ICU MANAGEMENT

THE OFFICIAL MANAGEMENT AND PRACTICE JOURNAL

VOLUME 12 - ISSUE 4 - WINTER 2012/2013

The Global ICU

INCLUDING:

- West Nile Virus Encephalitis: Recognising and Diagnosing Infection
- Managing Population Immunity for Vaccine-Preventable Diseases
- Improving Obstetrical Critical Care in Developing Nations

PLUS:

- Management of Candiduria: Grey Zones Still Exist
- A Review of the Evolving Paradigm Shift in Intensive Care Unit Sedation Practices
- Therapeutic Hypothermia in the ICU: Indication, Sedation and Prognostication
- Ethics in Simulation for Intensive Care

VALUING PREVENTION AS THE NEW PARADIGM IN GLOBAL HEALTH:

MANAGING POPULATION IMMUNITY FOR VACCINE-PREVENTABLE DISEASES

Kimberly M. Thompson, *ScD*

Professor of Preventive Medicine and Global Health
University of Central Florida College of Medicine
President
Kid Risk, Inc.

kimt@ucf.edu

One lesson from progress towards polio eradication suggests that using models and measurements together to manage population immunity may play a key role in supporting the paradigm shift required to value prevention and realise the full benefits of vaccines (Thompson et al. 2012b). This paper discusses individual and population immunity, prevention as a choice, valuing prevention, and some opportunities for intensive care unit (ICU) managers to further contribute to improving global health.

Introduction

Thanks to the miracle of vaccines, healthcare providers on the front lines continue to see progressively fewer cases of vaccine-preventable diseases (VPDs). Today, most medical students in developed countries graduate and expect to practice without seeing a single case of paralysis caused by polio, and their experience with many once-common VPDs remains limited to what they learnt from curriculum materials.

In these developed countries, infectious diseases once considered "horses" (referring to a likely diagnostic possibility) now fall into the category of "zebras" (referring to an unlikely diagnostic possibility) and related outbreaks no longer cause costly disruptions of health systems. However, healthcare providers still need to maintain the ability to rapidly recognise and manage a case of a no-longer-common VPD, as there remains a risk of their importation, since some susceptible individuals exist even in well-immunised populations (Sugerman et al. 2010; Thompson et al. 2012a) and global vaccine use remains uneven.

While most individuals in most developed countries enjoy significant protection from VPDs, the same is not true in all developing countries. Recognising both the inequity and opportunity presented by the current situation, the Global Vaccine Action Plan (GVAP) aspires to extend the full benefits of immunisation to all people by 2020, to create a world "in which all individuals and communities enjoy lives free from vaccine-preventable diseases" (WHO, 2012). The question remains, however, "how will we get from here to there?"

"As we approach the final stages of polio eradication, managing population immunity is emerging as the key to success"

Individual and Population Immunity

Vaccines, although not entirely risk-free, provide a safe and effective way to prevent cases of disease before they occur by enabling the immune systems of individuals to avoid or better fight infections upon exposure. Immunisation protects individuals, at least until the immunity wanes or the infectious agent changes. Population immunity reflects the integration of individual immunity over all people in the community. In the case of polio, we define population immunity as the overall level of protection from poliovirus transmission within a population, which focuses on the prevention of infections and goes beyond simply focusing on the cases of disease (Thompson et al. 2012b). High levels of population immunity effectively provide a barrier that inhibits sustained viral transmission, such that transmission stops once population immunity exceeds the threshold required for any introductions of the disease to die out. Levels of population immunity above the threshold protect unvaccinated individuals (e.g. those younger than the recommended age of the first dose, those with contraindications or vaccine failures, and those who miss vaccination unintentionally or intentionally), at least so long as the population maintains sufficiently high levels. The actual thresholds vary by population and conditions. Consequently, some populations need to achieve and maintain relatively higher levels of population immunity than others. This means that interventions that suffice in some areas fall short in others. For example, routine immunisation alone may work for some countries, while other countries may need to conduct supplemental immunisation activities.

The concept of population immunity may seem simple and obvious, but its characterisation can prove very challenging. We cannot directly observe or measure population immunity. Health systems and immunisation programmes typically monitor levels of routine immunisation coverage as a proxy for population immunity, but this metric only reveals one important part of the overall story. Similarly, while detecting cases as part of disease surveillance will indicate the lack of sufficient population immunity, the absence of cases does not provide information about potential risks or the accumulation of susceptible individuals. Serological studies provide important information about the individuals included in samples, but this only offers a snapshot view.

> "Shifting towards prevention does not necessarily mean eradication for all VPDs, but it means not tolerating cases or bad management of these diseases"

The ability of a population to sustain transmission depends on the integration of the entire population, and we must understand population immunity as a dynamic "stock" (i.e. a level of overall protection from infection that changes with time). The level of population immunity increases as individuals get vaccinated or recover from infection with the VPD, and the level decreases as non-immune individuals enter the population, immune individuals die, or immunity wanes. In this context, individuals who miss vaccination matter (e.g. migrants, certain age cohorts skipped due to a disruption in supply, etc.), because susceptible individuals can accumulate and participate in transmission if and when the disease occurs.

Development of a population immunity model along with the collection of measurements of current and historical vaccine coverage, demographics, and other factors makes it possible to characterise and visualise population immunity (or vulnerability). For polio, modelling population immunity facilitates consideration of the immunological implications of prior exposure to any circulating live polioviruses and/or vaccination with a live oral poliovirus vaccine (OPV) or injected inactivated poliovirus vaccine (IPV) (Duintjer Tebbens et al. 2005; Thompson et al. 2012b). Successful immunisation with either vaccine protects individuals from disease (i.e. paralytic polio), but even immune individuals can potentially become reinfected and participate asymptomatically in poliovirus transmission to some degree, with their participation likely increasing with time due to waning. The use of a model also captures the differences in how IPV and OPV work. For example, as a live virus, OPV infects vaccine recipients, which stimulates mucosal immunity and leads to the excretion of live polioviruses that can then cause secondary infections. In contrast, the relatively more expensive IPV does not cause secondary circulation or infection (i.e. it protects only the vaccine recipient). IPV also does not cause the relatively rare but real cases of vaccine-associated paralytic polio, which has made it a costly but attractive alternative to OPV for developed countries. Models can help us characterise the risks and consider the impacts of potential risk management options before we make a decision and take action. Similarly they can help to demonstrate the consequences of inaction, which is also a choice.

Choosing Prevention

Choosing to eradicate a disease represents the ultimate in prevention. Eradication presents a unique opportunity to protect current and future generations, and it requires stopping chains of transmission everywhere and maintaining this state. We can only eradicate the diseases that we can meaningfully stop from being transmitted and for which we can coordinate and cooperate globally. To date, global health systems successfully stopped the human transmission of smallpox, wild poliovirus serotype 2, and the SARS virus that circulated between November 2002 and July 2003 (Thompson and Duintjer Tebbens 2011). We also recently celebrated the global eradication of rinderpest, an animal virus similar to measles that led to devastating impacts on herd animals and food supplies. The global eradication of wild poliovirus serotypes 1 and 3, though as yet elusive, now appears within reach. The possibility of eradicating measles and rubella continues to emerge as a topic of discussion, particularly with successful elimination in the Americas and measles elimination goals in place in four of the five remaining WHO regions (WHO 2011; WHO 2012b).

The ability to use a model to characterise and manage population immunity represents a game changer for disease control and prevention. Since we can use models to make our choices and their impacts transparent, they can help us anticipate the consequences of our actions and manage expectations. As we approach the final stages of polio eradication, managing population immunity is emerging as the key to success. The case-based strategy of testing samples from patients that present with acute flaccid paralysis (AFP), which identifies symptomatic poliovirus infections after they have caused paralysis, does not provide an opportunity to identify immunity gaps before outbreaks occur. Eradication means preventing all future cases before they occur. Since polioviruses can circulate asymptomatically, eradication requires the use of a tool that supports the objective of no anticipated cases, while we also still actively use AFP surveillance to ensure that no paralytic polio cases actually occur from exposure to wild polioviruses. The models help us characterise the benefits of prevention, because they allow us to count the cases that do not occur and to give credit to prevention activities.

Valuing Prevention

Any healthcare provider who has treated a complicated case of measles, seen a child born with congenital rubella syndrome, provided respiration for a patient paralysed by polio, watched a child with pertussis whoop, or managed a serious case of any other VPD can easily appreciate the benefits of preventing these bad outcomes before they occur. Vaccines provide significant health and financial savings, and they represent some of the most cost-effective medical interventions available. However, immunisation requires the investment of resources, and they pose some risks. Sustained investments in population immunity depend on the perception of need, and successful immunisation programmes have dropped the burdens of disease to such low levels that even some healthcare providers may not recognise the critical role that vaccines continue to play in achieving and sustaining community and global health. Those without direct experience of outbreaks may find it difficult to understand the dynamics of infectious diseases and the reality that they can find susceptible individuals and spread devastatingly fast.

In the western hemisphere, progress in infectious disease control and prevention in combination with national and regional commitments to the elimination of polio, measles, and rubella have created a new normal. Most individuals and populations in the Americas expect complete prevention of VPDs. Health ministers of countries in the Americas sustain their investments in immunisation and hold each other accountable for importations. When informed by front line healthcare providers about even a single case of polio, measles, or rubella, health authorities in the Americas view the case as an indication of system failure and as a signal that emergency action is required. However, the shift to prevention represents a significant change around the world. For example, recent outbreaks of measles in Europe suggest that the disease is still tolerated as a normal and acceptable sickness, even though measles has caused preventable and tragic deaths. Significant drops in vaccine coverage in Ukraine, due to vaccine scares and politicisation of immunisation, may actually present a threat to the entire European region and its commitment to eliminate measles and rubella. If we want to achieve the full potential benefits of vaccines globally, then this will require a permanent paradigm shift to one that values prevention of VPDs. Shifting towards prevention does not necessarily mean eradication for all VPDs, but it means not tolerating cases or bad management of these diseases. For example, while we cannot remove all *Clostridium tetani* from the environment, with good management we can eliminate all cases of tetanus, including neonatal tetanus.

Perhaps the largest challenge to achieving and maintaining global health relates to the lack of sustained commitments and investments for prevention. We all know that individuals often do not receive credit for their contributions to endevours that prevent bad things from happening, because it is hard to count the cases that do not occur. In addition, the limited resources allocated to prevention activities may get shifted to managing the crisis of today instead of preventing the crises of tomorrow. This unfortunately creates a vicious cycle, because prevention often represents a more cost-effective option.

“Significant drops in vaccine coverage in Ukraine… may actually present a threat to the entire European region and its commitment to eliminate measles and rubella”

Opportunities for ICU Managers

All healthcare providers and health systems play important roles. At the individual level, they can monitor the immunisation status of individual patients and ensure that patients receive vaccinations on schedule or catch up on any they miss. The actions of individual providers collectively impact the health of the population, and it matters if providers pursue a goal of fully protecting 100% of their patients from VPDs.

Front line healthcare providers play a critical role in communicating the benefits of vaccines in their communities. Practicing providers should find ways to train medical students, residents and others to recognise and manage cases of VPDs. We must all appreciate the disruptive impact of VPD cases on health systems and the need for preparedness for managing outbreaks. The phrase, “preparing for the worst while managing for the best” is a powerful reminder of why prevention makes a difference. Particularly in the absence of cases, front line providers must play a critical role in advocating vaccination and helping patients and their communities to recognise the benefits of immunisation and prevention. Patients need to understand that it is not too late to get vaccinated against many VPDs and to know that if they do not get vaccinated then they remain at risk for contracting a serious disease.

Front line providers may also play an important role with respect to holding each other accountable for prevention. For example, ensuring that every individual who provides care on the front line has immunity either from vaccination or historical exposure to the VPDs that can spread through patient contact included in the national routine immunisation schedule would send an important message that the provider community values immunisation and prevention. Those who treat the cases that result when the system fails contribute powerfully to individual immunity and prevention in their immediate surroundings and all of the individual actions aggregate to global health. ■

References

Duintjer Tebbens RJ et al. (2005). A dynamic model of poliomyelitis outbreaks: Learning from the past to help inform the future. American Journal of Epidemiology, 162(4):358-372.

Nakkazi E (2012). Measles epidemic in Uganda. ScieGirl, May 24. Available at: http://estanakkazi.blogspot.com/2012/05/measles-epidemic-in-uganda.html (accessed 1 November, 2012).

Sugerman DE et al (2010). Measles outbreak in a highly vaccinated population, San Diego, 2008: Role of the intentionally undervaccinated. Pediatrics, 125(4):747-755.

Thompson KM and Duintjer Tebbens RJ (2011). Challenges related to the economic evaluation of the direct and indirect benefits and the costs of disease elimination and eradication efforts. Chapter 9 in Cochi SL and Dowdle WR (eds). Disease Eradication in the 21st Century: Implications for Global Health. Cambridge, MA: MIT Press, 115-130.

Thompson, KM et al. (2012a). Trends in the risk of U.S. polio outbreaks and poliovirus vaccine availability for response. Public Health Reports, 127(1):23-37.

Thompson KM et al. (2012b). Modeling population immunity to support efforts to end the transmission of live polioviruses. Risk Analysis. DOI: 10.1111/j.1539-6924.2012.01891.x.

World Health Organization (2012). Global Vaccines Action Plan, 2012. Available at: http://www.dovcollaboration.org/action-plan/ (accessed 1 November, 2012).

WHO (2011). Proceedings of the global technical consultation to assess the feasibility of measles eradication, 28–30 July 2010. Journal of Infectious Diseases 204(S1):S4-S13.

WHO (2012b). Global measles and rubella strategic plan. 2012-2020. Geneva, Switzerland: World Health Organization. Available at: http://www.who.int/immunization/newsroom/Measles_Rubella_StrategicPlan_2012_2020.pdf (accessed 1 November 2012).