Research Article

Quality Risk Management in Pharmaceutical Supply Chain, Warehousing and Dispensing - Practical Case Study from Sterile Pharmaceutical Industry.

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ABSTRACT

Quality Risk Management (QRM) during medicinal products manufacturing is now becoming an integral part of quality management system (QMS). Most if not all regulatory authorities have revised their current good manufacturing practices (GMP) to incorporate the concept of risk assessment in every single process regardless to the criticality of the process. Different Procedures in pharmaceutical QMS like deviation control, change control, investigation, customer complaints handling, validation & qualification, product release, etc. consider the principles of risk assessment at all steps. Extensive research in this area shows that there is scarcity of research on quality risk management during early stages of medicinal products manufacturing including (1) procurement/supply chain, (2) logistics/warehousing and (3) raw materials dispensing. To cover the gap in the literature, three practical case studies has been studied by selecting one major step from each manufacturing stage and applied risk assessment following the procedure described in ICHQ9 and using Failure Mode Effect Analysis (FMEA) as risk assessment quality tool. As a result of this review, QRM during early stages of medicinal products manufacturing may be useful to avoid unnecessary complaints or delay during subsequent drug processing in the manufacturing site. Being proactive and taking all necessary measures to avoid any possible defects or mishandling is one of the major objectives of QRM and ultimately patient protection. This study shows a model solution for industry professionals and regulators to reduce the possible risks associated with early stages of medicinal products manufacturing thereby paving the way for significant business growth.

Keywords: Quality management system, quality risk management, good manufacturing practice, supply chain & warehousing, dispensing.

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INTRODUCTION

The supply chain & warehousing of medicinal products is the first significant step in drug product manufacturing operation. Keeping well controlled measures in this important step requires a thorough knowledge and experience in the area of quality risk management. Medicinal products manufacturers have a fundamental obligation to maintain product quality during the drug product life cycle. An understanding of supply chain and warehousing process and the associated risks to the product shall enable manufacturers to carry on and control all logistics processes more effectively.

During supply chain and storage process, pharmaceutical manufactures face considerable challenges. These challenges such as risks can disrupts various processes in supply chain like delivery of the required quantities in the right time, storage/ protection of pharmaceutical products from contamination and mix up and delivery of the right product to the manufacturing site. Therefore, quality risk assessment during pharmaceutical products supply chain & warehousing process is highly suggested. [1]

Principles of Risk management are effectively used in many industry and government sectors, including banking, insurance, occupational safety, public health, pharmacovigilance, and agencies regulating and managing these industries. [2,3,4] In spite of the fact that there are some good applications of the use of quality risk management in various stages of pharmaceutical products manufacturing, most of them are mainly focused on production site. Furthermore, such application does not represent all the contributions that risk management can truly offer. [2, 5] One of the great quality risk management application resources are coming from Parenteral Drug Association (PDA). There are quite very good references in the form of technical reports show the application of QRM in area of filling, sterilization, inspection, labeling and packaging. Few are published in the area of supply chain and warehousing. [6, 7]

There are different internal and external stakeholders in pharmaceutical industry such as top management, regulators, medical practitioners and patients. Each stakeholder has different perspective on identifying different potential harms; placing a different probability for each harm occurring and assigning different severities to each harm. This results in complicating risk assessment process. Yet, managing risks and harms that could affect patient safety is considered major significant goal. [2, 3]

According to the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH) Q9, Quality Risk Management (QRM) is defined as, "the systematic application of quality management policies, procedures, and practices to the tasks of assessing, controlling, communicating and reviewing risk". QRM can be applied both proactively and retrospectively to optimize its benefit and balance the risk. [3, 8] Moreover, Concepts of QRM rely on the understanding of 'Quality' and 'Risk' terms. The term quality means the degree to which the requirements are met by a set of inherent properties of a product, system or process" (ICHQ9) and in accordance with ISO/IEC Guide 51, the expression Risk refers to "The combination of the probability of occurrence of harm and the severity of that harm". [9, 10]

Manufacture of medicinal products requires the holder of marketing authorization to assure that products are suitable for their intended use and will not put any risk to patients in terms of safety, quality, and efficacy. [8, 11] Moreover, quality risk management is an important component of an effective quality system. The effectiveness of quality risk management can further ensure the high quality of the medicinal product to the patient by presenting a proactive means to identify and manage potential quality issues during the entire product life cycle. Use of quality risk management will improve the decision making whenever a quality problem evolves. Effective quality risk management can help making better and informed decisions. It will also provide regulators with greater assurance of an organization's capacity to manage potential errors. The output of risk management gives compliance to external and internal requirements and supports the association to meet the characterized objectives. [5, 12]

There are two main requirements to have an effective quality risk management. First is the evaluation of the risk to quality should be established based on scientific knowledge, experience with the process, and ultimately link to patient protection. Second the level of effort, formality and documentation of the quality risk management process should be proportionate with the level of that risk. [8] Quality risk management involves 3 main parts: risk assessment, risk control and finally risk review. The risk assessment process contains three steps. Initial step is the risk identification, where a list of potential risks associated with the target process is listed, followed by risk analysis, where the possible harms of the risks are measured for better understanding and decision making, either qualitatively or quantitatively or in both cases. The third step forms the decision-making step where it is decided that which risks are to be reduced and which are acceptable; Following the risk assessment, there will be risk control then a review of risks is done to analyze whether the action taken brought a positive output or not. According to ICHQ9, communication of risks with all stakeholders should be exercised throughout the entire risk management process. [3, 13] The QRM process is briefly outlined in Figure 1

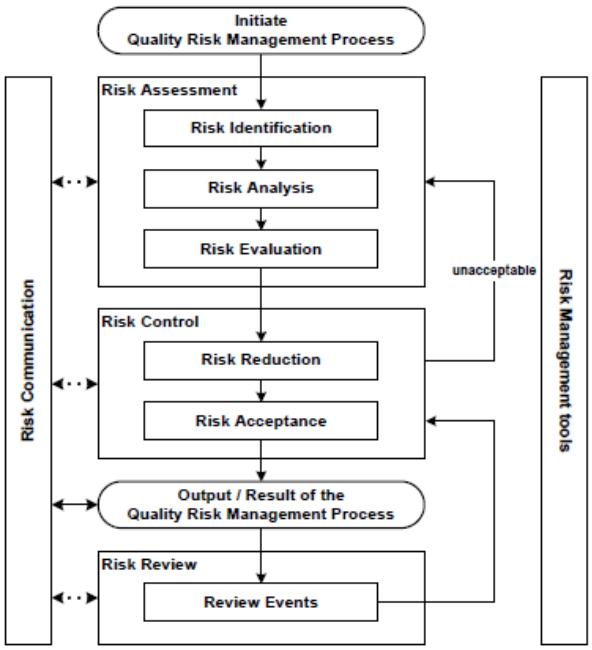

Figure 1: Overview of Quality Risk Management Process (ICH Q9).

Risk management methods and tools are very critical to discover the risk and minimize or limit its effect. Failure Mode Effect Analysis (FMEA) is a potential tool for evaluation of processes failures and its impact on the product. It aids to reveal important failures and its impact.[3,14] It also helps in assessing the possible ways in which failures might occur, assess the extent of the effects of failure, find the possible cause or causes of failure, and recognize what can be performed to prevent such failures or lessen the chance of their occurring or enhance their detectably. [15]

ICH Q9 QRM is developed by the Expert Working Group (Quality) of the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use. In this guideline, quality risk management tools are well described and examples of their application are demonstrated. Nowadays ICH Q9 QRM Guidance has been adopted in SFDA GMP Guidelines version 4.0, 2021 in Annex 20 [16], EudraLex V4 Annex 20- GMP Guidelines for Quality Risk Management [17] and PIC Guide to GMP 2018 Annex 20 [18]. These guidelines formally require manufacturers to apply the principles of quality risk management (QRM) as per ICHQ9. Regulatory bodies expect pharmaceutical manufacturers to assess and manage all risks associated with development, manufacturing, and marketing of medicinal products by understanding and implementing ICH Q9 guidelines. In the view of gap seen in the current research papers, demonstration of practical case studies is needed during supply chain and warehousing.

MATERIALS AND METHODS

A group of researchers including an academic instructor in cooperation with pharmaceutical industry consultant have selected one of sterile infusion solution product in the form of glass bottle of 100 ml size and decided to thoroughly review the entire process of product manufacturing covering product life cycle, (Figure 2). Product manufacturing operation composed of few and distinguished processing stages. Each stage consists of several small process steps. Generally speaking, all pharmaceutical manufacturing operations start from procurement & supply chain pass through storage and control of raw and packaging materials then production process such as raw materials dispensing, formulation, filling, inspection, labeling, packaging, palletization, and end by storage & distribution. In this research paper the entire process has been defined and three major steps have been selected to be the subject of this study. In each selected step, complete risk assessment was done using ICHQ9 guidance [3] and the application of FMEA [15]. To simplify methodology to others, a specific working scheme was followed:

A- Read and understand the relevant standard operation procedure of the selected process.

B- Meet with the owner of the process and his/her supervisor and transforming the procedure into separate well-defined steps.

C- Using brain storming technique and consulting risk management expert, all potential risks associated with every step is identified.

D- For risk analysis, risk table is completed by answering well-recognized risk questions: What might go wrong? What is the likelihood (probability) it will go wrong? What are the consequences (severity)? And what is the ability to detect the harm (detectability)? This is direct application of risk assessment tool called Failure Mode Effect Analysis (FMEA). (Figure 3)

E- FMEA risk evaluation will determine ratings for severity, probability of occurrence, and likelihood of detection on a scale of 10, where 1 is the rating with lowest risk and 10 is the highest possible risk to the safety of the product. The three numbers are then multiplied for each cause–effect-detection combination, to calculate risk priority number (RPN):

(Severity of effect) × (Likelihood of occurrence) × (Unlikelihood of detection)

For example, an effect rated 10 for severity, 10 for likelihood of occurrence, and 10 for unlikelihood of detection yields an RPN of 1000 – the worst possible case. On the Other Hand, ratings of 1, 1, and 1, respectively, yield an RPN of 1, indicating a cause–effect-detection combination of no concern. RPNs can fall anywhere along this scale of 1–1000 (Table 1)., and the higher the RPN, the greater is the cause for concern. Therefore, the team first addressed the potential failures of greatest concern. Corrective actions are identified and implemented enabling the team to reduce levels of risk to an acceptable status.

F- Risk control can be implementation of new policies/standards, physical changes, and procedural changes that can eliminate (if possible) or reduce the risk.

Stage 1: Procurement and Supply Chain - Vendor Management - Procurement of Raw & Packaging Materials - Purchase Order Process for Raw and Packaging Materials	**Stage 2: Logistics and Warehousing** - Temperature and Humidity Recording in Raw and Packaging Material Store - Raw & Packaging Materials Receiving - Raw & Packaging Material Store Entry - Raw & Packaging Materials Issuance and Returning - Raw & Packaging Materials Store Cleaning Procedure	**Stage 3: Dispensing** - Received Material De Dusting - Entry & Exit Procedure to Production Raw Material Store - Operation and Cleaning of Dispensing Booth - Raw Material Dispensing - CIP & SIP of Manufacturing (Mixing) Tank and its Accessories - CIP & SIP of Storage Tank - Batch Manufacturing /Formulation
Stage 4: Filling/Final Product Handling & Treatment - Glass Bottle Washing and Feed into Filling Line - Rubber Stopper Washing and feed to filling Line - Filling Operation Set Up and Monitoring - Final Product Receiving and Handling e.g., Sterilization	**Stage 5: Final Products Inspection, Labeling, Packaging & Palettization** - Final Product Inspection Operation - Final Product Labeling Operation - Final Product Collection and Packing Operation - Final Product Packaging and Palletization	**Stage 6: Finished Product Storage & Distribution** - Finished Product Pallet Labeling Operation - Finished Product Reconciliation Operation - Finished Product Pallets delivery to Warehouse - Finished Product Storage and Control Operation - Finished Product Distribution

Figure 2: Manufacturing Stages for sterile Drug Product filled in 100 ml glass bottle.

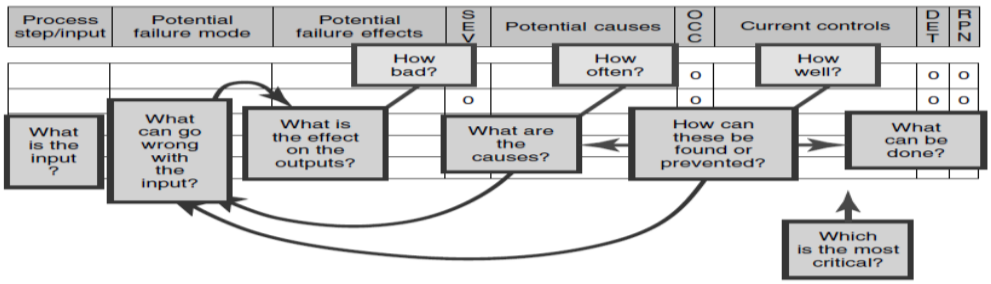

Figure 3: FMEA risk identification questions.

Table 1: Risk Priority Number Matrix

Risk Priority Number (Severity x Occurrence x Detection)	Level	Action
1-34	Low	Risk is acceptable
35-104	Medium	Risk may be acceptable. Reduce risk to as low as practically reasonably
105-1000	High	Risk is not acceptable. Risk reduction/mitigation is required

RESULTS AND DISCUSSION

One process has been selected from the first three stages of drug manufacturing operation. As mentioned in the methodology, each standard operating procedure (SOP) under study will be transformed into clear and well-defined steps. Number of steps resulted by transforming each SOP in this study range from 10 to 15 steps (SOPs steps are not shown). This facilitates the work of risk identification. Hence, risks associated with every step have been identified. Then FMEA table was constructed with all information required to complete risk assessment. (Table 2), (Table 3), and (Table 4). As seen in FMEA tables, data were filled in the columns; where steps in the process are defined (column 2), what can go wrong in performing this step (column 3), what is the effect if this step goes wrong (column 4), what are the possible causes of the step going wrong (column 6), any existing/current control on hand to avoid the step going wrong (column 8). Based on this initial information and by team consultation, the numerical scores are assigned to severity (column 5), probability (column 7) and detectability (column 9). Risk priority number is calculated and shown in column 10. Based on the risk score obtained, category of the associated risk was decided to be low, moderate or high risk (column 11), what action/decision need to be taken (column 12). Who is responsible to take the action (column 13) and the date action completed (column 14) and then team members recalculated the new RPN obtained after action implemented (column 17). Based on team experience and the meaning of risk severity, it is observed that the effect of such control measures introduced in the process step to mitigate the risk is seen only in risk probability and risk detectability. This explains why in all FMEA tables the risk severity score did not change after implementing the control.

Risk analysis of all steps and for the three selected drug manufacturing phases shows that there are many risks that fall in the low risk (green) area which means that the RPN is below 34 (not shown in this study) therefore no action or control measures should be taken. This study showed few examples of risks in the medium and high-risk regions and demonstrate the action taken to mitigate risk associated with that particular step. FMEA tables show risk analysis followed by data interpretation and conclusion.

Risk assessment associated with Vendor Management Step

All possible risks associated with the mentioned process (Table 2) have been considered and RPNs are calculated. Considering the severity, occurrence and detection level of the risk, (Table 2) shows one example of risk that is more than 34 (medium risk) and one risk that is more than 105 (high risk). The team decided to take the necessary control measures to either eliminate or reduce the risk. For the risk associated with reviewing vendor questionnaire by QA or factory technical manager, the control measure found to be defining the review target date and effective follow up by QA officer. Implementing such control, the risk probability (3) and detection (3) is changed to 2 & 2 respectively. This control changed RPN from 36 (medium risk) to 16 (low risk). The effectiveness of this action is under monitoring for 6 months. For the risk associated with using materials from unapproved vendor, the team decided to take the necessary measure to reduce this unacceptable risk. Examples of control taken is assure the presence of at least 2 approved vendors, implement auto control on approved vendor section for ordering materials, PO shall be reviewed by designated QA officer to assure the right selection of vendor. Such control changed the RPN from 128 (high risk) to 48 (medium risk).

All changes made in any GMP documents e.g., SOPs, Formats, software, etc. associated with the discussed risks shall be revised, reviewed and approved. Risk identification, analysis and evaluation were completed and documented for one of the critical manufacturing process that is Vendor Management. All steps associated with this process are kept under control. Risk communication will be considered with key persons. Annual risk review is in place and whenever there is a considerable change in the process.

Table 2: Risk assessment associated with Vendor Management Step

	Risk Assessment									Risk Control					
	Risk Identification		Risk Analysis					Risk Evaluation		Risk Reduction & Acceptance		Compliance of Action	Risk Re-evaluation		
Step no.	Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (S) (1 - 10)	Potential Occurrence	OCCURRENCE (O) (1 - 10)	Current Controls	DETECTION (D) (1 - 10)	RPN (S x O x D)	Risk Acceptance	Action Recommended	Resp.	Actions Taken	OCCURRENCE (O)	DETECTION (D)	RPN (S x O x D)
							What controls exist that either prevent or detect the failure?				What are the recommended actions for reducing the occurrence of the cause or improving detection?	Who is responsible for making sure the actions are completed?	What actions were completed (and when) with respect to the RPN?			
1	Quality assurance (QA) and Factory Technical Manager shall review vendor assessment questionnaire on time	Delay in the review of vendor assessment questionnaire by QA and or Factory Technical Manager	Delay in vendor approval activity Delay in getting the right material	4	- Vendor assessment questionnaire is not available -Miscommunication -Lack of responsibility -Review target date is not defined.	3	Follow-up through QA document officer is in place SOP in place	3	36	Acceptable but further control may be required	-Update SOP to Specify a due date for completing the form. -ensure communication with the right person.	Quality & Logistics Assurance	Completed on dd/mm/yyyy	2	2	16
2	All raw materials (RM) and packaging materials (PM) must be purchased from approved vendor	Use of materials from unapproved vendor	-Questionable quality -Violation of GMP guidelines -Regulatory authority concern may lead to product batch recall	8	Lack of effective QMS. Lack of proper control by purchasing department. lack of effective quality control (QC) management and control	4	-Vendor approval list is reviewed by QA Manager -Well trained Purchasing Officer considering purchase order (PO) only from approved list	4	128	Risk is unacceptable	-Keep always alternative approved vendors on hand. -Upgrade the software to make orders automatically from approved vendors list only. -Final purchase order should be reviewed by factory technical manager or QA manager.	Logistics & Quality Assurance	Completed on dd/mm/yyyy	3	2	48

Risk assessment associated with Temperature and Humidity Recording in Raw and Packaging Material Store step

All possible risks associated with the mentioned process (Table 3) have been considered and RPNs calculated. Considering the severity, probability and the detection level of the risk, (Table 3) shows one example of risk that is more than 34 (medium risk) and one risk that is more than 105 (high risk). The team decided to take the necessary control measures to either eliminate or reduce the risk. For the risk associated with reporting any deviations in temperature and humidity in the store, RPN is 128 which put this risk in high risk (red zone). Control measures such as having automatic alarm system (using sound, SMS, or emails) as well as keeping back up electric generator in case of emergencies is vital to reduce the risk. Implementing such control, the risk probability (4) and detection (4) is changed to 2 & 2 respectively. This control changed RPN from 128 (high risk) to 32 (low risk). The effectiveness of this action is under monitoring for 6 months. For the risk identified in step two that is using un-calibrated data loggers, the team decided to take the necessary measure to reduce this unacceptable risk. Examples of control taken are Retrain staff, having back up calibrated data loggers & use automatic means of communication when data loggers calibration expired. Such control changed the RPN from 48 to 16.

All changes made in any GMP documents e.g., SOPs, Formats, software, etc. associated with the discussed risks shall be revised, reviewed, and approved. Risk identification, analysis and evaluation were completed and documented for one of the critical manufacturing process that is temperature and humidity recording in raw and packaging material store process. All steps associated with this process are kept under control. Risk communication will be considered with key persons. Annual risk review is in place and whenever there is a considerable change in the process.

Risk assessment associated with Raw Materials Dispensing step

All possible risks associated with the mentioned process (Table 4) have been considered and RPNs calculated. Considering the severity, probability and the detection level of the risk, (Table 4) shows two example of risk that is more than 34 (medium risk). The team decided to take the necessary control measures to either eliminate or reduce the risk. For the risk associated with cleaning of dispensing booth, RPN score of having un-cleaned dispensing booth is 63 which put this risk in medium risk zone. Control measures such as keeping the current control, implement dispensing booth clearance by QA and review the risk annually or whenever there is change is important to reduce the risk. Implementing such control, the risk probability (3) and detection (3) is changed to 2 & 2 respectively. This control changed RPN from 63 (medium risk) to 14 (low risk). The effectiveness of this action is under monitoring for 6 months. For the risk identified in step two that is the dispensing technician failed to verify all or any of critical dispensing booth parameters if they comply with specifications. The team decided to take the necessary control measures to reduce this unacceptable risk. Examples of such controls are maintaining current control, assigning QA inspector to double check dispensing booth testing data and confirm compliance with specification & review the risk annually or whenever there is change. Such control changed the RPN from 72 to 16.

All changes made in any GMP documents e.g., SOPs, Formats, software, etc. associated with the discussed risks shall be revised, reviewed and approved. Risk identification, analysis and evaluation were completed and documented for one of the critical manufacturing process that is raw materials dispensing process. All steps associated with this process are kept under control. Risk communication will be considered with key persons. Annual risk review is in place and whenever there is a considerable change in the process.

Table 3: Risk assessment associated with Temperature and Humidity Recording in Raw and Packaging Material Store step

	Risk Assessment										Risk Control					
	Risk Identification		Risk Analysis						Risk Evaluation		Risk Reduction & Acceptance		Compliance of Action	Risk Re-evaluation		
Step no.	Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (S) (1 - 10)	Potential Occurrence	OCCURRENCE (O) (1 -10)	Current Controls	DETECTION (D) (1 - 10)	RPN (S x O x D)	Risk Acceptance	Action Recommended	Resp.	Actions Taken	OCCURRENCE (O)	DETECTION (D)	RPN (S x O x D)
							What controls exist that either prevent or detect the failure?				What are the recommended actions for reducing the occurrence of the cause or improving detection?	Who is responsible for making sure the actions are completed?	What actions were completed (and when) with respect to the RPN?			
1	Any deviations in Temperature and Humidity recording should be reported and non-conformity report (NCR) must be issued	Temperature and humidity data is out of specification (OOS) and no NCR issued	-Corrective and preventive actions (CAPA) system is ineffective. -Product quality questionable -Regulatory authority concern -Violation of GMP guidelines	8	-Lack of training -Lack of store supervision -Lack of QA follow up and monitoring. -Absence of backup generator.	4	Store staff is regularly checking any OOS results and report to store manager as well as QA manager	4	128	Risk is unacceptable	-Introduce an alarm system like (sound, SMS and emails). -Back up electric generator.	Engineering & Warehousing	Completed on dd/mm/yyyy	2	2	32
2	Use only calibrated data loggers	Use of not calibrated data loggers	GMP guideline violation Regulatory authority concern Questionable temp and humidity data Questionable product quality	8	-Untrained staff -Lack of store and QA supervision -Ineffective QMS	2	Calibration plan and schedule are well defined and followed by QA calibration staff	3	48	Acceptable but further control may be required	-Retrain staff. -Back up calibrated data loggers. -Use automatic means of communication when data loggers calibration expired	Warehousing, Engineering & Quality Assurance	Completed on dd/mm/yyyy	2	1	16

Table 4: Risk assessment associated with Raw Materials Dispensing step

	Risk Assessment										Risk Control					
	Risk Identification		Risk Analysis						Risk Evaluation		Risk Reduction & Acceptance		Compliance of Action	Risk Re-evaluation		
Step no.	Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (S)	Potential Occurrence	OCCURRENCE (O) (1 - 10)	Current Controls	DETECTION (D)	RPN (S x O x D)	Risk Acceptance	Action Recommended	Resp.	Actions Taken	OCCURRENCE (O)	DETECTION (D)	RPN (S x O x D)
							What controls exist that either prevent or detect the failure?				What are the recommended actions for reducing the occurrence of the cause or improving detection?	Who is responsible for making sure the actions are completed?	What actions were completed (and when) with respect to the RPN?			
1	Cleaning of Dispensing booth should be done as per Standard Operating Procedures.	Cleaning operations of Dispensing booth is not checked / verified.	Contamination of dispensed product with microbes and / or left over RM	7	-Untrained staff -Absence of checking list -Absence of QA inspector	3	-On the job training SOP and forms are available and implemented. -Staff trained on the procedure.	3	63	Acceptable but further control may be required	-Maintain current control. -Implement dispensing booth clearance by QA. -Review the risk annually or whenever there is change	QA & Production	Completed on dd/mm/yyyy	2	1	14
2	Dispensing technician should verify the integrity of dispensing booth filters, absence of left over materials and all dispensing tools are cleaned and ready for use.	Dispensing technician failed to verify all or any of critical dispensing booth parameters are comply with specifications	-Risk of bacterial and / or material contamination -Degradation of light sensitive RM	8	-Untrained staff -Lack of supervision -Lack of verification list -Lack of QA inspection & approval	3	-Dispensing booth critical operating parameters are well defined in SOP and staff trained -Assessment and retraining procedure is in place -QA inspection	3	72	Acceptable but further control may be required	-Maintain current control. -Dispensing booth clearance by QA. -Review the risk annually or whenever there is change	QA & Production	Completed on dd/mm/yyyy	2	1	16

CONCLUSION

Quality risk management is becoming more and more mandatory requirements in pharmaceutical industry. Most if not all regulatory authorities consider QRM as part of quality system to allow for reducing, monitoring, and controlling the probability and /or the impact of the risk. Management of risk in pharmaceutical industry including preventing the failure from happening, detecting the failure in early stage of the process, reducing the effect of failure, reducing the probability of occurrence and accepting some of the residual of failure.

Effective risk assessment supports the management to have objective and better decision and provide regulators and stakeholders assurance of company's ability to deal with potential risk. The case studies presented in this paper are examples of how to conduct systematic QRM activities and effective implementation of FMEA tool.

The case studies highlighted in this paper focused on three different processes selected from drug manufacturing operation. These three processes are considered critical processes and requiring continuous compliance with good manufacturing practices and quality oversight to assure such compliance. The aim in this study is to answer the following questions: what steps / events during the process of vendor management, temperature and humidity measurement in raw and packaging material store and raw materials dispensing create an unacceptable risk to the product quality and / or patient safety. The three case studies presented in this paper emphasis on the principles of ICH Q9 guidelines – QRM and how can be effectively applied on practice. They are not to enforce new regulatory requirements or redefine regulatory expectation but to provide practical examples for industries of how risk management can be applied in routine functions and throughout the product lifecycle.

Conducting risk analysis can be done through different ways and there is no one way right or wrong. Using of different tools, methods, risk scoring ranking and criteria is acceptable. It is mandatory for every pharmaceutical industry to adopt effective risk management program and be incorporated in company quality management system. If such program is not effective, risk can be incorrectly analyzed and prioritized. If this happened then it is waste of time, effort and money. It is important to save resources for managing important risks and to allocate the required resources to high priority risks. The output of risk management gives fulfillment to requirements and supports the organization to meet the defined goals by immediate actions and measurements taken to reduce the risk because it could be fatal to the consumer or risk might lead to product recall. Implementation led to lowering all risks to acceptable or reasonably practical levels by using the FMEA tool which appeared to be a powerful tool for summarizing the significant modes of failure, factors causing these failures and the possible effects of these failures.

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