed among non-responders in the initial series of Hepatitis B vaccination. Likelihood of responding to a revaccination schedule is reported to be high among initial non responders to vaccination.

Conclusion

The present study determined immune response to hepatitis B vaccine amongst health care workers. Anti HBs levels were measured and the influence of factors like gender, age, smoking, body mass index and duration after immunization on antibody levels was analyzed. The percentage of female protective responders was greater compared to male protective responders, but the association of anti-HBs status and gender was not statistically significant.

Increase in age leads to decline of anti-HBs protective responders. Smoking and higher body mass index (BMI >25) are significantly associated with inadequate anti HBs titers (<10 mIU/ml) following vaccination. The anti HBs titers show waning effect with regard to increase in post vaccination period. The highest numbers of protective responders are seen in initial 5 years of post-vaccination and least protective responders are observed in more than 10 years of post-vaccination.

What the study adds to the existing knowledge?

In the context of present study, it is recommended to test anti-HBS titer after 1-2 month of last dose of vaccination to check efficacy of immunization. Further it is also recommended that non-protective responders (with titer of <10mIU/ml) should be re-vaccinated with complete 3 dose series (as per CDC guidelines). Even after complete re-vaccination, if anti-HBs titer continues to remain <10mIU/ml, then such individual is categorized as non-responders. HCW, who are non-responders should be counseled that they are susceptible to HBV infection, in spite of vaccination.

Author's contribution

Dr. Gitanjali Kailas Badave: Conceived and designed the study, Prepared the manuscript

Priyanka Puneriya: Data collection and data analysis

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Conflict of interest: None declared
Ethical Approval: This study was approved by the Institutional Ethics Committee

References

1.Previsani N, Lavanchy D. World Health Organization. Hepatitis B(WHO/CDS/ CSR/LYO/ 2002.2). 2002.

2. Dannetun E, Tegnell A, Torner A, Giesecke J. Coverage of hepatitis B vaccination in Swedish healthcare workers. J Hosp Infect. 2006;63(2):201-204. doi: https://doi.org/10.1016/j.jhin.2006.01.014.

3. US Public Health Service. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for post exposure prophylaxis. MMWR 2001;29:50.

4. Elavia AJ, Banker DD. Hepatitis B virus infection in hospital personnel. Nat Med J India. 1992;5(6): 265-268.

5. Kumar KA, Baghal PK, Shukla CB, Jain MK. Prevalence of hepatitis B surface antigen (HBsAg) among Health Care Workers. Indian J Comm Med. 2000; 25 (2):93-96.

6. Kalaskar A, Kumar M. Prevalence of hepatitis B and hepatitis C viruses among nurses and nursing students in a medical college hospital in southern Tamil Nadu, India. Int Res J Microbiol. 2012;3(1):10-13.

7. Jha AK, Chadha S, Bhalla P, Saini S. Hepatitis B infection in microbiology laboratory workers: pre-valence, vaccination, and immunity status. Hepat Res Treat. 2012; 2012: 520362. doi: 10.1155/2012/ 52036

8. Laharia C, Subramanya C, Sosler S. An assessment of introduction of hepatitis B vaccine in India: Lessons for roll out and scale up of new vaccines in immunization programs. Indian J Public Health. 2013; 57 (1):8-14. doi: 10.4103/0019-557X.111357.

9. WHO Department of Immunization, Vaccines and Biologicals. 2009. World Health Organization (WHO) Vaccine Preventable Diseases: Monitoring System. 2009 Global Summary. WHO Geneva, Switzerland.

10. Beasley, R. Palmer & WHO Expanded Programme on Immunization. (1988). Hepatitis B: immunization strategies / R. Palmer Beasley. World Health Organization. Available at https://apps.who.int/iris/ handle / 10665/60119.

11. Pati NT, Sethi A, Agrawal K, Agrawal K, Kumar G T, Kuma M. et al. Low level of awareness, vaccine coverage, and the need for booster among health care workers in tertiary care hospitals in India. J Gastroenterol Hepatol. 2008; 23(11):1710-1715. doi:10. 1111/j.1440-1746.2008.05483.x.

12. Shrestha SK, Bhattarai MD. Study of hepatitis B among different categories of health care workers. J Coll Physicians Surg Pak. 2006;16(2):108-111. doi: 2. 2006 /JCPSP.108111.

13. Shefer A, Atkinson W, Friedman C, Kuhar DT, Mootrey G, Bialek SR, et al Immunization of Health CareWorkers,"Recommendation of advisory committee on immunization practice (ACIP) and the Hospital Infection Control Practice advisory committee (HICPAC)," MMWR, Recommendation and Report. 1997; 46:1–42.

14. Mast EE, Weinbaum CM, Fiore AE, Alter MJ, Bell BP, Finelli L, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part II: immunization of adults. MMWR Recomm Rep. 2006;55(RR-16):1-33; quiz CE1-4.

15. Jack AD, Hall AJ, and Maine N, Mendy M, Whittle HC. What level of hepatitis B antibody is protective? J Infect Dis. 1999;179(2):489-492. doi: https://doi.org/10. 1086/314578.

16. Alikasifoglu M, Cullu F, Kutlu T, Arvas A, Taştan Y, Erginöz E, et al. Comparison study of the immunogenicity of different types and dosages of recombinant hepatitis B vaccine in healthy neonates. J Trop Pediatr. 2001;47(1):60-62. doi: 10.1093/tropej/ 47. 1.60.

17. Tripathy S, Sathi HC, Puspa SS, Shankar R, Singh VK. Study of immune response after hepatitis B vaccination in medical students and healthcare workers. Ind J Prevent Soc Med. 2011 ;42: 315-321.

18. Nashibi R, Alavi SM, F. Yousefi F, Salmanzadeh S, Moogahi S, Ahmadi F et al. Post-vaccination immunity against hepatitis B virus and predictors for non-protective responders among medical staff. Jundishapur J Microbiol. 2015;8(3): e19579. doi: 10.5812/ jjm. 19579.

19. Francis DP, Hadler SC, Thompson SE, Maynard JE, Ostrow DG, Altman N, et al. The prevention of hepatitis B with vaccine: report of the Centers for Disease Control multicenter efficacy trial among homosexual men. Ann Intern Med. 1982;97(3):362-366. doi: 10.7326/0003-4819-97-3-362.

20. CDC. Updated US Public Health Service Guidelines for the Management of Occupational Exposure to HBV, HCV and HIV and Recommendation for Post exposure Prophylaxis. MMWR 2001;50(RR11):1-42.

21. Poovorawan Y, Sanpavat S, Pongpunglert W, Chumdermpadetsuk S, Sentrakul P, Vandepapelière P, et al. Long-term efficacy of hepatitis B vaccine in infants born to hepatitis B e antigen-positive mothers. Pediatr Infect Dis J. 1992;11(10):816-821. doi: 10. 1097/00006454-199210000-00002.

22. Acchammachary AA, Ubale M, Belurkar DD, Bhave PP, Malgaonkar AA, Kartikeyan S. A cross-sectional study of post-vaccination anti-HBs titer and knowledge of hepatitis B infection amongst medical students in a metropolitan city. Int J Res Med Sci. 2017;5(1):83-88. doi: http://dx.doi.org/10.18203/2320-6012.ijrms20164528.

23. Chaudhari C, Bhagat M, Shah T, Misra R. Antibody to Hepatitis B Surface Antigen in Vaccinated Health Care Workers. Med J Armed Forces India. 2008;64 (4):329-332. doi: 10.1016/S0377-1237(08) 80013-5.

24. Zeeshan M, Jabeen K, Ali AN, Ali AW, Farooqui SZ, Mehraj V, Zafar A. Evaluation of immune response to Hepatitis B vaccine in health care workers at a tertiary care hospital in Pakistan: an observational prospective study. BMC Infect Dis. 2007;7(1):120. doi: 10.1186/1471-2334-7-120.

25. Wood RC, Macdonald KL, White KE, Hedberg CW, Hanson M, Osterholm MT. Risk factors for lack of detectable antibody following hepatitis B vaccination of Minnesota health care workers. J Am Med Assoc. 1993; 270 (24):2935-2939. doi:10.1001/jama.1993.0351024 0047030.

26. Aghakhani A, Banifazl M, Izadi N, McFarland W, Sofian M, Khadem-Sadegh A et al. Persistence of antibody to hepatitis B surface antigen among vaccinated children in a low hepatitis B virus endemic area. World J Pediatr 2011; 7(4):358-360. doi: https:// doi.org/10.1007/s12519-011-0286-4.

27. Wick G, Grubeck-LoebensteinB. The aging immune system: primary and secondary alterations of immune reactivity in the elderly. Exp Gerontol. 1997; 32 (4-5): 401-413. doi: 10. 1016/ s0531- 5565 (96) 001 52-0.

28. Bock H, Kruppenbacher J, Sanger R. Immuno-genicity of a recombinant hepatitis B vaccine in adults. Arch Intern Med. 1996;156(19):2226-2231. doi:10. 1001/ archinte. 1996.00440180088011.

29. Shaw FE, Guess HA, Roets JM. The effect of anatomic injection site, age and smoking on the immune response to hepatitis B Vaccination. Vac. 1989; 7 (5): 425-430. doi: 10.1016/0264-410x (89) 90157-6.

30. Arcavi L, N. L. Benowitz. Cigarette smoking and infection. Arch Intern Med. 2004;164(20):2206-2216. doi: 10.1001/archinte.164.20.2206.

31. Sopori M. 2002. Effects of cigarette smoke on the immune system. Nat Rev Immunol. 2002;2(5):372-377. doi: 10.1038/nri803.

32. Winter A. P., E. A. Follett, J. McIntyre, J. Stewart, I. S. Symington. 1994. Influence of smoking on immunological responses to hepatitis B vaccine.Vac. 1994; 12(9):771-772. doi: https://doi.org/10.1016/0264-410X(94)90283-6.

33. Nejad EM, Jafari S, Rabirad N. Hepatitis B virus antibody levels in high-risk health care workers. Hepat Mon. 2011; 11 (8): 662-663. doi: 10.5812/kowsar. 1735143 X.707.

34. Weber DJ, Rutala WA, Samsa GP, Bradshaw SE, Lemon SM. Impaired immunogenicity of hepatitis B vaccine in obese person.N Engl J Med. 1986;314 (21):1393. doi: 10.1056/NEJM198605223142120.

35. Dinelli MI, Moraes-Pinto MI. Seroconversion to hepatitis B vaccine after weight reduction in obese non-protective responder. Rev Inst Med Trop Sao Paulo. 2008; 50 (2): 129-130. doi: 10.1590/ s0036-466520080002000 13.

36. Papathanassoglou E, El-Haschimi K, Li XC, Matarese G, Strom T, Mantzoros C. Leptin receptor expression and signaling in lymphocytes:kinetics during lymphocyte activation, role in lymphocyte survival, and response to high fat diet in mice. J Immunol .2006;176 (12):7745-7752. doi: 10.4049/jimmunol.176.12.7745.

37. Floreani A, Baldo V, Cristofoletti M, Renzulli G, Valeri A, Zanetti C, et al. Long-term persistence of anti-HBs after vaccination against HBV: an 18 year experience in health care workers. Vac. 2004; 22(5-6): 607-610. doi: https://doi.org/10. 1016/j.vaccine. 2003. 09.001.

38. Plotkin S, Orsenstein W, Offit P. Vaccines. Philadelphia: Elsevier, 2008.

39. Bauer T, Jilg W. Hepatitis B surface antigen-specific T and B cell memory in individuals who had lost protective antibodies after hepatitis B vaccination. Vac.2006;24(5):572–577.doi: https://doi.org/10. 1016/j. vaccine.2005.08.058

40. Wainwright RB, McMahon BJ, Bulkow LR, Parkinson AJ, Harpster AP. Protection provided by hepatitis B vaccine in a Yupik Eskimo population. Seven-year results. Arch Intern Med. 1991;151(8): 1634-1636. doi: 10.1001/archinte.151.8.1634.

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