**Title:** Pandemic Winners

Robyn Schreiber 1, Karissa Whiting 1, Rachel Bell 1, Catherine Machalaba 1, & Andrew G. Huff 1

**Affiliations**

1 EcoHealth Alliance, 460 W 34th, 17th Floor, New York, New York 10001

**INTRODUCTION**

The economic impacts of epidemics can be detrimental to the global economy. Workforce losses, reduced tourism and trade, and increased health care and preparedness expenditures can have severe and long-term effects on economies[[1]](#footnote-1). The World Bank (2014) estimated that the short-term economic impact of the 2013 - 2014 Ebola epidemic in Liberia, Sierra Leone, and Guinea would be between $2.2 and $7.4 billion, with even greater long-term losses projected. These costs are compounded if a disease reaches a pandemic level, and the World Bank estimated a severe pandemic flu could cost as much as $3 trillion globally[[2]](#footnote-3) [[3]](#footnote-4). In the U.S., an H5N1 pandemic could cost the United States an estimated $165.5 billion in healthcare and medical costs, with much of the burden falling on private hospitals[[4]](#footnote-5). While many industries suffer severe revenue and investment losses, some industries see increases in profits during times of disease outbreak or epidemic due to an increased demand for medical products and services[[5]](#footnote-6). Although economic losses from epidemics are widely studied, there is little research on the converse financial effects of disease outbreaks[[6]](#footnote-7). This study investigates and explores potential profiteers from infectious disease events.

**Specialized Equipment**

During an epidemic or outbreak the demand for personal protective equipment (PPE) grows rapidly in affected countries. Typically, companies that employ health care workers that are in close contact with infected individuals purchase PPE most often. However, during the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak a high level of public concern over sustained disease transmission created greater than expected demand for PPE among the general public[[7]](#footnote-8). This increased demand during outbreaks among government agencies, hospitals, and the general public may benefit the industries manufacturing and supplying protective equipment.[[8]](#footnote-9) [[9]](#footnote-10).

In 2014, PPE suppliers saw an initial uptick in demand for their products when the West African Ebola outbreak began receiving intensified media coverage. After news spread of the first Ebola infected patient in the U.S., Medline Industries, one of the largest PPE suppliers in the U.S., reported a 40% increase in domestic demand for facial-protection products and a 50% increase in demand for isolation gowns.[[10]](#footnote-11) Medline increased production of these items and packaged them in specialized Ebola protection kits which also included body suits, face shields, boot covers, masks, gloves and biohazard bags in order to meet the increased demand following the Dallas Ebola case. [[11]](#footnote-12). Much of the economic burden of these PPE purchases fell on U.S. hospitals, many of which bought enough supplies to meet or exceed the revised Center for Disease Control (CDC) guidelines[[12]](#footnote-14) [[13]](#footnote-15)

CDC’s new 2014 guidelines on Ebola preparedness required selected hospitals to increase supplies of PPE and other safety equipment[[14]](#footnote-16). U.S. Hospitals spent money on Ebola preparedness PPE including coveralls, gowns, face shields and respirators. One hospital in Kansas reportedly spent $100,000 in jumpsuits, hoods, and respiratory devices. This amount was estimated to be able to hypothetically treat one patient for two weeks[[15]](#footnote-17). The State University of New York Upstate Hospital estimated short term Ebola preparedness costs, including building modifications for containments at $448,052, with long-term ongoing Ebola operational costs (e.g., biosuits, respirators, laboratory costs, waste disposal costs, operating costs, lost revenue, training, and planning) at an additional $50,000 monthly.[[16]](#footnote-18). The North Shore Long Island Jewish Health System, a health care network of 21 hospitals, proposed building a biological containment unit to treat and contain infectious diseases within one of their facilities for an estimated cost of $15 million[[17]](#footnote-19). In addition to implementing new Ebola-preparedness guidelines, the CDC purchased $2.7 million worth of PPE including gowns, coveralls, aprons, boot covers, gloves, face shields, hoods, N95 respirators, and disinfecting wipes to create a strategic national stockpile. This equipment was divided into 50 kits, each able to treat one Ebola patient for up to 5 days[[18]](#footnote-20) [[19]](#footnote-21). Because there were so few Ebola cases in the U.S., critics questioned the necessity of CDC and hospital equipment stockpiling, which exhausted already depleted PPE manufacturer resources. DuPont, producer of chemical suits, boot covers, face masks, and hoods who works with the CDC and the Department of Homeland Security, struggled to fill demand in priority Ebola-stressed countries in Africa [[20]](#footnote-22) [[21]](#footnote-23)

Due to these surges in demand, companies like DuPont that were capable of producing and selling large quantities of PPE and other health equipment generally had stock spikes, increased sales, and designed new products specific to Ebola response. Medline Industries self-reported over $7 billion in sales in 2014, up from $5.8 billion in 2013[[22]](#footnote-24). BioMedical Devices received 10 times as many orders in October and November than September of 2014 and went into backorder[[23]](#footnote-25). Alpha Pro Tech (APT) and Lakeland Industries, both PPE suppliers, saw share increases of over 200% in 2014 (Figures 1 & 2) [[24]](#footnote-26). In their annual report, Lakeland Industries attributed their gross profit increase from 28.2 % in the previous year to 37.5% in the fourth quarter of 2015 to sales in PPE related to the U.S. Ebola response[[25]](#footnote-27). During this period, Lakeland tripled production capacity for PPE and obtained several large contracts[[26]](#footnote-28). Lakeland had to sell shares of common stock in October 2014 to support increased production due to demand of Ebola-related safety products, although shares began falling 26% after panic concerning the Ebola epidemic cooled slightly[[27]](#footnote-29). Nonetheless, Lakeland’s 2014 fiscal year showed financial figures markedly higher than previous years, and the company ended the year with a total revenue of $99,734,00 and a gross profit of $33,712,000[[28]](#footnote-30). Similarly, Alpha Pro Tech stated in their annual report that the 28% increase in Infection Control segment sales was primarily due to increased sales in the fourth quarter of 2014, a result of the U.S. response to the Ebola epidemic[[29]](#footnote-31).

The SARS outbreak in 2003 created similar demand surges for PPE and other protective products and some companies responded to this demand by developing new and highly effective preventative and protective equipment. Singapore Technologies Electronics, a company of Singapore Technologies Engineering, developed a thermal camera system able to detect fevers and within five weeks sold 138 camera systems, contributing an estimated $12 million to the company’s annual sales[[30]](#footnote-33). As seen in the Ebola epidemic, overall PPE demand increased as well: Halyard Health of Kimberly Clark reported a rise in PPE orders 30% above normal pre-influenza season annual levels and hit their cap production during the SARS outbreak in 2003[[31]](#footnote-34). Like with the Ebola epidemic, increased demand and sale of PPE during the SARS outbreak created unique opportunities for profit for companies that provide these necessary specialized equipment to affected governments and treatment facilities.

PPE is only one of many preparedness costs that face treatment facilities during a disease outbreak. Training healthcare workers and government personnel for disease outbreak response can be one of the most costly preparedness expenditures for organizations, yet the economic cost of training is seldom discussed in relation to the economics of pandemic events. Training procedures for infectious disease outbreaks are often resource-intensive and expensive, making it costly to train large amounts of people quickly, but adequately trained staff is necessary to control outbreaks of infectious diseases like Ebola[[32]](#footnote-35) [[33]](#footnote-36). In a report on the cost of Ebola-preparedness in U.S. hospitals, Daly suggests that the largest cost of Ebola preparedness was in fact staff training[[34]](#footnote-37). The sudden fear of Ebola spreading to the U.S. created a high demand for hospital staff training that was costly due to administrative costs and the opportunity cost of staff time spent learning Ebola procedures and protocols[[35]](#footnote-38) [[36]](#footnote-39). For example, hospitals in Connecticut estimated spending around 2 million in Ebola training cost alone[[37]](#footnote-40). For some appointed facilities, however, Ebola training initiatives brought in new funding opportunities, as was the case with Emory University, Nebraska Medical Center, and Bellevue Hospital who were awarded 12 million dollars total from the Department of Homeland Security (DHS) and the CDC to lead the National Ebola Training and Education Center[[38]](#footnote-41). These facilities were allocated these funds to assess capacity, and provide training and tools to prepare other treatments centers around the U.S. for a possible Ebola case.

Since traditional methods of personnel training can be incredibly costly, there is an increasing demand for cheaper pandemic training programs and resources[[39]](#footnote-42). These financial incentives may catalyze the development and sale of new electronic or internet based training technologies like the Ebola training toolkit produced by the CDC [[40]](#footnote-43) [[41]](#footnote-44). For example, initial studies have shown a computer-assisted resilience training tool can help workers prepare for the stressful working conditions associated with influenza outbreaks. This tool can help combat stress-related absenteeism, infection of workers, and psychological trauma, all of which can lead to significant losses of necessary hospital labor during a disease outbreak.[[42]](#footnote-45) [[43]](#footnote-46). While there is not yet definitive research to determine if these tools can effectively replace old standards of training, there is potential for a profitable market to develop around these cost effective training methods. If proven useful, these tools can help mitigate the economic cost of future pandemics.

**Pharmaceutical Industry**

The pharmaceutical response to pandemics is one of the most important factors in effectively preventing and eradicating the spread of infectious diseases[[44]](#footnote-48)**.** While some research has supported a combination of pharmaceutical and non-pharmaceutical interventions as the most cost-effective approach to a disease outbreak, others posit that increased vaccine and drug course availability alone may mitigate economic losses most effectively[[45]](#footnote-49) [[46]](#footnote-50). An effective vaccine response during an outbreak can significantly limit the spread and impact of infection within the affected country, which ultimately may mitigate in-country economic losses[[47]](#footnote-51). Large amounts of federal funds are invested in the development and provisioning of vaccines to hospitals and the public during an outbreak.

Increased demand for medicines and vaccines during an outbreak often leads to overall economic gains for the healthcare and pharmaceutical companies that produce them. Companies involved in influenza medicine or vaccine production often see greater profits during years with influenza outbreak or pandemic events. Sanofi-Aventis, now known as Sanofi, presented figures at the beginning of 2010 illustrating their net profits of 7.8 billion Euros (11%) due to record sales of anti-flu vaccines likely associated with the 2009 H1N1 influenza pandemic[[48]](#footnote-52). The value of the worldwide market for influenza preventative products and treatments alone has been estimated at $2.5 billion, with the flu antiviral market valued around $1.5 billion worldwide and cornered by Roche, Sanofi-Pasteur, GlaxoSmithKline, and Novartis[[49]](#footnote-53).

For these large pharmaceutical companies, vaccine sales are rarely as profitable as drugs sales, which can lower the incentive to develop them[[50]](#footnote-54). Prior to the 2014 Ebola epidemic, Ebola vaccine development was not considered profitable by pharmaceutical or medical research companies because outbreaks were considered too rare and limited in scope[[51]](#footnote-55). This perception may be changing, as developing countries become new viable markets for vaccines[[52]](#footnote-56). The global market for vaccines in 2014 is estimated at $25.5 billion and approximately $6.1 billion of $7.1 billion federal avian influenza funds in the United States has been earmarked for vaccine development, production and stockpiling[[53]](#footnote-57) [[54]](#footnote-58). Severe outbreaks like the 2014 Ebola epidemic have incentivized vaccine development and contributed to making vaccines one of the fastest-growing areas of research within the biotechnology industry[[55]](#footnote-59). Collaboration between governments and pharmaceutical companies is necessary to develop affordable and accessible vaccines for the next outbreak or epidemic. Strategies such as government stockpiling can help ensure supplies of vaccines are adequate in preparation for an infectious disease event while minimizing purchasing costs.

**Drug Stockpiling**

Stockpiling medicine can also be an economically efficient response to a pandemic[[56]](#footnote-60)**.** A cost benefit analysis performed by Balicer *et al.* (2005) revealed that stockpiling investments for influenza are economically cost-effective as long as there is more than one influenza pandemics every 80 years. However, overestimation or mismanagement of federal stockpiles can lead to significant federal economic losses. In a 2014 audit of DHS, the department was criticized for their poor management of Influenza vaccine and PPE inventory and their lack of stockpile replenishment plans for expired vaccines and equipment. Stockpile replenishment plans are especially important, as 81% of DHS’s Influenza antiviral vaccine stockpile will expire by the end of 2015, leaving the U.S. vulnerable to an Influenza outbreak. [[57]](#footnote-61) The DHS has also been called into question for their decision to place a $463 million dollar order with Siga Technologies for an expensive Smallpox vaccine to counter bioterrorism. It is suspected that the drug’s $200 per treatment purchasing cost is a significant markup from it’s production cost, and the 2 million dose government order significantly increased the small companies profits.[[58]](#footnote-62)

As was the case with Siga Technologies, drug stockpiling has significantly increased revenues for many pharmaceutical companies. After continuous outbreaks of H5N1 starting in 2003, the World Health Organization (WHO) amassed a stockpile of oseltamivir treatment courses that was ready for use by 2006[[59]](#footnote-64). In 2005, Hoffmann La-Roche, a private pharmaceutical company and the main producer of oseltamivir in the form of Tamiflu, reported it was their best year ever partially due these Tamiflu stockpile sales[[60]](#footnote-65). Relenza, a form of zanamivir sold by GlaxoSmithKline, was also internationally stockpiled in response to the H1N1 pandemic threat in 2009 and the company saw revenues of approximately 1.4 billion in pandemic vaccine sales alone[[61]](#footnote-66) [[62]](#footnote-67). Millions of these treatment courses were purchased by the U.S. government to be included in the CDC’s Strategic National Stockpile that was amassed in response in the 2009 H1N1 pandemic and maintained in the event of future influenza outbreaks[[63]](#footnote-68)., In 2009, estimated total sales of influenza vaccines and adjuvant totaled U.S. $6.9 billion in 2009, according to JP Morgan[[64]](#footnote-69).

Hoffman La-Roche also provided treatment courses in Vietnam as the government increased vaccine stocks as part of the 2005 H5N1 and Human Influenza Pandemic Preparedness Plan., The Vietnam government purchased 2.5 million treatment courses (25 million capsules) of oseltamivir from Roche to be added to their stockpile[[65]](#footnote-70). The Thailand government similarly purchased 260,000 treatment courses (2.6 million capsules) of oseltamivir from Roche for a national stockpile throughout 2005 and 2006, and enacted policies to increase the domestic production of oseltamivir each year by 100,000 treatment courses over the course of three years[[66]](#footnote-71). Manufacture Reserve Programs initiated by Roche and GlaxoSmithKline in 2008 charged hospitals and other private organizations in the program an annual fee to reserve the ability to buy treatment courses in the case of a future influenza outbreak. These programs have further inflated profits for drug manufacturers[[67]](#footnote-72). While pharmaceutical companies see an increase in profits due to outbreaks or intensification of government pandemic preparedness programs, the success is often short lived, and vaccines markets are exceptionally volatile during disease outbreaks. This is reflected in fluctuations of stock market prices.

**Stock Prices and Money Markets**

Changes in stock prices during outbreaks illustrate market fluctuations within pharmaceutical and biomedical research sectors during periods of intensified pandemic preparedness or heightened perceived pandemic risk. The recent Ebola epidemic of 2014 led to a huge push in medicine and vaccine development. The first case of Ebola in the U.S. caused stocks for many pharmaceutical companies to soar. One of the biggest market gainers was Tekmira Pharmaceuticals Corporation, now known as Arbutus Biopharma Corporation, who developed the Ebola drug TKM-Ebola under a $140 million contract with the U.S. Department of Defense. TKM-Ebola was fast-tracked for use in West Africa in 2014[[68]](#footnote-73) (Figures 1 & 2). According to Tekmira’s 2014 Annual Report, shares in the company jumped from $4.11 CAD per share to $27.85 CAD (17.31%) on the Toronto Stock Exchange[[69]](#footnote-74). Despite these financial gains, TKM-Ebola was found ineffective and the company suspended development and changed its corporate name to Arbutus Biopharma[[70]](#footnote-75). Once [Sarepta Therapeutics (SRPT)](http://www.usatoday.com/money/lookup/stocks/SRPT/) began developing an Ebola treatment with a high trial success rate, company shares went up from $1.67 to $22.77 in after-hours trading, eventually closing at $21.10[[71]](#footnote-76). Other companies involved in Ebola vaccine or medicine development, including Inovio Pharmaceuticals and AstraZeneca, also saw stock spikes in 2014, correlated to the timing of various events within the Ebola epidemic[[72]](#footnote-77). As seen with Sarepta’s stocks, spikes in pharmaceutical markets during outbreaks are often quick and drastic, however these spikes are often short lived (figure 2)[[73]](#footnote-78).

Biotechnology companies during the SARS outbreak of 2003 also saw sudden, brief spikes in stock prices related to statements or evidence that their products could be useful against SARS. Shares of SciClone Pharmaceuticals rose from $5.56 to $6.30 within a short period in May 2003, and the company saw a definitive increase in sales during this time (Figures 3 & 4)[[74]](#footnote-79). Stock returns of Taiwan’s biotechnology sector also had positive surges in stock returns in response to the SARS outbreak[[75]](#footnote-80). While disease outbreaks may be beneficial to biotechnology markets, other markets, like those for non-essential goods, can suffer severe losses as a result of panic or perceived risk among consumers. [[76]](#footnote-81).

Stock market fluctuations during outbreaks and epidemics also reflect the economic downturn faced by many sectors as spending decreases during disease outbreaks..Non- essential goods (e.g., furniture, recreational services, leather goods) and markets for goods that may be perceived as risky (e.g., meat or dairy products during a zoonotic disease outbreak) may also be affected[[77]](#footnote-82) [[78]](#footnote-83). During the 2015 Middle Eastern Respiratory Syndrome (MERS) epidemic in South Korea, fearful consumer sentiment drove the South Korean economy so low the central bank cut its benchmark interest rate to 1.50% to support the plunging economy[[79]](#footnote-84). The tourism sector was shaken, and the South Korean government reported 54,400 canceled trips to South Korea within a few days of confirming the outbreak in the region[[80]](#footnote-85).The Korean government devised a $19.8 billion dollar USD stimulus package to help combat these economic losses.

The fear instilled by pandemics can result in the rise of the dollar, ease of monetary policy and falling interest rates[[81]](#footnote-87). Outbreaks also affect financial trading behaviors. Stocks in tourism, airline, hospitality and consumer industry (malls, casinos) companies are often sold when there are outbreaks or threat of infectious disease spread while stocks in PPE and pharmaceutical companies are rapidly purchased with the assumption that sales of these goods will increase dramatically[[82]](#footnote-88). Professional finance companies use their extensive knowledge of these trends and industry expertise to profit during these times. In 2014, hedge funds predicted that Ebola would affect the Ivory Coast, a major cocoa producer, and profited off of their bet that cocoa prices would continue to rise[[83]](#footnote-89). Similarly, a 2005 Citigroup report warned investors about investing in labor-intensive industries and countries with inflexible labor laws during avian influenza outbreaks because in the event of decreased demand, laborers cannot be laid off[[84]](#footnote-90).

Several companies like Natixis Global Asset Management and BMO Nesbitt Burns have produced investor guides for avian influenza and other diseases with pandemic potential[[85]](#footnote-91). Visiongain, a business intelligence provider, advertises itself as being able to identify, examine and provide timely consultancy on sectors with profit potential, including the pharmaceutical and vaccine markets during pandemics[[86]](#footnote-92). While these investment decisions may be profit-driven, encouraging investments in biotechnology sectors may incentivize companies to work on developing the technologies necessary to combat the next pandemic.

**Public Health / Biomedical Research**

Governments also prioritize investments in biotechnology sectors during outbreaks through allocation of funds to public health research institutions like governmental agencies, universities and nonprofit organizations that work to mitigate and prevent pandemics. During the 2009 H1N1 pandemic, the Department of Health and Human Services’ (HHS) budget ($10,660,795,000) was more than 14 times the previous year’s and was the only annual budget in the past 15 years that allocated funds ($200,000,000) to the CDC[[87]](#footnote-93). In the same year, the European Commission announced approximately $1.5 million in funding for influenza research projects[[88]](#footnote-94). Disease risk mitigation and response funding is often funneled from government health and defense sectors, into specific collaborating institutes, centers, and universities for targeted research. During the 2003 SARS epidemic, the Chinese government allocated $108.7 million USD for SARS prevention work and an additional $73 million USD to the Chinese Centre for Disease Control and Prevention for facility upgrades and research on SARS prevention[[89]](#footnote-95). The Chinese Ministry of Science and Technology allocated 10 million yuan (1.2 millions USD) to invest in multidisciplinary SARS research groups working through institutes under the Chinese Academy of Sciences..[[90]](#footnote-96) In addition, U.S. government funding supported private companies Biota Holdings (now Biota Pharmaceuticals) and Tyson Bioresearch, and the National Taiwan University College of Medicine for SARS biotechnical research[[91]](#footnote-97).

Allocation of large research funds was also an integral part of the The U.S. response to the 2014 Ebola crisis. Out of the $6.18 billion Ebola response package, $2.32 billion was allocated for the HHS, including $1.83 billion to the Center for Disease Control and $238 million to the National Institute of Health (NIH) for medical research[[92]](#footnote-98). The United States pledged $1 billion to the Global Health Security Agenda to consolidate and expand efforts to prevent, detect and respond to future global pandemics[[93]](#footnote-99).

Development of effective pharmaceuticals is a critical part of efforts to prevent future pandemics, and government or non-profit organizations will often fund and coordinate medical research with pharmaceutical companies. For example, in 2015 the German Center for Infection Research (DIFZ) funded a 1.5 million Euro grant for the project "GMP Manufacture and Phase I Clinical Investigation of MVA-MERS-S, an Experimental Prophylactic Vaccine against the Middle East Respiratory Virus Syndrome," to be researched through the Erasmus Medical Center and Marburg University[[94]](#footnote-100). After the Ebola outbreak in 2014, public and private institutes collaborated on research of Marburg virus, and Ebola-like virus with epidemic potential. Sarepta Therapeutics worked with the University of Washington Medical Center and U.S. Army Medical Research Institute of Infectious Diseases to test experimental medicines for Marburg, and NIH’s Intramural Research Program and the National Institute of Allergy and Infectious Diseases vaccines (NIAID) both funded research on the effectiveness and safety of new Marburg and Ebola vaccines[[95]](#footnote-102) [[96]](#footnote-103). The Scripps Research Institute (TSRI) was also involved in collaborative research with Emergent BioSolutions, Mapp Biopharmaceutical and Integrated BioTherapeutics into finding antibodies that could successfully bind to weak spots on the Marburg virus[[97]](#footnote-104).As a result of these collaborative activities, both pharmaceutical companies and research institutes can experience increases in funding and financial gains, and pharmaceutical companies can develop new potentially profitable products to sell in the world vaccine and drug market.

**Trade**

Increasing globalization and trade liberalization over the past 20 years has greatly expanded the world economy, allowing new opportunities for both developed and developing countries. For most countries, International trade as a percentage of country’s gross domestic products (GDP) has consistently increased each year[[98]](#footnote-105). Disease outbreaks and epidemics cause market volatility, particularly in the most economically integrated, globalized countries where trade is a higher share of total GDP[[99]](#footnote-106). As dependence on international trade continues to increase, countries are left vulnerable to the market fluctuations during epidemics. These fluctuations stem from many factors, including consumer fears of health risks of traded goods, and international trade regulations limiting dissemination of goods from outbreak countries. In South Korea, overseas shipments fell 10.9% compared to the previous year, most likely in reaction to the outbreak of MERS in Seoul[[100]](#footnote-107). Outbreaks of zoonotic diseases can cause severe market shocks, and trade income is lost as a result of decreased demand or trade bans on livestock and poultry goods. This was evident in the Bovine Spongiform Encephalopathy (BSE) and new variant Creutzfeldt-Jakob disease (nvCJD) outbreaks in England, which caused $5.75 billion in total losses, with $2 billion lost in beef exports alone, and the outbreak of Nipah in Malaysia, which lost an estimated $120 million in pork exports[[101]](#footnote-109) [[102]](#footnote-110).

Economic losses from outbreaks extend beyond the outbreak country markets and affect the economies of trade partners as well. These secondary effects may be exacerbated in the future, as individual country economies become more dependent on foreign goods. China is the largest source of U.S. imports overall, accounting for over 21% of total U.S**.** imports in 2015[[103]](#footnote-111). China is a hotspot for disease emergence, and future disruptions to China’s economy similar to the 1997 avian influenza outbreak or 2003 SARS outbreak would have significant effects on the U.S. markets and consumption of these goods[[104]](#footnote-112) [[105]](#footnote-113) [[106]](#footnote-114) [[107]](#footnote-115).

Often markets fall due as consumer confidence in a product declines[[108]](#footnote-116). Sometimes, this can lead to increase in demand for an alternative good. After the 2004 outbreak of Avian influenza prices of non-poultry meats rose 30% as demand increased for meat goods that were considered more safe[[109]](#footnote-117). This can translate into higher export income for trading partners that sell products to help meet the raised demand for alternative goods.

Furthermore, when demand remains but trade bans or production losses due to an outbreak limit a country’s ability to meet the demand, competing markets may have the opportunity to increase their trade flow to replace the lost supply. Following the first case of BSE in the U.S., beef and cattle exports dropped and consumers of U.S. livestock products who instituted bans against import of U.S. goods, began looking to Australia, New Zealand, and South America to cover the shortage, allowing these markets to flourish[[110]](#footnote-118). A similar positive effect may be seen in U.S. poultry markets if outbreaks of Avian Influenza continue in Asian countries. If the U.S. continues to remain free of Avian Influenza outbreaks, it is predicted that the U.S. poultry industry may expand to cover the losses of the Asian markets[[111]](#footnote-119). Therefore, disease outbreaks or heightened perception of disease risk among consumers can have both positive or negative effects on trade profits and sector revenues depending on the relation of the goods being sold to the specific outbreak (e.g. beef trade decreases during BSE outbreak, but can increase during Avian Influenza outbreak).

**Other Profiting Sectors**

Changes in consumer sentiment during outbreaks have smaller scale effects as well, and can result in unusual success for specific products or services used by the public. The demand surges for PPE during the 2003 SARS outbreak in China was unusually galvanized by public consumers, and supermarkets and hypermarkets saw a short term doubling of business through increased sale of disinfectant and hygiene products[[112]](#footnote-120). Some businesses, like CK Life Sciences International who marketed their health beverage drink Vitagen as helping fight SARS, saw new avenues for profit in this new market for preventative products.[[113]](#footnote-121) The Federal Trade Commission (FTC), the U.S. Food and Drug Administration (FDA), and Margaret Chan, Hong Kong’s director of health, even criticized some companies for exploiting the high demand and consumer ignorance surrounding the SARS outbreak in China[[114]](#footnote-122). The FTC released an official warning to online companies that marketed these fraudulent products, and ordered removal of any claims or suggestions that their products would protect against, treat, or cure SARS without any scientific proof to support these claims[[115]](#footnote-124).

Another sector that experiences gains directly related to outbreak fear is that of Insurance companies. A representative of American International Group (AIG), an insurance company with a large presence in China, stated that the SARS epidemic would boost sales of life insurance and in response AIG would create products specifically catering to SARS concerns[[116]](#footnote-125). In addition, new types of insurance are being introduced for private businesses to mitigate pandemic-specific costs. In 2014, Miller Insurance Services and William Gallagher Associates (WGA) announced *Pandemic Disease Business Interruption Insurance*, a coverage plan that responds to the direct loss of income due to quarantine events[[117]](#footnote-126). This insurance is a direct response to health care facility shutdowns and low revenues in the aftermath of the Dallas, Texas Ebola quarantine. There are few insurers that offer pandemic insurance options for non-physical losses; under standard property policies physical damage is necessary and contamination is often not considered a physical damage with some insurers explicitly writing in a “contamination” exclusion[[118]](#footnote-127). Insurance companies providing pandemic insurance like Berkshire Hathaway, Catlin Insurance Company, Lexington Insurance Company and their Global Supply Secure Program, Munich Re, and Montpelier Re typically require an official government declaration, often a WHO level 3-6.

There is also a growing market for international pandemic insurance coverage to facilitate the quick deployment of health workers and supplies before an outbreak reaches pandemic-level threat. In response to the 2014 Ebola pandemic, the World Bank began consulting with the African Union, the United Nations, and national governments to develop a Pandemic Emergency Facility (PEF) with an insurance scheme for affected countries and international organizations[[119]](#footnote-128). Much of the planning for this scheme looks to the African Union’s African Risk Capacity, which uses bonds to leverage capital to help countries manage risks of climate change[[120]](#footnote-129). The PEF will cover the costs of deployment of workers, medical equipment and supplies, pharmaceuticals, food and coordination of efforts but not pandemic reconstruction costs. PEF funds will be available to countries and organizations like WHO, World Food Program, UNICEF and Medecins Sans Frontieres. PEF’s Private Insurance Mechanism will insure developing countries by buying insurance coverage from the private sector on their behalf. Projected risks to investors will likely make premiums for the Pandemic Emergency Facility expensive and therefore only useful when a large pandemic payout is needed[[121]](#footnote-130). Country-level pandemic insurance may be an economically efficient mechanism as well, as countries will have access to finances to control an outbreak or epidemic before there is pandemic threat and large sums of foreign aid is needed. As a result, there is a growing market for pandemic-related insurance coverage and companies have potential to profit from both private healthcare companies, countries and programs like PEF.

Conclusion/Future Work:

The negative economic impacts of an epidemic are well documented[[122]](#footnote-143),[[123]](#footnote-144),[[124]](#footnote-145),[[125]](#footnote-146),[[126]](#footnote-147). When countries experience a disease outbreak, their economies suffer from both loss of potential income (e.g., labor loss, reduced tourism, and loss of trade income) andtangible economic losses (e.g., money spent on health care). Often developing countries with labor-intensive industries are disproportionately vulnerable to infectious disease spread and economic risks[[127]](#footnote-148) [[128]](#footnote-149). Additionally, as trade and travel globalize, an infectious disease outbreak in one country can quickly become a global security threat[[129]](#footnote-150).

Positive economic effects of epidemics and outbreaks are less studied, and can provide insight into where money is flowing during these events….

* Already a lot of studies on money lost, but not a lot of research on where money is flowing during outbreaks and epidemics. Knowing more about this can help inform allocation of pandemic preparedness dollars
* Future work- Can further investigate cost of goods and services to see if profits due to private interests conflict with the public good (e.g., the up-priced Smallpox vaccine probably cost more than necessary and allowed Siga to make a huge profit). This could lead to productive actions like lobbying for lower drug prices etc.
* Can use this information about potential profits to provide financial incentives to organization and non-profits (e.g., Ebola vaccine development was intensified when companies saw potential for profit. Win for private industries and public good)
* Future work- in the line of allocation, more research needed into the nuances of different costs we’ve listed — need federal money to be spent responsibly (ie, not sitting on vaccines that expire)
* Future work- need more research into how to create effective private-government collaborations BEFORE another epidemic happens. highlights the need for precautions rather than reactions
* Know where to build capacity for preparedness. For example, PPE producers had to meet increased demand and were running low on resources during Ebola epidemic

**Figures:**

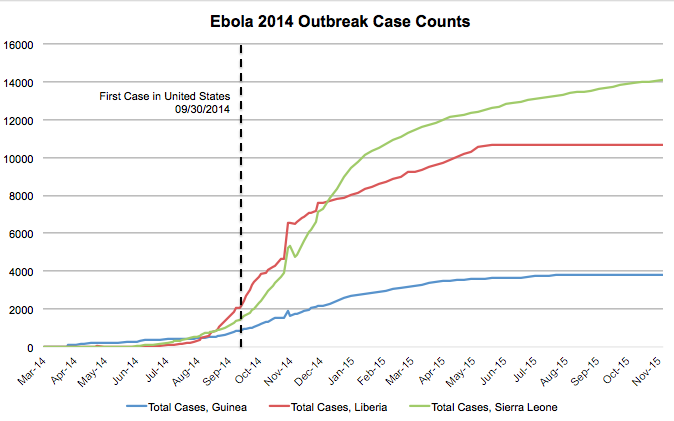


Figure 1. Total reported suspected, probable, and confirmed cases in Guinea, Liberia, and Sierra Leone provided in WHO situation reports March 25, 2014 through November 4, 2015[[130]](#footnote-151).

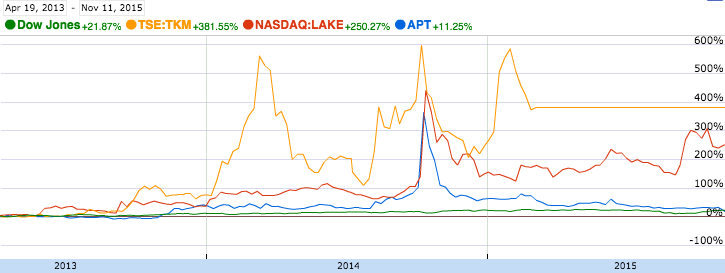


Figure 2. Stock history of percent change from 04/19/2013 for Arbutus Biopharma (formerly Tekmira Pharmaceuticals Corporation) TSE:TKM, Lakeland Industries NASDAQ:LAKE and Alpha Pro Tech APT during the 2014 Ebola crisis[[131]](#footnote-152). Noticeable spikes in late 2014 coincide with the the first diagnosed case of Ebola in the United States on 09/30/2014 and the increased rate of infection in West Africa.

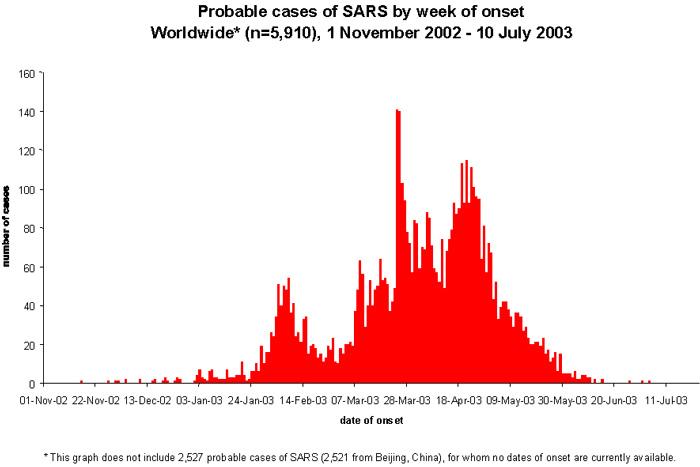


Figure 3. Worldwide probable cases of SARS provided in WHO situation reports from 11/01/2002 to 07/10/2003

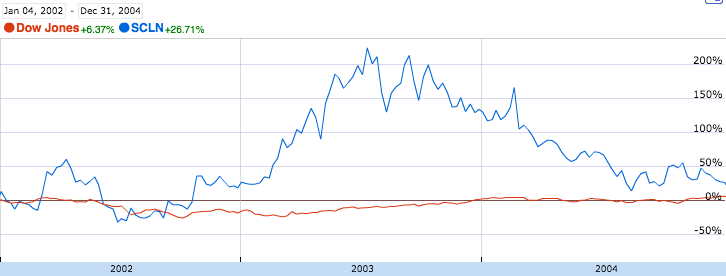


Figure 4. Stock history of percent change from 01/01/2002 for SciClone Pharmaceuticals SCLN during the 2003 SARS outbreak[[132]](#footnote-153). Company stocks increased during beginning to mid year in 2003, coinciding with the rise in SARS cases worldwide.

**REFERENCES**

Abrams R. 2014. Demand jumps for protective equipment as Ebola cases spur hospitals into action. <<http://www.nytimes.com/2014/10/22/business/demand-jumps-for-protective-equipment-as-ebola-cases-spur-hospitals-into-action.html?_r=3>>

African Risk Capacity <<http://www.africanriskcapacity.org/>>

Alpha Pro Tech. 2014. Annual report. <<http://www.alphaprotech.com/userfiles/doccenter/2014%20Annual%20Report%20with%20Bookmarks.pdf>>

Arbutus Biopharma. 2015. Tekmira Announces Launch of Arbutus Biopharma, a Hepatitis B Solutions Company. <<http://investor.arbutusbio.com/releasedetail.cfm?releaseid=922758>>

AstraZeneca. Google Finance. <<https://www.google.com/finance?chdnp=1&chdd=1&chds=1&chdv=1&chvs=maximized&chdeh=0&chfdeh=0&chdet=1444075200000&chddm=498916&chls=IntervalBasedLine&q=NYSE:AZN&ntsp=0&ei=wGxDVuHfKZHAeIephJAE>>

Balicer, R. D., Huerta, M., Davidovitch, N., & Grotto, I. (2005). Cost-benefit of stockpiling drugs for influenza pandemic. *Emerging infectious diseases*, *11*(8), 1280.

Bartsch, S. M., Gorham, K., & Lee, B. Y. (2015). The cost of an Ebola case. *Pathogens and global health*, *109*(1), 4-9.

Batson, A. (2005). The problems and promise of vaccine markets in developing countries. *Health Affairs*, *24*(3), 690-693.

Basu, P. (2003). Biotech firms jump on SARS bandwagon. *Nature biotechnology*, *21*(7), 720-720.

Becker, C. (2005). Influenza economics. Providers and suppliers who usually reap big profits during flu season might find that a pandemic could backfire on their bottom lines. *Modern healthcare*, *35*(45), 6-7.

Begley, S. (2013). Flu-conomics: The next pandemic could trigger global recession. <<http://www.reuters.com/article/2013/01/21/us-reutersmagazine-davos-flu-economy-idUSBRE90K0F820130121#Hv9LzZz6o7z8mrmT.97>>

Broyer, S & Brunner, C. (2009). Natixis Flash Economics: Pandemic: A short guide for investors.

Center for Disease Control. 2015. 2014 Ebola Outbreak in West Africa - Reported Cases Graphs. <<http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/cumulative-cases-graphs.html>>

Center for Disease Control. 2014. Cases of Ebola Diagnosed in the United States. <<http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html>>

Chen, C. D., Chen, C. C., Tang, W. W., & Huang, B. Y. (2009). The positive and negative impacts of the sars outbreak: a case of the Taiwan industries. *The Journal of Developing Areas*, *43*(1), 281-293.

Chicago Tribune. 2014. Ebola causes surge in sales of protective gear. <<http://www.chicagotribune.com/news/local/breaking/ct-ebola-equipment-sales-met-20141015-story.html>>

ClinicalTrials.gov. Evaluating an Ebola and a Marburg Vaccine in Uganda. <<https://clinicaltrials.gov/show/NCT00997607>>

Collin, N., de Radiguès, X., & World Health Organization H1N1 Vaccine Task Force. (2009). Vaccine production capacity for seasonal and pandemic (H1N1) 2009 influenza. *Vaccine*, *27*(38), 5184-5186.

Cooper, S & Coxe, D. 2005. BMO Nesbitt Burns Research: An Investor’s Guide to Avian Flu.

Crampton T. 2003. Nothing like deaths to sell life insurance: Some manage to profit by SARS. <<http://www.nytimes.com/2003/05/28/news/28iht-innovate.html>>

Daly, R. (2014). Hospitals' Ebola preparation costs can vary widely. *Healthcare financial management: journal of the Healthcare Financial Management Association*, *68*(12), 60-2.

Department of Health and Human Services Fiscal Year. 2016. Justification of Estimate for Appropriations Committees.

Dixon, P. B., Lee, B., Muehlenbeck, T., Rimmer, M. T., Rose, A., & Verikios, G. (2010). Effects on the US of an H1N1 epidemic: analysis with a quarterly CGE model. *Journal of homeland security and emergency management*, *7*(1).

Egan, M. 2015. Ebola is spooking Wall Street. <<http://money.cnn.com/2014/10/15/investing/ebola-spooks-wall-street-investors-stocks/>>

Fahmy, D. 2009. Drugmakers, Doctors Rake in Billions Battling H1N1 Flu. <<http://abcnews.go.com/Business/big-business-swine-flu/story?id=8820642>>

Federal Trade Commission. 2003. FTC and FDA Crack Down on Internet Marketers of Bogus SARS Prevention Products. <<https://www.ftc.gov/news-events/press-releases/2003/05/ftc-and-fda-crack-down-internet-marketers-bogus-sars-prevention>>

Food and Agriculture Organization of the United Nations and Animal Production and Health Commission for Asia and the Pacific (APHCA). 2002. Manual on the diagnosis of nipah virus infection in animals.

Flynn, P. (2010). The handling of the H1N1 pandemic: more transparency needed. *Council of Europe Parliamentary Assembly*.

Fonkwo, P. N. (2008). Pricing infectious disease. *EMBO reports*, *9*(1S), S13-S17.

Forbes. 2014. Medline Industries. <<http://www.forbes.com/companies/medline-industries/>>

Gallagher WGA. 2014. WGA Launches Ebola Pandemic Response Product for Loss of Income. <<http://www.wgains.com/launches-pandemic-response/>>

Gale A. 2015. Fear of MERS poses risks to South Korea’s economy. <<http://www.wsj.com/articles/fear-of-mers-risks-infecting-south-koreas-economy-1433928403>>

Global Health Security Agenda. <<http://www.globalhealth.gov/global-health-topics/global-health-security/ghsagenda.html>>

Godlee F. 2010. Conflicts of interest and pandemic flu. <<http://www.bmj.com/content/340/bmj.c2947>>

Gulland A. 2014. Cuts in aid are linked to Ebola crisis, say MPs. <<http://www.bmj.com/content/349/bmj.g5975>>

Harrington, J. E., & Hsu, E. B. (2010). Stockpiling anti-viral drugs for a pandemic: The role of Manufacturer Reserve Programs. *Journal of health economics*, *29*(3), 438-444.

HealthDay News. 2015. Drug might fight Ebola-like Marburg virus. <<https://www.economydrug.net/patient-resources/article/701555/drug-might-fight-ebola-like-marburg-virus>>

Hepeng, J. 2003. China boosts funding for SARS research. <<http://www.scidev.net/global/health/news/china-boosts-funding-for-sars-research.html>>

Herbert, L. 2014. Trading on quality and disease-free in the Middle East beef market. <<http://www.abc.net.au/news/2014-04-29/marketing-aussie-beef-to-middle-east/5417236>>

HKTDC. Business Alert China: Impact of SARS on Chinese Economy. <<http://info.hktdc.com/alert/cba-e0306sp-4.htm>>

Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, *451*(7181), 990-993.

Kalorama Information. 2015. Kalorama: Vaccines a 255 Billion Dollar Business in 2014 <<http://www.prnewswire.com/news-releases/kalorama-vaccines-a-255-billion-dollar-business-in-2014-300035312.html>>

Keogh-Brown, M. R., Smith, R. D., Edmunds, J. W., & Beutels, P. (2010). The macroeconomic impact of pandemic influenza: estimates from models of the United Kingdom, France, Belgium and The Netherlands. *The European journal of health economics*, *11*(6), 543-554.

Kim, S. 2014. Ebola Virus Hammers Airline Stocks, Boosts Pharma Stocks. <<http://abcnews.go.com/Business/ebola-virus-hammers-airline-stocks-boosts-pharma-stocks/story?id=25895726>>

Krantz M. 2014. Stocks involved with Ebola. <<http://americasmarkets.usatoday.com/2014/10/14/how-to-profit-from-ebola/?sf32477333=1>>

Lakeland Industries. 2014. Annual report. <<http://quicktake.morningstar.com/stocknet/secdocuments.aspx?symbol=lake>>

LAKE Company Financials. 2015. <<http://www.nasdaq.com/symbol/lake/financials?query=income-statement>>

Langton, D. (2008, January). Avian Flu Pandemic: Potential Impact of Trade Disruptions. LIBRARY OF CONGRESS WASHINGTON DC CONGRESSIONAL RESEARCH SERVICE.

Lee, V. J., Phua, K. H., Chen, M. I., Chow, A., Ma, S., Goh, K. T., & Leo, Y. S. (2006). Economics of neuraminidase inhibitor stockpiling for pandemic influenza, Singapore. *Emerging infectious diseases*, *12*(1), 95.

Lee, J. (2014). Demand soars for Ebola supplies as cost and safety concerns rise. *Modern healthcare*, *44*(44), 12-12.

Maconachie, R., & Hilson, G. (2011). Artisanal gold mining: a new frontier in post-conflict Sierra Leone?. *The Journal of Development Studies*, *47*(4), 595-616.

Marino, V. 2003. SARS Double Demand for Respiratory Masks. <<http://www.nytimes.com/2003/04/06/business/yourmoney/06BDIG.html>>

Marsh. 2009. Pandemic Insurance Program Options. <<http://usa.marsh.com/Portals/9/Documents/Pandemic_Insurance_Program_Options_Sept2009.pdf>>

Maron, DF. 2014. Cross-Border Ebola Outbreak a First for Deadly Virus. <<http://www.scientificamerican.com/article/cross-border-ebola-outbreak-a-first-for-deadly-virus/>>

Maunder, R. (2004). The experience of the 2003 SARS outbreak as a traumatic stress among frontline healthcare workers in Toronto: lessons learned. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *359*(1447), 1117-1125.

Maunder, R. G., Lancee, W. J., Mae, R., Vincent, L., Peladeau, N., Beduz, M. A., Hunter, JJ., Leszcz, M. (2010). Computer-assisted resilience training to prepare healthcare workers for pandemic influenza: a randomized trial of the optimal dose of training. *BMC health services research*, *10*(1), 72.

McCarthy M. 2014. Obama calls on Congress to fund $6.2bn emergency Ebola initiative. <<http://www.bmj.com/content/349/bmj.g7503>>

Medline Industries. 2014. Corporate facts. <<https://www.medline.com/about-us/key-facts/>>

Mei, L., Song, P., Tang, Q., Shan, K., Gai Tobe, R., Selotlegeng, L., Ali, AH., Cheng, Y. & Xu, L. (2013). Changes in and shortcomings of control strategies, drug stockpiles, and vaccine development during outbreaks of avian influenza A H5N1, H1N1, and H7N9 among humans. *Bioscience trends*, *7*(2), 64-76.

Meltzer, M. I., Cox, N. J., & Fukuda, K. (1999). The economic impact of pandemic influenza in the United States: priorities for intervention. *Emerging infectious diseases*, *5*, 659-671.

NASDAQ. 2015. Lake company financials. <<http://www.nasdaq.com/symbol/lake/financials?query=income-statement>>

News-Medical. 2015. Planning for first clinical trial of MERS-CoV vaccine candidate now underway. <<http://www.news-medical.net/news/20150622/Planning-for-first-clinical-trial-of-MERS-CoV-vaccine-candidate-now-underway.aspx>>

Ohlheiser, A. 2014. When Ebola comes to the U.S., who stands to profit? <<https://www.washingtonpost.com/news/to-your-health/wp/2014/10/01/when-ebola-comes-to-the-u-s-who-stands-to-profit/>>

Otte, J., Hinrichs, J., Rushton, J., Roland-Holst, D., & Zilberman, D. (2008). Impacts of avian influenza virus on animal production in developing countries. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*, *3*(080), 18.

Plotkin, S. A. (2005). Why certain vaccines have been delayed or not developed at all. *Health Affairs*, *24*(3), 631-634.

Pollack, A. (2005). THE SARS EPIDEMIC: TREATMENT; Sales of U.S. Company's Drug Rise as Chinese Try It Against SARS. <<http://www.nytimes.com/2003/05/06/world/sars-epidemic-treatment-sales-us-company-s-drug-rise-chinese-try-it-against-sars.html>>

Pongcharoensuk, P., Adisasmito, W., Silkavute, P., Muchlisoh, L., Hoat, P. C., & Coker, R. (2011). Avian and pandemic human influenza policy in South-East Asia: the interface between economic and public health imperatives. *Health policy and planning*, czr056.

Pozo, V. F., & Schroeder, T. C. (2015). Costs of Meat and Poultry Recalls to Food Firms.

The Economic Times. New antibody weapons against Marburg virus found. <<http://economictimes.indiatimes.com/news/science/new-antibody-weapons-against-marburg-virus-found/articleshow/47876251.cms>>

Quebec Financial Institutions. (2006). Influenza Pandemic Guide.

Rassy, D., & Smith, R. D. (2013). The economic impact of H1N1 on Mexico's tourist and pork sectors. *Health economics*, *22*(7), 824-834.

Ritchie, B. W., Dorrell, H., Miller, D., & Miller, G. A. (2004). Crisis communication and recovery for the tourism industry: Lessons from the 2001 foot and mouth disease outbreak in the United Kingdom. *Journal of Travel & Tourism Marketing*, *15*(2-3), 199-216.

Roche. Media Release. 2006. <<http://www.roche.com/media/store/releases/med-cor-2006-02-01.htm>>

Saker, L., Lee, K., Cannito, B., Gilmore, A., & Campbell-Lendrum, D. H. (2004). Globalization and infectious diseases: a review of the linkages.

Sarwar, U. N., Costner, P., Enama, M. E., Berkowitz, N., Hu, Z., Hendel, C. S., Sitar, S., Plummer, S., Mulangu, S., Bailer, RT., Koup, RA., Mascola, JR., Nabel, GJ., Sullivan, NJ., Graham, BS. & Ledgerwood, JE. DNA Vaccines Encoding Ebolavirus and Marburgvirus Wild Type Glycoproteins are Safe and.

Schmuel J. 2014. How Ebola could affect your stock portfolio. <<http://business.financialpost.com/investing/how-ebola-could-affect-your-stock-portfolio>>

Shim, E. (2015). South Korea faces end of MERS outbreak but economic woes remain. <<http://www.upi.com/Top_News/World-News/2015/07/24/South-Korea-faces-end-of-MERS-outbreak-but-economic-woes-remain/3211437761351/>>

Smith, R. D., & Keogh‐Brown, M. R. (2013). Macroeconomic impact of a mild influenza pandemic and associated policies in Thailand, South Africa and Uganda: a computable general equilibrium analysis. *Influenza and other respiratory viruses*, *7*(6), 1400-1408.

United Nations System Influenza Coordinator & World Bank. (2008). Responses to Avian Influenza and State of Pandemic Readiness. *Fourth Global Progress Report.*

United States Census Bureau. Foreign Trade Top Trading Partners September 2015. <<https://www.census.gov/foreign-trade/statistics/highlights/toppartners.html#imports>>

Velasco, R. P., Praditsitthikorn, N., Wichmann, K., Mohara, A., Kotirum, S., Tantivess, S., ... & Teerawattananon, Y. (2012). Systematic review of economic evaluations of preparedness strategies and interventions against influenza pandemics. *PLoS One*, *7*(2), e30333-e30333.

Velasco, R. Perez, Naiyana Praditsitthikorn, Kamonthip Wichmann, Adun Mohara, Surachai Kotirum, Sripen Tantivess, Constanza Vallenas, Hande Harmanci, and Yot Teerawattananon

Verikios G, Sullivan M, Stojanovski P, Giesecke J & Woo G. (2011). The Global economic effects of pandemic influenza. 14th Annual Conference on Global Economic Analysis, Venice, June 16-18, 2011.

Visiongain. <<https://www.visiongain.com/Content/3/About-Us>>

Whiting, A. 2015. New pandemic insurance to prevent crises through early payouts. <<http://www.reuters.com/article/2015/03/26/us-global-pandemics-insurance-idUSKBN0MM1XD20150326#E7CZOsAZOHPBPgki.97>>

World Bank. 2014a. The economic impact of the 2014 Ebola epidemic: short and medium term estimates for West Africa.

World Bank. 2014b. Pandemic risk and one health. <<http://www.worldbank.org/en/topic/health/brief/pandemic-risk-one-health>>

World Bank. 2015. Pandemic Emergency Facility. <<http://www.worldbank.org/en/topic/pandemics/brief/pandemic-emergency-facility-frequently-asked-questions>>

World Bank. Merchandise trade (% of GDP). <<http://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS?page=1>>

World Health Organization. (2012). Global Report for Research on Infectious Diseases of Poverty. <<http://www.who.int/tdr/publications/global_report/en/>>

World Health Organization. Epidemic curves - Severe Acute Respiratory Syndrome (SARS).

<http://www.who.int/csr/sars/epicurve/epiindex/en/index1.html>>

**New Sources:**

World Bank Pandemics Home Overview:http://www.worldbank.org/en/topic/pandemics/overview

Boffey 2014: <http://takingnote.blogs.nytimes.com/2014/10/30/c-d-c-ebola-guidelines-arent-good-enough-for-some-states/?_r=0>

Freisen 2013: http://logisticsquarterly.com/issues/9-2/article1.html

CDC 2014 PPE: <http://www.cdc.gov/media/releases/2014/p1107-ebola-ppe.html>

McCarter 2008: <http://www.hstoday.us/focused-topics/emergency-managementdisaster-preparedness/single-article-page/responders-today-getting-personal/00989504d4ef44d78b6fee8e3a515a6c.html>

Hinshaw 2014: http://www.wsj.com/articles/u-s-buys-up-ebola-gear-leaving-little-for-africa-1416875059

CDC Hospital Preparedness 2014 http://www.cdc.gov/media/releases/2014/fs1014-ebola-investigation-fact-sheet.html

Volkman 2014: <http://www.healio.com/infectious-disease/emerging-diseases/news/print/infectious-disease-news/%7Bf7350f78-49bb-4e3c-8641-47b59e1e1c81%7D/us-hospitals-step-up-training-preparation-for-ebola>

Hladley 2014 http://www.courant.com/health/hc-ct-ebola-costs-20141201-story.html

HHS Press 2015 : <http://www.hhs.gov/about/news/2015/07/01/hhs-launches-national-ebola-training-and-education-center.html>

CDC preparing health care workers 2014 <http://www.cdc.gov/vhf/ebola/hcp/safety-training-course/>

CDC Vaccinations 2014

Patel Gorman 2009 <http://onlinelibrary.wiley.com/doi/10.1038/clpt.2009.142/pdf>

McNeil 2013 <http://www.nytimes.com/2013/03/13/health/us-stockpiles-smallpox-drug-in-case-of-bioterror-attack.html?_r=0>

GloaxoklineSmith Annual 2009: https://www.gsk.com/media/279942/annual-report-2009.pdf

1. World Bank 2014a; Verikios 2011; Bartsch 2015; Meltzer 2015 [↑](#footnote-ref-1)
2. Becker 2005 [↑](#footnote-ref-3)
3. World Bank Pandemics Home Overview 2015 [↑](#footnote-ref-4)
4. Becker 2005 [↑](#footnote-ref-5)
5. Pozo and Schroeder 2015; Dixon 2010; Verikios 2011; Langton 2006 [↑](#footnote-ref-6)
6. Chen 2009 [↑](#footnote-ref-7)
7. Marino 2003 [↑](#footnote-ref-8)
8. Freisen 2003 [↑](#footnote-ref-9)
9. Lee 2014 [↑](#footnote-ref-10)
10. Chicago Tribune 2014 [↑](#footnote-ref-11)
11. Chicago Tribune 2014 [↑](#footnote-ref-12)
12. Boffey 2014 [↑](#footnote-ref-14)
13. Daly 2014 [↑](#footnote-ref-15)
14. Daly 2014 [↑](#footnote-ref-16)
15. Lee 2014 [↑](#footnote-ref-17)
16. Daly 2014 [↑](#footnote-ref-18)
17. Daly 2014 [↑](#footnote-ref-19)
18. Daly 2014 [↑](#footnote-ref-20)
19. CDC 2014 PPE [↑](#footnote-ref-21)
20. McCarter 2008 [↑](#footnote-ref-22)
21. Hinshaw 2014 [↑](#footnote-ref-23)
22. Medline Industries 2014; Forbes 2014 [↑](#footnote-ref-24)
23. Lee 2014 [↑](#footnote-ref-25)
24. Krantz 2014 [↑](#footnote-ref-26)
25. Lakeland Industries 2014 [↑](#footnote-ref-27)
26. Lakeland Industries 2014 [↑](#footnote-ref-28)
27. Krantz 2014 [↑](#footnote-ref-29)
28. LAKE Company Financials 2015 [↑](#footnote-ref-30)
29. Alpha Pro Tech 2014 [↑](#footnote-ref-31)
30. Crampton 2003 [↑](#footnote-ref-33)
31. Abrams 2014 [↑](#footnote-ref-34)
32. CDC Hospital Preparedness 2014 [↑](#footnote-ref-35)
33. Volkman 2014 [↑](#footnote-ref-36)
34. Daly 2014 [↑](#footnote-ref-37)
35. Daly 2014 [↑](#footnote-ref-38)
36. Daly 2014 [↑](#footnote-ref-39)
37. Hladley 2014 [↑](#footnote-ref-40)
38. HHS Press 2015 [↑](#footnote-ref-41)
39. Maunder 2010 [↑](#footnote-ref-42)
40. CDC Preparing Health care workers 2014 [↑](#footnote-ref-43)
41. Maunder 2010 [↑](#footnote-ref-44)
42. Maunder 2010 [↑](#footnote-ref-45)
43. Maunder 2004 [↑](#footnote-ref-46)
44. Abelin 2011 [↑](#footnote-ref-48)
45. Velasco 2012 [↑](#footnote-ref-49)
46. Keogh-Brown 2010 [↑](#footnote-ref-50)
47. CDC Vaccinations 2014 [↑](#footnote-ref-51)
48. Flynn 2010 [↑](#footnote-ref-52)
49. Becker 2005; Fahmy 2009 [↑](#footnote-ref-53)
50. Plotkin 2006 [↑](#footnote-ref-54)
51. Maron 2014 [↑](#footnote-ref-55)
52. Batson 2005 [↑](#footnote-ref-56)
53. Kalorama Information 2015 [↑](#footnote-ref-57)
54. Becker 2005 [↑](#footnote-ref-58)
55. Fahmy 2009 [↑](#footnote-ref-59)
56. Lee 2006; Balicer 2005 [↑](#footnote-ref-60)
57. Patel Gorman 2009 [↑](#footnote-ref-61)
58. MnNeil 2013 [↑](#footnote-ref-62)
59. Mei 2013 [↑](#footnote-ref-64)
60. Roche Media Release 2006 [↑](#footnote-ref-65)
61. Godlee 2010; Harrington and Hsu, 2010 [↑](#footnote-ref-66)
62. GlaxoKlineSmith Annual 2009 [↑](#footnote-ref-67)
63. Harrington and Hsu 2010 [↑](#footnote-ref-68)
64. Godlee 2010 [↑](#footnote-ref-69)
65. Pongcharoensuk 2012 [↑](#footnote-ref-70)
66. Pongcharoensuk 2012 [↑](#footnote-ref-71)
67. Harrington and Hsu 2010 [↑](#footnote-ref-72)
68. Schmuel 2014 [↑](#footnote-ref-73)
69. Schmuel 2014 [↑](#footnote-ref-74)
70. Arbutus Biopharma 2015 [↑](#footnote-ref-75)
71. Schmuel 2014 [↑](#footnote-ref-76)
72. AstraZeneca [↑](#footnote-ref-77)
73. Pollack 2003 [↑](#footnote-ref-78)
74. Pollack 2003 [↑](#footnote-ref-79)
75. Chen 2009 [↑](#footnote-ref-80)
76. Keogh-Brown et al 2010 [↑](#footnote-ref-81)
77. Pozo and Schroeder, 2015 [↑](#footnote-ref-82)
78. Verikios 2011; Dixon 2010; Langton 2008 [↑](#footnote-ref-83)
79. Shim 2015; Gale 2015 [↑](#footnote-ref-84)
80. Gale, 2015 [↑](#footnote-ref-85)
81. Begley 2013 [↑](#footnote-ref-87)
82. Egan 2015; Kim 2014; Schmuel 2014 [↑](#footnote-ref-88)
83. Ohlheiser 2014 [↑](#footnote-ref-89)
84. Begley 2013 [↑](#footnote-ref-90)
85. Cooper 2005; Broyer 2009; Quebec Financial Institutions 2006 [↑](#footnote-ref-91)
86. Visiongain [↑](#footnote-ref-92)
87. Department of Health and Human Services 2016 [↑](#footnote-ref-93)
88. Flynn 2010 [↑](#footnote-ref-94)
89. Hepeng 2003 [↑](#footnote-ref-95)
90. Hepeng 2003 [↑](#footnote-ref-96)
91. Basu 2003 [↑](#footnote-ref-97)
92. Daly 2014 [↑](#footnote-ref-98)
93. Global Health Security Agenda [↑](#footnote-ref-99)
94. News-Medical 2015 [↑](#footnote-ref-100)
95. HealthDay News 2015 [↑](#footnote-ref-102)
96. Sarwar 2014; ClinicalTrials.gov [↑](#footnote-ref-103)
97. The Economic Times [↑](#footnote-ref-104)
98. World Bank Merchandise trade (% of GDP) [↑](#footnote-ref-105)
99. Verikios 2011 [↑](#footnote-ref-106)
100. Gale 2015 [↑](#footnote-ref-107)
101. Fonkwo 2008 [↑](#footnote-ref-109)
102. FAO and APHCA 2002 [↑](#footnote-ref-110)
103. U.S. Census Bureau [↑](#footnote-ref-111)
104. Jones 2008 [↑](#footnote-ref-112)
105. Fonkwo 2008 [↑](#footnote-ref-113)
106. HKTDC [↑](#footnote-ref-114)
107. Langton 2008 [↑](#footnote-ref-115)
108. Pozo and Schroeder, 2015 [↑](#footnote-ref-116)
109. Otte 2008 [↑](#footnote-ref-117)
110. Herbert 2014 [↑](#footnote-ref-118)
111. Langton 2006 [↑](#footnote-ref-119)
112. HKTDC [↑](#footnote-ref-120)
113. Crampton 2003 [↑](#footnote-ref-121)
114. Federal Trade Commission [↑](#footnote-ref-122)
115. Federal Trade Commission [↑](#footnote-ref-124)
116. Crampton 2003 [↑](#footnote-ref-125)
117. Gallagher WGA [↑](#footnote-ref-126)
118. Marsh 2009 [↑](#footnote-ref-127)
119. World Bank 2015 [↑](#footnote-ref-128)
120. African Risk Capacity [↑](#footnote-ref-129)
121. Whiting 2015 [↑](#footnote-ref-130)
122. Bartsch et al., 2015 [↑](#footnote-ref-143)
123. Daly, 2014 [↑](#footnote-ref-144)
124. Dixon et al., 2010 [↑](#footnote-ref-145)
125. Fonkwo, 2008 [↑](#footnote-ref-146)
126. Langton, 2008 [↑](#footnote-ref-147)
127. Maconachie and Hilson, 2015 [↑](#footnote-ref-148)
128. World Health Organization 2012 [↑](#footnote-ref-149)
129. Saker et al., 2004 [↑](#footnote-ref-150)
130. CDC 2014; CDC 2015 [↑](#footnote-ref-151)
131. Google Finance [↑](#footnote-ref-152)
132. Google Finance [↑](#footnote-ref-153)