Pharmaceutical Supply Chain Security and Efficiency: The Case of the Great East Japan Earthquake

NAKAMURA Tsutomu

Graduate School of Arts and Sciences, The University of Tokyo; 153–8902, Japan.
E-mail: nakamura@humgeo.c.u-tokyo.ac.jp

Received August 27, 2012; Accepted February 4, 2013

Abstract Based on experience during the Great East Japan Earthquake, this article examines the efficiency and high-security requirements of Japan's pharmaceutical supply chain and its response pattern in an emergency. Ensuring supply chain security requires an enormous amount of investment, sacrifices, and improvement in efficiency. The practical measures being implemented need to maintain a strict balance between supply chain security and efficiency. To assess the supply chain security needs of the pharmaceuticals, interviews were conducted with Japan's pharmaceutical supply chain players. Although faced with some difficulties, the supply chain functioned effectively during the sudden change in demand following the 2011 quake. The distribution centers are located mainly in the three major metropolitan areas unevenly, but dispersing inventories are maintained at all the branch offices outside the area of specific lead time. However, this article has found that the changes in the pharmaceutical supply chain could lead to a low level of security. The national or local governments might be required to provide public assistance for the management. Additional measures might be needed if differences between municipalities in the extent of the measures result in substantial regional disparities in access to pharmaceuticals. Users and suppliers need to continue risk communication about how much money they should invest in secure supply chain. Geographical studies are required to contribute to the spatial arrangement of the pharmaceutical supply chain that considers both moderation of the medical insurance system's finances and the supply chain's function as a social infrastructure.

Key words the Great East Japan Earthquake, pharmaceutical supply chain, security, efficiency, pharmaceutical wholesaler

Introduction

Background

This article examines the efficiency and high-security requirements of Japan's pharmaceutical supply chain by viewing the Great East Japan Earthquake as an example of how the supply chain is able to respond in the event of an emergency. The term "supply chain security" refers to the degree of supply capacity for essential pharmaceuticals to be delivered where they are needed in an emergency. Added security needs to be established on a regular basis. However, pharmaceutical wholesalers are struggling over supply chain security upgrades owing to low profits. Because pharmaceuticals are directly connected to life and wellbeing and the difficulty of predicting demand, but urgently required when used, a stable supply of pharmaceuticals needs to be established (Kataoka et al. 2003).

In Japan, prescription drugs have been distributed based on market principles since World War II. Within this structure, there are price negotiations among pharmaceutical manufacturers, pharmaceutical wholesalers and suppliers such as medical institutions and pharmacies under the drug price system. As prescriptions were dispensed in hospitals at one time, the related drugs were delivered only to medical institutions, and pharmacies dispensed few such medicines. Pharmaceutical wholesalers handled sales promotion and delivery services to clinics and smaller hospitals as agents of pharmaceutical manufacturers. Drug price margins became the main source of income for medical institutions because the pricing system allowed for large gaps between the supposed standard prices and the actual prices for hospitals. However, medical institutions could no longer depend on drug price margins after the supposed standard prices were reduced and the pricing system was improved to include a new invoice pricing system in the 1990s. The separation of the dispensary and prescription functions has placed pharmacies together with existing medical institutions as customers of pharmaceutical wholesalers since the late 1990s. These changes have required such wholesalers to control their prices, increase their ability to negotiate prices with customers, and deliver pharmaceuticals more efficiently in consideration of the dispersion of their customer base (Nakamura 2010).
Purpose and method

Geographical studies on medical services in Japan fall into three main categories. The first reveals spatial characteristics of medical facilities as a public service (Hayashi and Niimi 1998; Higurashi 1994; Kamiya 2002; Otsubo 2006). The second seeks the optimal location of medical facilities, taking overall efficiency and equity into consideration (Sakagawa 1980). The third estimates accessibility to medical services on the basis of patient behavior (Takashashi and Nam 1981; Takeda 1993; Sekido 1998; Sekine 2003; Otsubo 2008). Research in all three categories focuses on common issues in Japan's medical supply system, most of which are caused by uneven distribution of medical institutions and regional disparities in accessibility to medical services.

Though pharmaceutical supply chains face similar issues, few geographical studies on pharmaceuticals are conducted in Japan. Among them, Kawabata (1990, 1995) and Nakamura (2003, 2011) examine the manner in which pharmaceutical wholesalers have sought efficiency while facing deregulation and analyze the consequent functional division and locational changes among their establishments. Nakamura (2005) examines the identical information networks established jointly by local pharmacies to ensure equitable access to pharmaceuticals through inventory information sharing. All these studies focus on Japan's routine pharmaceutical supply chain, but pharmaceuticals must be accessible even in emergency situations such as a disaster or pandemic. However, there is currently no study on how Japan's pharmaceutical supply chain would be able to meet urgent pharmaceutical needs from a spatial perspective.

To assess the supply chain security needs of the pharmaceutical supply chain, interviews were conducted with Japan's pharmaceutical supply chain players including major pharmaceutical manufacturers; warehouse companies; pharmaceutical wholesalers; the Ministry of Health, Labour and Welfare (MHLW); and the Japan Pharmaceutical Manufacturers Association (JPMA).

Pharmaceutical supply chain security and efficiency

The emphasis on security in Japan's pharmaceutical supply chain would require the decentralization of distribution centers, implementation of irregular delivery procedures, and procurement of a safety stock according to the interviews. In addition, buildings and infrastructure equipment would need to be reinforced against earthquakes, with installed backup measures such as private electric generators. The security measures also call for high-frequency delivery, favorable returns policy, inventory management, and credit administration during the distribution process.

However, recent changes in regulation are forcing the wholesalers to improve their efficiency and security at the same time. In contrast to the emphasis on secure supply chain, the emphasis on efficiency requires centralization of distribution centers, regular delivery schedules, and minimization of stocks. In favor of investments in efficiency, the management of buildings and infrastructure equipment can be outsourced. Outsourcing helps reduce the burden of investment in facilities. The deregulation of Japan's National Health Insurance (NHI) drug price scheme is the source of the changes that the pharmaceutical supply chain is facing. The NHI's current plan calls for drug price reduction, separation of the dispensary and prescription functions, and a push for generics.

Moreover, the wholesalers have been under downward price pressure exerted by medical institutions and pharmacies as well as upward price pressure exerted by manufacturers. These changes require them to deliver pharmaceuticals more efficiently in consideration of their customer base.

Pharmaceutical supply chain after the 3.11 quake

Around 14:46 on March 11, a massive earthquake, the Great East Japan Earthquake, with a magnitude of 9.0 struck Sanriku Coast, Japan. The earthquake and tsunami devastated Tohoku and other regions. Damages were inflicted in Kanto district, too. The number of deaths is 15,874, the number of injured is 6,114, and the number of missing is 2,744 (as of November 26, 2012 according to the National Police Agency). The number of those evacuated is 324,858 (as of November 7, 2012 according to the Reconstruction Agency). Power, gas, and water supplies were disrupted in many areas, mostly in the Tohoku region. Roads, railways, airports and other infrastructure were also severely damaged (Ministry of Foreign Affairs of Japan).

Of the 82 offices owned by nine pharmaceutical wholesalers, 29 branch offices in Iwate, Miyagi, and Fukushima Prefectures were devastated by the earthquake that hit the Northeast coast of Japan in March 2011 (Nihon Keizai Shimbun, August 29, 2011, 30). As for the wholesalers’ distribution centers, five major wholesalers experienced flood, fire, power cuts, or building and equipment damage (Figure 1). In particular, Company A was the worst
hit, with 4.5 billion yen in extraordinary losses.

How did pharmaceutical wholesalers endeavor to maintain a stable supply during this emergency? Examining the case of Company D clarifies the details. Before the devastation, Company D's daily pharmaceutical supply chain operated as follows: Pharmaceuticals were shipped from the manufacturers to each of Company D's distribution centers and placed in storage (Figure 2). Their inventory management system allowed their 250 branch offices located around the nation to place restocking orders from the distribution centers. Company D fulfilled its regular deliveries to medical institutions and pharmacies twice a day.

Fortunately, all of Company D's offices were not damaged by the tsunami, but eight offices in Miyagi, Fukushima, and Iwate Prefectures were damaged by the earthquake and could not be used. Company D's neighboring offices were forced to replace the lost supply capacity of the damaged offices.

In addition, one of their distribution centers, located in Fukushima Prefecture, which delivered to Yamagata, Miyagi, and Fukushima Prefectures, was damaged (Picture 1). The earthquake caused ceiling panels to fall, stopping the automatic racks, which meant that there would be no supply capacity coming from this center. In consideration of the delivery channel and its capacity on the day after the earthquake, deliveries to Fukushima were fulfilled by Saitama prefecture distribution center and those to the Yamagata and Miyagi prefectures were fulfilled by the center at Shinagawa Ward, Tokyo (Figure 3).
Supply volume for the Tohoku region was consequently kept at normal levels and accounted for a total of 756 tons in the thirteen days from March 13 to March 25. Company D was able to maintain stable supplies because of three reasons: its high inventory levels at each branch office, the backup system, and ability to ensure delivery means.

First, the industry average level of the month-end inventory drops to 0.3 months. However, each of Company D’s branch offices has a set inventory of 0.7 months. This extra inventory allows each office to supply about two weeks’ worth of volume without the use of distribution centers. Second, their backup system was created under normal conditions. When the Great Hanshin-Awaji Earthquake occurred in 1995, Company D had not yet established the branch office support system. This resulted in failure to deliver pharmaceuticals to the right location at the right time. As a result of this failure, Company D invested 1.8 billion yen to implement a backup system in both eastern and western Japan in 2006. The backup system allows mutual support between offices when specific distribution centers or branch offices suffer damage. Third, regarding their delivery means, Company D implemented procedures to ensure swift delivery of pharmaceutical supplies to the disaster areas. Tohoku, Joban, and Ban-etsu Expressways are normally restricted to emergency vehicles, such as ambulances and fire engines, or other vehicles registered as emergency vehicles. Company D was among the first wholesalers to receive a certificate of passage on these expressways.

These routine preparations for ensuring supply to the right location at the right time, even in an emergency situation, allowed Company D to maintain a stable pharmaceutical supply chain right after the 2011 earthquake. Although other pharmaceutical wholesalers had also made routine preparations to maintain stable supplies, some of them were ill-prepared for maintaining a stable supply in an emergency such as the earthquake and tsunami on the following three points: disruptions of communication infrastructures, the inability to understand the local needs, and a lack of delivery means.

First, the reason for the disruptions of communication infrastructures is the lack of private electric generators, or a backup system which allows transfer of data. Second, some wholesalers could not understand the locations of evacuation centers and local needs. Local medical association or the pharmaceutical administration of each prefecture tried to understand the local needs and it was difficult for the wholesalers to collect information through cooperation with these different kinds of organizations. Third, some wholesalers could not ensure gasoline for
their commuter cars. The government gave pharmaceutical delivery vehicles priority to fuel except for commercial vehicles. Therefore, gasoline shortage made it difficult for the sales staffs to accept and deliver customers’ order through face-to-face contact, or to drive to their offices for recovery work.

Pharmaceutical manufacturers faced challenges similar to those faced by the wholesalers during the disaster. Some manufacturers were not able to deal with the fluctuation in the shipping volume because of limited shipping methods, particularly pertaining to the inability to understand local needs and a lack of delivery means. One cause of these limitations is the absence of an administrator throughout the supply chain as many manufacturers have been outsourcing logistics—which is not considered core to their business—since the 2000s (Table 1).

Contract warehouse companies need to store and deliver pharmaceuticals in accordance with the manufacturers’ instructions. This makes it difficult for the warehouse companies to limit the items shipped from the manufacturers. On the other hand, when several manufacturers share a specific company’s warehouse, it is difficult for them to require shipping adjustment based on their own business. Consequently, outsourcing logistics helps drive down shipping costs but makes it difficult for individual companies to control their shipping volumes.

Most pharmaceutical manufacturers had inventories after the earthquake, but owing to gasoline shortages and interrupted traffic they were unable to supply pharmaceuticals to where they were needed. Furthermore, manufacturers were twice asked to supply pharmaceuticals free of charge. These requests impacted their ability to deliver the supplies.

The first request came from the Japan Medical Association (JMA) on March 16, and 15 member manufacturers supplied 10 tons of pharmaceuticals such as antimicrobials, antidiabetics, and antihypertensives, having a value of 0.6 billion yen, to shelters by air and land routes (Figure 4). They made clear their intention to provide the pharmaceuticals for free on March 17. The pharmaceuticals went out on March 19 on three trucks headed to the US Yokota Air Base. They were moved from Yokota Air Base to the airports of Miyagi and Iwate by transport aircraft. The Japan Ground Self-Defense Force transported the pharmaceuticals from each airport to each local medical association. These pharmaceuticals were delivered to each emergency evacuation area and medical team through the local medical association and some medical teams.

In a parallel operation, transport of about 800 kilograms of drugs procured by the Aichi Medical Association from Nagoya Airfield to Fukushima Airport by two Mitsubishi Heavy Industries jet aircraft was carried out on March 19. The drugs offloaded at the airports were moved from Fukushima Airport to a local medical association in Fukushima Prefecture. They were distributed by a local medical association in Fukushima Prefecture. Based on a list of insufficient medical supplies received from Fukushima on March 22, the Aichi Medical Association made a plan to transport about 4 tons of relief goods to Fukushima (Japan Medical Association 2011).

The second request came from Iwate, Miyagi, and Fukushima Prefectures on March 19, and about 30 member manufacturers prepared 70 tons of pharmaceuticals (Figure 5). JPMA grouped the pharmaceuticals of member manufacturers together in the warehouse of Mitsubishi Logistics in Saitama and took them to each prefecture. They supplied 34 tons of them such as anti-infectives, antidiabetics, and antihypertensives, having a value of 1 billion yen, to shelters by surface transportation. However, the remaining 36 tons of pharmaceuticals with a value of 0.7 billion yen were left without being supplied. This enormous shortfall caused the recognition by the JPMA that shortage of pharmaceutical supply should be avoided, as it would disturb people in the disaster areas.

Table 1. Expanding outsourcing strategies of manufacturers

<table>
<thead>
<tr>
<th>Date</th>
<th>Manufacturer</th>
<th>Location of warehouse</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep. 2002</td>
<td>Company 1</td>
<td>Osaka</td>
<td>Mitsubishi Logistics</td>
</tr>
<tr>
<td>2005</td>
<td>Company 2</td>
<td>Aichi</td>
<td>Fuji Logitech</td>
</tr>
<tr>
<td>Apr. 2005</td>
<td>Company 3</td>
<td>Saitama, Osaka</td>
<td>Mitsubishi Logistics</td>
</tr>
<tr>
<td>Aug. 2007</td>
<td>Company 4</td>
<td>Tokyo, Osaka</td>
<td>Mitsubishi Logistics</td>
</tr>
<tr>
<td>Aug. 2008</td>
<td>Company 5</td>
<td>Osaka</td>
<td>Mitsubishi Logistics</td>
</tr>
<tr>
<td>Jan. 2009</td>
<td></td>
<td>Saitama</td>
<td>Mitsubishi Logistics</td>
</tr>
</tbody>
</table>

Source: Interviews and press materials.
Pharmaceutical wholesalers’ vision for pharmaceutical supply chain

Pharmaceutical wholesalers understand that it is essential to strengthen their countermeasures for earthquakes and power failures. However, they do not have enough capacity to invest in ensuring security because they need to improve in efficiency at the same time. The degree of security measures being implemented ultimately depends on the judgment of each wholesaler. Security efforts being implemented since the 2011 earthquake can be categorized into three types: review of initial response to the disaster, duplexing of infrastructure equipment, and enhancement of the supply chain.

In Japan’s current pharmaceutical supply chain, pharmaceuticals are stored in about 250 branch offices of each wholesaler through their distribution centers located around the nation. To fulfill an order, most products are
shipped from stock in each of their branch offices. Going through multiple branch offices allows wholesalers to maintain a balance between inventory reduction and the shortening of lead time due to the increasing number of generics and shipping points.

Most wholesalers’ frequency of delivery to medical institutions and pharmacies is twice a day, with the exception of Company A whose frequency is four times a day. However, wholesalers do accept requests for immediate delivery from customers who are incapable of inventory management. This shows that the wholesalers’ priority is shortening of lead time rather than improvement in supply efficiency, which is due to the severe price competition among wholesalers.

Figure 6 shows pharmaceutical wholesalers’ vision for the pharmaceutical supply chain before the earthquake. Companies A, B, and C, whose trade areas are located throughout the country, planned to establish distribution centers in thirteen to seventeen locations. Company D, whose trade area is also located throughout the country, had already established six distribution centers, although these are fewer than those of Companies A, B, and C. Company E, whose trade area consists of the Tohoku, Hokuriku, and Kinki regions, had also established six distribution centers.

The location of the distribution centers is based on sales volume, which results in an uneven distribution of the centers mainly in Tokyo, Osaka and Nagoya, the three major metropolitan areas. Nonetheless, each wholesaler has indicated that it will maintain inventories at each of the branch offices because dispersing inventories to shorten lead time remains a significant factor in customer satisfaction.

Despite the increased capacity and pricing pressures, the pharmaceutical supply chain must move forward with its agenda for improving security and efficiency. One of the wholesalers’ first priorities will be to establish distribution centers in areas where there may not be enough coverage. For example, in the Tohoku region, the pharmaceutical supply area of each distribution center is wider than...
in other regions. However, some wholesalers have not yet developed their own distribution centers in this region. For example, before the earthquake, Company A had not established any distribution center in the Tohoku region and its distribution center in Saitama Prefecture supplied the Tohoku region as well. If the Tohoku Expressway had not been open, it would have been difficult to supply pharmaceuticals to the disaster area soon after the earthquake. Since the earthquake, Company A has established a new distribution center near Sapporo City, Hokkaido. In addition, its existing plan was accelerated and a new distribution center, which supplies the Tohoku region, started operating in Iwate Prefecture in June 2012. Additional centers will also be built in Kawasaki City, Kanagawa Prefecture, Hiroshima Prefecture, and Fukuoka Prefecture.

Along with the above plan, Company A will shorten lead times and operate at a low cost by cutting the number of branch offices that hold inventories to 200 from the current 250. However, the daily competitive environment in Japan's pharmaceutical wholesale industry is worsening continuously. All wholesalers experienced a dramatic drop in operating profits as of fiscal year 2011 and posted big earthquake-related extraordinary losses. Company A tolerated the low profitability and suffered through insufficient investment in added security. The annual report of Company A shows an operating profit of 13.5 billion yen but an earthquake-related extraordinary loss of 5 billion yen for the fiscal year ending in March 2011.

As for Company E, the situation might be even more serious. Being a local company, not only Company E itself, but also most of its customers were damaged severely, and the earthquake made Company E’s financial conditions worse. Overall, Company E posted an operating loss of 0.8 billion yen as of fiscal year 2011. Behind this was an earthquake-related extraordinary loss of 2.8 billion yen including an unrecoverable loan caused by the quake and tsunami of 2.4 billion yen. It is assumed that Company E faces difficulties in further investment.

Pharmaceutical wholesalers are struggling with capacity for investment in additional facilities to ensure secure supply chain. Price competition is very severe in the current NHI drug price scheme as wholesalers are under increasing price and lead time pressures from their customers. Improvement of security is also not an immediate profit that can be gained in this scheme. At the same time, the pharmaceutical supply chains have the aspect of social infrastructure and the pharmaceuticals must therefore be kept in stock all the time. Thus, pharmaceutical wholesalers will need to establish very strict corporate management policies that would enable them to engage in a price-cutting war while retaining the function of stable supply in an emergency.

Future pharmaceutical supply chains will be encouraged to strengthen crisis management including backup system. The national or local governments might be required to provide public assistance for such management. At present, some prefectures build stockpiles of pharmaceuticals in preparation for disasters or other unavoidable circumstances. Others require pharmaceutical supply of wholesalers in preparation for a contingency. Additional measures might be needed if differences between municipalities in the extent of the measures result in substantial regional disparities in access to pharmaceuticals.

Conclusions

The findings of this study are summarized as follows. The emphasis on security in the pharmaceutical supply chain would require establishment of a backup system, the decentralization of distribution centers, implementation of irregular delivery procedures, and procurement of a safety stock. However, ensuring supply chain security requires an enormous amount of investment, sacrifices, and improvement in efficiency. The practical measures being implemented need to maintain a strict balance between supply chain security and efficiency.

The location of the wholesalers’ distribution centers is based on sales volume. These centers are unevenly distributed in metropolitan areas. However, dispersing inventories are maintained at each of the branch offices outside the scope of specific lead time. The inventory is intended to strengthen the pharmaceutical wholesalers’ ability to cope with fluctuations in demand and avoid shortages. Most wholesalers’ frequency of delivery to medical institutions and pharmacies is twice a day with a stable supply chain in an emergency.

Japan’s pharmaceutical wholesalers work to enhance security for a stable pharmaceutical supply chain on a routine basis. The supply system functioned effectively for the sudden shifts in demand after the 2011 quake, although not without some issues. The pharmaceutical supply chain has experienced changes that could lead to a low level of security. These changes include the inability to respond to fluctuations in shipping volume owing to the increased outsourcing of logistics by manufacturers and a reduced capacity to invest in security measures because of a decrease in the wholesalers’ profits.

It is required that government departments such as the MHLW, local governments, JPMA, pharmaceutical association, medical association, and Federation of Japan
Pharmaceutical Wholesalers Association strengthen mutual collaboration for acquisition and sharing of local needs and for in-time delivery.

After all, while the reimbursement prices for all newly launched prescription drugs are set by MHLW, the distribution process is left to market mechanisms. That includes the fear of inappropriate benefit sharing. Within the present framework of profit sharing, a decrease in the wholesalers’ profits suggests that ensuring stable pharmaceutical supply does not lead to a reasonable profit.

On the other hand, new drug prices in Europe are determined and maintained freely by pharmaceutical manufacturers until the expiration of the relevant patent. Among European countries, wholesaler and pharmacy margins are controlled on an official basis in order to avoid excessive competition and allocate a fair profit. If it remains difficult to ensure stable pharmaceutical supply while also sharing equitably benefits at the same time, Japan’s pharmaceutical supply chain requires a new framework independent of market mechanisms, that includes public management of the supply chain.

Who should share how much cost of maintaining stable pharmaceutical supply under the public health insurance? Users and suppliers need to continue risk communication about how much money they should invest in a secure supply chain. Geographical studies are required to contribute to the spatial arrangement of the pharmaceutical supply function that considers both the moderation of the medical insurance system’s finances and the supply chain’s function as social infrastructure.

Acknowledgments

I would like to thank all interviewees in the case study. The main outline of this paper was presented at the 6th Korea-China-Japan Joint Conference on Geography in 2011 (Seoul National University). Special thanks go to Donald Macarthur for commenting on a draft version of this article.

References


