BRIEF REVIEW ON THE QUALITY CONTROL AND QUALITY ASSURANCE IN PHARMACEUTICALS

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Abstract

QFD aims to increase quality and reduce costs in industrial and business domains by ensuring building construction selections align with owner needs. The system utilizes matrices to align owner preferences with project specifications and requirements. QFD helps project managers identify and prioritize owner and labor requirements for conceptual and final design. The early design stages of an AQMS play a crucial role in determining the control object's aims and quality standards. Human services delivery has evolved beyond simply checking patients and providing treatment. Social insurance administrations have experienced rapid growth over time. Research center analysis is increasingly important in today's practice due to its role in the production process and dissemination of investigative information. Since the 1980s, our nation has seen significant advancements in research center administrations. By using quality management practices, research centers may ensure the reliability of their findings, allowing for confident decision-making. Quality control and certification are part of value administration.

Keywords: Quality Management System, Information Support, Quality Control, Quality testing, Quality Control and Quality Assurance in Pharmaceuticals

Introduction

The IPCC's good practice guidance aims to help create quality and complete national greenhouse gas inventories. Implementing QA/QC methods in national greenhouse gas inventories is recommended to achieve this goal.[1]This guidance aligns with the IPCC Guidelines for National Greenhouse Gas Inventories, as revised in 1996

Good Laboratory Practices (GLP):

Definition: Quality refers to consistently producing a product that meets the same specifications. GLP was modified to ensure the integrity and quality of laboratory data supporting product applications.(1)

1) 1.Organization and Personnel
2) 2. Installations and Facilities
3) 3. Documentation
4) 4. Equipment/Instruments
5) 5. Materials and Reagents
6) 6. Reference and assay samples.

7) 7. Assay techniques. Validation
8) 8. Self checks and audits
9) 9. Quality assurance of the assays(2)

GMP(Good Manufacturing practices):

Concept Of GMP

WHO inspections of pharmaceutical factories in poor countries found several violations from WHO GMP standards, including severe shortcomings that could endanger patients. The WHO GMP compliance process is risk-based, focusing on areas with low compliance that pose the highest risk to medicine quality, safety, and efficacy. It is structured in phases, allowing for a gradual transition to full compliance with clear targets at each stage. (3)

ICH Guidelines:

1) Stability testing for new drug substances and products.
2) Photostability Testing for New Drug Substances and Products.
3) Stability Test for New Dosage Forms
4) Bracketing and Matrixing Designs for Stability Testing of New Drugs and Products
5) Evaluation of Stability Data
6) Stability Data Package for Registration in Climatic Zones III and IV(4)

QSEM Guidelines

Q-Quality:

The stability study aims to demonstrate how environmental factors such as temperature, humidity, and light affect the quality of drug substances and products over time. It also establishes recommended storage conditions, re-testing intervals, and shelf-life. The test circumstances are determined by the climate in the EU, Japan, and the United States.

S- Safety:-

Preclinical studies include both in vitro and in vivo approaches.

E-Efficasy :

Clinical research conducted on human subjects.

M- Multidisciplinary :

cross-cutting Non-category topics.

The ICH process is effective due to the commitment of Regulatory Members to deploy relevant national/regional tools.(5)

Analysis of Raw Materials:

The principles of analysis of raw materials from various sources are similar in many ways but they significantly differ in the sample preparation, the reason being the necessity of maximum recovery of the test material from the matrix. The classification of the methods of analysis is given in accordance with the above-mentioned classification of the raw materials.(6)

Polyvinyl Chloride (PVC)

It can be transparent or can be made opaque or can be tinted different colors to block specific wavelengths of light.

Laminations with polychlorotrifluroethylene (PCTFE): This thermoplastic is madefrommodified polyethylen(PE). It is attached to PVC using adhesive.
Aluminum: Packs are made by mixing. Examples include Alu-Alu, aluminum paper, and aluminum-PET. Aluminum is commonly used for strip packs and blister pack lids.
Cellulose polymers: are the primary components of paper-based packaging. Pulps vary in content and are used as lids for aluminum or PVC blister packs. These are the materials used to package tablets. However, the manufacturer cannot utilize their preferred material to create containers or packaging for any dosage. The FDA has issued a list of materials that are "generally regarded as.(7)

In process quality control IPQC

IPQC refers to In-process Quality Control. These checks are performed before the manufacturing process is completed. This testing improves the drug's effectiveness and safety. Pharmaceutical validation and process control play a crucial role in addressing quality, safety, and efficacy issues. Pharmaceutical validation and process control are crucial for addressing quality, safety, and efficacy issues. Process control includes raw material inspection, in-process control, and achieving end product targets(8)

Tablet : Tablets and smart mobile devices are the most recent addition to the long list of technological innovations believed to support and enhance the teaching process and learning process.(9)

Capsule : Reported rates of posterior capsule opacification (PCO) vary greatly, depending on the definition of PCO, the length and intervals of follow-up, and the use of different surgical techniques, intraocular lens (IOL) designs, and IOL implantation methods.(10)

Ointment : A comprehensive review and meta-analysis were conducted to summarize the current status of the literature on the efficacy and applications of clostridial collagenase ointment (CCO) in the burn patient.(11)

Suppository : Modern suppository bases are analyzed based on their physicochemical qualities, and excipients are classified according to global pharmacopoeias. This article outlines the benefits and drawbacks of different suppository bases for developing future suppositories, specifically for extemporal medicines.(12)

Cream: Painful cutaneous procedures are frequently performed on neonates as part of their medical treatment. Lidocaine-prilocaine 5% cream (EMLA) is a topical anesthetic that may help relieve pain from various treatments. EMLA is commonly utilized in both children and adults.(13)

Parenterals : The toxicity of aluminium (Al) in parenteral nutrition solutions (PNS) has been a problem for decades and has yet to be overcome. The purpose of this study is to compile up-to-date knowledge on this topic, including legislation, manifestations, diagnosis and treatment, the patient group at risk, and the steps to be done to limit its accumulation. Up to November 2012, a structured search using MeSH vocabulary and Title/Abstract searches was conducted in PubMed(14)

Regulatory Authorities :

FDA : To describe the prospective controlled clinical trials for all innovative medications that were initially approved by the Food and Drug Administration based on minimal evidence.(15)

USFDA : We evaluated the evidence at the time of transvaginal mesh product approval, as well as the impact of safety studies requested by the FDA in 2012 in response to developing problems.(16)

WHO : The 5-item World Health Organization Well-Being Index (WHO-5) is one of the most commonly used questionnaires for measuring subjective psychological well-being.

(1)the WHO-5's clinimetric validity; (2) the WHO-5's responsiveness/sensitivity in controlled clinical studies; (3) the WHO-5's potential as a depression screening tool; and (4) the WHO-5's application across study disciplines.(17)

MHRA : The Medicines and Healthcare Products Regulatory Agency, part of the Department of Health and Social Care in the UK, oversees the safety and effectiveness of medicines and medical devices.(18)

TGA : Biomass is an organic substance found in nature as a fresh or waste material that is considered renewable energy and coincides with the zero-carbon strategy to lessen reliance on fossil fuels. However, after conversion, the physical and chemical features of biomass have a significant impact on biofuel qualities. A variety of equipment can be used to determine biofuel reactivity. Among commonly used equipment, thermogravimetric analysis (TGA) is a simple, fast, and efficient approach to measure biofuel characteristics and reactivity.(19)

Documentation in Pharmaceutical Industry

Procedure and Work Instructions : One of the hurdles to widespread adoption of augmented reality (AR) in diverse and complicated industrial operations is a lack of adaptable and scalable AR work instruction (ARWI). This study proposes a methodical approach to solving the challenge. The suggested method introduces an adaptable representation structure that describes and manages the four interconnected parts of ARWI adaptiveness: writing, environment, guidance, and process control. Instead of developers or engineers, the proposed ARWI design approach can incorporate industrial AR features through on-site operator inputs that do not require programming. At the same time, the adaptive ARWI can adapt to different individuals, environment objects, and processes in complicated industrial activities.(20)

Standard Operating Procedure: Semen analysis is a basic test for evaluating male reproductive potential, and it is critical in determining how couples will manage and treat infertility going forward. Manual semen analysis evaluates

both macroscopic and microscopic parameters, whereas automated semen analysis uses a computer-aided sperm analysis system and may incorporate additional parameters not examined by manual analysis.(21)

Batch Manufacturing Record : Advanced manufacturing is a key national strategy in the United States (AMP), Germany (Industry 4.0), and China (Made in China 2025). The concept of Cyber Physical Systems (CPS) and big data have made manufacturing smarter and more competitive among nations. Many academics have proposed novel solutions using big data-enabled tools for manufacturing applications in three areas: product, production, and business. Big data has been a rapidly evolving study subject, with numerous novel uses in manufacturing.(22)

Principles of Drug Discovery And Development : Structure-based drug discovery (SBDD) is becoming an important approach for rapid and cost-effective lead finding and optimization. The use of rational, structure-based drug design has been shown to be more efficient than traditional drug discovery methods because it tries to comprehend the molecular basis of a disease and incorporates knowledge about the biological target's three-dimensional structure.process, such as receptor and library pre-processing, to docking, scoring, and post-processing of top-scoring hits. Recent enhancements to structure-based virtual screening (SBVS) efficiency via ensemble docking, induced fit, and consensus dockingStructure-based drug discovery (SBDD) is becoming an important approach for rapid and cost-effective lead finding and optimization and incorporates knowledge about the biological target's three-dimensional structure. process, such as receptor and library pre-processing, to docking, scoring, and post-processing of top-scoring hits Recent enhancements to structure-based virtual screening (SBVS) efficiency via ensemble docking, induced fit, and consensus docking(23)

Clinical Research Process

Investigational new drug application (IND): Mesenchymal stem/stromal cells (MSCs) offer a wide range of applications in regenerative medicine due to their self-renewal, high plasticity, ability to differentiate, and immunological response and regulation. There has never been a greater interest in developing MSCs for clinical applications than now As a result, the increasing demand for MSC regulatory publication in China needs a variety of talks in easily available professional journals. The National Medical Products Administration has issued regulations governing the clinical use of MSC treatment.(24)

New drug application : The pharmacological creation of amorphous solid dispersions (ASDs) via hot-melt extrusion (HME) is briefly discussed. A systematic step-by-step approach is described that combines thermodynamics, polymer screening, multivariate statistics, and process optimization to improve the success rate of HME-based medicinal product development. The quality by design (QbD) idea is introduced and implemented in HME. Steps and tools for optimal implementation are presented, including a risk assessment that highlights key issues.(25)

Abbreviated new drug application: The FDA suggests that nanomedicine generics can be approved under the usual ANDA approval procedure under Section 505 of the Food, Drug, and Cosmetic Act (FDCA), notwithstanding the hurdles associated with complicated generics. Section 505 applies to therapeutic products containing small molecules Nanomaterial-containing medicinal products may also contain tiny molecules.(26)

Scale-up post approval changes (SUPAC): In 1991-1992, three scientific organizations—the American Association of Pharmaceutical Scientists, the Food and Drug Administration (FDA), and the United States Pharmacopeia (USP)—worked together to organize two workshops to investigate the Scale-Up and Post-approval Change (SUPAC) principles for immediate-release oral solid dosage forms (1991) and oral extended-release dosage forms. The proceedings of both workshops were published in 1993 and have been used as guidance by industry and regulatory organizations. The proceedings of both workshops addressed and characterized the impact of formulation or compositional modifications, process variable changes, process scale changes, and process site changes on the completed quality characteristics of these products. Each area of change was further categorized to show a hierarchy of "significance" and so assisted in developing (27)

Product registration guidelines: Pharmaceutical companies collaborate with the FDA to employ RWE to support NDAs and BLAs. Guidance materials are provided for RWE research. The FDA defines RWE as clinical proof of a medical product's utilization, benefits, and hazards based on real-world data analysis (RWD). RWD refers to data collected on patient health status and healthcare delivery from various sources, including electronic health records, claims and billing data, product and disease registries, patient-generated data, and mobile devices.(28)

CDSCO: This thorough summary examines the regulatory processes for registering medical devices in three main jurisdictions: the United States Food and Drug Administration (FDA), the European Union (EU), and India's Central Drugs Standard Control Organization (CDSCO). Each regulatory agency is responsible for guaranteeing the safety, effectiveness, and quality of medical devices in their particular markets. The FDA, as the United States' regulatory body, has a rigorous registration system in place to assess and approve medical devices before they may be marketed and sold. Manufacturers must follow certain methods and programs to comply with FDA rules, which are intended to protect patient health and stimulate innovation in the medical device business.(29)

In the European Union, medical device registration is governed by the Medicinal Products for Human Use Directive, which establishes high safety and quality standards. Before introducing their devices to the European market, manufacturers must go through a rigorous assessment process and obtain CE Mark certification. The EU's regulatory framework seeks to align standards across member states and promote consistency in device registration procedures.Manufacturers must follow CDSCO standards and provide extensive documentation to establish the safety and performance of their equipment.(29)

USFDA:

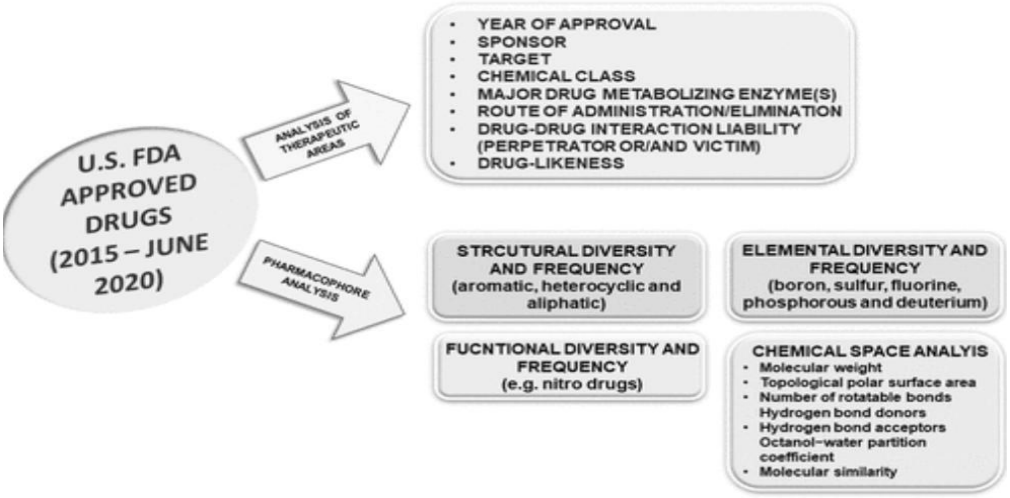

Fig . 1 USFDA

Quality control tests :

Tablet: Oral solid dosage forms (tablets and capsules) are the most common way to administer medicines to patients. These forms combine an active pharmaceutical ingredient (API) with excipients to improve manufacturability, ease of use, and therapeutic effect. Control strategies are used to ensure the safety and efficacy of the medication product during manufacture . To ensure success, it's crucial to identify, control, and monitor any material or process deviations that could affect the medication product's critical quality characteristics (CQAs).(30)

Tablets should be appropriately sized and shaped to meet dose requirements, with dimensions that can be monitored and controlled. The tooling used during compression procedur. determine the result. Color helps identify medication tablets and improves consumer acceptance. However, uniformity inside a single tablet and between batches is necessary. Odors in tablets, such as vitamins, can signal stability issues. Consumer adoption of chewable tablets is heavily influenced by their taste.(31)

Capsule : These tests, known as Generalized Tests, are applicable to all oral dose forms. These rules ensure that commercialized items fulfill basic quality standards. These tests include:

1) Describe the dosage form
2) Identifythedosageform.
3) Strength, which includes assay tests.
4) Impurities, whether organic, inorganic, or residual solvents(32)

Parenterals : Parenteral medications (large/small volume) are injected into the skin, veins, artery muscles, or other outer border tissue to reach systemic circulation and create an onset effect. Parenteral methods include intravenous (IV), subcutaneous (SC), and intramuscular (IM). Intradermal and intra-arterial routes are less commonly utilized.

They are classified as large or small volume parenteral based on package size. If the package size exceeds 100 ml, it is classified as big volume parenteral. Otherwise, it is classified as small volume parenteral, with the exception of biological products. Advancements in technology have led to increased automation in major pharmaceutical corporations. In addition, manufacturers of parenteral medications.(33)

Semi solid dosage forms: The purpose of this work is to go over all aspects of in vitro release testing (IVRT) using semisolid dosage forms. Although none of the formal dissolve methods have been specified for use with semisolid dosage forms, their utility in determining drug release rates from semisolid dosage forms has sparked significant attention. Such complexities can be avoided in the future, when the official "Topical and Transdermal Drug Products—Product Performance Tests" are published in a Pharmacopeial Forum issue. Many factors, including the kind of dissolve media, membrane, temperature, and speed, have an impact on the mechanism and kinetics of release tests from gels, creams, and ointments; thus, these parameters have been extensively discussed.(34)

Pre formulation study for tablet : It is the phase of research and development in which preformulation studies analyze the physical and chemical properties of a therapeutic molecule in order to create a safe, effective, and stable dose form.

Preformulation emerged in the late 1950s and early 1960s due to a shift in focus on industrial pharmaceutical product development. Improvements in analytical approaches led to the development of "preformulation" programs. Preformulation testing aims to provide formulators with information for producing stable and bioavailable dosage forms suitable for mass production.(35)

Primary and secondary packaging material: A Pharmaceutical Package Container is an article or equipment that carries a Pharmaceutical Product and may or may not have direct contact with it. The container developed for pharmaceutical applications must be stable.[36]

Primary Package : Primary packages are in direct touch with the pharmaceutical formulation. The primary package aims to protect the formulation against environmental, chemical, mechanical, and other risks. (36)

Secondary Package. Secondary package refers to the package that is not part of the primary package. This package protects drugs during warehousing and includes product information, such as leaflets.(36)

Preparatio of SOP: In accordance with the requirements of good manufacturing practices, proper documentation in compounding pharmacies licensed to prepare medicines should be an integral part of the quality assurance system and a key component at all stages of compounding preparation preparation and quality control. One crucial aspect of appropriate documentation is the use of standard operating procedures (SOPs). The purpose of this article is to outline the approach for generating standard operating procedures (SOPs) for licensed compounding pharmacies. Standard procedures should be designed based on the present regulatory framework and research. The staff that are involved in the procedure's implementation create SOPs. SOPs should be evaluated by the appropriate personnel and authorized by the head.(37)

Identify needs. Determine which procedures need to be recorded and report them to the QA manager or supervisor.

Subject-matter experts should write the SOPs. .A team approach can be utilized for processes that involve multiple tasks.

Include enough detail: SOPs should be precise enough that someone with basic *understanding may do the procedure without supervision.

Include the experience necessary to conduct the activity in the personnel qualifications section. Use positive sentence structure in your SOP.

Print the SOP on one side of an A4-sized page.(38)

Instrument Handaling

Demonstration of TLC:

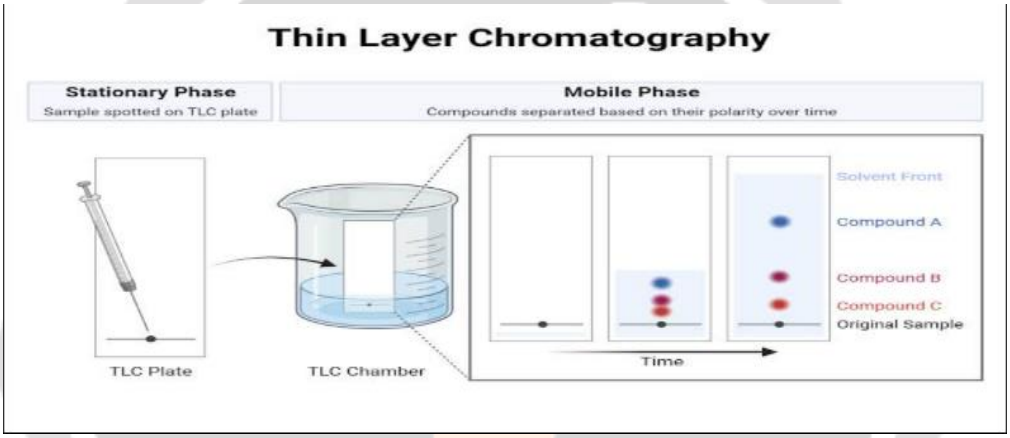

Fig.2 TLC

This type of chromatography involves a solid-liquid adsorption.for the isolation of non-volatile mixtures. In this approach,The mobile phase is a liquid, whereas the stationary phase is silica gel.Coated glass plate. The polarity of the particles to these phases(mobile and stationary) helps them separate from one another.(39)

UV V spectrophotometer: Ultraviolet (UV) spectroscopy is a physical technique of optical spectroscopy that analyzes light in the visible, ultraviolet, and near-infrared ranges. It is based on Beer-Lambert law, which states that the absortance of a solution is directly proportional to the concentration of the absorbing species in the solution and path length. Thus, for a fixed path length, it is possible to calculate the concentration of the absorber in a solution. It is crucial to understand how quickly absorbance changes with concentration. UV-VIS spectroscopy has been widely used for the past 37 years, and it has evolved into the most important analytical equipment in today's laboratories.(40)

HPLC (High performance liquid chromatography) : High-Performance Liquid Chromatography, also known as High Pressure Liquid Chromatography, is a type of column chromatography that is widely used in biochemistry and analysis to isolate, identify, and quantify active compounds. It is a widely used analytical technique for separating,

identifying, and quantifying each component of a mixture. HPLC is a sophisticated column-based liquid chromatography method." The solvent ordinarily flows through the column due to gravity, but in the HPLC process, the solvent is pressed under high HPLC typically consists of a column with packing material (stationary phase), a pump that moves the mobile phase(1) through the column, and a detector that detects molecule retention durations.(41)

Potentiometer: The potentiometer is, of course, one of the fundamental tools used by students in the undergraduate physical chemistry laboratory. It becomes a genuine difficulty for the laboratory instructor to ensure that the essential apparatus is provided in a way that allows for efficient use of laboratory time while also allowing for a thorough comprehension of the instrument's operation from both practical and theoretical perspectives.The standard devices offered by Leeds and Northrup, Rubicon, and others under the label "student potentiometer" meet the ruggedness and accuracy criteria of the measurement instrument itself.(42)

Dissolution test Apparatus: Pharmacopeia uses issolution testing to evaluate medication release in both solid and semisolid dose forms. Dissolution tests were devised to measure medication release from solid oral dosage forms like tablets and capsules. Dissolution testing is crucial for drug release in various dosage forms, including tablets, gums, capsules, suppositories, patches, aerosols, and semisolids. Physical chemists have been studying dissolution since the late nineteenth century. Our goal is to have a fully functional set of USP performance tests for various dosage forms.(43)

PH meter: The majority of everyday items, including food, drink, and cosmetics, are now pH tested. The glass electrode pH meter size approach is commonly used in water monitoring to evaluate aquatic conditions . . A pH meter measures the hydrogen-ion activity in water to determine its alkalinity or acidity.14. The pH of a substance is related to the ratio of hydroxyl [OH-] to hydrogen ions [H+] . If the pH cost is less than seven.(44)

validation

Define validation: A documented program ensures that a process regularly produces a product that meets predetermined criteria and quality features.

1) Began in the 1970s.
2) Originally sterilized-based.
3) Now encompasses all product, process, and facility .(45)

Scope of validation: Identifying the validation scope can be difficult due to the broad nature of pharmaceutical validation, which includes all phases of manufacturing. A thorough review of pharmaceutical processes may reveal crucial areas for validation.(46)

1) Analytical
2) Instrument Calibration
3) Process utility services
4) Raw materials

5) Packaging materials
6) Equipment
7) Facilities
8) Manufacturing Operations
9) Product Design
10) Maintaining cleanliness
11) Operators (47)

Difference between calibration and validation:

Calibration	Verification
▪ Determination of the relationship between the measured values and the corresponding values realized by standards: - under defined conditions - at a specified date and time ▪ Statement of both the deviation, or correction, and the uncertainty of measurement ▪ Issuing of a calibration certificate	▪ Examination of conformity of measuring instruments with legal requirements - qualitative tests - maximum permissible errors (mpe's) ▪ Marking of the instrument tested ("passport function") ▪ Issuing of a verification certificate as required or requested

Advantages of validation:

1) Improved reporting ability.
2) Improved ability to specify goal parameters and control limits for routine manufacturing, which align with validation results.
3) Improved data and evaluation capabilities, increasing trust in process reproducibility and product quality.
4) Improved statistical evaluation of process performance and product factors, including individuals, means, ranges, and control limits.(48)

Master plan of validation:

In this area, mention the company name, location, division or subsidiary name (if applicable), and business sector served. A brief project summary provides background information from a macro perspective. Referring to the company's Quality Assurance Policy is appropriate.

The Validation Management Plan (VMP) sets the route, justifies the approach, outlines early test and acceptance criteria, and documents procedures for ongoing validation.(49)

Types of validation:

1) Validate processes prospectively
2) Retrospectively validation
3) Concurrently validation(50)

1. Prospective validation:involves establishing documented evidence of a system's ability to perform as intended based on a plan. Validation occurs before new products are distributed.
2. Retrospective Validation: This involves reviewing and analyzing existing data to establish documented evidence of a system's functionality. This involves analyzing data from production, testing, and control for a previously deployed product.

3. Concurrent Validation: Documented evidence of a system's functionality based on information gathered during implementation.(51)

Validation process: Validation of manufacturing procedures and systems is crucial for ensuring product quality. Process validation is a quality assurance function that ensures a process consistently delivers a product that fulfills established standards and quality attributes using recorded proof. Validation of production processes ensures continuous monitoring and evaluation of their performance. To retain the validated status of an inadequate process, it's important to identify and address any substantial modifications. These measures may apply to equipment, standard operating procedures, production instructions, ambient conditions, or other aspects of the processing system.(52)

Validation process:

a)Quality assurance Integrating validation into the pharmaceutical process helps improve product quality.
b)Cost reduction.
Continuous validation and control lead to fewer rejects and reworks, resulting in significant cost savings.
c)Government Regulation.
Validation is an important aspect of GMPs. Before introducing a new product to the market, organizations must meet global validation requirements.(52)
***Qualification of mfg equipment:**

Dry powder mixers –The theory of dry powder mixing has been extensively investigated during the last century, most likely due to its widespread use in a variety of sectors. Early theoretical work on powder mixing mostly discusses the concept of random mixing. Random mixing can be characterized as a purely statistical process in which particles displace one another via processes such as diffusion or convection, with disorder accumulating until it reaches a stable peak. At the maximum.(53)

Tray dryers: A tray dryer is a piece of equipment in which trays are put on shelves next to one another. Tray Dryers are utilized in industries where heating and drying are key components of manufacturing processes, such as chemicals, dyes, pharmaceuticals, food products, and colors. The materials placed in the drying trays are either moist or solid. A control panel is used to adjust the dryer's temperature and other settings. These dryers are available in Mild Steel and Stainless Steel1. Tray Dryers are used in conventional methods to achieve the finest drying results possible. The

cabinet is double-walled, with either one or two doors and a gasket. The high-density fiberglass wool insulation material is filled in.(54)

Tablet compression machine : Tablets are the most often utilized dosage form due to their convenience, cost-effectiveness, and aesthetic appeal. This article covers the general characteristics, introduction, classification, and formulation considerations for compression coating tablets. Compression coating granulations or blends can be preformulated to provide desired coating functionality. The compression-coated tablet dosage form requires a core material that can flow into a die during manufacture.In recent years, chemical entities are typically synthesized as free-flowing granulations and encapsulated in hard gelatin capsules. The medicine was deployed via traditional methods, such as a single dose form that included both the API and the excipient.(55)

Capsule filling machine :

An automatic capsule-filling machine was instrumented using techniques similar to those used for tablet presses. The dosing unit was changed to enable the bonding of strain gauges to the compression piston. The gauges represented the arms of a Wheatstone bridge circuit. Thus, compression and ejection events were monitored by detecting the bridge imbalance voltage with an appropriate amplifier recording device. The instrumented piston was calibrated using a physical testing equipment. To rotate the dosing unit, a mercury contact swivel was required between the amplifier and the instrumented piston.(56)

Quality By Design

QBD:

QBD can be traced back to Quality Planning, one of Joseph M. Juran's three Quality Pillars (the other two being Quality Improvement and Quality Control) [9]. The underlying premise is that quality must begin before manufacturing and capital allocations are decided. In reality, this means that organizations should start by setting their quality goals, developing products features that achieve these goals, developing processes capable of delivering such products, and implementing controls that allow operations to be executed consistently.(57)

(PAT)Process Analytical Technology:

The FDA (2004) describes process analytical technology as creating, assessing, and managing important quality and performance characteristics of materials and processes using real-time measurements to ensure product quality. This analytical technique combines chemical, physical, microbiological, mathematical, and risk analysis. PAT aims to understand and control the production process that aligns with our present drug quality system. The pharmaceutical industry's quality idea should be: "Quality should be designed for pharmaceutical products and built in this direction. Quality tests applied to the final product do not show actual quality.(58)

Audit :

Objective of Audit:

1) More than four-fifths of reported tobacco marketing expenditures occur at the retail point of sale (POS).
2) To far, no systematic review has synthesized the approaches utilized to monitor POS marketing.
3) This evaluation aimed to summarize the audit objectives, methodology, and metrics utilized to investigate retail tobacco settings.(59)

Planning Process of Adult:

STAGE 1- APPOINTMENT.

STAGE 2- RISK ASSESSMENT

STAGE 3- AUDIT APPROACH.

STAGE 4- ADMINISTRATION.

STAGE 5- AUDIT TEAM BRIEFING

STAGE 6- CLIENT SERVICE.

STAGE 7- CLIENT COMMUNICATION(60)

Classification of Audit:

1) Evidence from external sources, such as consumers, suppliers, or banks, is more dependable than that gathered from clients. Client-provided accounts receivable confirmation is more credible than self-prepared records.
2) Auditor-prepared evidence is more reliable than that obtained from clients. Auditors' bank reconciliations are more dependable than accountants'.
3) Client-prepared evidence's dependability is based on their internal control. Written audit evidence is considered more reliable than spoken evidence. For example, management confirmation in the form.(61)

Audit checklist for drug industries:

1) Product cross-contamination.
2) Incorrect labelling.
3) Active substances that do not meet the standards.
4) Product created using outmoded or unapproved processes.
5) Open sterile materials stored in a non-aseptic place.(62)

Reference :

1. Prieto, Y. O. (2008). Good Laboratory Practices and the ISO 9001: 2000 standards. *Biotecnología Aplicada*, *25*(3), 258-261.
2. Padilla-Zakour, O. I. (2009). Good manufacturing practices. *Microbiologically safe foods*, 395-414.

3. World Health Organization. (2016). Concept paper for discussion: A stepwise approach for pharmaceutical companies in developing countries to attain WHO GMP standards. WHO Drug Information, 30(2), 186-198.
4. Chinchole, A., Poul, B., Panchal, C., & Chavan, D. (2014). A review on stability guidelines by ICH and USFDA guidelines for new formulation and dosage form. *PharmaTutor*, *2*(8), 32-53.
5. Rahi, S., & Rana, A. (2019). Role of ICH guidelines in registration of Pharmaceutical Products. *International Journal of Drug Regulatory Affairs*, *7*(4), 14-27.
6. Sarkisyan, V., Bessonov, V., & Kochetkova, A. (2017). Raw materials analysis and quality control. In Developing New Functional Food and Nutraceutical Products (pp. 195
7. Thunga, G., Agrawal, S. K., Joshi, M., Sathyanarayana, M. B., Tippavajhala, V. K., & Kulyadi, G. P. (2020). Solid Dosage Forms: A Detailed Research on Non-conforming Product Quality. *Indian Journal of Pharmaceutical Education & Research*, *54*.
8. Manikanta Kumar, Y. S. S., Deepthi, R., & Srinivasa Rao, Y. (2021). IN PROCESS QUALITY CONTROL.DOI: 10.20959/wjpr20215-20415
9. Tamim, R. M., Borokhovski, E., Pickup, D., Bernard, R. M., & El Saadi, L. (2015). Tablets for teaching and learning: A systematic review and meta-analysis.
10. Schaumberg, D. A., Dana, M. R., Christen, W. G., & Glynn, R. J. (1998). A systematic overview of the incidence of posterior capsule opacification. *Ophthalmology*, *105*(7), 1213-1221. https://doi.org/10.1016/S0161-6420(98)97023-3
11. Pham, C. H., Collier, Z. J., Fang, M., Howell, A., & Gillenwater, T. J. (2019). The role of collagenase ointment in acute burns: A systematic review and meta-analysis. *Journal of wound care*, *28*(Sup2), S9-S15.https://doi.org/10.12968/jowc.2019.28.Sup2.S9
12. Melnyk, G., Yarnykh, T., & Herasymova, I. (2020). Analytical review of the modern range of suppository bases. *Syst. Rev. Pharm*, *11*, 503-508.
13. Taddio, A., Ohlsson, A., Einarson, T. R., Stevens, B., & Koren, G. (1998). A systematic review of lidocaine-prilocaine cream (EMLA) in the treatment of acute pain in neonates. *Pediatrics*, *101*(2), e1-e1. https://doi.org/10.1542/peds.101.2.e1
14. Hernández-Sánchez, A., Tejada-González, P., & Arteta-Jiménez, M. (2013). Aluminium in parenteral nutrition: a systematic review. *European journal of clinical nutrition*, *67*(3), 230-238.
15. Pease, A. M., Krumholz, H. M., Downing, N. S., Aminawung, J. A., Shah, N. D., & Ross, J. S. (2017). Postapproval studies of drugs initially approved by the FDA on the basis of limited evidence: systematic review. *bmj*, *357*. https://doi.org/10.1136/bmj.j1680
16. Heneghan, C. J., Goldacre, B., Onakpoya, I., Aronson, J. K., Jefferson, T., Pluddemann, A., & Mahtani, K. R. (2017). Trials of transvaginal mesh devices for pelvic organ prolapse: a systematic database review of the US FDA approval process. *BMJ open*, *7*(12), e017125.https://doi.org/10.1136/bmjopen-2017-017125
17. Khan, K. S., Wojdyla, D., Say, L., Gülmezoglu, A. M., & Van Look, P. F. (2006). WHO analysis of causes of maternal death: a systematic review. *The lancet*, *367*(9516), 1066-1074.https://doi.org/10.1159/000376585

18. Turton, P., El-Sharkawi, D., Lyburn, I., Sharma, B., Mahalingam, P., Turner, S. D., ... & Mercer, N. (2021). UK guidelines on the diagnosis and treatment of breast implant-associated anaplastic large cell lymphoma (BIA-ALCL) on behalf of the Medicines and Healthcare products Regulatory Agency (MHRA) Plastic, Reconstructive and Aesthetic Surgery Expert Advisory Group (PRASEAG). *European Journal of Surgical Oncology*, *47*(2), 199-210.
19. Aniza, R., Chen, W. H., Kwon, E. E., Bach, Q. V., & Hoang, A. T. (2024). Lignocellulosic biofuel properties and reactivity analyzed by thermogravimetric analysis (TGA) toward zero carbon scheme: A critical review. *Energy Conversion and Management: X*, *22*, 100538.
20. Geng, J., Song, X., Pan, Y., Tang, J., Liu, Y., Zhao, D., & Ma, Y. (2020). A systematic design method of adaptive augmented reality work instruction for complex industrial operations. *ComputersinIndustry*, *119*,103229.https://doi.org/10.1016/j.compind.2020.103229
21. Agarwal, A., Sharma, R., Gupta, S., Finelli, R., Parekh, N., Selvam, M. K. P., ... & Henkel, R. (2022). Standardized laboratory procedures, quality control and quality assurance are key requirements for accurate semen analysis in the evaluation of infertile male. *The world journal of men's health*, *40*(1), 52.doi: 10.5534/wjmh.210022
22. Cui, Y., Kara, S., & Chan, K. C. (2020). Manufacturing big data ecosystem: A systematic literature review. *Robotics and computer-integrated Manufacturing*, *62*, 101861.https://doi.org/10.1016/j.rcim.2019.101861
23. Lionta, E., Spyrou, G., K Vassilatis, D., & Cournia, Z. (2014). Structure-based virtual screening for drug discovery: principles, applications and recent advances. *Current topics in medicinal chemistry*, *14*(16), 1923-1938.
24. Zhao, Q., Han, Z., Wang, J., & Han, Z. (2021). Development and investigational new drug application of mesenchymal stem/stromal cells products in China. *Stem cells translational medicine*, *10*, S18-S30.https://doi.org/10.1002/sctm.21-0083
25. Simões, M. F., Pinto, R. M., & Simões, S. (2019). Hot-melt extrusion in the pharmaceutical industry: toward filing a new drug application. *Drug Discovery Today*, *24*(9), 1749-1768. https://doi.org/10.1016/j.drudis.2019.05.013
26. Emily, M., Ioanna, N., Scott, B., & Beat, F. (2018). Reflections on FDA draft guidance for products containing nanomaterials: is the abbreviated new drug application (ANDA) a suitable pathway for nanomedicines?. *The AAPS journal*, *20*, 1-6.
27. Van Buskirk, G. A., Asotra, S., Balducci, C., Basu, P., DiDonato, G., Dorantes, A., ... & Vaithiyalingam, S. (2014). Best practices for the development, scale-up, and post-approval change control of IR and MR dosage forms in the current quality-by-design paradigm. *AAPS PharmSciTech*, *15*, 665-693.
28. Arondekar, B., Duh, M. S., Bhak, R. H., DerSarkissian, M., Huynh, L., Wang, K., ... & Demetri, G. D. (2022). Real-world evidence in support of oncology product registration: a systematic review of new drug application and biologics license application approvals from 2015–2020. *Clinical Cancer Research*, *28*(1), 27-35.

29. Priyadharshini, S., Sivaranjani, P. S., & Nagalakshmi, S. (2024). The Registration of Medical Device in FDA, EU and CDSCO: Overview. *Journal of Advances in Medical and Pharmaceutical Sciences*, *26*(8), 76-88. https://doi.org/10.9734/jamps/2024/v26i8709
30. Bhutani, P., Joshi, G., Raja, N., Bachhav, N., Rajanna, P. K., Bhutani, H., ... & Kumar, R. (2021). US FDA approved drugs from 2015–June 2020: a perspective. *Journal of Medicinal Chemistry*, *64*(5), 2339-2381. https://doi.org/10.1021/acs.jmedchem.0c01786
31. Markl, D., Warman, M., Dumarey, M., Bergman, E. L., Folestad, S., Shi, Z., ... & Zeitler, J. A. (2020). Review of real-time release testing of pharmaceutical tablets: State-of-the art, challenges and future perspective. *International journal of pharmaceutics*, *582*, 119353.
32. Chavan, H., Chhabra, G., Gujarathi, N., & Jadhav, A. (2018). Comparative study of In-process and finished products quality control test for tablet and capsules according to pharmacopoeias. *Asian Journal of Pharmaceutical Research and Development*, *6*(3), 60-68.
33. Kumar, S., Tonk, R. K., & Sharma, P. C. (2021). Some Quality Control Analysis Parameters for Parenteral Formulations.
34. Olejnik, A., Goscianska, J., & Nowak, I. (2012). Active compounds release from semisolid dosage forms. *Journal of pharmaceutical sciences*, *101*(11), 4032-4045. https://doi.org/10.1002/jps.23289
35. Chaurasia, G. (2016). A review on pharmaceutical preformulation studies in formulation and development of new drug molecules. *Int J Pharm Sci Res*, *7*(6), 2313-2320.
36. Nasa, P. (2014). A review on pharmaceutical packaging material. *World Journal of Pharmaceutical Research*, *3*(5), 344-368.
37. Zdoryk, O. A. (2015). Development of standard operating procedures and their introduction in compounding pharmacies. *News of Pharmacy*, (3 (83)), 56-59.https://doi.org/10.24959/nphj.15.2042
38. Akyar, I. (2012). Standard operating procedures (what are they good for?). *Latest research into quality control*, *12*, 367-91. DOI: 10.5772/50439
39. Tiwari, S., & Talreja, S. (2022). Thin Layer Chromatography (TLC) VS. Paper Chromatography: A Review. *Acta Scientific Pharmaceutical Sciences (ISSN: 2581-5423)*, *6*(9). DOI:10.31080/ASPS.2022.06.0894
40. Sriram, G. K. (2022). A comprehensive survey on metaverse. *International* Research *Journal of Modernization in Engineering Technology*, *4*(2), 772-775. e-ISSN: 2582-5208
41. Sahu, P. K., Ramisetti, N. R., Cecchi, T., Swain, S., Patro, C. S., & Panda, J. (2018). An overview of experimental designs in HPLC method development and validation. *Journal of pharmaceutical and biomedical analysis*, *147*, 590-611.http://dx.doi.org/10.47583/ijpsrr.2022.v74i02.003
42. Bender, P. (1947). A demonstration potentiometer. *Journal of Chemical Education*, *24*(4), 195. https://doi.org/10.1021/ed024p195
43. Sharma, S., Khinchi, M. P., Agrawal, D., Sharma, N., & Gupta, M. K. (2013). A review on dissolution apparatus. *Asian Journal of Pharmaceutical Research and Development*, 34-40.

44. 35. https://doi.org/10.1007/978-3-030-64492-5Elavarasi, S., Saravanan, K., & Renuka, C. (2013). A SYSTEMATIC REVIEW ON MEDICINAL PLANTS USED TO TREAT DIABETES MELLITUS. *International Journal of Pharmaceutical, Chemical & Biological Sciences*, *3*(3
45. Monteleone, R., & Klarmann, D. (2022). Qualification and validation. *Quality Management and Accreditation in Hematopoietic Stem Cell Transplantation and Cellular Therapy: The JACIE Guide*, 35. https://doi.org/10.1007/978-3-030-64492-5
46. PHARMACEUTICAL VALIDATION: A REVIEW PHARMACEUTICAL VALIDATION: A REVIEW Anand Sabne1, Mahesh Sontakke1, Vaishnavi Rathi1, Sachin Gholve1https://www.jetir.org
47. PHARMACEUTICAL VALIDATION: A REVIEW PHARMACEUTICAL VALIDATION: A REVIEW Anand Sabne1, Mahesh Sontakke1, Vaishnavi Rathi1, Sachin Gholve1https://www.jetir.org
48. Sabale, S., & Thorat, S. (2021). An overview on validation process in pharmaceutical industries. *Sch Acad J Pharm*, *6*, 95-101. DOI: 10.36347/sajp.2021.v10i06.001 |
49. Saxton, B. W. (2001). Reasons, regulations, and rules: a guide to the Validation Master Plan (VMP). *Pharmaceutical engineering*, *21*(3), 18-26.
50. PHARMACEUTICAL VALIDATION: A REVIEW PHARMACEUTICAL VALIDATION: A REVIEW Anand Sabne1, Mahesh Sontakke1, Vaishnavi Rathi1, Sachin Gholve1 https://www.jetir.org
51. PHARMACEUTICAL VALIDATION: A REVIEW PHARMACEUTICAL VALIDATION: A REVIEW Anand Sabne1, Mahesh Sontakke1, Vaishnavi Rathi1, Sachin Gholve1https://www.jetir.org
52. PHARMACEUTICAL VALIDATION: A REVIEW PHARMACEUTICAL VALIDATION: A REVIEW Anand Sabne1, Mahesh Sontakke1, Vaishnavi Rathi1, Sachin Gholve1https://www.jetir.org
53. Spahn, J. E., Zhang, F., & Smyth, H. D. (2022). Mixing of dry powders for inhalation: A review. *International Journal of Pharmaceutics*, *619*, 121736. https://doi.org/10.1016/j.ijpharm.2022.121736
54. Patil, B. N., Tippavajhala, V. K., & Pai, K. G. (2019). Equipment Qualification of a New Laboratory Tray Dryer. *Research Journal of Pharmacy and Technology*, *12*(2), 805-811. DOI:10.5958/0974-360X.2019.00140.9
55. Pawar, R., Jaimini, M., Chauhan, B. S., & Sharma, S. K. (2014). Compression coated tablets as drug delivery system (tablet in tablet): a review. *International Journal of Pharmaceutical Research and Development*, *6*(1), 21-33.
56. Small, L. E., & Augsburger, L. L. (1977). Instrumentation of an automatic capsule-filling machine. *Journal of Pharmaceutical Sciences*, *66*(4), 504-509. https://doi.org/10.1002/jps.2600660412
57. 58. Lee, J. G., Henriksen, L., Myers, A. E., Dauphinee, A. L., & Ribisl, K. M. (2014). A systematic review of store audit methods for assessing tobacco marketing and products at the point of sale. Tobacco control, 23(2), 98-106. doi: 10.1136/tobaccocontrol-2012-050807
58. 57. Calhan, S. D., Eker, E. D., & Sahin, N. O. (2017). Quality by design (QbD) and process analytical technology (PAT) applications in pharmaceutical industry. European Journal of Chemistry, 8(4), 430-433. https://dx.doi.org/10.5155/eurjchem.8.4.430-433.1667

59. Ayinde, L., Orekoya, I. O., Adepeju, Q. A., & Shomoye, A. M. (2021). Knowledge audit as an important tool in organizational management: A review of literature. *Business Information Review*, *38*(2), 89-102.
60. Bunjaku, F. (2019). Audit components: Literature Review on Audit Plan, Risk and Materiality and Internal Control. *Journal of Economics*, *4*(1).
61. Yin, X. (2020). Audit Evidence Classification and Collection Techniques in China and the US. *Global Journal of Management and Business Research*, *19*(5), 1-6. DOI: 10.25236/FSST.2020.021421
62. Hales, B. M., & Pronovost, P. J. (2006). The checklist—a tool for error management and performance improvement. *Journal of critical care*, *21*(3), 231-235.