HPV Infection: Immunizing for Cancer Prevention

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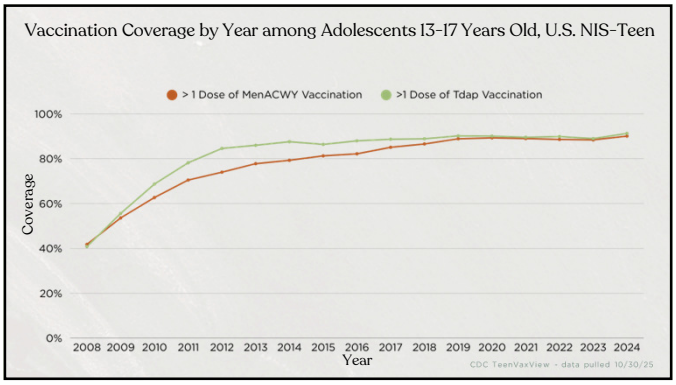

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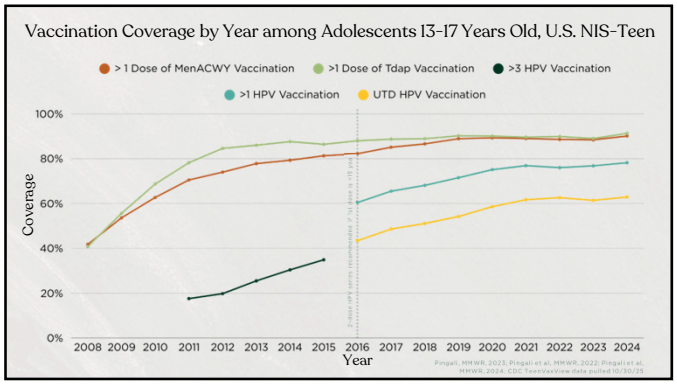

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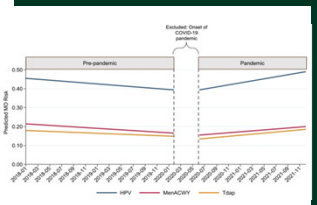
Proportion of adolescent vaccine missed opportunities (MO) at well child visits



Greatest increase in MO are for HPV vaccination

Kelly et al. J Adolesc Health. 2023

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4

Objectives

By the end of today we hope you feel more confident in addressing HPV vaccination with patients and have fewer missed opportunities!

1. Describe the epidemiology and pathology of human papillomavirus (HPV).
2. Summarize HPV vaccine efficacy, real-world effectiveness, and current coverage data.
3. Apply effective communication strategies to improve HPV vaccination confidence and reduce missed opportunities in practice.

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5

Epidemiology and Pathology

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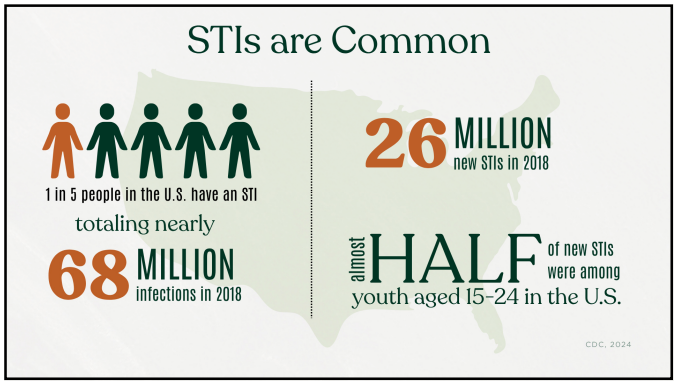
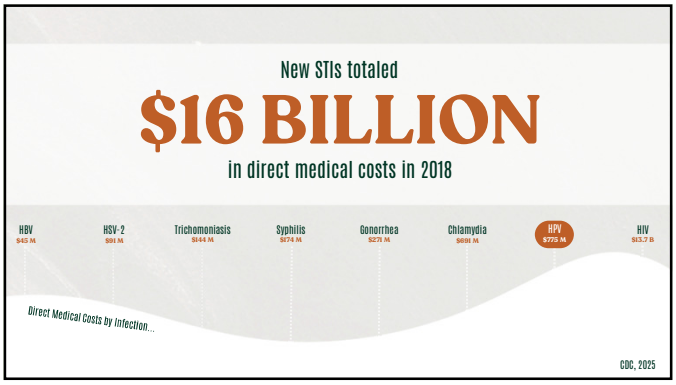
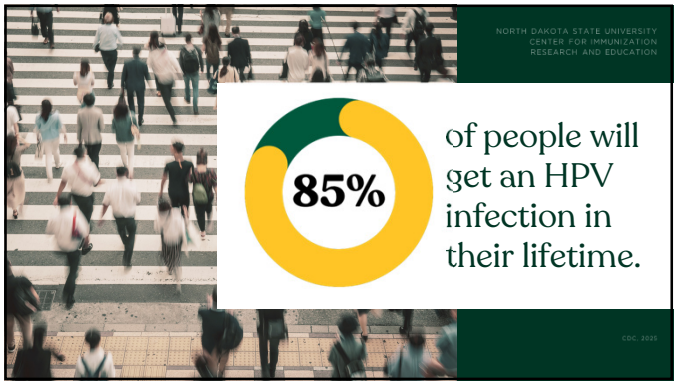
6


STIs are Common
1 in 5 people in the U.S. have an STI
totaling nearly
68 MILLION
infections in 2018
26 MILLION
new STIs in 2018
almost HALF
of new STIs were among youth aged 15-24 in the U.S.
CDC, 2024

7


New STIs totaled
$16 BILLION
in direct medical costs in 2018
HBV
HSV-2
Trichomoniasis
Syphilis
Gonorrhea
Chlamydia
HPV
HIV
Direct Medical Costs by Infection...
CDC, 2025

8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85%
of people will get an HPV infection in their lifetime.

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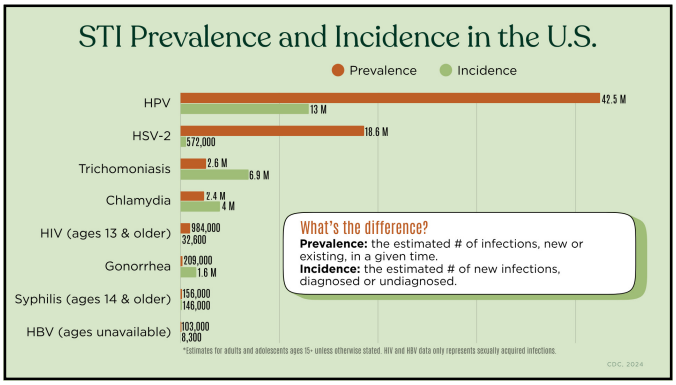
STI Prevalence and Incidence in the U.S.
Prevalence
Incidence
HPV
42.5 M
13 M
HSV-2
18.6 M
572,000
Trichomoniasis
2.6 M
6.9 M
Chlamydia
2.4 M
4 M
HIV (ages 13 & older)
984,000
32,600
Gonorrhea
209,000
1.6 M
Syphilis (ages 14 & older)
156,000
146,000
HBV (ages unavailable)
103,000
8,300
What's the difference?
Prevalence: the estimated # of infections, new or existing, in a given time.
Incidence: the estimated # of new infections, diagnosed or undiagnosed.
*Estimates for adults and adolescents ages 15+ unless otherwise stated. HIV and HBV data only represents sexually acquired infections.
CDC, 2024

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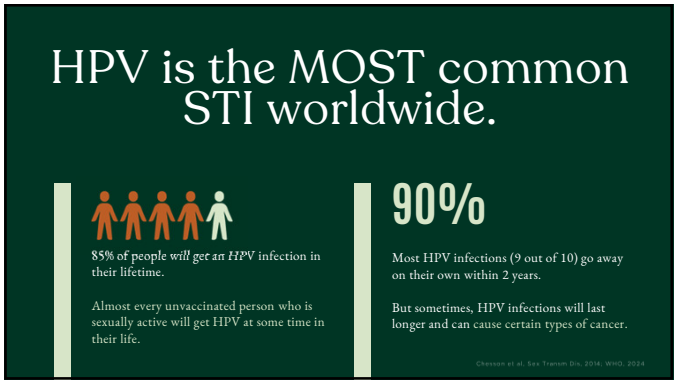
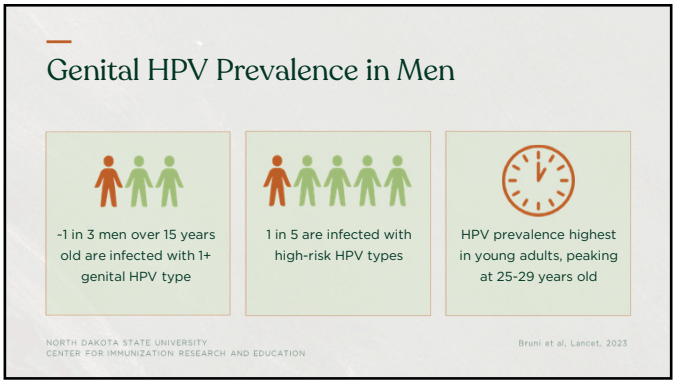

HPV is the MOST common STI worldwide.
85% of people will get an HPV infection in their lifetime.
Almost every unvaccinated person who is sexually active will get HPV at some time in their life.
90%
Most HPV infections (9 out of 10) go away on their own within 2 years.
But sometimes, HPV infections will last longer and can cause certain types of cancer.

11


Genital HPV Prevalence in Men
~1 in 3 men over 15 years old are infected with 1+ genital HPV type
1 in 5 are infected with high-risk HPV types
HPV prevalence highest in young adults, peaking at 25-29 years old
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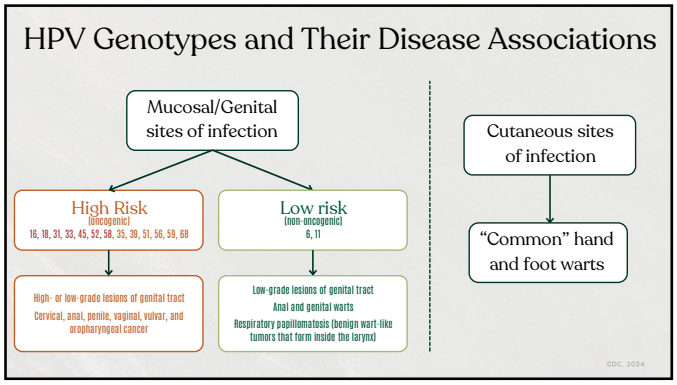
Bruni et al, Lancet, 2023

12



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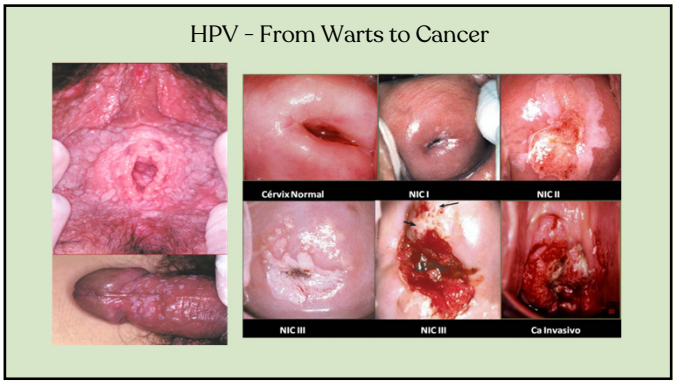

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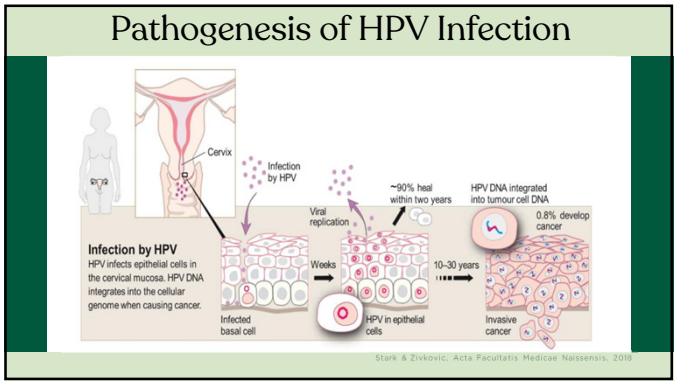

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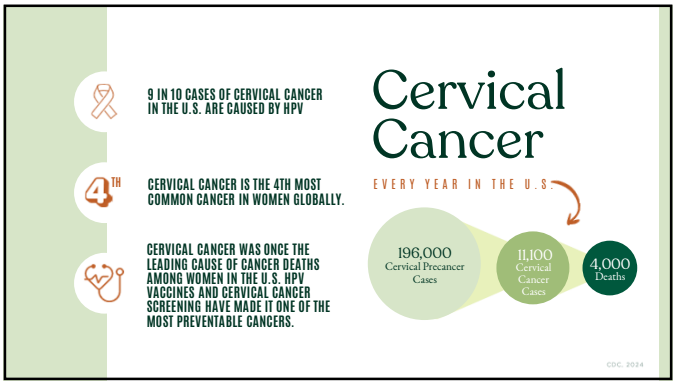

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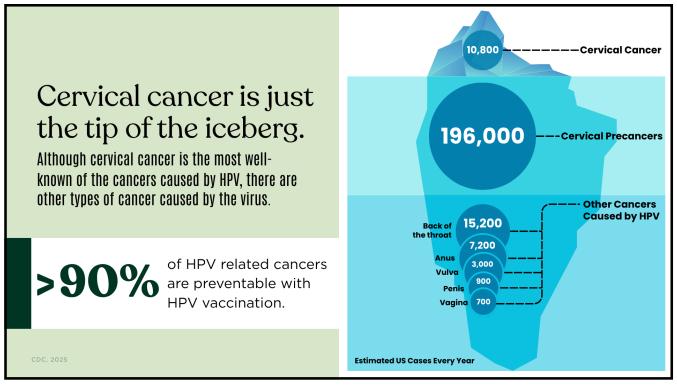

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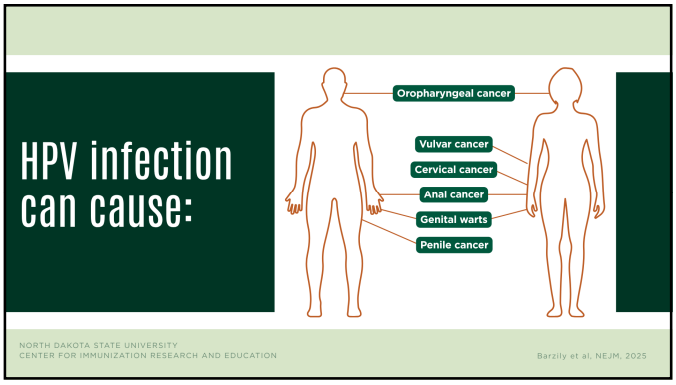

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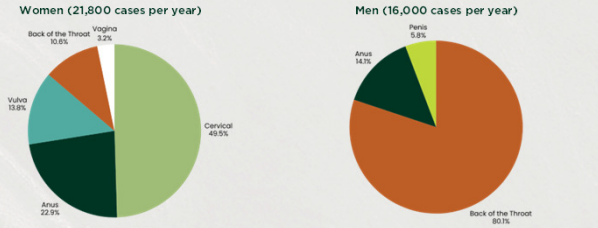
% of New HPV-Associated Cancer Cases Each Year in the U.S.



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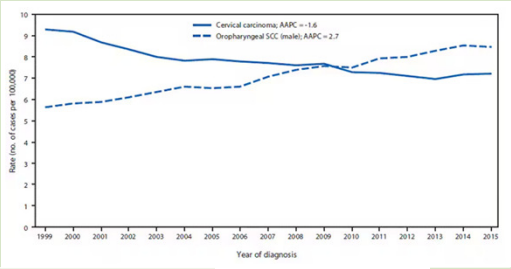
Data as of August 2022 - CDC, 2025

19

U.S. incidence of cervical cancer (females) and oropharyngeal cancer (males), 1999-2015



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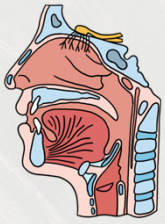
Van Dyne et al, MMWR, 2018

20

HPV + Oropharyngeal Cancer



60-80% of oropharyngeal cancers are caused by HPV

A majority are caused by HPV type 16

Oropharyngeal cancers are more common in men than women.

HPV-positive oropharyngeal cancers differ from HPV-negative ones: younger age at diagnosis, less smoking/alcohol history, better response to treatment.

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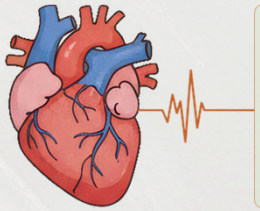
CDC, 2024; StatPearls, 2023

21

HPV + Cardiovascular Outcomes



Relative to HPV-negative participants, HPV patients had a:

40% higher risk of cardiovascular disease

2X higher risk of coronary artery disease

After adjusting for factors various factors - HPV patients had a 33% higher risk of cardiovascular disease.

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American College of Cardiology, 2025

22

HPV + Infertility

IN WOMEN:

- High-risk HPV may increase odds of infertility (evidence mixed)
- Possible impact on endometrial implantation and trophoblastic cells
- Treatment of cervical lesions (e.g., LEEP, cone biopsy) **can increase** risk of cervical changes affecting pregnancy
- Treatment for cervical cancer (e.g., hysterectomy, radiation, chemotherapy) **can cause** infertility

IN MEN:

- HPV linked to reduced sperm motility and quality
- May cause abnormal sperm morphology and DNA fragmentation
- Associated with oxidative stress affecting sperm function

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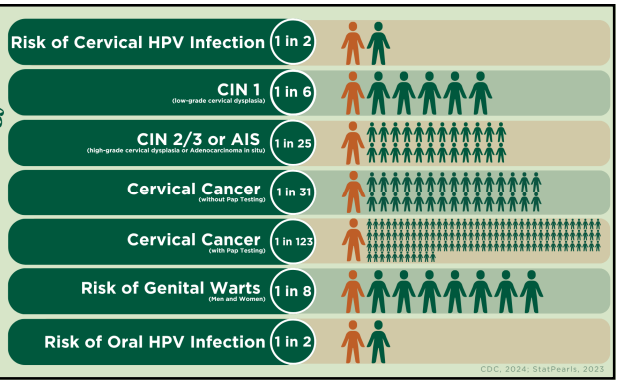
Notari et al, Nature, 2024; Ardekani et al, Eur J Med Res, 2025; Pereira et al, J Pathog, 2015

23

Lifetime Risk of HPV-Related Pathology



CDC, 2024; StatPearls, 2023

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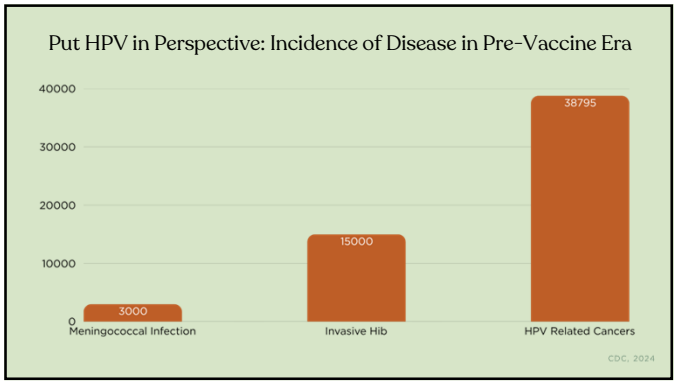

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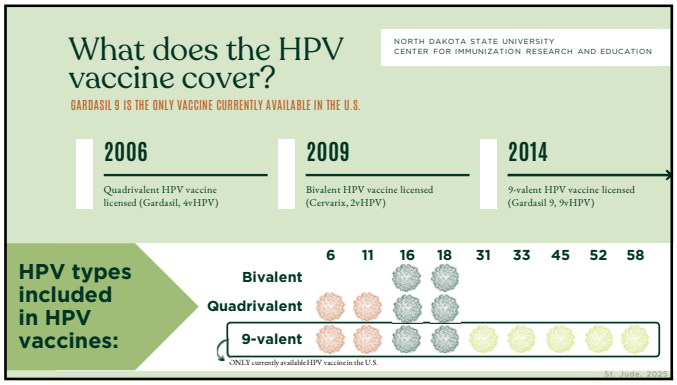

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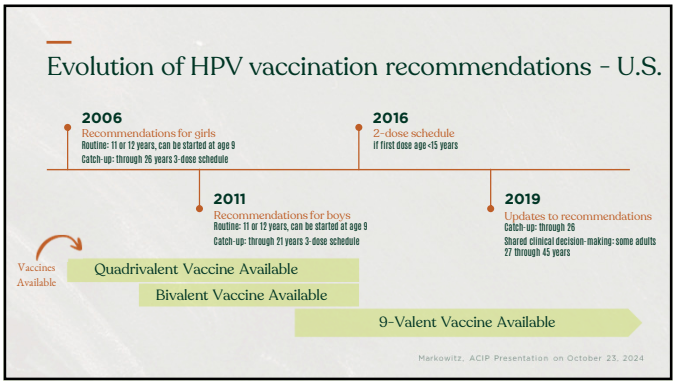

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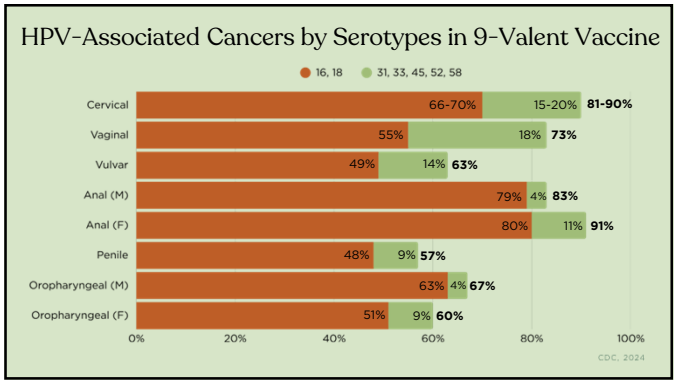

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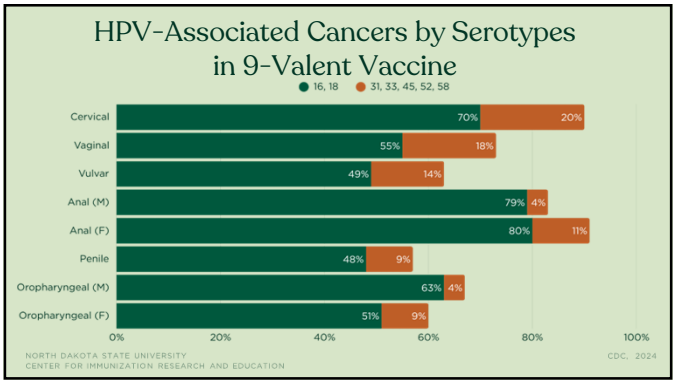

30

Average annual number and rate of HPV-associated cancers and estimated % cancers attributable to HPV, by HPV type, cancer type, and sex – U.S. 2012–2016

Reported HPV-associated cancer			Estimated % of each reported HPV-associated cancer by types
Cancer Type	Total #	Rate	9vHPV-targeted / Other HPV / HPV-negative
Cervix	12,015	7.2	
Vagina	862	0.4	
Vulva	4,009	2.1	
Penis	1,303	0.8	
Anus	6,810	1.8	
Female	4,539	2.3	
Male	2,270	1.3	
Oropharynx	19,000	4.9	
Female	3,460	1.7	
Male	15,540	8.5	
Total	**43,999**	**12.2**	
Female	24,886	13.7	
Male	19,113	10.6	

Van Dyne et al. MMWR, 2018

0% 20% 40% 60% 80% 100%

31

HPV Vaccine: Who Gets it and When

9-26 years
Routinely recommended at 11-12 years (ACIP – can be given down to age 9 years) or starting at 9 years (AAP). Catch-up vaccination recommended for everyone through 26 years.

Adults >26 years
Shared clinical decision-making for some people 27-45 years. HPV vaccines are not licensed for >45 years.

Administration
2 doses if started <15 years; 3 doses if after. No prevaccination testing.

Cervical cancer screening
All routine screening guidelines should be followed

Special populations and medical conditions
Pregnancy: delay until after pregnancy; pregnancy testing not needed before vaccination.

Breastfeeding: safe to receive

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Meites et al, MMWR, 2019

32

HPV Vaccine: Who Gets it and When

2-dose series
2 doses if started <15 years to complete the vaccine series.

1st shot – Today
2nd shot – between 6-12 months after 1st shot

3-dose series
3 doses required to complete the series if series is started *after* a patient's *15th birthday*

1st shot – Today
2nd shot – 1-2 months later
3rd shot – between 6-12 months after 1st shot

Meites et al, MMWR, 2019

33

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Vaccine Efficacy

34

Efficacy of the quadrivalent and 9-valent HPV vaccines against clinical endpoints among patients aged 16-26

	Vaccine		Placebo		
Clinical endpoint	# of people	# of cases	# of people	# of cases	Vaccine efficacy % (95% CI)
Cervical Cancer: HPV 16/18-related CIN 2/3 OR AIS	8,493	2	8,464	112	-98% (93.5, 99.8)
Vulvar Cancer: HPV 6/11/16/18-related VIN 2/3	7,772	0	7744	10	100% (55.5, 100)
Vaginal Cancer: HPV 6/11/16/18-related VaIN 2/3	7,772	0	7,899	9	100% (49.5, 100)
Anal Cancer in Males: HPV 6/11/16/18-related AIN 2/3	194	3	208	13	-75% (8.8-95.4)

	Gardasil 9		Gardasil		
Clinical endpoint	# of people	# of cases	# of people	# of cases	Vaccine efficacy % (95% CI)
HPV 31/33/45/52/59-related CIN 2/3, AIS, VIN 2/3, VaIN 2/3	6,016	1	6,017	30	-97% (80.9, 99.8)

Merck, 2025

35

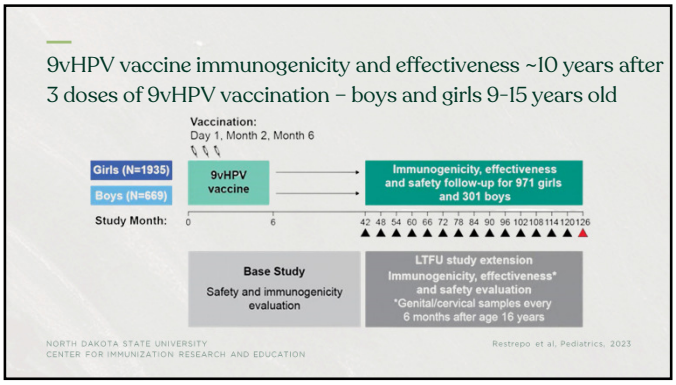
HPV Vaccine Efficacy – cervical, vaginal, vulvar disease

HPV Vaccine	Efficacy in HPV-naive populations	Overall Population
Bivalent	99%	61%
Quadrivalent	97-100%	44-62%
9-Valent	97%	

Garland et al, NEJM, 2007; The FUTURE II Study Group, NEJM, 2007; Journa et al, NEJM, 2015; Lehtinen et a l, Lancet, 2012

36

37



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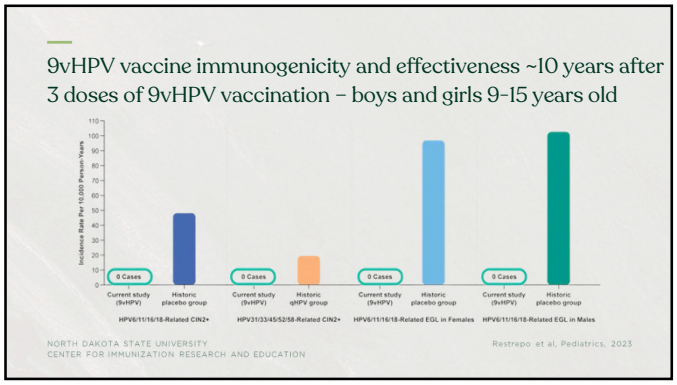

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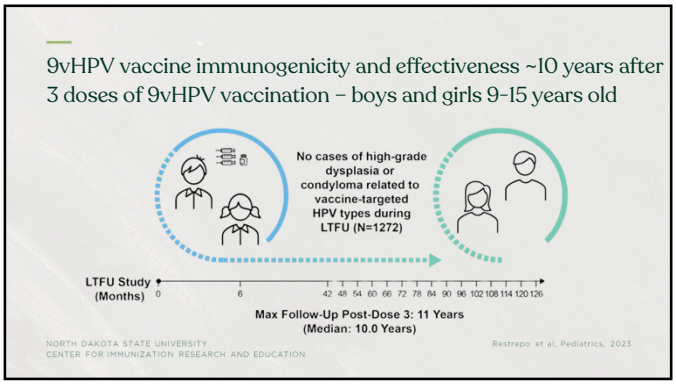

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41

42

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HPV infections and cervical precancers have dropped since 2006, when HPV vaccines were first used in the U.S.

88% drop in infections among teen girls with HPV types that cause most HPV cancers and genital warts.

81% drop in infections among young women with HPV types that cause most HPV cancers and genital warts.

40% drop in cervical precancers caused by the HPV types most often linked to cervical cancer among vaccinated women.

CDC, 2025

43

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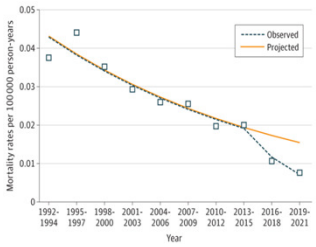
HPV vaccinations are associated with reduced cervical cancer mortality in young women.

62% Reduction in cervical cancer deaths in young women due to HPV vaccination.



Dorali et al, JAMA, 2024

44

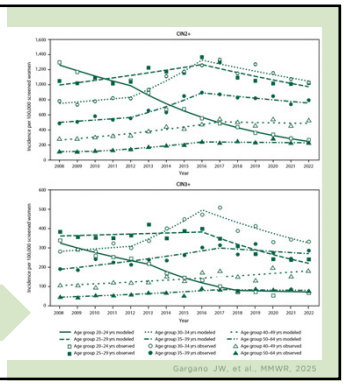
Trends in Cervical Precancers Identified Through Population-Based Surveillance

HPV VACCINE IMPACT MONITORING PROJECT, 5 SITES, U.S., 2008-2022

79% Decline in cervical precancer incidence

80% Decrease in higher-grade precancer incidence among screened women 20-24 years

The age group most likely to have been vaccinated



INCIDENCE (CASES PER 100,000 SCREENED WOMEN) OF CERVICAL PRECANCERS

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Gargano JW, et al. MMWR, 2025

45

Herd Immunity - HPV Vaccination

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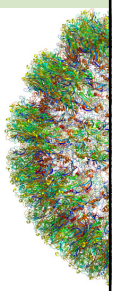


HERD IMMUNITY

Population-level effectiveness and herd immunity were robust 17 years after HPV vaccine introduction.

REGARDLESS OF SEXUAL EXPERIENCE

Immunity was robust even in sexually experienced adolescent girls and young women at relatively high risk for HPV who may not have received the full vaccination series.

"Reductions in infection rates were primarily due to the vaccine's introduction and not because of changes in sexual behavior or other factors." -Aislinn DeSieghardt, MS (first author)

EVEN UNVACCINATED WOMEN SAW SIGNIFICANT DROP IN HPV TYPES 16 AND 18

Among unvaccinated women included in the study, infections with HPV types 16 and 18 decreased by 71.6%, and infections with HPV types covered in the 4-valent vaccines dropped by 75.8%.

Strong evidence of herd immunity was due to vaccine uptake among both girls and boys in the U.S.

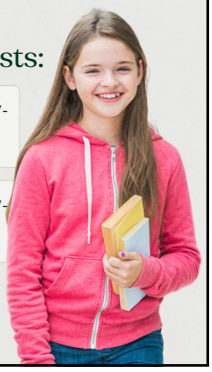
DeSieghardt et al, JAMA Pediatrics, 2025

46

Early real-world evidence suggests:

54% Lower odds of developing HPV-related cancers among boys. (especially head and neck cancers)

30% Lower odds of developing HPV-related cancers among girls (cervical cancers and any HPV-related cancer)



These results add to the evidence of HPV vaccine's real-world effectiveness in preventing several types of cancer and precancerous changes caused by HPV.

DeKloe et al, Journal of Clinical Oncology, 2024

47

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KEN SHE

HPV Vaccination: Real-World Takeaways from the KEN SHE Trial

99% protection against HPV 16/18 infections maintained for **4½ years after vaccination**.

No evidence of waning protection over time.

- Broad protection also seen for additional oncogenic types (31/33/45/52/58).
- Consistent efficacy across vaccine types (bivalent and 9-valent).

Strong follow-up and real-world conditions (young women, high retention) strengthen confidence in durability.

A single dose works — and it lasts.

Barnabas, Presentation at April 15, 2025 ACIP Meeting

48

Cochrane Review – HPV Vaccination

Girls ages 16 years or younger who received HPV vaccines were **80% less likely than their unvaccinated counterparts to develop cervical cancer**.

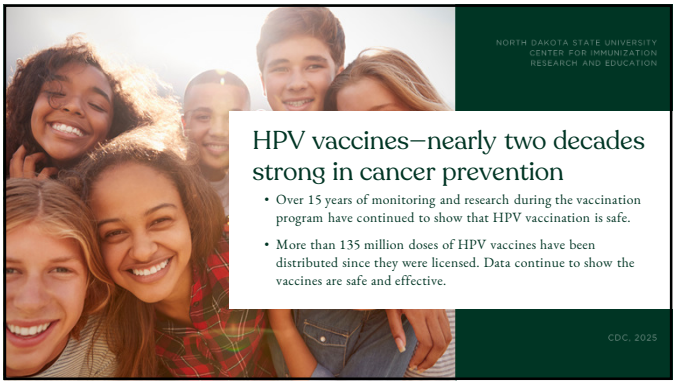
Evidence from 23 studies showed with moderate certainty that **HPV vaccination lowered the incidence of high-grade cervical precancers**.

Vaccinated persons had **25 fewer cases of anogenital warts per 1,000 participants at 48 months**, regardless of HPV type.

Among 39 RCTs with 97,272 participants, HPV vaccine groups showed little difference compared with controls in rates of serious adverse events at up to 72 months

Bergman et al. Cochrane Database of Systematic reviews, 2025

49



50

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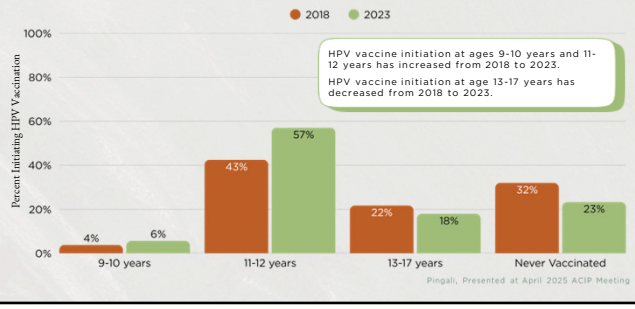
HPV Vaccination Rates

51

Age at Initiation of HPV Vaccine

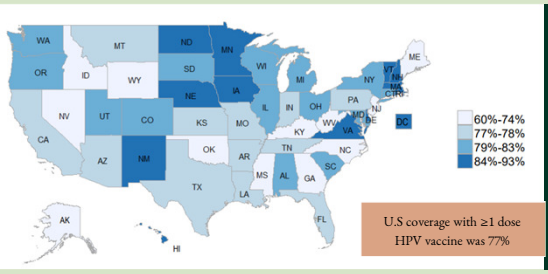
NIS-Teen, U.S., 2018 and 2023



Pingali, Presented at April 2025 ACIP Meeting

52

Estimated vaccination coverage with ≥1 dose of HPV vaccine among adolescents aged 13–17 years, National Immunization Survey–Teen (NIS-Teen), United States, 2023



Pingali, Presented at April 2025 ACIP Meeting

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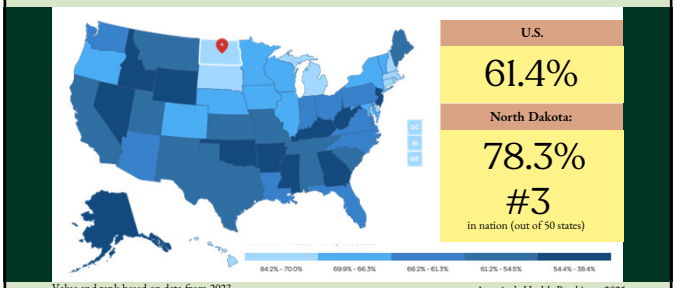
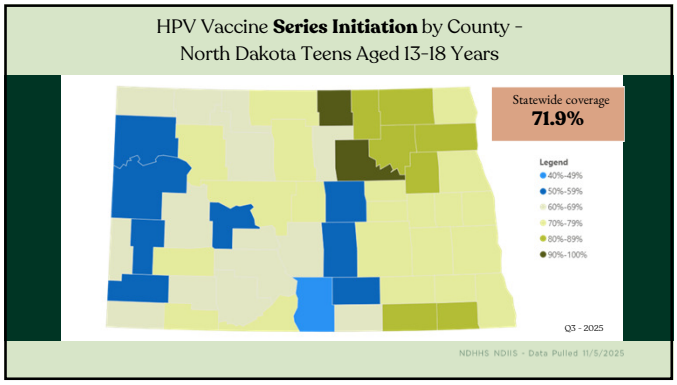
% of adolescents ages 13-17 who received all recommended doses of the HPV vaccine



Value and rank based on data from 2023

America's Health Rankings, 2025

54



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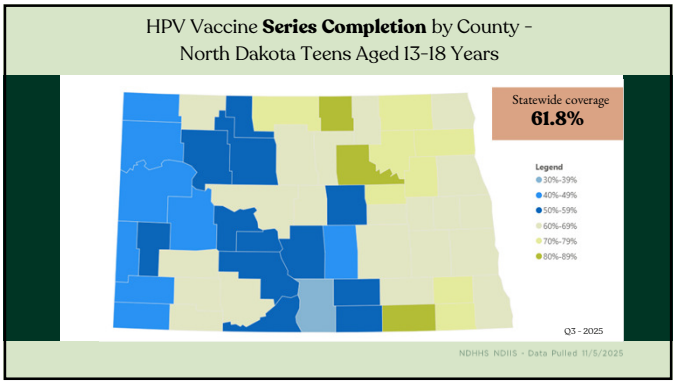

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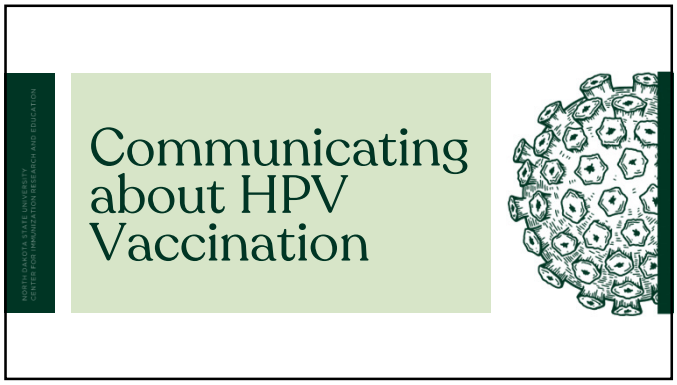

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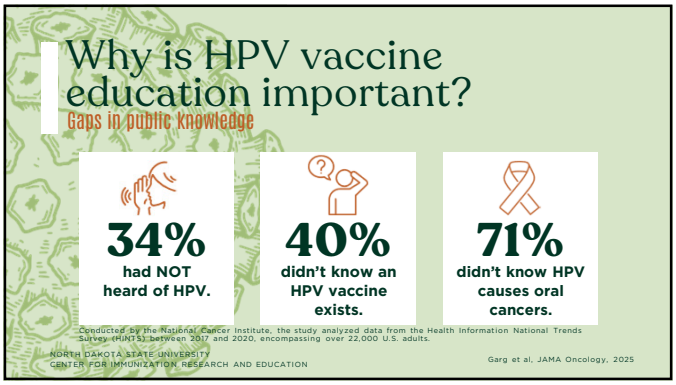

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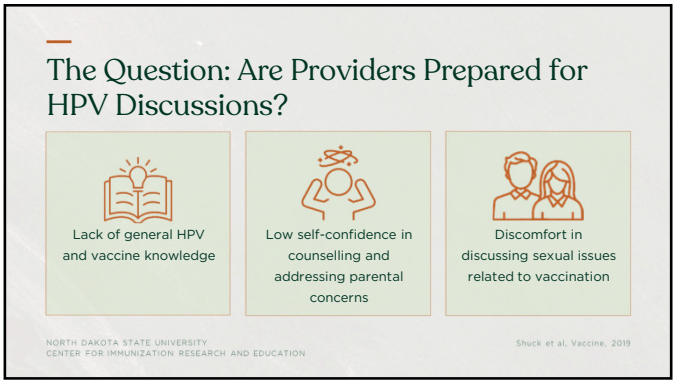

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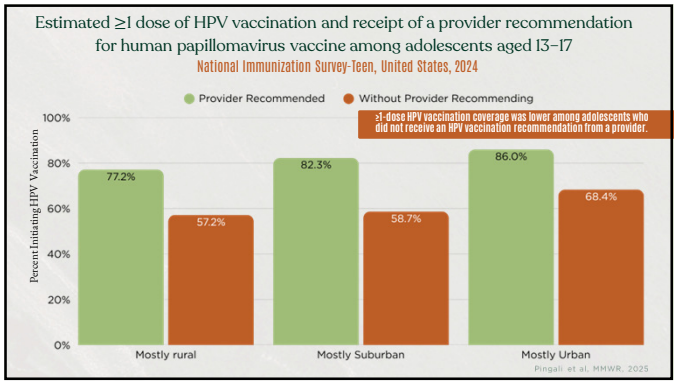

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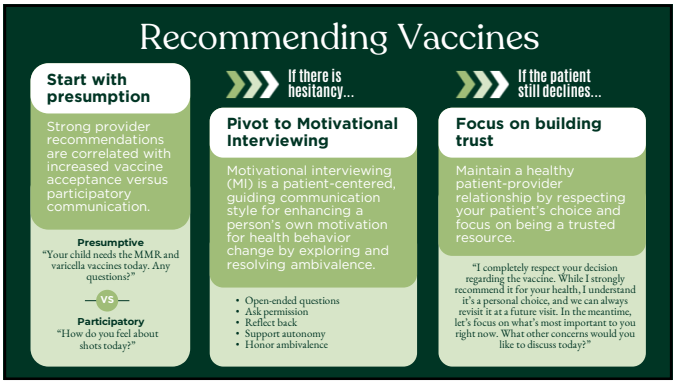

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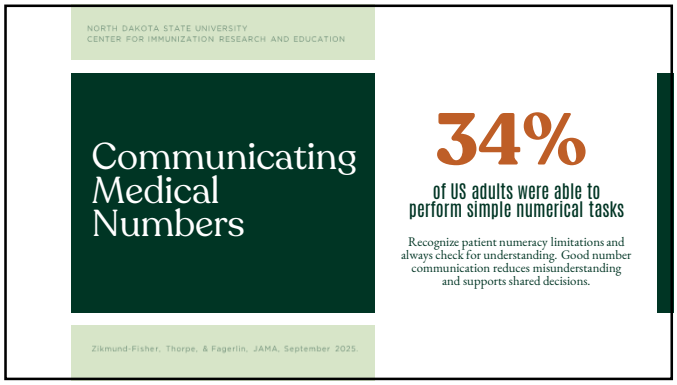

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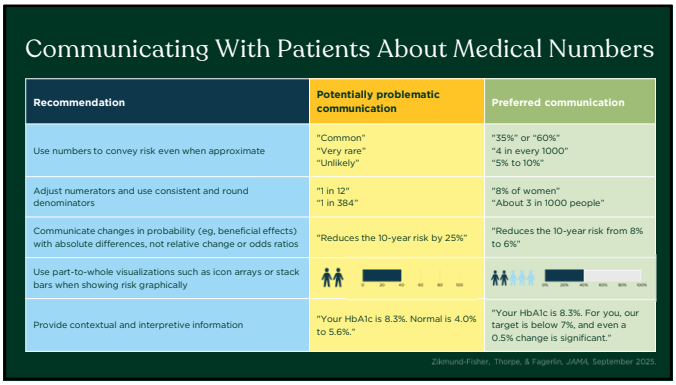

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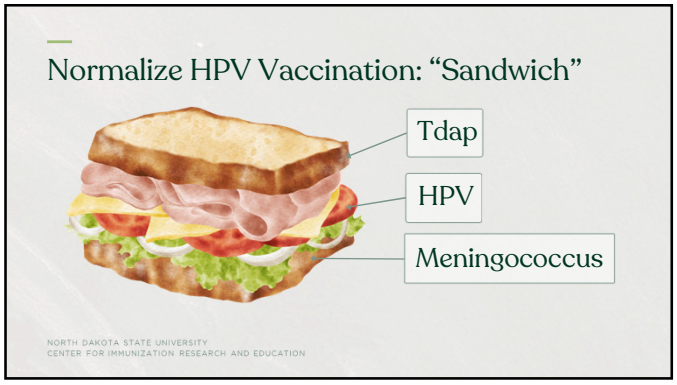

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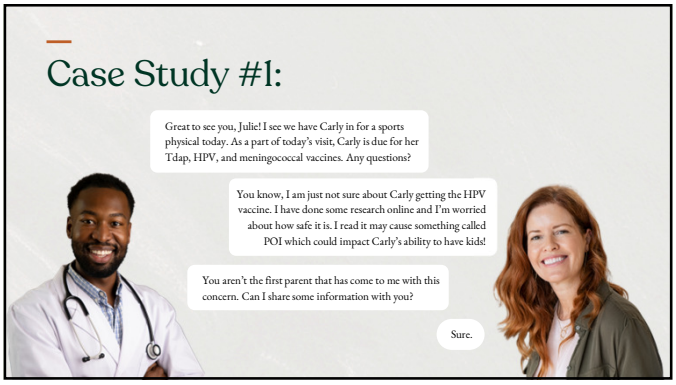

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Case Study: Know the facts!

HPV vaccine has been around for 15+ years.

- Extensive safety testing occurs before any vaccine is licensed by the FDA in the U.S., including HPV vaccination! Gardasil 9 was approved for use and licensed in 2014. Clinical trials looked at 15,000+ men and women indicated that the vaccine was safe and the benefits outweigh any risk.
- 130+ million doses of HPV vaccine have been distributed since they were licensed.
- 160+ studies have shown that HPV vaccines have a favorable safety profile.

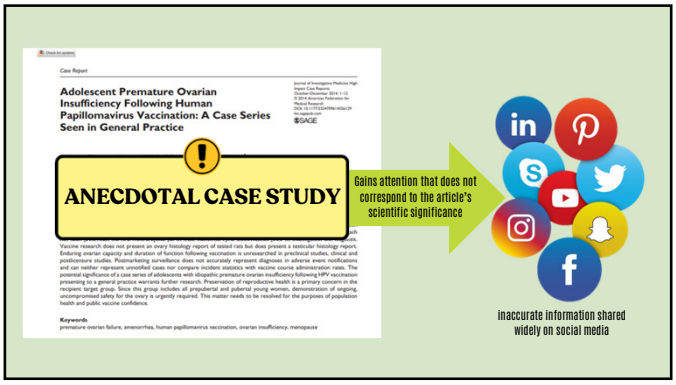
HPV vaccine safety will continue to be monitored.

- Systems like VAERS, VSD, and CISA work together to provide timely data on vaccine safety in our country on vaccines that licensed and recommended for use.

Acknowledge common side effects of HPV vaccination.

- Pain, redness, or swelling in the arm where the shot was given are common.
- Side effects are generally self-limiting. Put into perspective: HPV vaccination is cancer prevention.

67



68

What is primary ovarian insufficiency (POI)?

Also known as "premature menopause," this is a condition in which a woman's ovaries stop functioning before age 40. Causes of primary ovarian insufficiency include:

- Genetics
- Chemicals in the environment
- Cancer treatments
- Cigarette smoking
- Autoimmune disorders
- Some viral infections

However, in many cases it's not possible to determine the cause. CDC and FDA have not found any proof that HPV vaccines cause POI.

69

How have the CDC & FDA addressed the concerns of HPV vaccines causing POI?

As part of ongoing safety monitoring of HPV vaccines, CDC has reviewed reports of POI to VAERS following both Gardasil 9 and Gardasil vaccination

CDC has also conducted additional safety research on HPV vaccine in the Vaccine Safety Datalink

Let's take a look at the research...

70

With more than 12 years of HPV vaccine safety monitoring and research from the United States and other countries, we have robust data showing the HPV vaccines are safe. With regard to concerns about HPV vaccination and fertility in women, CDC and FDA have not found any convincing evidence that HPV vaccines cause primary ovarian insufficiency (POI).

Also known as "premature menopause," POI is a condition in which a woman's ovaries stop functioning before age 40. Causes of POI include genetics, chemicals in the environment, cancer treatments, smoking cigarettes, autoimmune disorders, and some viral infections.

A 2018 study from CDC's Vaccine Safety Datalink that included nearly 200,000 women did not find an increased risk of POI following HPV vaccination.

-Frank Destefano, Director, Immunization Safety Office, CDC

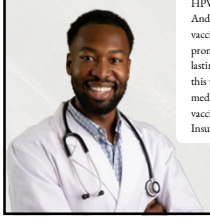
71

Research in other countries:

In 2021, a retrospective cohort study was published in JAMA looking at a nationwide dataset of ~1M Danish-born girls/women aged 11-34. No association was found between HPV vaccination and primary ovarian insufficiency.

72

Case Study #1:

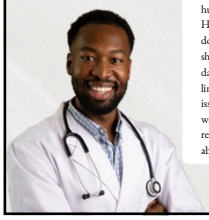


HPV vaccines have been around a long time now, over 15 years! And during this time, over a hundred million doses of HPV vaccines have been distributed in the U.S. We have very promising and reassuring data that these vaccines provide long-lasting protection and that they are very safe. The rumor that this vaccine causes infertility still makes the rounds on social media. What I hear you saying is that you are concerned this vaccine may cause infertility, and specifically Primary Ovarian Insufficiency or POI?

Yes.

73

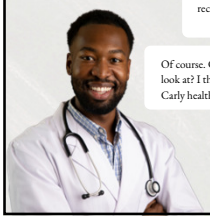
Case Study #1:



As part of ongoing safety monitoring of HPV vaccines, researchers have taken a look at the risk of POI following both Gardasil 9 and Gardasil vaccination – many studies looking at hundreds of thousands of girls have found no link between HPV vaccination and infertility or POI. Some of my patients do experience some soreness, swelling, and redness at where the shot was given. But this is common and should get better in a day or two. AND do you want to know what is absolutely linked to infertility? HPV cancers. The fact that they can cause issues with having children is unquestioned in the medical world. I vaccinated my own daughter against HPV, and I highly recommend Carly get vaccinated, too. What stands out to you about what I shared?

74

Case Study #1:



No, that makes sense, and I guess I hadn't really realized that HPV vaccination had been around that long. I really appreciate you taking the time to talk to us about it. Your recommendations are important to us. But, I think we are going to take some time to think about it.

Of course. Can I send some resources home with you to take a look at? I think HPV vaccination is an important part of keeping Carly healthy. Can we re-address this at our next appointment?

Absolutely.

75

Questions?

THANK YOU FOR LISTENING

SPECIAL THANKS TO:
- MAEVE WILLIAMS
- LAUREN DYBSAND, MPH

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ndsu.cire@ndsu.edu

WEB:
www.ndsu.edu/centers/immunize

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76

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  - Change Talk & Scaling Questions
  - Best First Responses

77

EXTRA SLIDES

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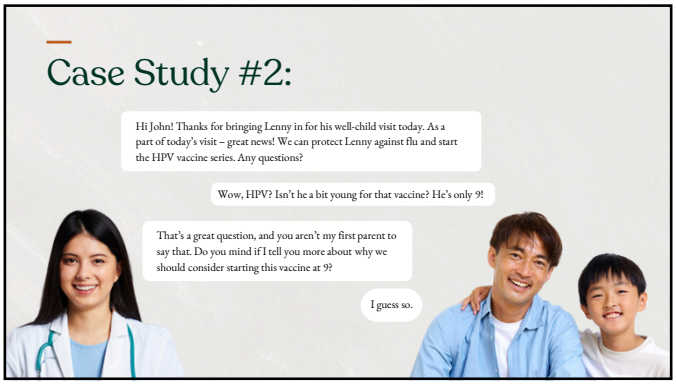
79



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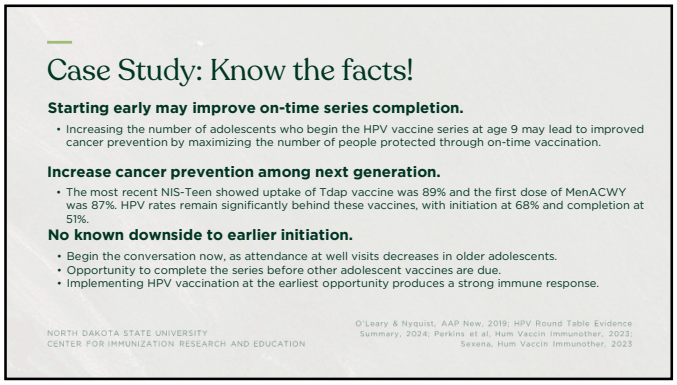

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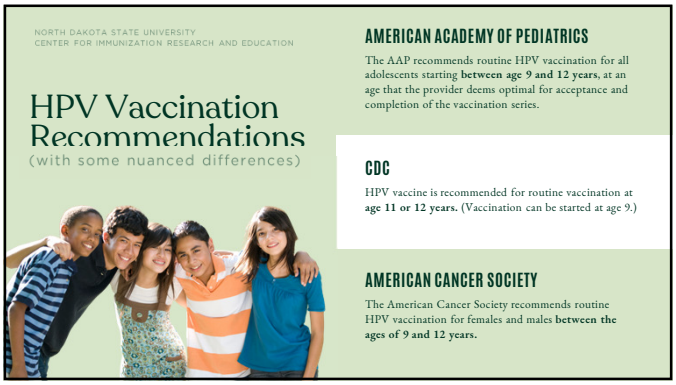

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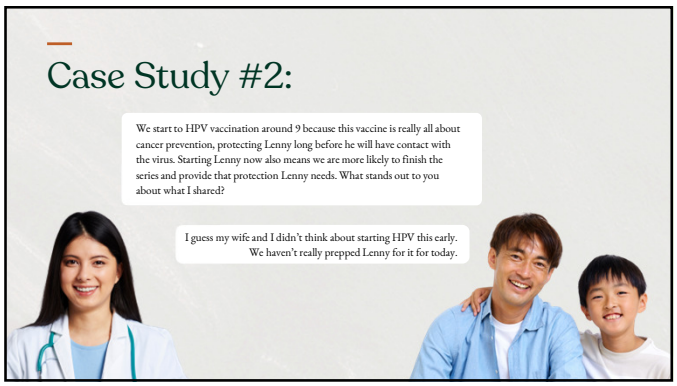

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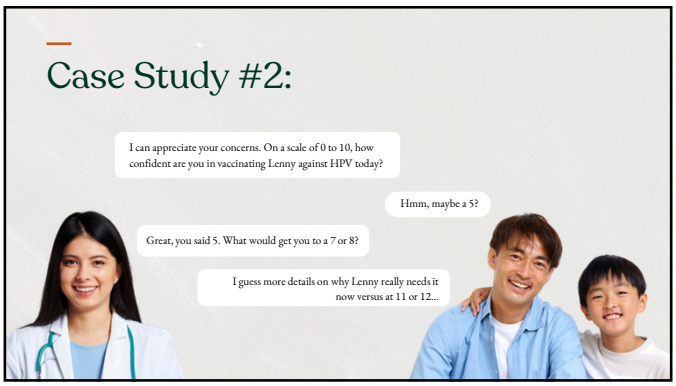
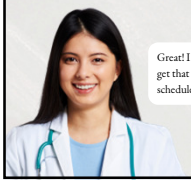


84

Case Study #2:

Absolutely. Mind if I provide you with some additional details [John nods]. We know that giving this vaccine at 9 or 10 also produces stronger protection than giving it later in adolescence. Also – if we start this series before 15, Lenny only needs two doses to be up-to-date! This also means less shots at his next well child at age 11. What would you like to do? I highly recommend HPV vaccination to all my patients and recommend we get Lenny started today!



Great! I will have the nurse come in and get that taken care of for you and get him schedule for his second dose!

Ok, let's do it.

85

Case Study

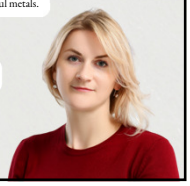
I see on the form you mentioned you have some concerns about the vaccines today—can you tell me a bit more about what's on your mind?

Yeah, I've been reading about aluminum in vaccines, and it worries me. I don't want to expose June to harmful metals.

You want to be sure that what June is getting is safe.

Exactly. I just don't understand why aluminum would even be in there.

That's a good question. You're looking for a clear reason why it's used and whether it's really okay for your child. Would it be okay if I shared a bit about why aluminum is in vaccines?



86

What is in a vaccine?

Type of Ingredient	Purpose	Example	Most Common Source Found
Adjuvants	Improve the body's immune response to antigens	Aluminum salts	From drinking water, infant formula, or taking antacids, buffering aspirin, & antiperspirants
Preservatives	Prevent contamination	Thimerosal (only in multi-dose vials of flu vaccine)	From eating foods such as certain kinds of fish
Stabilizers	Maintain vaccine potency during transportation and storage	Sugars, gelatin	From eating Jell-O
Residual antibiotics	Prevent contamination by bacteria during manufacturing process	Neomycin	Antibiotics people are most likely allergic to – like penicillin – aren't used in vaccines
Residual inactivating ingredients	Killed virus or inactivate toxins during the manufacturing process	Formaldehyde	Resides in body naturally
Residual cell material	To grow enough of the virus or bacteria to make the vaccine	Egg protein	From eating foods containing eggs

CDC, 2024

87

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Aluminum

VACCINE INGREDIENTS

13
Al
Aluminum
26.9815385

The conversation has increasingly shifted to claims that injection fundamentally changes aluminum's safety profile compared to ingestion.

88

Aluminum- What to Know

3rd most abundant element in Earth's crust - in soil, water, air, plants, and food.

Most adults consume 7-9 milligrams of aluminum daily.

Aluminum has been safely used in various products for decades.

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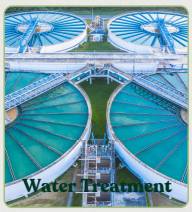
Steier et al, Unbiased Science, 2025

89

Aluminum - Common Sources



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Steier et al, Unbiased Science, 2025

90

Which vaccines contain Aluminum?

Aluminum is only used in vaccines that require it to stimulate a robust immune response.

Hepatitis A & B vaccines
- 0.225-0.5 mg per dose

DTaP/Tdap vaccines
- diphtheria, tetanus, pertussis
- 0.33-0.625 mg per dose

Hib vaccines
- 0.225 mg per dose

HPV vaccines
- 0.5 mg per dose

Pneumococcal vaccines
- 0.125 mg per dose

Meningococcal vaccines
- 0.25-1.5 mg per dose

Aluminum is NOT used in live vaccines like MMR (measles, mumps, rubella), varicella (chickenpox), or rotavirus vaccines.

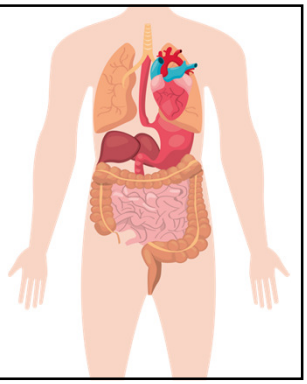
CHOP, 2025; Steier et al, Unbiased Science, 2025

91

What about injection vs ingestion?

Great question!

- Only ~0.3% of ingested aluminum absorbed; more absorbed when injected
- Ingested aluminum far exceeds vaccine exposure
- Elimination is the same regardless of source (ingested vs injected)
- Clearance: ~50% in 24h, ~85% in 13d
- Normal tissue levels: lung ~20 mg/kg, bone 5–10 mg/kg



CHOP, 2025; Steier et al, Unbiased Science, 2025

92

Case Study

Aluminum is used in some vaccines—including the HPV vaccine—to help the immune system respond better. It makes the protection stronger and longer-lasting. The amount is very small—much less than what kids get naturally from food, water, and even breast milk when they were babies. Aluminum has been safely used in vaccines for over 70 years.

I didn't realize it was in food and water too.

Yes, it surprises a lot of parents. Our bodies naturally process small amounts of aluminum every day. What I hear from you, though, is that you just want to make sure your child is protected safely.

Exactly

93

Case Study

That's why I recommend the HPV vaccine—it helps prevent several types of cancers, including cervical, throat, and other cancers that HPV can cause later in life. The safety data we have are very strong, and the tiny amount of aluminum helps the vaccine work well without posing a risk.

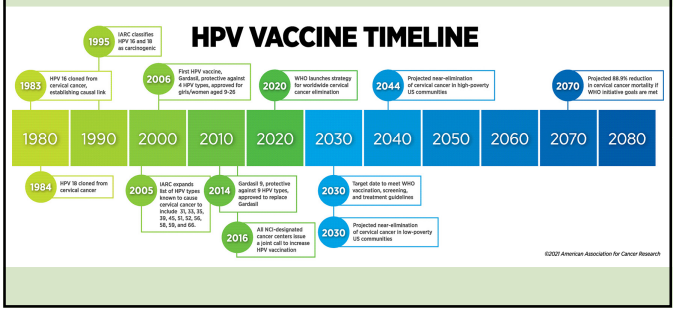
Okay, I appreciate you explaining that. I just want to be sure I'm doing the right thing.

That makes sense. Most parents I talk to want the same thing—to protect their kids from anything that could harm them. Would it be helpful if I shared a resource that explains aluminum in vaccines and how it compares to what kids get in their daily lives?

Yes, that would be great.

94

History of HPV Vaccination



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