Influenza: Managing the Supply and Distribution of the Influenza Vaccine

by

Douglas R. Owens

April 4, 2005

A Master's paper submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Public Health in the School of Public Health, Public Health Leadership Program.

Influenza: Managing the Supply and Distribution of the Influenza Vaccine

Background and History of Influenza as a Public Health Issue

Historically, influenza has proven to be a significant challenge to public health (Prisco, 2002). Medical historians have documented several major influenza pandemics throughout the early modern and modern eras that have served to substantially diminish the global population, while also disrupting economic, cultural, and social practices (Gensheimer, Fukuda, Brammer, Cox, Strikas & Patriarca, 1999). For centuries, the lack of a clear understanding of the nature and mechanism of influenza, as well as the absence of effective prevention and treatment methods, significantly served to exacerbate the impact of the illness.

In the twentieth century, as the collective body of medical and scientific knowledge expanded, the nature and characteristics of influenza and other related viruses began to be explored. However, the rudimentary understanding of the disease that had been attained by the early decades of the twentieth century was not sufficient to reduce the scope of the massive pandemic that killed millions of people worldwide in 1918.

The magnitude and impact of the 1918 pandemic, paired with emerging advances in medical and scientific knowledge, understanding, and technology, brought the problem of influenza into the burgeoning field of public health. In the context of the progressive political environment that had emerged in the early decades of the twentieth century, early public policy dictating prevention techniques and allocating

federal and state monies for research began to be dedicated to the issue. Paired with the rapid advances that were being made in the field of vaccines, these early efforts forced the issue of influenza to the forefront of public health and policy (Couch, 1999).

In the mid-twentieth century, after several decades of intensive research and experimentation, the first influenza vaccines were developed and deemed ready for widespread public application (Couch, 1999). While the use of the vaccine proved to stem the tide of contagion, the ever-evolving nature of the virus proved to be a difficult challenge for vaccine developers. Even in the early years of influenza vaccine availability, many of the issues that surround the use, supply, and distribution of the vaccine today were prevalent, including questions of which segments of the population should have access to the vaccine and how the supply should be managed and distributed in order to achieve the most effective defense.

Throughout the latter half of the twentieth century, the standards and practices used in the development and distribution of the influenza vaccine were solidified in the United States and other Western nations. Several pandemics emerged during this period, due in large part to the unexpected spread of previously undetected strains of influenza. Still, the increasingly widespread use of the vaccine limited the amount of morbidity and mortality associated with influenza, preventing the recurrence of the massive loss of life associated with the 1918 pandemic (Couch, 1999).

Over the course of the last decade, the distribution and prioritization of the influenza vaccine has become increasingly standardized, with a high proportion of the geriatric population, health care workers, some young children, and other segments of the population deemed to be at high risk for infection (Couch, 1999). However, in

many jurisdictions, state and municipal oversight has developed and implemented guidelines for the supply and distribution of the vaccine. As a result, the methods and regulations governing the supply and distribution of the vaccine may differ significantly in different states and cities (Gensheimer, Meltzer, Postema & Strikas, 2003).

Although management of the development, supply, and distribution of the influenza vaccine has grown more sophisticated and standardized in recent years, the lack of standard procedures between different municipalities, states, and regions has prompted some criticism. This censure has grown more pointed in the years in which shortages and other disruptions or irregularities in the supply and distribution of the vaccine has been interrupted. Some critics have called for stricter government oversight and regulation of the development, supply, and distribution of the influenza vaccine as a result (Gensheimer, Meltzer, Postema & Strikas, 2003).

Over the last decade, several shortages and/or supply interruptions have caused difficulty in the supply and distribution of the influenza vaccine. However, few instances of vaccine shortfalls have received as much media and public attention as the shortage that was revealed in the fall of 2004. Despite early problems with supply and distribution, most states were able to procure sufficient stocks of the vaccine to serve the most vulnerable segments of the population. Indeed, in some states, a predicted shortfall eventually turned into a surplus of the vaccine.

Although no significant public health problem or pandemic has yet been linked to the irregularities in the influenza vaccine supply that were brought to light in the fall of 2004, the situation has cast light on many shortcomings, loopholes, and deficiencies in the current approach to the management and oversight of the development, supply,

and distribution of the influenza vaccine. While some critics suggest that the heightened media scrutiny directed at the problems surrounding the influenza vaccine was artificially magnified by the incorporation of the issue into the then-ongoing presidential campaign, many Americans in the general public, as well as public health experts, feel that the recent attention that has been paid to the vagaries of the vaccine system is justified and necessary.

In the wake of the 2004 shortage, the current system of influenza vaccine development, supply, and distribution has been called into question, as has been the management of the process by federal, state, and municipal government agencies. There are increasing calls for heightened government scrutiny of the process emanating from many quarters, although some conservatives regard the issue as evidence that fear of lawsuits has stymied the otherwise natural functionality of the free market. At the current juncture, although it remains unclear what the exact policy implications of the vaccine shortage will be in the long-term, it is abundantly clear that this issue, recently thrust into the public discourse, requires significant remediation.

Influenza and the Vaccine Supply

Despite the fact that significant gains have been made in the development, supply, and distribution of the influenza vaccine over the course of the last several decades, periodic difficulties with shortages and other irregularities demonstrate the weaknesses in the current system, which is characterized by a plurality of different, and in some instances, contradictory standards set forth by various federal, state, and

local jurisdictions. The shortage that was revealed in the fall of 2004 demonstrated the fatal problems that continue to render the current approach to vaccine development, supply, and distribution vulnerable and untenable in the long-term.

For a number of reasons, the specter of an unstable, unpredictable influenza vaccine supply chain is a variable that must be addressed. In recent years, public health experts have repeatedly asserted that neither the United States nor other industrialized nations are adequately prepared to deal with the consequences of a serious pandemic (Saito & Tashiro, 2000).

Furthermore, as demonstrated in the aftermath of the September 11, 2001 terrorist attacks, even a short interruption in the normal function of the American economy can create aftershocks that continue to resonate for years, negatively impacting not only productivity and labor, but also more intangible factors such as standard of living, quality of life, and overall public health (Meltzer & Cox, 1999; Cram, Blitz, Monto & Fendrick, 2001). As a related issue, the volatile political environment that has emerged since the 9/11 attacks has rendered the possibility of an influenza pandemic being deliberately initiated by bioterrorists, once believed to be a highly unlikely scenario, a much more credible threat. Taken together, all of these considerations underscore the significance of the current lack of a cohesive, unified body of public policy regarding the development, supply, and distribution of the influenza vaccine.

Influenza: Pandemics and the Future Outlook

According to leading epidemiologists and public health experts who have studied the dissemination and evolution of the influenza virus, the emergence of a worldwide influenza pandemic is inevitable. Many of these same experts have asserted that both the industrialized world and developing nations are ill-prepared to meet the challenges a pandemic will bring (Fedson, Gellin & Modlin, 2003).

Although the prospect of creating a comprehensive pandemic preparedness plan presents many formidable challenges, the shortcomings and deficiencies that were revealed to be inherent in the United States' current approach to the development, supply, and distribution of the influenza vaccine is an important starting point. Furthermore, many public health experts have agreed that a comprehensive policy addressing the development, supply, and distribution of the influenza vaccine could help avoid shortages in the future (Fedson, Gellin & Modlin, 2003).

Influenza: Characteristics, Prevalence, and Impact upon Public Health

Although variations of the influenza virus have been active for centuries, current patterns of the illness continue to evolve in many ways, some of which are predictable and others that are not. Currently, in the United States, an estimated 15% of the population contracts the influenza virus in any given year (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). However, of these millions of individuals, the strength and intensity of the virus can vary significantly. Some may experience little or no outward

symptoms, while others may develop severe complications, such as pneumonia, which can be fatal (Harper, Fukuda, Uyeki, Cox & Bridges, 2004).

Current estimates hold that between 30,000 and 40,000 deaths in the United States are caused annually either indirectly or directly by influenza. Recent figures show that an average of over 200,000 hospitalizations occur annually as a direct or indirect result of influenza (Wood, Nguyen & Schmidt, 2000).

While influenza itself can be fatal, the far more prevalent risk is that the illness will cause complications or exacerbate extant problems in individuals weakened by other health conditions (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). This is why the geriatric population is often regarded as being at the greatest risk from influenza, as well as the frequent classification of the elderly as a vulnerable population that merits top priority for dispensation of the influenza vaccine (Couch, 1999).

Another group at significant risk of developing complications associated with influenza consists of individuals of any age with chronic health problems or ongoing medical conditions. Of specific concern are individuals whose pre-existing medical problems or treatment regimens have caused vulnerabilities in the immune system (Saito & Tashiro, 2000). In addition, infants and very young children have a high risk of developing complications with influenza due in part to their immature respiratory systems (Harper, Fukuda, Uyeki, Cox & Bridges, 2004).

Any individual whose occupation or living situation necessitates frequent contact with others who may be carrying the influenza virus is also typically considered to be at heightened risk of contracting the illness. This group typically includes health care workers, infants and young children who attend preschool or daycare, and, to a

lesser extent, any individual who comes into contact with the public on a frequent basis (Couch, 1999).

In the United States and the rest of the Northern Hemisphere, the winter months comprise the height of influenza season (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). In recent years, the month of February has seen the highest influenza activity. One of the most dangerous aspects of influenza is the ease of transmitting the illness. Described by epidemiologists as "droplet spread," influenza can be transmitted between individuals within a virus-contaminated droplet of liquid (Meltzer & Cox, 1999).

The propulsion provided by a sneeze or a cough provides the movement needed to carry the influenza virus into a new host body. Though thought to be a less frequent mode of transmission, recent research has indicated that the influenza virus can also be contracted by coming into contact with an infected droplet on a surface and then touching one's own mucous membranes (Meltzer & Cox, 1999).

The mechanism of the influenza virus as it enters the human body and begins to replicate itself is complex, and has only recently come to be more fully understood. The complexity and stealth of the influenza virus is one of the reasons why it takes the average human immune system one to two weeks to begin to mount an effective defense against the invading virus, which represents the average length of time that most cases of influenza incapacitate an infected individual (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). It is this complexity that also renders the development of an effective influenza vaccine such a difficult and potentially delicate process (Saito & Tashiro, 2000).

The Efficacy of the Influenza Vaccine

The influenza vaccine works by exposing the immune system to a weakened form of the multiple strains of the virus (Lee, 2003). Each dose of the influenza vaccine contains several types of the virus, albeit in an inactive form that can be easily overtaken by the body's immune system (Couch, 1999). As with all vaccines, this process stimulates the body's resistance to these strains of the virus. Therefore, if the vaccinated individual comes into contact with droplets that contain any of the strains that have been used in the vaccine, the immune system can rapidly overtake the virus without allowing the full illness to develop (Lee, 2003).

Generally, individuals who have received the influenza vaccine have protection from the virus beginning two weeks after the administration of the vaccination. Furthermore, the vaccine is effective for a year, barring the widespread introduction of a strain of influenza that was not included in the year's vaccination (Harper, Fukuda, Uyeki, Cox & Bridges, 2004).

Each year, medical researchers and representatives of the World Health Organization recommend the strains of influenza that should be included in the year's vaccine. This determination is made based on the strains of influenza that appear to be the most resilient, intense, and widespread at the juncture when the development of the vaccine must be initiated in order to attain an adequate supply before the next influenza season begins.

For the majority of individuals who receive an influenza vaccination, the chances of developing a full-blown case of influenza over the course of the next year are diminished by 70% to 90%. For those who are in ill health or who are otherwise immuno-compromised, the vaccine's success rate falls to 30% to 40% (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). However, studies have demonstrated that the vaccine is successful in preventing the intensity and severity of influenza cases across the full spectrum of individuals who receive it (Harper, Fukuda, Uyeki, Cox & Bridges, 2004).

One important indicator of the vaccine's success is the decline in hospitalization from influenza or common influenza complications, such as pneumonia, among individuals who have been vaccinated against the virus (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). Furthermore, it is estimated that the morbidity and mortality associated with influenza and influenza complications are significantly reduced among those who have received an influenza vaccine.

The Production of the Influenza Vaccine

After the determination has been made as to which influenza strains will be included in the year's vaccine formulation, the correct proportion of viral stock is delivered the manufacturers of the vaccine. The process of influenza vaccine production is complex and relatively vulnerable to disruption or damage. Indeed, the vaccine production firm that failed to deliver the promised quantity of vaccine doses for

the 2004-2005 influenza season cited irregularities in the production process as one of the primary reasons behind the failure.

The most common process of developing the influenza vaccine involves introducing the viral stock into fertilized chicken eggs, with each individual strain of the virus grown in separate batches. Once the virus has been introduced into the chicken egg, it begins its reproductive process. Once this process has created a viable sample of each strain of the virus, the allantoic fluid that contains the influenza is harvested from the eggs (Couch, 1999).

The next phase in the production process involves inactivating the virus and purifying it, so that it is suitable for the weakened form that is required in the vaccine process. The next phase involves combining the various strains of influenza that have been developed into a single-dose formulation, and the last phase of the production process is the dispensation of the doses into the single-use vials that are used to administer the vaccine (Harper, Fukuda, Uyeki, Cox & Bridges, 2004). In a year in which the production process has been completed with no significant delays or problems, the completed influenza vaccine supplies are delivered to supply centers and health care facilities in September and October.

Currently, there are few viable alternatives to this complex and potentially delicate vaccine development process. The most promising alternative to emerge is a type of vaccine that uses a weakened, but live form of the virus and is administered through a nasal spray (Couch, 1999). This form of the vaccine was available in limited quantities in the 2004-2005 influenza season, but long-term determinations of its efficacy have not yet been made.

A significant amount of research attention has been focused upon the development of alternative methods of delivery and production of the influenza vaccine. There are several potential innovations that may be introduced in the near future, but because of the scale and scope of the public health variables involved, certification of a new approach to vaccine production and/or administration involves a lengthy, multi-tiered administrative process (Kandel & Hartshorn, 2001). As such, many public health experts have asserted that changes and reforms need to be implemented that effectively address the shortcomings and deficiencies in the current process of influenza vaccine production (Harper, Fukuda, Uyeki, Cox & Bridges, 2004).

Examining the 2004-2005 Influenza Vaccine Shortage and Its Systemic Implications

Over the course of the last several years, the emergence of several previously-undocumented, particularly virulent strains of influenza have heightened anxiety about the efficacy of the traditional formulation of the vaccine to combat newly evolved types of the virus (Kandel & Hartshorn, 2001). However, in the 2004-2005 influenza season, it proved to be anomalies and deficiencies in the vaccine production, supply, and distribution process that caused a significant problem.

In October 2004, vaccine manufacturer Chiron alerted federal government officials that the supplies being readied in the company's UK manufacturing facilities would not be delivered as a result of a widespread bacterial contamination that was thought to have rendered most of the supply unusable (Krisberg, 2005). The Liverpool

plant in which a majority of the vaccines were being prepared had had its certification revoked by the government regulatory agency, an action that was deemed appropriate by the FDA's subsequent investigation of the matter.

Chiron had promised to deliver approximately half of the annual national supply of influenza vaccine. Because Chiron was one of only two vaccine manufacturers that were charged with the task of developing 2004-2005 influenza vaccines for the United States, the remaining suppliers were able to promise 54 million doses of the traditional vaccine and approximately 1 million doses of the nasal-spray formulation (Krisberg, 2005). Taken together, the supply that was thought to be available at that juncture fell far short of the estimated 80 million doses that were thought to be needed to meet demand.

After the initial announcement of an expected shortfall, the initial response that was marshaled by both the government and the medical/public health community was the issuance of guidelines determining which segments of the population should be granted priority to receive the influenza vaccine (Krisberg, 2005). For the most part, the initial guidelines that were issued overlapped with the typical recommendations for who should receive the vaccine. However, in addition, those in good health, without any substantial risk factors, were advised to delay or cancel their annual influenza vaccination.

The second phase of response to the shortage announcement was an attempt to replace the vaccine shortfall with doses procured from other sources. In this endeavor, there was very little coordination, as representatives from various federal, state, municipal governments, as well as an array of non-governmental organizations,

sought to procure additional doses of influenza vaccine (Krisberg, 2005). While some of these procurement efforts were met with success, the relative dearth of worldwide suppliers of the vaccine resulted in very little surplus materials being available.

Although the possibility for widespread influenza outbreaks still exists at the current moment, as the typical influenza season runs through March, it appears that the shortage had little overall impact on the public health. Indeed, in many locales, officials were ultimately left with surplus stores of the 2004-2005 vaccine (Krisberg, 2005). It has been suggested that the initial announcement of temporarily more stringent guidelines for determining who should receive the vaccine prompted a significant decline in demand during this influenza season.

Factors that Contributed to the Shortage

It is clear that the direct cause of the initial shortage of the 2004-2005 influenza vaccine that was announced in October 2004 was the reliance on only two manufacturers for the development of the United States' entire vaccine supply. If the manufacturing process had been dispersed throughout a broader field of companies, representing a wide array of production facilities, it is highly unlikely that production problems within a single manufacturing site could have resulted in such a substantial loss for the nation's vaccine supply as a whole (Krisberg, 2005).

However, to state that the dearth of manufacturers responsible for developing the nation's influenza supply is the sole cause of the shortage that occurred in October 2004 would be an oversimplification of the situation. In actuality, numerous

contributing factors and variables culminated in not only the lack of adequate supply of the influenza vaccine, but also in the over reliance on two pharmaceutical manufacturers as the sole suppliers of a preventative treatment that is vitally important for the maintenance of public health in the United States.

Although the CDC, FDA, and other agencies of the federal government participate in plans for the development, supply, and distribution of the influenza vaccine on an annual basis, there exists no overarching government body charged with closely managing the process from both an epidemiological and a logistical standpoint. Private manufacturers and suppliers contract to meet the projected needs set forth by epidemiologists and public health experts, but there are no unambiguous government directives or incentives that compel participation in the manufacturing process. To the contrary, many industry analysts assert that the federal government's bargaining power has actually driven down the market price for influenza vaccine, further eliminating the potential for a competitive field of vaccine manufacturers seeking to enter the market (Krisberg, 2005).

There is little certainty of profitable revenues in the production and manufacturing of the influenza vaccine. The current manufacturing process is complex, delicate, and susceptible to problems such as contamination. Furthermore, the wholesale prices that can be garnered for each dose rarely exceed a few dollars each, meaning that manufacturing costs often come close to the sale price of each dose (Fedson, Gellin & Modlin, 2003).

The unstable nature of the vaccine market presents another disincentive for potential manufacturers and suppliers. Because the strength and intensity of the

influenza season are variables that are often unpredictable, manufacturers are often saddled with millions of surplus vaccines that they must buy back if unused. Because the nature of the influenza vaccine process requires a new formulation for each annual influenza season, the manufacturing costs for these surplus doses often cannot be recouped, resulting in further loss of profit (Fedson, Gellin & Modlin, 2003).

A controversial claim that has been made about the lack of interest in influenza vaccine development among private sector pharmaceutical manufacturers is that the fear of being faced with a lawsuit has served to further eliminate potential competitors. According to this argument, because of the high rates of morbidity and mortality associated with the contraction of influenza, the risk of being sued by a patient or a patient's family for whom the vaccine did not prevent infection or complications is too high to allow for any profit margin or return-on-investment from entering the manufacturing market (Krisberg, 2005).

However, while there is risk involved in the manufacture of any pharmaceutical product, there is a lack of clear evidence supporting this claim, considering that fewer than ten such malpractice cases have been tried over the course of the last several decades. In addition, because the issue of medical malpractice suits has become a frequent political topic for the current administration, this argument may be based more in the ideology of the current conservative movement, rather than the prevailing conditions of the nation's health care sector.

Taking all of these considerations together, it is clear that the current process of manufacturing the influenza vaccine often represents an unprofitable, uncertain business venture for manufacturers (Fedson, Gellin & Modlin, 2003). However,

currently, the nation's primary method of responding to the inevitable annual influenza season is dependant upon the willingness of private-sector pharmaceutical manufacturers to commit to a complex, uncertain undertaking that is only occasionally profitable. Acknowledging the beliefs about the self-regulating powers of the free market that are prevalent within the current administration, this type of reliance upon the private sector to engage in a financially detrimental business endeavor seems extremely ill-advised.

At the core of the problem are two competing philosophies of economics, public health, and the autonomy of the free market. In the current political climate, the traditional conservative beliefs in the free market and its ability to regulate and modulate itself prevails.

At the same time, those on the conservative end of the spectrum typically tend to discourage the development of programs or regulatory oversight responsibilities that would result in an expansion of the scope and power of the centralized federal government. Because both the executive and the legislative branches of federal government are currently dominated by conservative Republicans, the current trend towards supporting deregulation, minimizing government oversight, and the free reign of the market is explainable.

On the other side of the debate are Democrats, liberals, and progressives, who regard the protection and strengthening of the public good as a higher objective than ensuring that the forces of the market are allowed to function freely. As such, those on this side of the debate regard government oversight, and even subsidy, of the development, production, supply, and distribution of the influenza vaccine as a wise

investment, considering the loss of productivity, spiraling health care costs, and potential loss of life that are associated with influenza and its complications on an annual basis (Cram, Blitz, Monto & Fendrick, 2001).

Recommendations for Reforming the Current System of Influenza Vaccine Production

To a large degree, the point of view that increased government oversight and participation in the development and distribution of the influenza vaccine supply is necessary is echoed by many in public health and health care policy. Because many leading epidemiologists have long warned that a world-wide pandemic is an inevitable occurrence, the current lack of preparedness for such an eventuality has prompted many experts in public health and health policy to call for reform of the current system for many years (Snacken, Kendal, Haaheim & Wood, 1999; Fedson, Gellin & Modlin, 2003).

This urgency has increased exponentially since the emergence of particularly virulent strains of influenza, including avian flu, over the course of the last several years (Lazzari & Stöhr, 2004; Trampuz, Prabhu, Smith & Baddour, 2004). Because of low human resistance to avian flu, a pandemic outbreak could kill between 2 and 7 million, according to recent estimates (Fedson, Gellin & Modlin, 2003; Trampuz, Prabhu, Smith & Baddour, 2004).

In addition, the increased possibility of bioterrorism attack involving a virulent strain of influenza has also prompted many to call for the development of a more comprehensive, unified approach to the problem that includes more government

participation and the development of financial or other incentives for manufacturers who agree to assist in the development of influenza vaccine in the future (Fedson, Gellin & Modlin, 2003).

Another reform that could increase the profitability of the manufacture of influenza vaccine is initiating federal legislation that would mandate full coverage of the vaccine for individuals in all at-risk categories in all public and private health insurance plans. This would create a more stable market for the influenza vaccine by expanding the demand for the drug.

Profitability incentives for manufacturers of influenza vaccines is perhaps the best solution to the urgent problem facing government in deciding the direction of vaccine distribution. Free market distribution does need an incentive due to the fickle nature of the flu vaccine business and the low profit margin of conventional vaccine production. Placing manufacturing and distribution channeling in the hands of the government has proved unsuccessful in the past when various other vaccination threats faced the nation. For example, the 1993 Omnibus Budget Reconciliation Act included the Vaccines for Children program, which drove up the cost of vaccines in the private sector prohibitively for immunization and created polarization between the government and the vaccine industry over cost containment (Pollock, 1994). Another program failure was the National Vaccine Plan, instituted to operate in conjunction with the CDC in an attempt to solve the social problem of vaccine distribution. While good intentioned, the program never materialized. Thus, keeping vaccination in the hands of the private sector while offering incentives to manufacturers works better in the overall scheme of pubic health services and within the government's capabilities.

Since the government does not have control over a vaccine production facility, contracting with an outside vendor to ensure a certain level of production a year is the only feasible way to present vaccines to the public. In order to insure that pricing remained consistent and a guaranteed amount of vaccine would be produced each year, a fixed price plus or a cost plus contract would have to be offered. The parallel of this type of contracting in government is similar to defense contracting, a poor model for success over the years. This model is not practical due to the complex structure of the vaccine industry, with multi-tiered levels of pricing and service dependent upon the distribution to the public, private firms or governmental agencies. As the Vaccines for Children's program illustrated, the government could very well pay 50 to 80 percent more for vaccines, transferring this cost to an already beleaguered healthcare budget (Russell, 1996).

A number of recently proposed legislative measures begin the process of creating a federal infrastructure for more scrutiny and oversight of the development of the influenza vaccine and management of the vaccine supply. In addition, other recently proposed measures will seek to significantly expand the funding available for government-subsidized research into influenza and the development of viable alternatives to the current method of developing and administering the influenza vaccine, including the development of a more broadly effective vaccine formulation that could combat multiple strains of the virus simultaneously, or be used in a pandemic situation (Kandel & Hartshorn, 2001; Fedson, Gellin & Modlin, 2003).

Conclusion

It remains unclear whether the 2004-2005 influenza vaccine shortage will exert a significant impact upon the public health. However, the shortage has brought to light the many shortcomings and deficiencies of the current system of vaccine development, production, supply, and distribution. Rather than continue to rely on the forces of the free market to meet needs crucial to maintaining the public health, increased government participation, scrutiny, and oversight of the process is needed to remedy this dangerous situation.

References

Couch, R.B. (1999). "Measures for control of influenza." *Pharmacoeconomics, 16(6),* 41-45.

Cram, P., Blitz, S.G., Monto, A. & Fendrick, A.M. (2001). Influenza: Cost of illness and considerations in the economic evaluation of new and emerging therapies. *Pharmacoeconomics, 19(3),* 223-230.

Fedson, D.S., Gellin, B. & Modlin, J.F. (2003). Pandemic influenza and the global vaccine supply. *Clinical Infectious Diseases, 36,* 1552-1561.

Gensheimer, K.F., Fukuda, K., Brammer, L., Cox, N., Strikas, R.A. & Patriarca, P.A. (1999). Preparing for pandemic influenza: The need for enhanced surveillance. *Emerging Infectious Diseases, 5(2),* 297-299.

Gensheimer, K.F., Meltzer, M.I., Postema, A.S. & Strikas, R.A. (2003). Influenza pandemic preparedness. *Emerging Infectious Diseases, 9(12),* 1645-1648.

Harper, S.A., Fukuda, K., Uyeki, T.M., Cox, N.J. & Bridges, C.B. (2004). Prevention and control of influenza. *Morbidity & Mortality Weekly Report. 53(RR-6),* 1-40.

Kandel, R. & Hartshorn, K.L. (2001). Prophylaxis and treatment of influenza virus infection. *Biodrugs, 15(5),* 303-323.

Krisberg, K. (2005). Flu vaccine crisis spurs debate, actions on U.S. vaccine system. *Nation's Health, 34(10),* 1-3.

Lazzari, S. & Stöhr, K. (2004). Avian influenza and influenza

pandemics. *Bulletin of the World Health Organization, 82(4)*, 242-243.

Lee, P.P. (2003). Prevention and control of influenza. *Southern Medical Journal, 96(8),* 751-757.

Meltzer, M.I. & Cox, N.J. (1999). The economic impact of pandemic influenza in the United States: Priorities for intervention. *Emerging Infectious Diseases, 5(5),* 659-671.

Pollock, R. (1994). Shots in the dark – Health Care. *Reason*, November.

Prisco, M.K. (2002). Update your understanding of influenza. *Nurse Practitioner, 27(6),* 1-10.

Russell, P.K. (1996). Development of Vaccines to Meet Public Health Needs: Incentives and Obstacles. RISK: Health, Safety & Environment. 7(239), 1-8.

Saito, T. & Tashiro, M. (2000). Vaccines and therapeutics against influenza virus infections. *Pediatrics International, 42(2),* 219-225.

Snacken, R., Kendal, A.P., Haaheim, L.R. & Wood, J.M. (1999). The next influenza pandemic: Lessons from Hong Kong, 1997. *Emerging Infectious Diseases, 5(2),* 195-203.

Trampuz, A., Prabhu, R.M., Smith, T.F. & Baddour, L.M. (2004). Avian influenza: A new pandemic threat? *Mayo Clinic Proceedings, 79(4),* 523-530.

Wood, S.C., Nguyen, V.H. & Schmidt, C. (2000). Economic evaluations of influenza vaccination in healthy working-age adults: Employer and society perspective. *Pharmacoeconomics, 18(2),* 173-183.