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Analysis of the Effectiveness of the Immune Reaction When Using Vaccination Against the Hepatitis B Virus

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Abstract It is known that the main way to prevent viral hepatitis B is vaccination. The goal is to evaluate the effectiveness of the immune response against the background of immunization against the hepatitis B virus. **Materials and methods.** An enzyme immunoassay was carried out on 280 blood samples of vaccinated children for the presence of HBs antigen (rapid test and ELISA) and antibodies against HBs antigen (using an enzyme immunoassay). To determine the HBsAg express method, the American-made Aria test system "HBs COMBO RAPID TEST" (CTK Biotech, Inc, expiration date 2025-01-29) was used. After confirming the express test, an ELISA test was performed to check the antigen using the Vector-best test system "Vectogep B - HBs-antigen". The amount of immune Anti-HB antibodies against hepatitis B vaccination was determined by ELISA using the "Vector Best" test system (international certificate ISO 13485, expiration date 2024-05-12) "VectoHBsAg-antibody". **Results and conclusions.** The study did not reveal positive results for the hepatitis B viral antigen, which is proof of the effectiveness of immunity acquired as a result of vaccination. It is important to note that over time, this immunity may begin to wane due to lack of exposure to the antigen. This emphasizes the need for regular monitoring of the condition and, if necessary, additional vaccinations in order to maintain the body's protective functions.

Keywords Viral hepatitis B, Gender differences, Immunity, Vaccine

1. Introduction

Viral hepatitis is one of the global health problems, causing great damage to human health and healthcare systems [1].

According to the World Health Organization (WHO), 820,000 people die from hepatitis B every year, of whom more than 650,000 died from liver cirrhosis or hepatocellular carcinoma and about 130,000 from acute viral hepatitis. [2.8]. Currently, 296 million people worldwide are infected with chronic hepatitis B, and an additional 1.5 million people become ill with the disease each year. Hepatocellular carcinoma ranks third in mortality among cancers in the world [3].

Hepatitis B virus can be effectively prevented through vaccination. The introduction of the vaccine into national immunization programs has led to a reduction in transmission of the virus in highly endemic countries [6]. To increase adherence to a healthy lifestyle and vaccination, it is important to carry out outreach to the population and introduce educational programs [5]. This will help prevent infection and the development of chronic forms of the disease [4]. By 2030, vaccination is expected to prevent approximately 210 million cases of chronic hepatitis B virus infection and eliminate approximately 1.1 million deaths [7].

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2. Material and Research Methods

The study was conducted at the Republican Specialized Center for Epidemiology, Microbiology, Infectious and Parasitic Diseases in the city of Tashkent. Blood samples were taken from 280 vaccinated children against viral hepatitis B. For analysis, an express method was used (Aria HBsAg Kombo Rapid test, manufactured by CTK Biotech, expiration date until January 29, 2025) to determine the presence of HBsAg and an ELISA test system to assess immunological tension (Vecto HBsAg antibody test system, certified according to ISO 13485, valid until 05/12/2024). Blood samples from patients treated for hepatitis B virus in the clinic were also used as a control group, and their sera were analyzed using a rapid test for HBsAg and ELISA tests for the quantitative determination of antibodies to HBsAg. After collection, the blood was transported to the laboratory with a cold reagent, blood serum samples were stored in a refrigerator at -200C, and before use were kept at room temperature for 1 hour, then tests were carried out. Among the children examined, boys made up 52%, girls 48%. Analysis of the age of the examined children showed that children under 1 year old accounted for 9% (24), 1-3 years old - 36% (101), 3-5 years old - 30% (84), 5-8 years old - 25% (71). Of the 280 children who participated in the study, vaccination cards for 259 children were analyzed.

Statistical analysis was carried out using the StatTech v program. 4.1.2 (developer - Stattekh LLC, Russia).

3. Results and Discussion

As a result of the analysis of vaccination cards, it was found that out of 280 children, 7.5% (21) had no vaccination cards. Among the examined children who had vaccination cards, 5.4% (15) received one dose of the vaccine, 2.5% (7) received 2 doses, 8.9% (25) received 3 doses, 75.7% of children (212) received 4 doses of the vaccine. (Fig. 1).

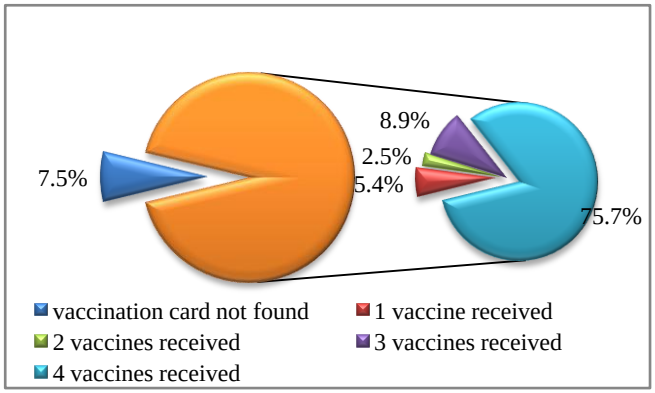

Figure 1. Distribution of examined children depending on the frequency of vaccination. (n=280)

The results of the analysis showed that the proportion of children who received 4 doses of the vaccine (75.7%) was significantly higher ($P<0.05$).

All children examined had negative HBsAg results. The results of testing for the presence of antibodies against HBsAg showed that antibodies to HBsAg were detected in 62% of children out of 280 children, the remaining 38% of children had negative test results.

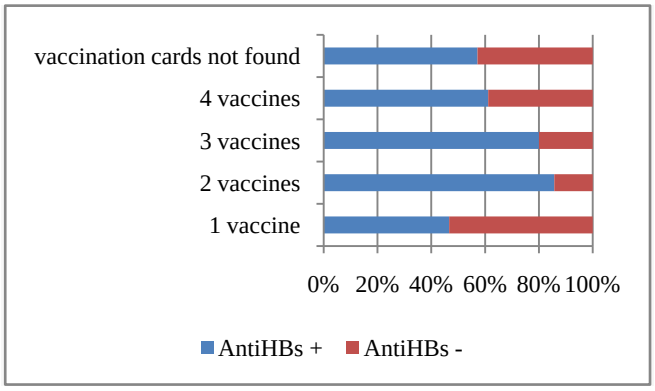

Figure 2. Proportion of children vaccinated against HBV with antibodies to HBsAg

We analyzed the proportion of children with antibodies to HBsAg depending on the frequency of vaccination; it was revealed that 47% of children who received one dose of the vaccine, 86% of children who received two doses of the vaccine, 80% of children who received three doses of the vaccine, 61% of children who received four doses of the vaccine have antibodies to HBsAg, 54.5% of children whose vaccination cards were not found also had antibodies to HBsAg. (Fig. 2). So, based on the results of the study, we can conclude that almost half of the children examined developed antibodies to the HBs antigen after receiving one dose of the vaccine. Despite the fact that all children were vaccinated, not all children developed antibodies in response to vaccination or persisted at the time of the examination.

The next step was to analyze the presence of anti-HBs antibodies in the examined children depending on gender. Based on the results of an analysis of the presence of anti-HBs antibodies in children depending on gender (Table 1). It was found that there were more boys with antibodies to the HBs antigen than girls.

Table 1. Proportion of children with the presence of anti-HBs antibodies in the examined children, depending on gender (n=280)

Gender	Anti-HBs (+)	Anti-HBs (-)
Boys	95 (66%)	50 (34%)
Girls	79 (59%)	56 (41%)
Total (%)	174 (62%)	106 (38%)

In our comprehensive analysis of childhood vaccination data, we also examined the timeliness of HepB-BD vaccination and found that the proportion of children vaccinated in the maternity ward who received the vaccine within 0-1 days after birth was 97.5%. The remaining 2.5% of children were vaccinated within 2-6 days after birth. The proportion of children who received 4 doses of hepatitis B vaccine during the first year of life was 56% (117). Among them, 8.7% (18) of children were vaccinated at the age of 0 to 4 months, 47.6% (99) - from 5 months to 1 year, and the rest after a year. Thus, 8.7% of children who received the vaccine against viral hepatitis B on time and the full dose indicated in the national vaccination calendar accounted for 56% of children who received it during the first year, the rest received it later. (Table 2) presents the timing of vaccination of children fully vaccinated against viral hepatitis B (n=208).

Table 2. Vaccination schedule for children who received 4 doses of hepatitis B vaccine. (n-208)

Timing of vaccination (4 doses of vaccine received)	Amount of children	Percent (%)
Up to 4 months	18	8.7%
5-12 months	99	47.6%
12-24 months	74	35.6%
24-36 months	13	6.3%
After 36 months	4	1.9%

Analysis of the detection of antibodies to HBsAg depending on the age of children (Fig. 3.) showed that the percentage of detection of antibodies decreases with increasing age of children. It can be seen that anti HBs were detected in 75% of children under one year of age, and by 7 years this figure was 43%.

At the next stage of our study, the titers of antibodies to HBsAg were studied depending on the length of time after receiving the last vaccine (Table 3.). As a result of the analysis, it was revealed that the median duration of time after the last vaccination in 96 children with an antibody titer

to the HBs antigen below 10 mIU/ml was 28.97 months (Q1–Q_3:16.66-49.01). In the majority of children (120 children), antibody titers were 10-100 mIU/ml with a median duration of time after vaccination of 22 months, antibody titers after the last vaccination of 100-200 mIU/ml were determined up to 14 months, the median duration of detection of concentrated antibodies to HBsAg after the last vaccination in the titer, in the titer of 200-300 mIU/ml, 19 months, in the titer of 300-400 mmI/ml was 23 months, and in the amount of 400 mmI/ml did not exceed 2 months. Taking into account the above, we can conclude that over time after vaccination, the concentration of antibodies to HBsAg in the blood of all children decreases.

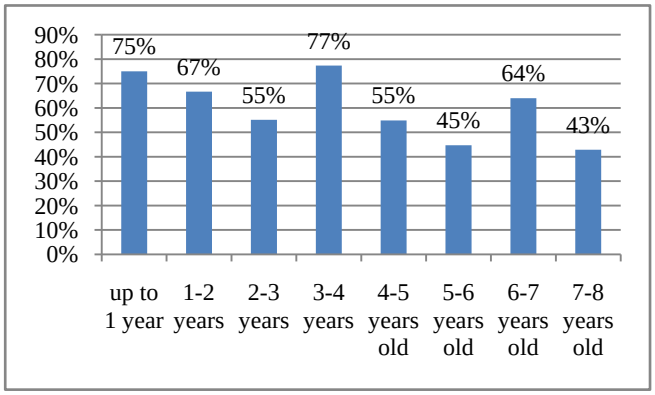

Figure 3. The proportion of children with antibodies to HBsAg depending on the age of the children

Table 3. Detection threshold of AntiHBs (N-259) after receiving the last vaccine (months)

Antibody titers	Me (months)	Q1–Q_3	n	p
<10 mIU/ml	28.97	16.66 – 49.01	96	0.035*
10-100 mIU/ml	22.03	7.39 – 43.16	120	
100-200 mIU/ml	14.83	5.55 – 32.01	16	
200-300 mIU/ml	19.63	12.28 – 31.32	12	
300-400 mIU/ml	23.92	9.03 – 45.43	12	
400 mIU/ml <	2.27	2.12 – 8.63	3	

Using ROC analysis, determine the dependence of the probability of detecting antibodies to HBsAg on the length of time after the last vaccination. (Fig. 4.)

It has been found that the detection of antibodies to HBsAg in children by ROC analysis is expressed in the form of a curve that is largely dependent on the length of time since the last vaccine.

The area under the ROC curve was 0.597 ± 0.037 with 95% CI: 0.524 – 0.669. The resulting model was statistically significant (p = 0.009).

The threshold value of the length of time after the last vaccination at the cut-off point, which corresponded to the highest value of the Youden index, was 21.367 months. The presence of antibodies was predicted at a value below this value. The sensitivity and specificity of the model were 52.1% and 68.8%, respectively.

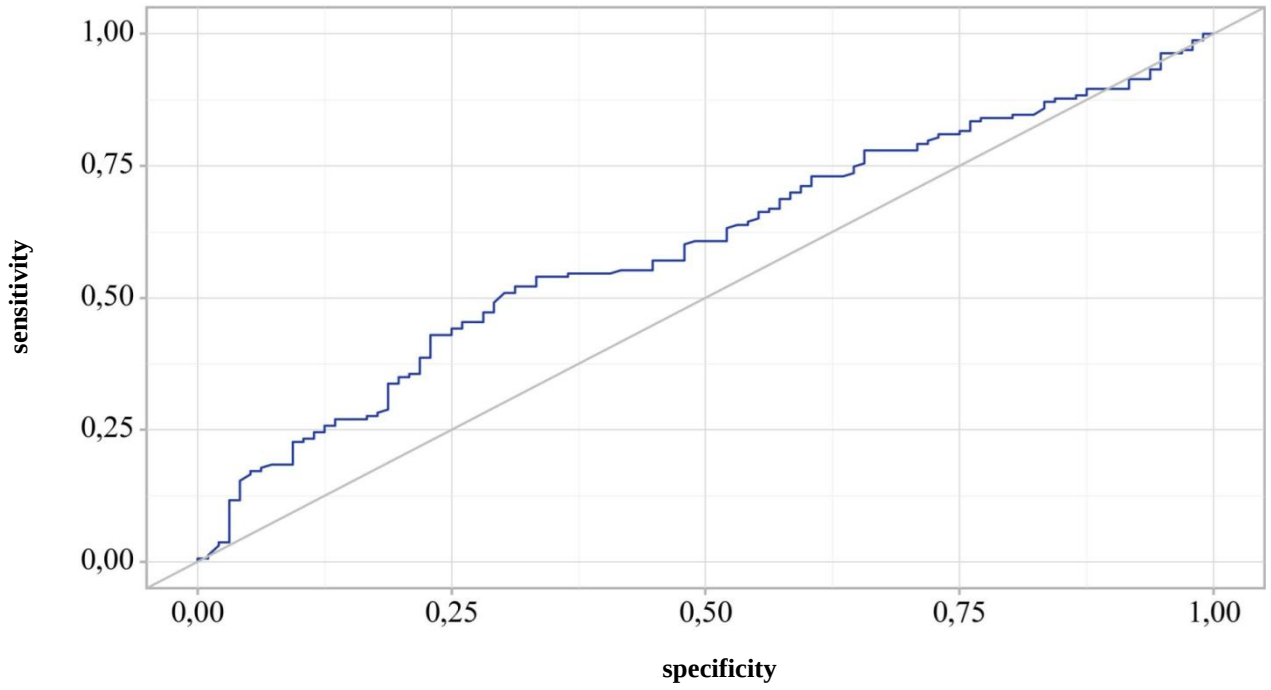

Figure 4. ROC curve representing the dependence of the probability of detecting antibodies to HBsAg on the length of time since the last vaccination

4. Conclusions

1. According to the national immunization schedule, 8.7% of children received the full dose of hepatitis B vaccine on time, and 56% of children received it within one year.
2. A study related to the detection of HBs antibodies depending on the age of children showed that the percentage of antibody detection decreases with age. Antibodies were detected in 75% of children under the age of one year, and by 7 years this figure was 43%.
3. The concentration of HBs antibodies in the blood did not exceed 10 mIU/ml in 37.5% (105) children, 10-100 mIU/ml in 46.8% (131), and in 15.7% (44) children more than high titers (more than 100 mIU/ml).
4. ROC analysis showed that the probability of detecting HBsAg antibodies after the last vaccination persists for up to 21,367 months.
5. The concentration of antibodies to HBsAg in the blood serum of children decreases over time after vaccination.

Thus, the study did not find positive results for hepatitis B virus antigen, confirming the effectiveness of the immunity obtained as a result of vaccination. It is important to note that this immunity may wane over time due to lack of exposure to the antigen. Therefore, regular monitoring of the condition and, if necessary, additional vaccination will help maintain the body's protective functions. Immunity gained through vaccination is an important element of protection against viruses and diseases. However, like any system, it requires care and attention. Regular observation and monitoring of the state of immunity will help to promptly identify possible problems and take the necessary measures to eliminate them.

REFERENCES

[1] Requirements for global elimination of hepatitis B: a modeling study./ Nayagam Sh [et al.] // Lancet Infect. Dis., 2016, vol. 16, no. 12, pp. 1399–1408. (In English)

[2] Nelson, N. Epidemiology of hepatitis B virus infection and impact of vaccination on dissease/ N. Nelson, P. Easterbrook, B. McMahon // Clin. Liver Dis., 2016, vol. 20, no. 4, pp. 607–628. (In English)

[3] Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality world wide for 36 cancers in 185 countries / Sung H [et al.] // CA Cancer J. Clin. 2020; 71(3): P.209–49. (In English)

[4] Time-series analysis of tuberculosis from 2005 to 2017 in China. / Wang H [et al.] // Epidemiol. Infect., 2018, vol. 146, no. 8, pp. 935–939. (In English)

[5] Xasanova GM Kompleksnaya reabilitatsiya bolnix gemorragicheskoy lixoradkoy s pochechnim sindromom/ monografiya. – Ufa. - 2011. pp. 272. (In Russ)

[6] WHO. Hepatitis B: Fact sheet. Available at: https://www.who.int/news-room/fact-sheets/detail/hepatitis-b (accessed November 29, 2021). (In English)

[7] Informatsionnye byulleteni o selyax v oblasti ustoychivogo razvitiya: zadachi, svyazannye so zdorovem. Virus hepatitis. Available at: https://www.euro.who.int/__data/assets/pdf_file/0003/364953/viral-hepatitis-rus.pdf (Accessed 22.02.24 01.07.2022). (In Russ)

[8] Virus gepatiti: klinika, diagnostika, lechenie./Yushuk ND [et.al.]// M.: GEOTAR-Media; 2014. (In Russ)