Expert Interviews

National STD Curriculum Podcast

HPV Vaccines: Results & Impact of Australia's National Immunization Program

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Dr. Eric Chow, STI epidemiologist and biostatistician based at the Melbourne Sexual Health Center in Australia, reviews data from the school-based HPV National Immunization Program and the impact on the prevalence of different HPV serotypes, genital warts, and HPV-related cancers.

Topics:

- HPV
- genital warts
- herd effect

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Transcript

Read along with the audio or jump to a particular chapter.

In this episode:

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introduction**[00:00] Introduction**

Dr. Ramchandani

Hello, everyone. My name is Meena Ramchandani. I'm an infectious disease physician at the University of Washington in Seattle. This podcast is dedicated to an STI [sexually transmitted infections] review for health care professionals who are interested in remaining up to date on the diagnosis, management, and prevention of STIs.

We are excited to welcome Dr. Eric Chow for this episode to discuss HPV and HPV vaccination. Dr. Chow is an STI epidemiologist and biostatistician based at the Melbourne Sexual Health Center in Australia. He heads the health data management and biostatistics unit and is a professor at Monash University. Dr. Chow's research program aims to improve the treatment, prevention, and control of STIs with a particular focus on gonorrhea and human papillomavirus (or HPV). And to all of our regular listeners, Dr. Chow led the randomized control trials to evaluate whether a mouthwash would work to treat or to prevent gonorrhea, which we reviewed in our August 2021 episode and is one of our most listened episodes. In this particular episode, we're going to focus on his work related to HPV. Welcome, Eric. Thank you so much for being on this episode.

Dr. Chow

It's my pleasure to be here. Thanks for inviting me.

what-is-hpv**[01:08] What is HPV?**

Dr. Ramchandani

What is HPV and what does it cause?

Dr. Chow

So HPV is a very common virus that can spread through skin-to-skin contact, and this also includes sexual activities. HPV can affect all genders, both boys and girls, male and female. It has been estimated that about 85% of females and 91% of males will get an HPV infection during their lifetime. We know there are probably more than 200 different types of HPV and many do not cause symptoms, but some will do. So, some HPV will cause warts or pre-cancer lesions. For example, we have low-risk HPV types 6 and 11 that actually cause 90% of genital warts, and while high-risk types such as 16 and 18, they can also cause cancer, and about 70% of cervical or anal cancers are caused by these two high-risk types, 16 and 18.

Dr. Ramchandani

There's lots of HPV serotypes. Some of them don't really cause disease and the patient's immune system or the person's immune system can overcome that HPV, but there are particular serotypes that lead to either warts or to cancer, correct?

Dr. Chow

Yes, that is correct.

vaccine-why-when-who**[02:39] Vaccine: Why? When? Who?**

Dr. Ramchandani

And then, what are the benefits of HPV vaccines and why is it recommended?

Dr. Chow

I think we are very fortunate to have HPV vaccines available. So, the HPV vaccine can actually protect us from getting serious outcomes and also can also protect the community by reducing the spread of the disease, and can also protect you from a range of different cancers and also other diseases that are caused by HPV. We know that since we have the HPV vaccine, and lots of different clinical trials and also population-level studies have also shown a reduction in HPV infection and related disease.

Dr. Ramchandani

Who should be vaccinated against HPV? What are the recommendations, at least in Australia?

Dr. Chow

Well, I think ideally, I think everyone should get the HPV vaccine. And, when I say everyone, like this is including both men and women. But it is better to get the vaccine before they become sexually active, because we know the vaccine has a better protection when it is given before someone is exposed to the virus.

Dr. Ramchandani

And so, who is getting the HPV vaccine in Australia?

Dr. Chow

So, Australia, we have a school-based program, and both school boys and school girls aged 12 to 13 will get the free HPV vaccine. This is part of the National Immunization Program.

3-types-vaccines**[04:05] 3 Types of Vaccines**

Dr. Ramchandani

Can you tell us a little bit about the different vaccines available for HPV in Australia and the different serotypes they might protect against?

Dr. Chow

So, right now we have the three different HPV vaccines on the market. First, we have the bivalent vaccine, which protects against the two high-risk types, 16 and 18. And next, we have the quadrivalent vaccine, which

not only cover the two high-risk types, but also the two low-risk types, 6 and 11, which cause the genital warts or anal warts that I just mentioned. Finally, we have the nonavalent vaccine, which also provides protection against the nine different HPV types.

Dr. Ramchandani

So, we have the 4-valent vaccine, which prevents against serotypes that cause the highest number of cervical or different types of cancers, as well as some serotypes that cause genital warts, and then the 9-valent type, which has an expanded set of HPV serotypes it protects against, correct?

Dr. Chow

Yeah, that's correct.

school-based-program**[05:07] School-Based Program**

Dr. Ramchandani

So, you mentioned the national school-based HPV vaccination program. Tell us a little bit more about this program.When did it start and what led to the program being implemented?

Dr. Chow

Australia was one of the very first countries in the world to introduce the school-based HPV vaccination program, which made the vaccine free for teenagers through the National Immunization Program. Right now, teenagers aged 12 to 13 years old can also get the HPV vaccine for free at school. They can also go to doctors, local council, and also even pharmacies in order to get the vaccine.

Dr. Ramchandani

What if they don't get it through the program? Is there a catch-up vaccination program?

Dr. Chow

The HPV vaccination program started back in 2007, and initially for school girls for ages 12 to 13 years old. We did have a catch-up program for young women aged up to 26, but that catch-up program was only run until 2009, and we currently don't really have any other catch-up program. And I forgot to mention that the program actually expanded to include boys in 2013, so this gender-neutral approach actually helped to ensure everyone, regardless of gender, to get protected from HPV.

Dr. Ramchandani

Now, Australia is pretty unique in that this was really the first national school-based program. What led to the school-based vaccination program being implemented, and how was it implemented? It's pretty amazing to be able to vaccinate such a large number of individuals from getting cancer in the future.

Dr. Chow

I think we were very fortunate that our government actually made the decision to implement this school-based program. This is basically based on scientific evidence, and it actually showed to be very effective and also protects against serious conditions such as cancer. And, it's actually rolled out through school, so usually they have education to the teenagers, and also some education and packages to the parents and also the kids to understand what HPV is and also the benefits of having the HPV vaccine.

Dr. Ramchandani

What type of education do you do with the school-based children and with the parents?

Dr. Chow

I think it varies. So, there are lots of official education, like the printed material or some YouTube videos that can be provided to both the kids and their parents. But also, some schools will probably have a school nurse and they can also provide some additional education in terms of, not just HPV, but maybe related to other health or sexual health education.

vaccination-uptake**[08:00] Vaccination Uptake**

Dr. Ramchandani

And so, what has been the vaccination uptake across jurisdictions?

Dr. Chow

It has been really high over the decade, so it's also very good to see, it's very similar for both boys and girls. I just looked up the data back in 2023, so about 86% of girls and 83% of boys turning 15 have been vaccinated against HPV. So, 86% and 83% is a very similar number in both genders, which is really good to see.

Dr. Ramchandani

Yeah, that's fantastic. Were there any barriers that you know of to vaccination uptake, and how was that overcome?

Dr. Chow

Yeah, I think for the vaccines, when first introduced, some people were very hesitant, I think mainly because they worry about the vaccine safety. But over the decade of education, and also we had a lot of awareness campaigns, this is probably not the big issue anymore. But we do know there's some gaps in vaccine coverage, and this is probably mostly due to whether they can have access to the vaccine, and also sometimes maybe probably due to the cultural and also regional reasons that they may not want the vaccine. So, this is probably the major gap and major challenge that we'll probably need to deal with, particularly with people living in remote and rural areas that may have limited access to health care services and also the vaccine as well.

vaccine-dosing**[09:34] Vaccine Dosing**

Dr. Ramchandani

How many doses are administered of the vaccine? Are you doing three doses or two doses? And then, did you find that when you went from three doses to two doses, if you did, did that increase uptake or make it easier for individuals?

Dr. Chow

This is a very, very complicated question, because we actually changed quite a few times. So, from 2007 to 2017, so a decade, we used the 3-dose quadrivalent vaccine. That is the vaccine that covers four types. In 2018, we switched from the three doses (quadrivalent) to two doses (nonavalent), which covers the nine types of vaccine. And, more recently, in 2023, we dropped it to one dose, the nonavalent. So, it has been quite a bit of changes over time, but also, if people have a weakened immune system, we still recommend

them to have three doses. I think the change is very recent, so we'll probably need to wait a bit more time to see the impact about two doses versus one dose. We have a long history of three-dose vaccine.

Dr. Ramchandani

So, it's really only one dose. That can really reduce barriers to people getting the vaccine, because they don't have to come back for subsequent vaccination.

Dr. Chow

Correct. Also, the coverage is also a bit tricky to calculate, as you mentioned there, because previously they calculated complete dose, which is three doses, and then two doses, and then one dose, but we didn't actually see much decrease. And it's actually slightly increased, but it's just very difficult to compare, because you are comparing one, two, and three doses over time. But having one dose and the coverage was about 85%, which is really good, I think.

education-focus**[11:31] Education Focus**

Dr. Ramchandani

When the vaccine education is being discussed with families or with school-based children, how is it being discussed? Is it a way that this vaccine will prevent against cancer? When talking to parents, is it about sexual health or STIs? Where is the emphasis, or is it a combination?

Dr. Chow

I think different schools doing different things, so from the national perspective, we actually focus on the cancer prevention. So, it doesn't really mention anything about STIs, so some schools may, but I'm not entirely sure how the schools do the education. But, at a national level with the material, it’s always mentioned about cancer.

Dr. Ramchandani

So, it's a cancer-prevention vaccine.

Dr. Chow

Yes.

Dr. Ramchandani

And that's really where the focus is. That's really helpful.

impact-on-prevalence**[12:26] Impact on Prevalence**

Dr. Ramchandani

What has been the impact of the national vaccination program on HPV prevalence?

Dr. Chow

I think the impact of the national HPV program on HPV prevalence has been massive. We actually have quite a lot of different studies showing a dramatic drop in HPV vaccine types among those people who have been vaccinated, particularly those people in the younger age, and also Australian-born people who were eligible

for the vaccine.

Dr. Ramchandani

Has this impacted HPV prevalence for serotypes formulated in the vaccine, and what about serotypes that are not part of the vaccine?

Dr. Chow

Yes, so we did a study looking at probably 10 years of a cohort of men and women coming to our sexual health clinic with chlamydia, and we actually find that for females with chlamydia, we compared the HPV type before the vaccination and after the vaccination period, and we saw a 54% reduction in HPV that's covered in the vaccine. And we also saw a very similar reduction in heterosexual men as well. It's about 60%. And, I just want to point out that because this cohort is individuals coming to the STI clinic and they're very sexually active, and they're also at high risk of HPV. So, compared to the general population, so that means the actual impact of the vaccination program may be even higher than what we have observed.

And, back to your question, for those genotypes that is not covered in the vaccine, and in the same study we actually didn't see any changes or decline or even increase in those types, which is also really good news that you actually reduce the vaccine type, but may have an increased risk to other types. So, I think this is actually evidence showing the vaccine actually works really well and also protects against some high-risk and also low-risk types that may cause a serious outcome.

Dr. Ramchandani

Do you think that there's potentially some sort of immune response that's being elicited by the vaccine that protects people from HPV, whether it's HPV serotypes in the vaccine versus even serotypes that are not part of the vaccine?

Dr. Chow

There has been lots of wide discussion, and I don't think we still quite understand. That could be potential, but looks like we don't really have any risk of having other higher prevalence among those vaccine types that is not covered in the vaccine.

genital-warts--cancer-rates**[15:16] Genital Warts & Cancer Rates**

Dr. Ramchandani

What has been the impact on high-grade cervical disease and genital warts?

Dr. Chow

I may probably start with genital warts first, which is easier. In Australia, we have set up this national surveillance network which actually tracks cases of genital warts across about 40 sexual health clinics in Australia. So, a few years ago, we actually published a study looking at national impact, examining genital warts trends over time, and we actually found that genital warts has dropped about 58% in females and 45% in heterosexual men, which is very, very promising, since we started our HPV vaccination program in 2007. And also, I just want to remind everyone that the boys were not included in the school-based program until 2013, so most of these men were not vaccinated, and the reduction we saw in this population is called “herd protection” or “herd effect.” That actually means that these men were not directly vaccinated, but they still get the benefits from the female partners because there's fewer people around them carrying the virus.

Dr. Ramchandani

What about high-grade cervical disease? That might be harder to study because it's a longer time before you can see that impact, right?

Dr. Chow

So, we do have some national data from Australia showing a big drop in high-grade disease in women, that's who were eligible for the HPV vaccine. I think the biggest or fastest reduction was seen in the youngest group. For example, before the vaccination, it is estimated that about 14 out of every 1,000 women screened had a high-grade lesion or high-grade disease, but now it's actually dropped down to 5 cases per 1,000 women screened. So, we definitely see a huge reduction among these women. We didn't see any of this kind of reduction in women that were not eligible for the vaccine, so definitely, it's the impact from the vaccine.

Dr. Ramchandani

And the fact that you're not seeing an increase in other serotypes even makes it more of an impact, because it's not like it's being replaced by other serotypes that could cause genital warts or high-grade cervical disease.

Dr. Chow

Correct. There's also some data on cervical cancer incidence that actually show a significant drop after we introduced the HPV vaccine program, and I actually looked up some data. So, they actually said that in 1982, that the age standardized incidence rate was 16 cases per 100,000 women, and it dropped down to 8 cases per 100,000 women in 2022, so it's actually half of the incidence. So, very, very promising.

Dr. Ramchandani

Have you looked at other types of cancers that are HPV-related? For example, the potential impact on HPV-related oropharyngeal cancer, or anal cancer, or penile cancer?

Dr. Chow

I would love to look at those cancers to see whether there's any impact from the vaccination program, but it's also very challenging to track those cancers. This is because it usually takes decades to develop the cases, but we do have some studies actually showing reduction in HPV in those sites, including the oropharyngeal and also the penile area. So, if we see a very similar reduction in the HPV types that can cause cancer at those sites, I can't see why we are not seeing a reduction in cancer, but you probably just need to take time for us to look at the impact and also to get the data.

Dr. Ramchandani

And, you, I imagine, are going to look at the impact of the 9-valent vaccine compared to the 4-valent vaccine. I wonder if that's going to adjust the impact as well over time.

Dr. Chow

It will be quite challenging for us to look at different vaccines and also different doses, as well, so it's a really good point.

Dr. Ramchandani

What about mortality from HPV-related cancers? Has there been any data to suggest that there's been an impact on that?

Dr. Chow

So, we do have some national data has shown that the number of deaths from cervical cancer decreased over time, over the same period, from 1982. The death rate decreased from 6.2 deaths per 100,000 women to 2 deaths per 100,000 women in 2022, so definitely a very good improvement, to save lots of lives.

Dr. Ramchandani

That's a big deal.

herd-effect-impact**[20:20] Herd Effect Impact**

Dr. Ramchandani

Now, you mentioned the herd effect. For our audience, can you describe the herd effect? And, you mentioned that there has been a reduction in HPV prevalence that might have been an impact of the herd effect. How about genital warts or cancers, or impact on cervical disease?

Dr. Chow

So, herd effect means those people who were not vaccinated actually get some benefit from their vaccinated partners, because those vaccinated partners will have a lower prevalence or lower rates of certain diseases, so they will be less likely to get the infection or disease. But, there's actually a condition that would probably need a fairly high vaccination rate in the population in order to create this herd protection. Most of the studies that we did was only looking at genital warts, because it's a proxy that we can actually use as an outcome. We also did some study on HPV prevalence, as well, so we also see reduction in HPV prevalence among those who were not vaccinated, but that their female partners got vaccinated with the vaccine type. We did see a reduction in those types. I'm not aware of any study looking at herd protection for cervical disease and cancer, and again, it may probably need some time to get data.

Dr. Ramchandani

This has really had a huge impact on the community, this school-based vaccination program, in a much larger way than potentially it had even been anticipated.

Dr. Chow

Yes, because with the female-only school-based program, we already saw a very significant reduction in heterosexual men, and also, we do have some data when we added the gender-neutral program, we also saw a further reduction in screened men. Also, because females have been really, really low, and so it still remains low. But I think it's a really important point for the gender-neutral program, we need to remind ourselves that there's some other populations such as gay men they probably won't receive the same benefit as heterosexual men due to their sexual preference. Most gay men were not vaccinated, so they probably won't get the same protection. We didn't see any reduction in genital warts and HPV prevalence in gay men during the female-only vaccination program. So, this is actually not only making the vaccine more inclusive, to have both genders to have the protection against HPV, but also, even when we're talking about heterosexual men, the heterosexual men can get the vaccine and can also protect against their female partner, if the female is not vaccinated. So, it's kind of like a win-win situation. You can actually protect the entire community.

other-national-hpv-programs**[23:31] Other National HPV Programs**

Dr. Ramchandani

Do you know of other countries who also implemented a national HPV vaccination program based on the

experience from Australia, since you guys were the first ones?

Dr. Chow

I think that the U.S. was the first one, technically, but yeah, we're very, very close. One of the very first few ones. Lots of countries, I think, have followed. I think, including the UK and some European countries. In the guidelines, they also cite our papers and evidence in their recommendations, but I think different countries may probably implement their vaccine in a different way, depends on the setting. The coverage and also the different types of vaccine may probably also impact on what they're going to measure at the end as the public health benefit. I think, as of today, I think the WHO [World Health Organization] reports about 148 countries have already implemented a national HPV program, and very, very good to see. Almost half of them actually took both boys and girls, so it's definitely much improving, and hopefully we're seeing more countries coming on board to provide a gender-neutral national HPV program to the people in the country.

measuring-impact**[24:50] Measuring the Impact**

Dr. Ramchandani

So, are you going to measure the impact of the 9-valent now that you have switched over to that? Do you have any data so far of the impact on HPV prevalence or HPV-related disease?

Dr. Chow

Unfortunately, I don't have any data yet, because we only switched to the nonavalent vaccine, not until 2018, so it's still very recent and it takes time to see the effect, but we're doing a study currently. So, we'll look at the impact of the 9-valent vaccine among young gay and bisexual men who got the vaccine from the school-based program. So, these boys would have been vaccinated from school, having the nonavalent two doses at school when they were aged 12 to 13. So, in this study, we collect samples from the mouth, genital, and anal areas, and then we send the samples to the lab for HPV testing, and then we can compare the HPV prevalence, because this is the third cohort that we are doing. The first cohort was people who were not vaccinated, second cohort was vaccinated against the quadrivalent type, and this cohort would have been vaccinated for the 9-valent type. We'll have three different cohorts to compare the prevalence. We plan to finish recruiting by the end of this year. It has been very challenging for recruitment because they're very young, aged 16 to 20, so very difficult to get them to the clinic and also do extra swabs. Fingers crossed, hopefully we will have some data to share sometime next year, so stay tuned with us.

Dr. Ramchandani

I look forward to seeing that data. Are there any other areas that you are going to be evaluating for the impact of the national school-based HPV vaccination program?

Dr. Chow

So we're also planning to do some surveillance, particularly from the genital wart surveillance that I mentioned. The previous genital wart surveillance that I mentioned was only focusing on women and heterosexual men, but we haven't done any study on gay and bisexual men. But that will be quite challenging, because, not only the school-based program but also in Australia, some states also implemented some HPV vaccination programs for MSM [men who have sex with men] for a very, very short period of time just before COVID. So, some states actually offered gay and bisexual men aged up to 26 a free vaccine, having the three doses quadrivalent vaccine within a year or two, and that probably needs to bring into the consideration when we do the analysis. So, it's underway.

can-hpv-be-eliminated**[27:44] Can HPV Be Eliminated?**

Dr. Ramchandani

Based on this data and the data you gathered, do you think the elimination of a vaccine-type HPV disease in Australia seems achievable?

Dr. Chow

I think so. In 2019, there's a modeling paper from Australia actually predicting the incidence rates of several cancers in Australia will fall below 4 cases per 100,000 women by 2028.

Dr. Ramchandani

Wow.

Dr. Chow

So, why they use 4 cases per 100,000 women? This is because this is the factor that we use in Australia and also in Europe to define a rare cancer. So, if we actually push it down to under 4, that means that with the current vaccination program and also the screenings program, Australia could be on track to eliminate several cancers by 2028. And also, there are lots of other data showing reduction in HPV prevalence in other sites, in the penile site and also anal site. That actually shows that we may be able to reduce the cancer and also reduce, potentially eliminate the cancer. And, in terms of genital warts, we have a very successful vaccination program, and then we saw a very, very low prevalence of genital warts. So, over the last few years, particularly the youngest group, I think the prevalence of genital warts was less than 1%. It has been, remained really, really low over the last few years in young Australian-born people. So, if we actually continue the trend, we might also see near elimination of genital warts. But I should also add, it's not just only the vaccination. It's a bit more complicated than what we thought, because people also may have sex with people that who are not vaccinated or from countries that are not vaccinated, so this kind of mixing, we call sexual mixing, that makes us unable to really eliminate, but we should actually be able to keep it to a very low prevalence.

Dr. Ramchandani

What a wonderful achievement already, for how much it's decreased the prevalence and the incidence of some of these diseases, but also the future potential.

most-common-questions**[30:16] Most Common Questions**

Dr. Ramchandani

What is the most common question you get about the national vaccination program in Australia?

Dr. Chow

I just mentioned before, they're probably worried if they miss a dose at school, would they actually be eligible to get the same dose somewhere else? Yes, you can, so you can actually get it from your primary care, your sexual health doctors, or even pharmacy or local council as well. Some parents may also be concerned about whether it actually triggers their sexual activities, but there are lots of other studies showing it doesn't really have any correlation.

hpv-study-young-msm**[31:03] HPV Study with Young MSM**

Chow EPF, Fairley CK, Zou H, Wigan R, Garland SM, Cornall AM, Atchison S, Tabrizi SN, Chen MY. Human papillomavirus antibody levels following vaccination or natural infection among young men who have sex with

men. Clin Infect Dis. 2022 Aug 25;75(2):323-329. **[PubMed Abstract]**

Dr. Meena Ramchandani:

Let's talk about a paper that you published in *Clinical Infectious Diseases* in July of 2022. It was titled “Human papillomavirus antibody levels following vaccination or natural infection among young men who have sex with men.” I thought this was a great article to read. Tell us more about the study and why it was done.

Dr. Chow

Thank you for that. So, this study actually looked at two groups of young gay and bisexual men, aged 16 to 20 years old. They were all recruited in Melbourne, Australia, and our aim was actually to measure HPV antibody levels in the blood or serum when they received the quadrivalent HPV vaccine at the age of 12 to 13. We also compared this level to those men who were not vaccinated, but they may have been naturally infected with HPV. So, the idea was to try to figure out a cutoff value, to identify people that can actually have the antibody level from the vaccine or from natural infection. Since gay and bisexual men may have a higher risk of HPV-related disease, so it's actually very important to understand the threshold, and then we can tell whether this antibody is actually kind of boosted by the vaccine or by their past infection.

Dr. Ramchandani

What were the main findings of this study?

Dr. Chow

So we found that men who got the HPV vaccine have a much higher level of antibodies compared to those men who got it from the natural infection. This is also true for all HPV types that are covered in the quadrivalent vaccine, which includes 6, 11 (the two low-risk types) and also the high-risk types, 16 and 18. And, this is also giving us more evidence that the vaccination leads to a higher antibody level, which has a high protection compared to natural infection in this population.

Dr. Ramchandani

Why do you think the antibody levels were higher after vaccination compared with natural infection? Is it because maybe they were getting three doses, or, what are some of the theories?

Dr. Chow

I think it's more about like, the vaccine can actually boost the immune system to generate more antibodies, and this is probably one of the mechanisms. Also, you're probably right as well, they have three doses and they may probably also act as a booster to generate more antibodies.

Dr. Ramchandani

And so, in this study, how long were antibodies levels sustained in those who were vaccinated compared to those who had natural infection? How long did you follow the cohort for?

Dr. Chow

In our study, so we looked at the time they had the last vaccine, and also the time they had the samples. So, the time actually ranged from 27 to 66 months, but we actually find that the antibody can actually last, very stable, for up to 66 months, so we didn't actually see any changes or drop in antibody level over time.

Dr. Ramchandani

And, that's for those people who received the vaccination?

Dr. Chow

Correct. So, we only looked at those people who had the vaccine, and then we did ask them, when did they have the last vaccine? Then we looked at the period over time. Unfortunately, we can't do this analysis for those people who were not vaccinated, because we don't know when did they have the HPV infection.

Dr. Ramchandani

Was there any correlation between antibody level for each of the four HPV serotypes and time since the last HPV vaccine? So, for example, was there a difference between the different serotypes that were present in the vaccine?

Dr. Chow

In terms of the changes over time or remained stable, it didn't have any differences across the four types, but in terms of the antibody level, we actually saw a much higher level for HPV 16 among those who were vaccinated. And this is also very important, because this is the serotype that causes most of the cancer, including cervical and anal cancer.

future-hpv-research-areas**[35:39] Future HPV Research Areas**

Dr. Ramchandani

What are your next areas of research in this field of HPV prevention?

Dr. Chow

So, I think we probably need to still do more surveillance and to understand, as we mentioned, to understand the impact of the changes of different dosage and different vaccine to the population. Also, we know gay and bisexual men have a higher rate of HPV-related disease compared to heterosexuals, so we really need to do more study, do more research in order to understand the uptake, and because most of them would not have been vaccinated from the school-based program, and also the cancer program. What would be the prevalence of them, and what would be the cancer rate in this population compared to those who have been vaccinated from the school-based program?

Dr. Ramchandani

It's been such a pleasure to have you this episode, and I learned so much from you, and I know our audience is really going to enjoy all your knowledge about these topics, so thank you. Thank you for your time.

Dr. Chow

Thanks for inviting me.

credits**[36:40] Credits**

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immunization-program