**Title: Pandemic Winners**

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**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-2) [[3]](#footnote-3) 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-4) While many industries suffer severe revenue and investment losses, some industries see increases in profits during disease outbreaks or epidemics due to an increased demand for medical products and services.[[5]](#footnote-5) Although economic losses from epidemics are widely studied, research on the converse financial effects of disease outbreaks is sparse.[[6]](#footnote-6) This study investigates and explores potential profiteers from infectious disease events.

**PANDEMIC WINNERS**

**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-7) The overall increased demand of PPE during outbreaks, between government agencies, hospitals, and the general public, may benefit the manufacturers and suppliers of personal protective equipment.[[8]](#footnote-8) [[9]](#footnote-9)

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-10) 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 to meet the increased demand following the Dallas Ebola case.[[11]](#footnote-11) 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-12) [[13]](#footnote-13)

CDC’s new 2014 guidelines on Ebola preparedness required selected hospitals to increase supplies of PPE and other safety equipment.[[14]](#footnote-14) U.S. Hospitals spent money on Ebola preparedness PPE including coveralls, gowns, face shields, and respirators. One hospital in Kansas reportedly spent $100,000 on jumpsuits, hoods, and respiratory devices. This is the estimated amount of PPE to treat one patient for two weeks.[[15]](#footnote-15) 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 per month.[[16]](#footnote-16) 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-17) Additionally, when 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-18) [[19]](#footnote-19) 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, a producer of chemical suits, boot covers, face masks, and hoods, who works with the CDC and the Department of Homeland Security (DHS), struggled to fill demand in priority Ebola-stressed countries in Africa.[[20]](#footnote-20) [[21]](#footnote-21)

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. For example, Medline Industries reported over $7 billion in sales in 2014, up from $5.8 billion in 2013.[[22]](#footnote-22) BioMedical Devices received 10 times as many orders in October and November than September of 2014 and their products went into backorder.[[23]](#footnote-23) Alpha Pro Tech (APT) and Lakeland Industries, both PPE suppliers, saw share increases of over 200% in 2014 (Figures 1 & 2). [[24]](#footnote-24) Lakeland Industries attributed their gross profit increase of 9.3%, in the fourth quarter of 2015, to sales of PPE related to the U.S. Ebola response.[[25]](#footnote-25) During this period, Lakeland tripled production capacity for PPE and obtained several large contracts[[26]](#footnote-26). Lakeland had to sell shares of common stock in October 2014 to support increased production due to the high demand of Ebola-related safety products, although the share price fell 26% after panic concerning the Ebola epidemic cooled slightly.[[27]](#footnote-27) Nonetheless, in fiscal year 2014 Lakeland’s performance was higher than previous years, and the company ended the year with total revenue of $99,734,000 and a gross profit of $33,712,000.[[28]](#footnote-28) Similarly, Alpha Pro Tech stated that the 28% increase in their company’s Infection Control business segment 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-29).

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-30) As seen in the Ebola epidemic, overall PPE demand increased: 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-31) Similar to the Ebola epidemic, increased demand and sale of PPE during the SARS outbreak created unique opportunities for companies that provide necessary specialized equipment to profit from affected governments and treatment facilities.

**Pharmaceutical Industry**

The pharmaceutical response to pandemics is one of the most important factors in effectively preventing and eradicating the spread of infectious diseases.[[32]](#footnote-32) 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.[[33]](#footnote-33) [[34]](#footnote-34) An effective vaccine response during an outbreak can significantly limit the spread and impact of disease spread within the affected country, which ultimately may mitigate in-country economic losses.[[35]](#footnote-35). 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. After the 2009 H1N1 influenza pandemic, Sanofi-Aventis, now known as Sanofi, reported that their net profits were 7.8 billion Euros and was due to the production of vaccine sales.[[36]](#footnote-36) 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 this market is mostly controlled by Roche, Sanofi-Pasteur, GlaxoSmithKline, and Novartis.[[37]](#footnote-37)

For these large pharmaceutical companies, vaccine sales are rarely as profitable as drugs sales, which can lower the incentive to develop them.[[38]](#footnote-38) 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.[[39]](#footnote-39) This perception may be changing, as developing countries become new viable markets for vaccines.[[40]](#footnote-40) 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 were earmarked for vaccine development, production, and stockpiling.[[41]](#footnote-41) [[42]](#footnote-42) 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.[[43]](#footnote-43).Collaboration between governments and pharmaceutical companies is necessary to develop affordable and accessible vaccines for the next outbreak or epidemic. Strategies like 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 be an economically efficient response to a pandemic.[[44]](#footnote-44) A cost benefit analysis revealed that stockpiling investments for influenza are economically cost effective as long as there at least 2 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.[[45]](#footnote-45) 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.[[46]](#footnote-46)

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.[[47]](#footnote-47) 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[[48]](#footnote-48). 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.[[49]](#footnote-49) [[50]](#footnote-50) 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.[[51]](#footnote-51) In 2009, estimated total sales of influenza vaccines and adjuvant totaled U.S. $6.9 billion in 2009, according to JP Morgan.[[52]](#footnote-52)

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.[[53]](#footnote-53) 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[[54]](#footnote-54). 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.[[55]](#footnote-55) 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 & 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 (Figures 1 & 2).[[56]](#footnote-56) 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.[[57]](#footnote-57) Despite these financial gains, TKM-Ebola was found ineffective and the company suspended development and changed its corporate name to Arbutus Biopharma.[[58]](#footnote-58) 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.[[59]](#footnote-59) Other companies involved in Ebola vaccine or medicine development, including Inovio Pharmaceuticals and AstraZeneca, also had stock spikes in 2014, correlated to the timing of various events within the Ebola epidemic.[[60]](#footnote-60) As observed with Sarepta’s stocks, spikes in pharmaceutical markets during outbreaks are often quick and drastic; however, these gains are often short lived (figure 2).[[61]](#footnote-61)

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).[[62]](#footnote-62) Stock returns of Taiwan’s biotechnology sector also had positive surges in stock returns in response to the SARS outbreak.[[63]](#footnote-63) 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.[[64]](#footnote-64)

Outbreaks also affect financial trading behaviors. Professional finance companies use their extensive knowledge of these trends and industry expertise to profit during disease outbreaks. 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. [[65]](#footnote-65) In fact, the authors of this study were unable to identify a shortage of cocoa. 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.[[66]](#footnote-66)

Several companies like Natixis Global Asset Management and BMO Nesbitt Burns have produced investor guides for avian influenza and other diseases with pandemic potential.[[67]](#footnote-67) 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.[[68]](#footnote-68)

**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.[[69]](#footnote-69) Disease outbreaks and epidemics cause market volatility, particularly in the most economically integrated, globalized countries where trade is a higher share of total GDP.[[70]](#footnote-70) 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.[[71]](#footnote-71) 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.[[72]](#footnote-72) [[73]](#footnote-73)

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[[74]](#footnote-74). 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.[[75]](#footnote-75) [[76]](#footnote-76) [[77]](#footnote-77) [[78]](#footnote-78)

Often markets fall due as consumer confidence in a product declines.[[79]](#footnote-79) 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 safer.[[80]](#footnote-80) 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.[[81]](#footnote-81) 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.[[82]](#footnote-82) Therefore, disease outbreaks, or heightened perception of disease risk among consumers, can have both positive and 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 too, 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.[[83]](#footnote-83) 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.[[84]](#footnote-84) 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.[[85]](#footnote-85) 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.[[86]](#footnote-86)

Similarly, the insurance industry experiences gains directly related to outbreak fear. 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.[[87]](#footnote-87) Additionally, 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.[[88]](#footnote-88) This insurance is a direct response to health care facility shutdowns and low revenues in the aftermath of the Dallas, Texas Ebola quarantine. 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.[[89]](#footnote-89) 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.[[90]](#footnote-90) Country-level pandemic insurance may be an economically efficient mechanism too, 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.

**CONCLUSION**

The negative economic impacts of an epidemic are well documented.[[91]](#footnote-91),[[92]](#footnote-92),[[93]](#footnote-93),[[94]](#footnote-94),[[95]](#footnote-95) The positive economic effects of epidemics and outbreaks are less studied, and in many cases organizations are heavily profiting from pandemics. Infectious disease outbreaks, epidemics, and pandemics place governments in a difficult position where limited government funds have to be reallocated to deal with imminent infectious disease threats. Interestingly, the redirection of funds to combat imminent infectious disease threats like Ebola and SARS is increasing society’s preparedness for dealing with future infectious disease threats.

Future research should investigate the price of specialized healthcare equipment and supplies to determine corporate profiteering is in 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 better policies and regulations for goods critical for public health. Additional research should examine the wasteful policies of vaccine and anti viral prophylaxis stockpiling, and the government should work more closely with the pharmaceutical industry to develop agile and flexible production systems to maintain corporate profitability while reducing wasteful spending by the government. Lastly, the government should use a systems based approach to build capacity for preparedness. For example, PPE producers had to meet increased production demand and were running low on necessary production resources during the 2014 Ebola epidemic. By working more collaboratively and closely with industry, there is much opportunity to create effective policies that increases public health preparedness to the next pandemic threat and industry plays a critical role in this process. Corporations making a profit is not a problem, but the knee jerk reaction to emerging infectious disease threats ends up costing society more than it has to.

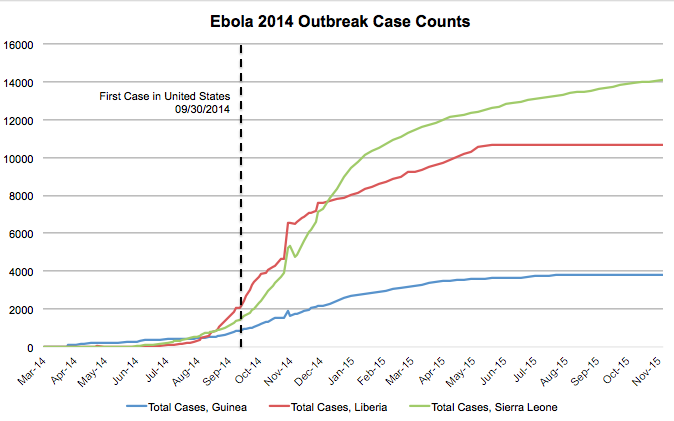


Figure 1. Total reported suspected, probable, and confirmed cases in Guinea, Liberia, and Sierra Leone provided in WHO situation reports March 25, 2014 through November 4, 2015.[[96]](#footnote-96)

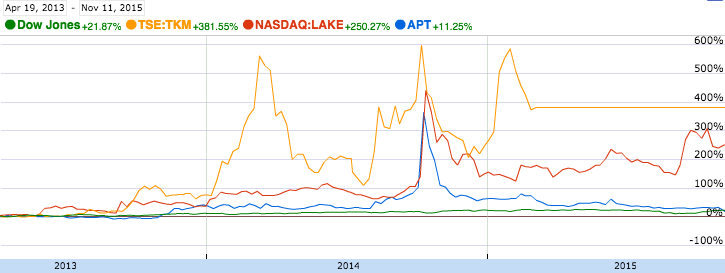


Figure 2. Stock history of percent change from 04/19/2013 for Arbutus Biopharma (formerly Tekmira Pharmaceuticals Corporation) TSE:TKM, Lakeland Industries NASDAQ:LAKE and Alpha Pro Tech APT during the 2014 Ebola crisis.[[97]](#footnote-97) Noticeable spikes in late 2014 coincide with the first diagnosed case of Ebola in the United States on 09/30/2014 and the increased rate of infection in West Africa.

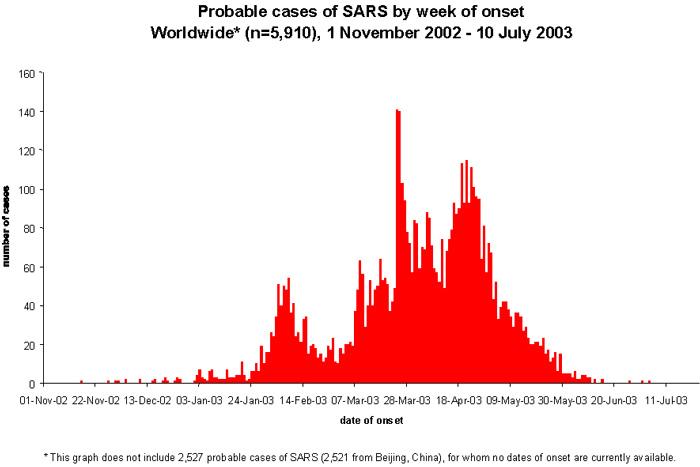


Figure 3. Worldwide probable cases of SARS provided in WHO situation reports from 11/01/2002 to 07/10/2003

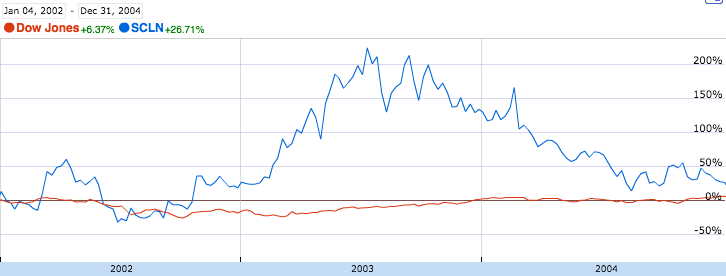


Figure 4. Stock history of percent change from 01/01/2002 for SciClone Pharmaceuticals SCLN during the 2003 SARS outbreak.[[98]](#footnote-98).Company stocks increased during beginning to midyear in 2003, coinciding with the rise in SARS cases worldwide.

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