Chapter 37
Research on Risk Identification and Control of Medicine Supply Chain

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Abstract With the deepening of medical and health system reform in China, it is necessary to strengthen risk management of medicine supply chain so as to improve the medicine distribution level and cut down the medicine price, and increasingly great concern has been aroused by government, pharmaceutical industry and society. In light of the complexity and uncertainty of medicine market, this paper makes analysis on the composition of medicine supply chain and its risks, constructs a risk identification hierarchy structure of medicine supply chain, and then designs the risk control model. This paper aims at providing support for medicine supply chain to reduce the risks and increase the operational level.

Keywords Medicine supply chain • Risk identification • Risk control

Introduction

In the tangled warfare of Chinese medical market, there are intensified competitions among pharmaceutical companies which lead to the abnormal competitive costs shifting to the consumers, therefore, how to optimize the medicine circulation and further reduce medicine price have become the focus both for government and for pharmaceutical industry. In the pharmaceutical industrial competition which has transformed from the single company or group competition to the alliance

Sponsors: National Natural Science Fund (71173062), Humanity and Social Science Project of Ministry of Education (10YJC630246), Natural Science Fund of Heilongjiang Province (QC2011C063), Scientific and Technological Project of Heilongjiang Province (GZ11D209), Postdoctoral Science-research Developmental Fund of Heilongjiang Province (LBH-Q10063)

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R. Dou (ed.), *Proceedings of 2012 3rd International Asia Conference on Industrial Engineering and Management Innovation(IEMI2012)*,
DOI 10.1007/978-3-642-33012-4_37,

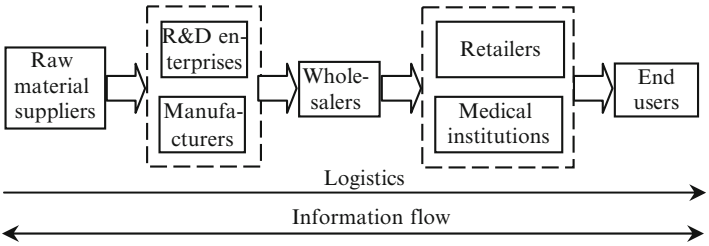

Fig. 37.1 The composition of medicine supply chain

competition, a medicine supply chain of high efficiency and low cost is playing an increasingly important role. Due to the special function of medicine compared with other commodities which is featured by curing the sickness and saving the lives, there are higher demands for the supply of medical raw materials as well as the medicine preservation and timely medicine supply; meanwhile, the great complexity and uncertainty of medical market bring high risks to the medicine supply chain. Therefore, to quickly identify the risks of medicine supply chain and effectively control the risks to the lowest level are beneficial to accelerating the medicine circulation, reducing the medicine price and solving the contradictions between medicine supply and demand.

Analysis on the Composition and Risk of Medicine Supply Chain

Medicine supply chain is a complete medicine supply network from the raw materials supply to the medicine sales terminal which is composed of the pharmaceutical companies, related institutions, logistics companies and end users, as shown in Fig. 37.1.

In the medicine supply chain from raw material suppliers to end users, each member accounts for each node of supply chain, in which medicines are generally sold to the end users by hospital or pharmacy. In such operational process, supply chain can't run effectively and smoothly without a modern logistics system, while in the network environment, resource sharing, management decision making and coordinated operation of each node in supply chain can be achieved through information flow, so logistics and information flow are the key factors that influence the stability and performance of supply chain. The operation of medicine supply chain is influenced by a lot of favorable and unfavorable factors, thus the behavior of each body in supply chain, the smoothness of logistics and information flow as well as the uncertainty of market environment commonly cause the medicine supply chain risks namely the interest loss or the possibility of loss compared with the objective.

Learning from the literatures and according to the characteristics of China's pharmaceutical market and the development state of medicine supply chains, medicine

supply chain risks can be departed into nine types including R&D, quality, demand, logistics, information, collaboration, policy, law and competition (Shen et al. 2009).

R&D Risk

R&D risk refers to that new medicine can not achieve the expected effect, or fail to be developed so that new medicine is unable to be continuously introduced due to the high investment, high risk and long R&D cycle. New medicine development is a long and complex engineering, so successful development of new medicine will be strongly related to the operational efficiency and performance of the entire medicine supply chain.

Quality Risk

Quality risk is the risk related to the production characterized with low quality or negative medicine effect that bring harm to the human health which is caused by raw materials, manufacturing process, production safety and technical personnel's operational activities.

Demand Risk

Demand risk refers that the medicine fails to meet the demand or there is medicine backlog because of changes in customer demand. Changes in customer demand include periodic fluctuations of part seasonal medicine demand, sharp demand increase or decrease of medicine caused by public emergencies and so on (Shen et al. 2009).

Logistics Risk

Logistics risk means that due to the imperfect logistics and distribution system, or impacts of natural disasters and emergencies, the delivery time, storage time, storage temperature and so on are unable to reach the medicine management standards which result in the medicine damage during storage and transportation, or failure of timely delivery. The specificity of medicine determines its particularity for storage and transportation, and proposes more stringent requirements for medicine logistics and distribution system.

Information Risk

Information risk is the phenomenon of information asymmetry or information distortion because each node in supply chain can not effectively share information in the information bidirectional transmission process from raw material suppliers to end users. From the view of end users, the information risk is information asymmetry which makes the hospital almost determine the medicine needs without understanding the real requirements of patients. From the view of medicine developers and manufacturers, because they are in the front of medicine supply chain and nearly fail to access market information, they can not accurately determine the direction of technology development, adjust product output, arrange the logistics and make market forecast which lead to their inferior positions in the whole supply chain in the aspects of medicine supply capability, cost and so on.

Collaboration Risk

Collaboration risk refers to the incomplete collaboration degree of supply chain members or the vicious competition among members due to credit and information barrier in their resource sharing and interaction process (Faemsl et al. 2010), which result in absence of resource optimal allocation, low operational efficiency and profitability, and furthermore lead to the lack of overall competitive advantage of supply chain.

Policy Risk

Policy risk means that due to the government regulations on pharmaceutical industry by introducing various policies such as medicine price reduction control, new rural cooperation and the construction of two networks which result in the cost rise, profit decrease and necessary adjustment of business for medicine supply chain, thereby affecting the timely and adequate supply of medicine (Shen et al. 2009; Sachs et al. 2008).

Legal Risk

Legal risk refers to that the operating activities in medicine supply chain cannot comply with the law's changes and new requirements, or the contracts of medicine supply chain are unable to be executed because of conflicting with the laws and regulations. To reflect the requirements of the times, government has constantly introduced various laws and regulations to normalize medicine R&D, production and business activities, so the medicine supply chain must grasp and conform to the requirements of laws and regulations in time (Shen et al. 2009).

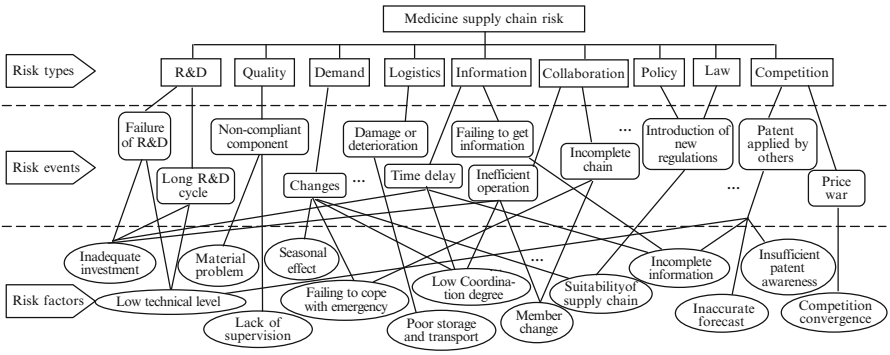

Fig. 37.2 Identification hierarchy structure of medicine supply chain risk

Competition Risk

Competition risk means that one medicine supply chain may face competitive pressures of other similar medicines in price, function and other aspects, and it may compete with several external medicine supply chains.

The Identical Hierarchy Structure of Medicine Supply Chain Risk

By referencing the literatures, the process of identifying medicine supply chain risk is as follows: firstly identify risk events, and then find out various factors that lead to the risk events, finally classify the various types of risk events (Shao and Lin 2010), as shown in Fig. 37.2.

Figure 37.2 shows part of the risk events and risk factors in medicine supply chain, for different types of medicines and their supply chains, the risk events and risk factors are also different. As is shown in Fig. 37.2, the medicine supply chain risk consists of a range of different types of risk events, and various risk factors lead to the risk events; in which a variety of factors may lead to a certain risk event and a risk factor may result in multiple risk events. For example, the inadequate investment may lead to the failure and long cycle of new medicine development which makes the supply chain miss opportunities and operate in poor efficiency. In addition, the not enough investment, inadequate degree of coordination among members and the changes of members are the main factors leading to inefficient operations of supply chain. Therefore, the essence of identifying medicine supply chain risk is to further find out risk factors from different risk events to provide basis for risk control. Because these risk factors are the sources of risk events or losses, they are the basic objects of risk control for medicine supply chain (Shao and Lin 2010).

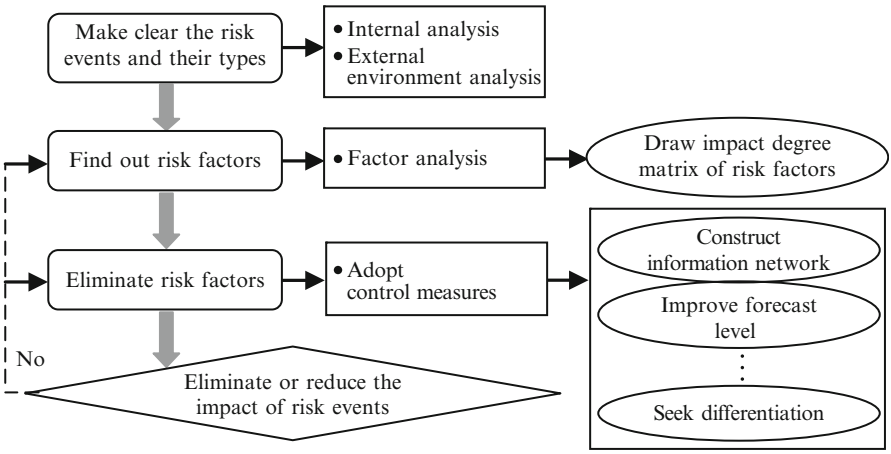

Fig. 37.3 The risk control model of medicine supply chain

Risk Control Model and Measures of Medicine Supply Chain

Risk Control Model of Medicine Supply Chain

The medicine supply chain risk control is to adopt control measures to eliminate risk factors after finding out risk factors, thus the risk can be reduced. The risk control model of medicine supply chain is shown in Fig. 37.3.

After analyzing internal and external environment and conditions of medicine supply chain and making clear the risk events, there is need to make a further factor analysis to identify risk factors, draw an impact degree matrix of risk factors to understand risk factors' impact degree on risk events, take some control measures to eliminate or reduce the impact of risk factors, and ultimately achieve the goal of eliminating risk or reducing the probability of risk events.

Impact Degree Matrix of Medicine Supply Chain Risk Factors

After finding out the risk factors, the impact degree matrix of risk factors should be drawn so as to grasp the key factors, as shown in Table 37.1.

In Table 37.1, the impact degree values for all risk factors that belong to a same risk event sum to 100, and a larger value of a single risk factor's influence on the risk event indicates that the factor has a greater impact on the risk event which should be regarded as the focus of risk control.

Table 37.1 Impact degree matrix of risk factors

Impact degree — Event / Factor	Risk event 1	Risk event 2	Risk event 3	...	Risk event *m*
Risk factor 1	60		80		30
Risk factor 2		100			50
⋮			20		
Risk factor *n*	40				20

Control Measures of Medicine Supply Chain Risk

According to the general characteristics of the medicine supply chain, risk control measures can be taken as flows, in which what should be focused on are quality risk, information risk and collaboration risk.

1. *R&D risk control:* The R&D companies in medicine supply chain need long-term and sustained investments, if possible, they should apply for the patent when there is a more satisfactory result in medicine effect or production process. In this process, the patent map analysis tools can be used to formulate R&D strategies in order to determine the time and objective of R&D, resource distribution structure as well as specific development, application and implementation tactics of patent (Wang and Tian 2010).
2. *Quality risk control:* As mentioned earlier, quality risk is related to the production, so not only the production process should be managed, but also the source in the front of supply chain should be controlled, and the timely feedback in sales process is necessary. The main points of quality risk control of supply chain are shown in Fig. 37.4.
   In the link of raw material purchase, the supplied raw materials must get approval of use in order to control the medicine quality from source. Besides, the incoming raw materials should be strictly examined according to the standards and requirements. In the process of medicine production, pharmaceutical machinery, medical formula and manufacturing process should be strictly in accordance with GMP standard, and all production and inspection records should be arranged I n file to ensure the pharmaceutical manufacturing process error-free and pollution-free. If conditions permit, pharmaceutical production monitoring system should be established, thereby increasing off-site supervision capability. In the sales link, the supervision system and medicine recall system should be built up to reply to hidden dangers and undesirable reactions.
3. *Demand risk control:* Medicine supply chain must strengthen the customer relationship management and seriously seek the patients' needs and feedback

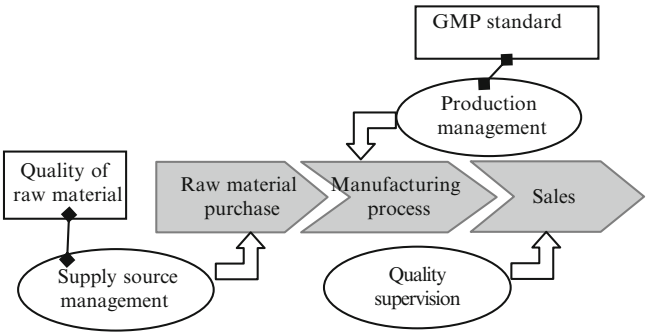

Fig. 37.4 The main points of quality risk control of medicine supply chain

information; simultaneously medicine distributors may also respond to market demands timely by establishing flexible stock.

4. *Logistics risk control:* Logistics risk should be controlled from two ways including quality and speed.

   ① Guarantee the logistics quality. For pharmaceutical companies, sellers and other medicine business institutions, the medicine circulation including medicine purchase, warehouse-in inspection, storage, sales and service must be in strict management according to GSP standard, so that the hardware, software and business practices of medicine business units can meet the requirements to ensure the medicine quality in circulation. Logistics enterprises should establish the assessment and prevention system on the uncertainty impact of natural environment so as to prevent or reduce disruption of logistics tasks caused by flooding, fires and other natural disasters.

   ② Improve the speed of logistics services. The bar code technology can be used to improve logistics speed. When a medicine supply chain's transportation, packaging, handling and other logistics services are executed by a number of logistics service providers, in order to avoid the risk transmission among logistics enterprises, close cooperation and synergistic development among the logistics enterprises should be maintained (Li et al. 2010).

5. *Information risk control:* Information risk can be prevented from the following three aspects.

   ① The status of hospital in presentation of patients' demands must be changed, and hospital should strengthen exchanges and communications with patients by utilizing their professional advantages thus establishing a good relationship between health care staff and patients, understanding the needs of patients, establishing patients' files and feeding back information to the upstream businesses in medicine supply chain (Jiang et al. 2008).

   ② For pharmacies, in the course of medicine sales, information on medicine sales should be arranged, analyzed, and forecasted in order to provide basis for pharmaceutical production and inventory decision.

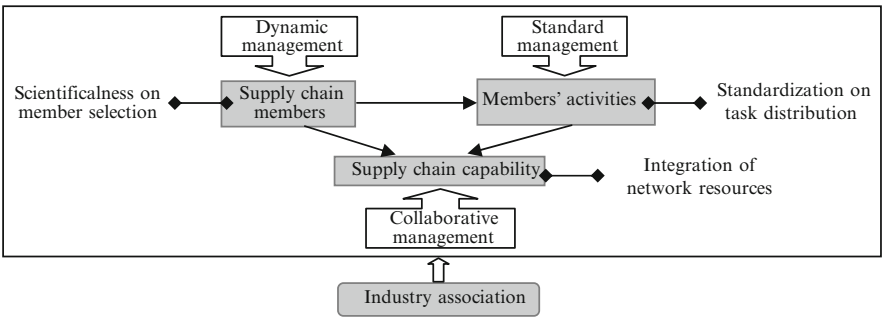

Fig. 37.5 The collaboration risk management focus of medicine supply chain

③ An information system of supply chain ought to be established both for each member and for the network of supply chain. For pharmaceutical companies, ordering and inventory systems for hospitals and medicine distributors should be set up so as to learn sales information and guide the replenishment and sales. For the logistics system, logistics and distribution system should be perfected to speed up the medicine circulation speed and to reduce error rate. For hospitals, the establishment of information management system and the use of bar code technology for managing medicine incoming and outgoing inventory will help constructing new upstream and downstream relationships so that the needs of patients and medicine storage state can be rapidly grasped (Chen and Chen 2009). For the entire medicine supply chain, the use of information technology can enhance supply chain network management level, thus contributing to the optimization of resource allocation and supply chain scientific decision as well as the improvement of supply chain efficiency.

6. *Collaboration risk control:* The management focus of collaboration risk can be seen from Fig. 37.5.

① In light of the dynamic development needs of supply chain, the mechanism for selecting members of supply chain is to be constructed so that complementary enterprises or organizations will be introduced. In order to maintain supply chain stability, it is important to consider the relation capital, cultural compatibility and credibility (Chen and Sheng 2009). Besides, a database of backup participants should also be developed to timely supplement the supply chain's missing or weak links.

② A clear division of tasks and the behavior standard of supply chain make all members accomplish their missions in quality and quantity according to the schedule.

③ Building up effective channels such as information platform for the resource sharing of supply chain will contribute to the effective integration of supply chain network resources, thus it will reduce transaction costs, improve operational efficiency and effectiveness of collaboration as well as enhance the overall capacity of supply chain.

④ Pharmaceutical industry association should play a coordinating and guiding role in recommending partners to supply chain, monitoring supply chain activities, counting up and publishing industrial information, organizing medical exhibitions and fairs, etc. When supply chain members encounter serious problems, the industry association should help providing solutions to them (Zhang and Wang 2010).

7. *Policy and law risk control:* Medicine supply chain should pay close attention to the dynamic policies, laws and regulations of its resident region, strengthen the utilization of relevant policies and adapt to laws and regulations. On the one hand, supply chain should seize opportunities, obtain policy support and adjust business, behavior and management methods in response to the development requirements; on the other hand, it should better bear the social responsibilities including complying with business ethics, product safety, resource conservation and environmental protection (Meng et al. 2010). Meanwhile, in the course of providing support for medicine supply chain, the industry association should timely feed back the problems and requirements to the relevant government departments so that the formulation of planning, policies, laws and regulations of government are more in line with the needs of medicine supply chain and much closer to the global pharmaceutical industry standards.
8. *Competition risk control:* In response to the rapidly changes of industrial environment and challenges from competitors, medicine supply chain should pay close attention to industrial technology and market trends, and enhance prediction ability in order to understand the development trend. Also, the supply chain should know the competitors' dynamics and seek differentiations so as to occupy the favorable position in medicine competition.

Conclusion

At present, for most medicine supply chains, the low level of risk management is the main reason for low performance, high price, incardination between supply and demand as well as imperfect health care system, which has also become the main problem for supply chain's sustainable development. As the medicine supply chain risk does not attract enough attention, strengthening the risk management is of significance both for the national health care reform and for the human health. This paper first makes an analysis of composition and risks of medicine supply chain, then it proposes risk identification hierarchy structure, at last it designs the risk control model and relative measures, which may provide reference for medicine supply chain risk management. Although this paper has made a preliminary exploration in medicine supply chain risk management, it is only limited to qualitative description, in the future the quantification and the early warning system of risk needs to be constructed by use of quantitative methods and information technologies.

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