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THE IMPORTANCE OF VACCINATION IN THE PREVENTION OF MEASLES

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Abstract. Measles remains one of the most highly contagious viral diseases known to humanity and continues to represent a significant cause of childhood morbidity and mortality globally, despite the availability of a safe and highly effective vaccine. This article provides a comprehensive analysis of the paramount importance of vaccination in preventing measles outbreaks, maintaining public health security, and moving towards global disease eradication. Following the traditional Introduction, Methods, Results, and Discussion framework, the study examines the epidemiological impact of the measles vaccine since its introduction and evaluates the biological, immunological, and social dimensions of immunization. The methodology involved a systematic review of peer-reviewed literature, epidemiological reports, and clinical data regarding vaccine efficacy and population immunity dynamics. The results unequivocally demonstrate that a two-dose vaccination regimen provides lifelong immunity in approximately ninety-seven percent of recipients. Furthermore, the findings highlight the critical role of the vaccine not only in preventing acute measles infection but also in protecting against measles-induced immune amnesia, a phenomenon where the wild-type virus obliterates pre-existing immune memory and leaves children vulnerable to other secondary infections for extended periods. The discussion addresses the contemporary challenges threatening measles eradication, primarily the resurgence of outbreaks fueled by vaccine hesitancy, socioeconomic disparities, and disruptions to routine immunization programs. Achieving and sustaining a minimum herd immunity threshold of ninety-five percent is strictly necessary to halt viral transmission. The paper concludes that continuous, robust, and equitable immunization strategies, coupled with persistent public health education, are entirely indispensable for the prevention and ultimate eradication of measles worldwide.

Keywords: Measles, vaccination, herd immunity, viral epidemiology, infectious diseases, public health, immune amnesia, immunization programs.

ЗНАЧЕНИЕ ВАКЦИНАЦИИ В ПРОФИЛАКТИКЕ КОРИ

Аннотация. Корь остается одним из самых высококонтагиозных вирусных заболеваний, известных человечеству, и продолжает представлять собой значительную причину детской заболеваемости и смертности во всем мире, несмотря на наличие безопасной и высокоэффективной вакцины. В данной статье представлен всесторонний анализ первостепенной важности вакцинации для предотвращения вспышек кори, поддержания безопасности общественного здравоохранения и продвижения к глобальному искоренению этого заболевания. Следуя традиционной структуре, включающей введение, методы, результаты и обсуждение, исследование рассматривает эпидемиологическое влияние противокоревой вакцины с момента ее внедрения и оценивает биологические, иммунологические и социальные аспекты иммунизации. Методология включала систематический обзор рецензируемой литературы, эпидемиологических отчетов и клинических данных, касающихся эффективности вакцины и динамики популяционного иммунитета. Результаты однозначно демонстрируют, что режим двухдозовой вакцинации



обеспечивает пожизненный иммунитет примерно у девяноста семи процентов реципиентов. Кроме того, результаты подчеркивают критическую роль вакцины не только в предотвращении острой коревой инфекции, но и в защите от индуцированной корью иммунной амнезии — явления, при котором вирус дикого типа уничтожает ранее существовавшую иммунную память и оставляет детей уязвимыми для других вторичных инфекций на длительные периоды. В обсуждении рассматриваются современные проблемы, угрожающие искоренению кори, в первую очередь возобновление вспышек, вызванных нерешительностью в отношении вакцинации, социально-экономическим неравенством и сбоями в программах плановой иммунизации. Достижение и поддержание минимального порога коллективного иммунитета в девяносто пять процентов строго необходимо для остановки передачи вируса. В заключении делается вывод о том, что непрерывные, надежные и справедливые стратегии иммунизации в сочетании с постоянным просвещением в области общественного здравоохранения абсолютно незаменимы для профилактики и окончательного искоренения кори во всем мире.

Ключевые слова: Корь, вакцинация, коллективный иммунитет, вирусная эпидемиология, инфекционные заболевания, общественное здравоохранение, иммунная амнезия, программы иммунизации.

INTRODUCTION

Measles is an acute, profoundly contagious viral illness caused by a single-stranded ribonucleic acid virus belonging to the Morbillivirus genus within the Paramyxoviridae family. Before the widespread introduction of the measles vaccine in the latter half of the twentieth century, the virus infected virtually every child by the time they reached adolescence. The historical burden of the disease was monumental, with an estimated two to three million deaths occurring annually across the globe, primarily among young children. The extreme contagiousness of the virus is characterized by its basic reproduction number, which dictates that a single infected individual in a completely susceptible population will typically transmit the virus to twelve to eighteen other individuals [1]. Transmission occurs predominantly through aerosolized respiratory droplets that can remain suspended and infectious in the air or on infected surfaces for up to two hours after the infected person has departed the area.

The clinical manifestation of measles extends far beyond the characteristic maculopapular rash and high fever. The disease is notoriously associated with severe complications, particularly in malnourished children, pregnant women, and immunocompromised individuals. These complications encompass severe bacterial pneumonia, debilitating otitis media, keratoconjunctivitis leading to permanent blindness, and profound neurological sequelae such as acute post-infectious encephalitis. Furthermore, a rare but invariably fatal degenerative disease of the central nervous system known as subacute sclerosing panencephalitis can develop years after the initial acute infection. Given the sheer ferocity of the virus and the severity of its potential complications, therapeutic interventions are largely limited to supportive care and the management of secondary bacterial infections. Therefore, primary prevention through widespread immunization remains the sole definitive strategy to combat the disease and preserve global health security.

The development and subsequent deployment of the live attenuated measles vaccine represents one of the most extraordinary triumphs in the history of preventive medicine. The widespread administration of this vaccine fundamentally altered the epidemiological landscape of the disease, transforming a ubiquitous and deadly childhood illness into a preventable condition [2]. The concept of herd immunity is particularly critical in the context of measles



prevention. Due to the exceptional transmissibility of the virus, public health authorities must ensure that a minimum of ninety-five percent of the population is fully immunized to interrupt the chain of transmission and protect vulnerable groups who cannot receive the vaccine, such as infants under six months of age and individuals with severe immunosuppression. However, maintaining this extraordinarily high threshold requires relentless vigilance and robust healthcare infrastructure.

The primary objective of this review is to rigorously evaluate the critical importance of vaccination in preventing measles from both an epidemiological and immunological perspective. By analyzing the historical impact of the vaccine, the severe biological consequences of the wild-type virus, and the ongoing social challenges related to vaccine coverage, this paper aims to reinforce the absolute necessity of sustaining comprehensive immunization programs. The analysis will delve into the profound secondary benefits of the vaccine, evaluate the consequences of sub-optimal vaccination coverage, and discuss the modern barriers that threaten the global initiative to ultimately eradicate the measles virus.

METHODS

To systematically evaluate the overarching importance and sustained efficacy of measles vaccination, a comprehensive and structured review of existing biomedical literature and epidemiological databases was conducted. The primary search strategy involved querying major academic repositories, specifically PubMed, the Web of Science, Scopus, and the Cochrane Library. The review targeted peer-reviewed clinical trials, extensive retrospective cohort studies, global epidemiological surveillance reports, and meta-analyses published primarily over the last two decades. This timeframe was intentionally selected to capture the most recent data regarding vaccine efficacy, the contemporary resurgence of measles in post-elimination settings, and the modern sociological factors influencing vaccine uptake. Search terminologies were meticulously combined to encompass variations of measles epidemiology, live attenuated vaccine efficacy, herd immunity thresholds, and the immunological phenomenon of measles-induced immune amnesia.

Strict inclusion and exclusion criteria were established to guarantee the analytical rigor of the synthesized data. Studies were designated for inclusion if they provided robust statistical evaluations of the primary efficacy of one-dose and two-dose measles vaccination schedules, documented large-scale public health outcomes following national immunization campaigns, or biologically quantified the secondary immunological consequences of natural measles infection compared to vaccination [3]. Official epidemiological reports from the World Health Organization and the Centers for Disease Control and Prevention were also included to provide macroscopic data on global morbidity and mortality trends. Conversely, isolated case reports, narrative reviews lacking distinct methodology, non-peer-reviewed observational opinions, and studies with statistically insignificant sample sizes were excluded from the analysis to maintain a high standard of evidence.

The data extraction phase focused on quantifying several pivotal parameters central to the research objective. These parameters encompassed the precise seroconversion rates following the administration of the first and second doses of the vaccine, the statistical reduction in disease incidence globally since the initiation of widespread vaccination efforts, and the specific morbidity rates associated with recent outbreaks in unvaccinated or under-vaccinated community clusters. Furthermore, the methodology placed a strong emphasis on extracting immunological data detailing the extent and duration of immune suppression caused by the wild-type paramyxovirus. By meticulously synthesizing these diverse streams of epidemiological, clinical,



and biological data, the review framework was designed to yield a scientifically definitive perspective on the indispensable nature of the measles vaccine in modern healthcare.

RESULTS

The synthesis of epidemiological and clinical data underscores the profound efficacy and monumental public health impact of the live attenuated measles vaccine. The analytical results consistently demonstrate that a single dose of the measles-mumps-rubella vaccine administered at twelve to fifteen months of age confers protective immunity in approximately ninety-three percent of recipients. Because the virus is so highly transmissible, this primary failure rate of seven percent represents a significant vulnerability on a population level. Consequently, the universal recommendation for a mandatory second dose, typically administered between four and six years of age, increases the overall vaccine efficacy to an exceptional ninety-seven percent. The data show that immunity derived from this standard two-dose regimen is incredibly robust and is generally considered lifelong, with exceedingly rare instances of waning immunity leading to breakthrough clinical disease in healthy adults.

From an epidemiological standpoint, the introduction of the vaccine has yielded unprecedented results in reducing global morbidity and mortality. According to aggregated global surveillance data, the intensification of routine measles vaccination programs coupled with supplementary mass immunization campaigns prevented an estimated twenty-three million deaths globally between the years two thousand and two thousand eighteen. In regions where the ninety-five percent herd immunity threshold was consistently maintained, local transmission of the virus was completely halted, leading to the official verification of measles elimination in numerous countries across the Americas and Europe over the past two decades. However, the data simultaneously reveal the fragility of this achievement. The results clearly indicate that whenever vaccination coverage within a specific geographical or demographic cluster drops even marginally below the critical threshold, explosive outbreaks inevitably follow, disproportionately affecting unimmunized children and producing high rates of hospitalization.

Beyond the direct prevention of acute measles infection and its immediate complications, recent immunological research has illuminated a profound secondary benefit of the vaccine that further elevates its medical importance. Findings firmly establish that infection with the wild-type measles virus causes a devastating depletion of pre-existing memory lymphocytes, a phenomenon scientifically termed immune amnesia. The wild-type virus actively infects and destroys memory B cells and T cells that the body had previously generated against other environmental pathogens. Consequently, children who survive a natural measles infection experience a severe, prolonged period of immunosuppression lasting two to three years, during which they are exceptionally susceptible to other infectious diseases such as pneumonia and diarrheal illnesses. Crucially, the results verify that the live attenuated virus utilized in the vaccine does not induce this catastrophic immunological depletion. Therefore, by preventing wild-type infection, the measles vaccine actively protects the integrity of the entire pediatric immune system, indirectly preventing a massive but historically under-recognized burden of secondary childhood mortality.

DISCUSSION

The overwhelming body of evidence validating the efficacy and necessity of the measles vaccine stands in stark contrast to the alarming resurgence of the disease observed in recent years. This resurgence is predominantly driven not by a failure of the vaccine itself, but by a failure to administer the vaccine to a sufficient proportion of the population. The discussion surrounding measles prevention must, therefore, heavily emphasize the sociological, logistical, and psychological barriers that currently hinder global immunization efforts. The concept of vaccine



hesitancy has emerged as a formidable threat to public health security. Fueled by misinformation, unsubstantiated fears regarding vaccine safety, and the rapid dissemination of anti-scientific rhetoric through digital platforms, a growing demographic of parents in developed nations have chosen to delay or refuse vaccination for their children. The fraudulent claims linking the measles-mumps-rubella vaccine to neurodevelopmental disorders, despite being thoroughly debunked and universally retracted by the scientific community, have inflicted enduring damage on public trust and directly catalyzed numerous large-scale outbreaks in previously secure regions.

In low-income and developing nations, the barriers to achieving universal vaccination coverage are primarily systemic and logistical rather than ideological. Fragile healthcare infrastructures, inadequate cold chain storage facilities required to maintain the viability of the live attenuated vaccine, political instability, and persistent armed conflicts critically disrupt routine immunization schedules. The global disruption of medical services precipitated by the severe acute respiratory syndrome coronavirus 2 pandemic further exacerbated these vulnerabilities, resulting in millions of children missing their scheduled measles vaccinations. This massive accumulation of susceptible individuals creates extremely volatile epidemiological conditions, transforming entire communities into fertile ground for rapid and devastating viral transmission. Addressing these disparities requires coordinated international efforts, substantial financial investments in local health systems, and the development of innovative delivery mechanisms to reach deeply marginalized and inaccessible populations.

Maintaining the exceptionally high herd immunity threshold of ninety-five percent is a constant and unforgiving public health imperative. Unlike other infectious diseases with lower transmissibility, measles exploits the smallest gaps in community immunity. When localized pockets of unvaccinated individuals aggregate, whether due to religious exemptions, philosophical beliefs, or geographical isolation, the protective barrier of herd immunity completely collapses within that specific network. The subsequent outbreaks impose severe economic burdens on healthcare systems through intensive care hospitalizations, exhaustive contact tracing efforts, and the implementation of emergency outbreak control measures. Therefore, policymakers must carefully balance the principles of individual autonomy with the overarching duty to protect public health, potentially by implementing stricter criteria for non-medical vaccine exemptions for school and daycare enrollment.

Furthermore, the scientific revelation regarding measles-induced immune amnesia radically reframes the importance of the vaccine. The prevention of measles is no longer viewed simply as the prevention of a single rash-inducing illness, but rather as the preservation of a child's entire immunological memory. By avoiding the catastrophic cellular destruction caused by the wild-type virus, the vaccine acts as a broad-spectrum shield against a multitude of opportunistic infections. This deeper biological understanding underscores the immense ethical responsibility of medical professionals to vigorously advocate for vaccination. Physicians and public health officials must continuously engage with hesitant communities, utilizing transparent, empathetic, and evidence-based communication to dismantle misconceptions and reinforce the absolute necessity of widespread immunization. The journey toward the global eradication of measles is biologically feasible, as the virus has no animal reservoir, but it relies entirely on the unwavering commitment of human societies to prioritize and sustain universal vaccination protocols.

CONCLUSION

The overwhelming consensus of epidemiological and immunological evidence dictates that vaccination is the most critical, effective, and indispensable intervention for the prevention of measles. The live attenuated vaccine not only provides profound individual protection against an



acutely dangerous and potentially fatal virus but also serves as the fundamental cornerstone of collective public health security. The ability of the vaccine to halt the transmission of one of the most contagious pathogens on earth, while simultaneously protecting the pediatric population from the devastating secondary consequences of immune amnesia, highlights its unparalleled value in modern medicine. However, the biological efficacy of the vaccine is fundamentally dependent on achieving and sustaining rigorous population coverage. The contemporary resurgence of measles outbreaks serves as a severe warning regarding the fragility of herd immunity in the face of vaccine hesitancy and systemic healthcare disruptions. Ultimately, the future successful control and potential global eradication of measles demand unwavering international collaboration, the strengthening of equitable immunization infrastructures, and relentless public health advocacy to ensure that every child is protected by the profound benefits of vaccination.

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