DATA INTEGRITY - A CRUCIAL REQUIREMENT FOR PHARMACEUTICAL INDUSTRIES REGULATORY COMPLIANCE

Abstract

In the dynamic realm of pharmaceuticals, the assurance of data integrity emerges as a linchpin for achieving and sustaining regulatory compliance. This book chapter meticulously explores the multifaceted dimensions of data integrity, dissecting its significance within the stringent frameworks governing the pharmaceutical industry. Acknowledging data as the lifeblood of drug development and production, the chapter scrutinizes the profound impact that lapses in data integrity can exert on the quality, safety, and efficacy of pharmaceutical products. Navigating through the complex terrain of regulatory requirements, the chapter elucidates key concepts underpinning data integrity, ranging from the fundamental principles to the intricacies of implementation. It delves into the challenges inherent in maintaining data integrity throughout the product life cycle, addressing issues such as data accuracy, completeness, and consistency. Practical insights are offered on establishing robust data management systems that not only meet regulatory expectations but also elevate overall operational efficiency. With a focus on proactive measures, the chapter outlines best practices for data governance, validation, and documentation. Case studies and real-world examples underscore the tangible consequences of inadequate data integrity, emphasizing the critical need for a steadfast commitment to regulatory compliance. By synthesizing theoretical frameworks with practical guidance, this chapter serves as a comprehensive resource for pharmaceutical

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professionals striving to fortify their systems against data integrity vulnerabilities. Ultimately, the pursuit of data integrity is portrayed not merely as a regulatory obligation but as a fundamental ethical imperative, safeguarding public health and reinforcing the industry's commitment to the highest standards of quality and transparency.

Keywords: Data Integrity, Quality Assurance, Pharmaceutical industries, WHO

I. INTRODUCTION

When we envision any product, quality is always a crucial need. Therefore, the highest standards of quality need to be used in medicine manufacturing. The quality of the product cannot be ensured by testing only the final product. Therefore, quality assurance techniques are used to build a quality product at every step and not just tested at the end [Sarvani. et al, 2013].

In this account, the Food and Drug Administration embraced good manufacturing practices (GMP) and viewed validation as an integral part of cGMP. Validation studies have been conducted for a long time in industries. In recent times to better the quality of pharmaceutical products, industries emphasize quality assurance programs [Raul. et al, 2014].

In the mid-1970s, Ted Byers and Bud Loftus were the two FDA officials, who first proposed the concept of validation. This concept has broadened virtue to support a wide variety of activities from the methods of analytical quality testing of APIs and products to computerized clinical trial systems, research, and process control. This term is derived from the word valid or validity meaning "legally defined" [Singh. et al, 2018].

The FDA defines "Validation as the process of collecting and evaluating data to draw scientific evidence that an equipment, utility, or facility is capable of consistently delivering quality products". [Singh. et al, 2018].

Quality assurance (QA) refers to those planned systematic actions necessary to provide appropriate confidence that a product or service will satisfy given quality standards [Butler, 2012].
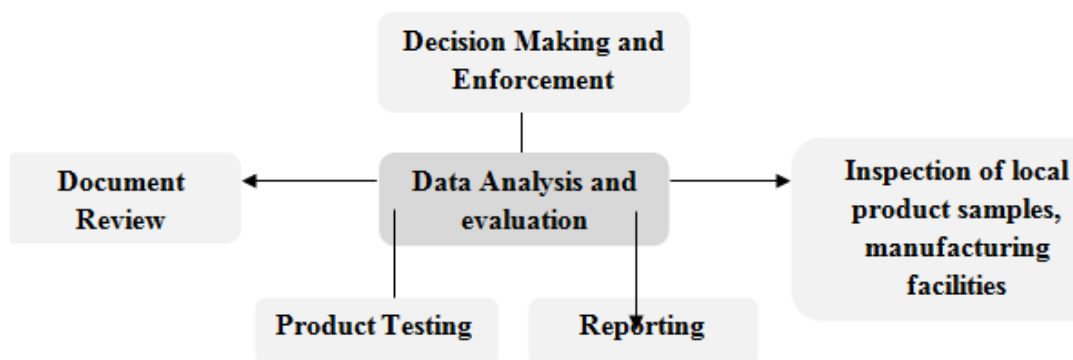
II. QUALITY ASSURANCE

Quality Assurance (QA) is as all the predetermined steps required to ensure sufficient assurance that goods or services meet the established standards for quality and suitability. It is the culmination of all efforts made to meet the necessary standard. [Singh. et al, 2021].

Components of Quality Assurance

1. Setting up the system
2. The Quality Manual
3. Training
4. Standard Operating Procedure
5. The Quality Assurance manager
6. Auditing and checking compliance
7. Maintaining Quality Assurance

III. DATA COLLECTION AND QUALITY ASSURANCE

Data management—the comprehensive system for acquiring, maintaining, organizing, tracking, assessing, and presenting on identifying data and determines the usefulness of the data for accomplishing the aims of the register. On the other hand, quality assurance works to ensure that the information was in fact gathered in accordance with the guidelines and that the information recorded in the registrar system satisfies the necessary norms of quality, which are typically established based on the intended uses.

Figure 1: Quality Assurance Framework

In addition, certain data's ultimate users could demand that data gathering and verification follow certain rules or specifications. A database that digitally gathers data and intended for the utilization of United States Food and Drug Administration (FDA) the information, for instance, should adhere to the authentication standards of the system and for the final recipient of that information, such as Title 21 of the Code of Federal Regulations Part 11 (21 CFR Part 11).The framework of quality assurance regarding data management is shown in [Fig.1] [Hesham, Pathan, 2020].

**Functions of Quality Assurance**

- Provides assurance to validated and designated formulations.
- Provides qualification of batches that to be scaled up to production batches.
- Provides assistance in the designing of validation protocol.
- Provides clinical program for the manufacturing of bio batches, in order to form the objective of FDA pre - approval clearance. [Raul, 2014]
- To deliver safe, effective, and quality medicines to patients.
- It includes both technical and managerial activities required to fulfill all quality functions.
- Also include documentation, reviewing quality control laboratory, tests, and product performance**.** [Nandhakumar. et al,2012]

IV. PHARMACEUTICAL VALIDATION

In pharmaceutical industries, validation is one of the vital parts of quality assurance system; it involves the regular study of methods, equipments, facilities and processes for determining whether they produce consistent and constant results as per the pre-determined standards. To maintain the quality of system at every step and not just at the end is the main aim of doing validation. The validation activities mainly include production training, Standard Operating Procedures, people, facilities and processes involved in that system. A process is said to be validated when it provides a high degree of assurance that uniform batches give specified results as predicted.

The validated processes are helpful in understanding the Quality Management System and also applicability of manufacturing processes. As per FDA guidelines, quality assurance of a product is estimated by drawing strict attention to several important factors from selecting suitable method for testing of product at each level [Storey. et al, 2014].. **World Health Organization (WHO)** defines validation as "The collection and evaluation of data throughout the life cycle of a product from the process design stage through to commercial production and provides scientific evidence that a process is capable of consistently delivering a quality product" [Rockville, 2014].

The types of validation in pharmaceutical industries are described in [Figure 2]
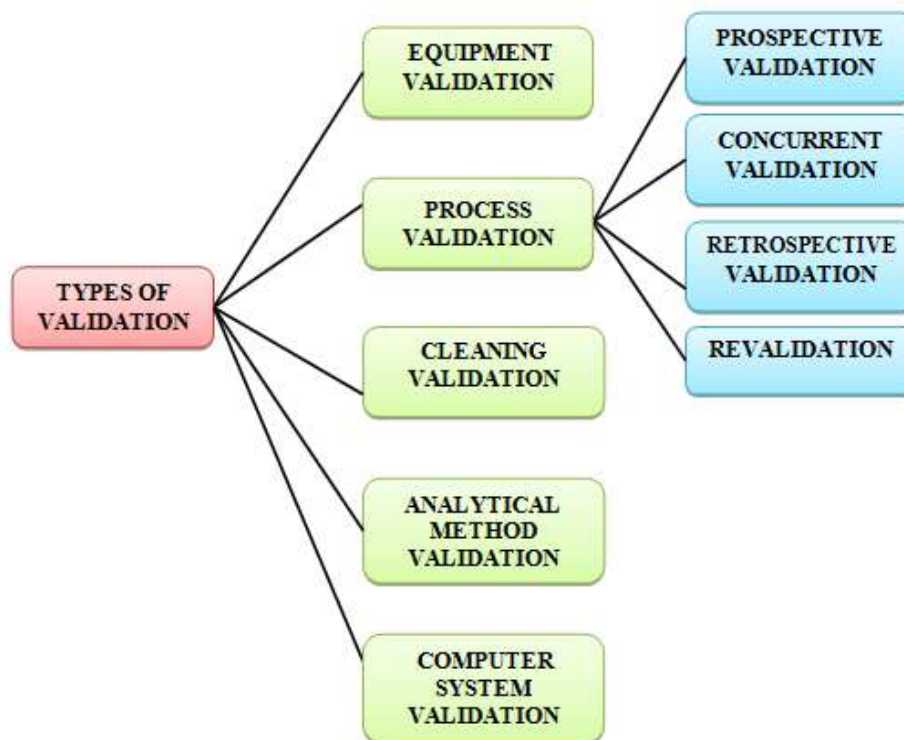
Figure 2: Types of Validation

V. COMPUTER SYSTEM VALIDATION

CSV (Computer System Validation) is also known as software validation. The FDA defines validation as "Confirmation by examination and provision of objective evidence that software specifications conform to user needs and intended uses, and that the particular requirements implemented through software can be consistently fulfilled"

1. **Confirmation by examination:** Suitability of the system software is determined by inspecting it for the fulfillment of user requirements.

2. **Provision of objective evidence**
   - Software requirements must be identified.
   - All validation efforts and test results should be documented.

3. **User needs and intended uses:** Examine the software to ensure that it satisfies the user's expectations and needs

4. **Particular requirements implemented through software:** Ensure that the standards can be met consistently

In the pharmaceutical sector, validation judgment is crucial to ensuring adherence to pharmaceutical cGMP rules and assisting businesses in maintaining consistent quality. Computer systems or information technology systems can still be validated using the same basic principles. Validation of computer systems examines the efficacy and efficiency with which the system achieves there intended goals [Zihan Xu, 2022]

They additionally offer superior products as part of a personalized assistance programme to increase the efficiency of the manufacturing process, reduce costs of production, and boost the quality of the product.
Successful validation includes:

- All standard supporting procedures are carried out satisfactorily
- Proper instructions
- Proper management of documents
- Improved Change control system
- Proper configuration management
- Easily traceable specifications
- Need of self-inspection
- Improved deviation management system

VI. NEED OF CSV IN PHARMACEUTICAL INDUSTRY

- Helps in managing various phases of expanding, designing, evaluating and organizing the software life cycle
- Helps deliver accuracy, security, reliability and consistency to pharmaceutical industry
- Helps in finding time to time error, flaws and mistakes (software bugs) in order to minimize data integrity
- Helps perform quality checks to ensure correctness of process and to reduce manual mistakes
- Helps improve product quality, to accelerate process performance, and to support high quality of product [Loo & Jonge, 2020].

VII. IMPORTANCE OF VALIDATION [BRUNNER, 2004]

- For quality assurance
- For time reduction
- For process optimization
- For reduction of quality cost
- Minimal batch failures, improved efficiently and productivity
- Reduction in rejections
- Better regulatory compliance
- Increased output, Rapid automation
- Rapid reliability on startups of new equipments
- Easy scale up of developmental work
- Validated equipments are easy to maintain

VIII. DATA VALIDATION

Data validation is the activity where one decides whether or not a particular data set is fit for a given purpose. The decision making is done on the basis of observation and dataset when compared to pre-determined standards. A straightforward formalization is to define it as a function from the collection of data sets that could have been observed to True or False [Lakshmi.et al, 2016].

IX. SPREADSHEETS

The spreadsheets are the type of collective computer application used for the analysis and data storage in the form of tables to make it valid for other organizations. The paper-based documentation was replaced by such sheets throughout the business world. In early days they were used for keeping accounts, books while today multiple data is stored, shared and sorted in the form of tables and lists.

Spreadsheet software of today can contain numerous interconnected sheets, execute basic mathematical and arithmetic operations, and display data either graphically or as text and numbers. For typical economical and scientific activities, it offers integrated functions.

X. SPREADSHEET'S HISTORICAL IMPORTANCE

- The original version, Dan Bricklin Visi Calc for the Apple II, was created by a Harvard student in the late 1970s, and the most well-known version was Lotus 1-2-3.
- In charge of the corporate world's adoption of the PC.

- Decision-makers who approve computer acquisitions have profited from:
  ➢ Faster and easier operations.
  ➢ Original invention of new or utilised.
  ➢ At a period when PCs were mostly utilised by enthusiasts, spreadsheet software was exclusively available on PCs.

- In contrast, word processing was evolutionary.
  ➢ Mostly administrative workers are benefited.
  ➢ By comparison, productivity increases were minimal.

XI. EXCEL SHEETS/ SPREADSHEETS /DATASHEETS VALIDATION

In the laboratory, various types of equipment are used to examine the quality of products. The greater challenge for analysts is the interpretation of the analysis data. Hence, Excel is the most popular software application for automatic calculation and data visualization. To fulfill regulatory compliance such as GMP, GLP, and GDP the spreadsheets used must be monitored and verified. Spreadsheets are also used for testing acceptance criteria and as a database view tool i.e. there additional application.

These sheets must adhere to the FDA's 21 CFR Part 11 guideline on electronic documentation and electronic signatures as well as Good Manufacturing Practice. To validate the data, an exhaustive method must be used in the creation and validation of the spreadsheets. Spreadsheets should be utilised for several purposes rather than just one. Eg: A spreadsheet used for more than one product or a spreadsheet producing multiple results for single data set. Like weight variation evaluation as per European Pharmacopeia (EU), British Pharmacopeia (BP), and Indian Pharmacopeia (IP) [Ansel, 2017].

XII. CREATION OF SPREADSHEETS

1. **The Spreadsheet's Design should be**

- Organized and structured
- Data entry should be done either automatically or manually by the user
- Able to summarize a clear description of its goals and objectives

- Able to include clearly defined procedures (such as limit checks, data transmission to other spreadsheets, online creation, and usage of macros), computations
- Able to provide results that are simple to track for each unique product

2. Objective of Spreadsheets

- The spreadsheets are simple to utilize for different goods
- The spreadsheet must be adaptable to produce results even if values alter.
- The data that is utilised to calculate results should be readily visible in the spreadsheet.
- It should be simple to validate and revalidate the spreadsheet.
- To prevent modifications or manipulation, the spreadsheet cells holding important data should be secure

XIII. MATHEMATICAL CALCULATIONS IN PHARMACY

Calculations are used in pharmaceuticals in many different ways. It covers calculations made by chemists in conventional and advanced practice contexts, as well as in administrative and research settings in industries, government agencies, and academia. In the broad context, the scope of pharmaceutical calculations includes computations related to:

1. Chemical and physical properties of drug substances and pharmaceutical ingredients;
2. Biological activity and rates of drug absorption, distribution, metabolism and excretion (pharmacokinetics)
3. Statistical data from basic research and clinical drug studies
4. Pharmaceutical product development and formulation
5. Prescriptions and medication orders including drug dosage, dosage regimens, and patient compliance
6. Pharmacoeconomics and other areas [OECD, 2021].

XIV. FUNDAMENTALS OF PHARMACEUTICAL CALCULATIONS

The field of research known as pharmaceutical calculations applies the fundamental ideas of mathematics to the manufacturing, use, and disposal of drugs. To have a complete understanding of various types of calculations which are involved in dispensing, it is desirable that the pharmacist should have a thorough knowledge regarding the mandatory calculations [16].

XV. GOOD LABORATORY PRACTICE (GLP) ON DATA INTEGRITY [15, OECD, 2021]

To guarantee the accuracy and integrity of test results is one of the primary goals of the Principles of Good Laboratory Practice (GLP). This includes an increase in the use of computer technology, automation, and other methods of collecting electronic information. However,

maintaining belief in the accuracy and reliability of the data appears to be the primary goal of the GLP principles' criteria.

XVI. DATA

Data are facts, numbers, and facts that might be quantitative or qualitative that has been gathered for use in investigation or comparison. Data can be presented or stored on a variety of media, including paper, DVDs, photo films, tapes, electronic files, and other media. Data can also have a variety of forms, including analogue and digital, and various structures. It can also be laid out differently, such as on paper or on a screen. It is the kind of information that has been altered in such a way that it can be effectively moved around or processed, making it one of the most important resources for the development or successful conclusion of any project or research effort. [17]

Data can be collected or recorded in the following ways:

- Manually recording a report or an action in the form of paperwork or through an electronic framework
- Automatically recording an observation or an activity on paper or in an electronic format using equipment ranging from basic instruments to sophisticated highly configurable computerized systems.
- Using a hybrid system, where the initial information is made up of a mix of written and digital files.
- On other means of media such as photography, imaging methods and technologies, etc. could be generated manually, automatically or by hybrid system. [18]

1. **Raw Data:** The Principles of GLP define raw data as all original test facility records and documentation, which are the result of the original observations and activities in a study and allow complete reconstruction and evaluation of the GLP activities. [19]

2. **Archival:** The records which are protected from any possible deletion, alteration or storing them under the control of the particular individual responsible for the data management required during the retention of the records. These archived documents include the metadata documents and electronic signatures. [20, 21]

3. **Static Data:** The documents whose format remains unchanged are termed as static data records. They can be in the form of paper or electronic records. These documents have very minimum interaction between the user and the content creator. The limitation of this record is once it was processed into the static format it was enabled for any kind of changes in any details or hidden fields [18, 22].

4. **Dynamic Data:** The data is mainly retained in there dynamic format to enable the interaction with the data. This retention is important to maintain the integrity of data for later

verification. It is justified based upon the risk and also allows an interaction between both the content creator and a user [23].

5. **Record:** The record is a piece of data or information. The initial source of information or data acquisition is referred to as the primary record. Usually, the original documents are only raw data. If an original record meets the definition of raw data, but is not considered as such, this must be justified [19].

6. **Derived Data:** They are obtained and reconstructed from raw data (e.g. final concentrations as calculated by a spreadsheet relying on raw data obtained from an instrument; result tables as summarized by a Laboratory Information Management System (LIMS), etc.) obtained by data processing [19].

7. **Metadata:** Metadata are data providing information used for the identification, description, and relationships of data [19].

8. **Audit Trail:** It is a type of metadata that includes data related to acts involving the production, alteration, or destruction of digital information. It also facilitates the reconstruction of the history of such events relating to the record, including the 'who, what, when and why' of the action [19].

9. **Electronic Signature:** An e-signature is a scribbled (or "wet") signature that is represented digitally. Different types of systems exist from simple ones (e.g. internal user identification with password) to complex systems of signatures (e.g. with an external, certified electronic signature service that provides with timestamp and encrypted information behind the signature [19].

10. **Data Quality**

- The term data quality is referred to as "Data Integrity."
- The entire data life-cycle is based on the maintenance while assuring the accuracy and consistency of data.
- The assurance that the data produced was generated in accordance with applicable standards and is suitable for their intended use is known as the quality data.
- Data quality is ensured by appropriate study designs that accurately and scientifically address the experimental question and studied hypotheses, as well as by the availability of sufficient resources.
- Data quality affects overall acceptability of the data in regard to decision-making or onward use. [16]

11. Configuration Management

- Quality assurance for managing software addresses all documentation associated with the system and is applied during all operational phases of software use, including the development and maintenance phases. [17]

12. Data integrity

- It is the extent to which data are comprehensive, logical, precise, dependable, and accurate and that these data attributes remain intact across the data life cycle.
- It is done to avoid intentional, accidental falsification or deletion of data to withstand data quality during regulatory inspections
- Data integrity and security infractions are not only 21 (CFR) Part 11 issues, but also severe cGMP violations.
- Data integrity requires appropriate quality and risk management systems, including sound scientific principles, GDP and training of personnel. [20]
- It plays a very crucial role in USFDA audit. It is important to back up the data containing valid reports from the entire department [1].
- On the basis of mechanism and data integrity stream integrity can be divided as shown in the [Figure 3] [21].

XVII. TYPES OF INTEGRITY
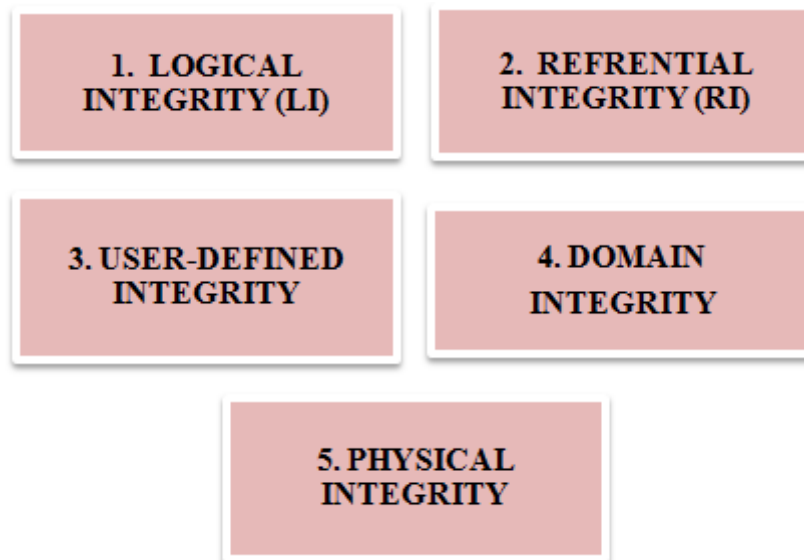
Figure 3

1. **Logical Integrity (LI):** This is an essential component of DI since it involves a physical integrity mechanism and protects data from human error, piracy, and data hackers. Logical

integrity is critical in the pharmaceutical industry for the preservation and processing of data gathered from the proper department. Human mistake that results from manually inputting crucial information into storage databases poses a serious danger to data integrity. DI is prone to faults and viruses while transferring and saving data information from one spot within a data base to another field of storage data base. In the pharmaceutical sector, the quality assurance department has been given specific tasks. The supervisor in this department is responsible for a variety of tasks related to the data evaluation and storage from the QC department. The data collected from the quality control department is less likely to include errors because to the logical integrity [22].

2. **Refrential Integrity (RI):** Integrity can take many different forms, including procedures and the application of laws related to data storage and retrieval. Foreign keys are a crucial component of referential integrity. This foreign key is made up of a number of valve-related ideas. The states are either made up of a foreign key valve, referred to as the primary encryption value of a separate table, or they are null. The referring Integrity is a crucial component of the collection of data produced across multiple departments in the pharmaceutical sector. By adopting the Referential Integrity approach, the numerous regulations published by regulatory organisations place a focus on information security and safeguarding against the security of several crucial components. With a foreign key as a tool, all the processes and laws are enforced to give correct implementation and data collection in line with standard operating procedure [16].

3. **User-Defined Integrity (UDI):** Data acquired via post-marketing monitoring and information gathered from pharmacovigilance supervisors are specific to a certain group of people in the pharmaceutical sector. In this particular case, the process of integration requires that the data be user-defined. Data created by diverse persons can be safeguarded and kept with the deployment of data integration or user specified integrity processes, respectively, in accordance with standard operating procedure established by regulatory rules. The use of user-defined integrity speeds up data retrieval in the event that an error is detected and notified [23]

4. **Domain Integrity (DI):** Because the operational records of the pharmaceutical sector contain many different sets of regulations and processes, this data may be streamlined and saved by using the DOI technique. By using domain integrity, information made up of numerous variables and constants, such as places, names, numbers, value created, profit, and loss, may be organised in chronological order. In data storage and retrieval processes involving diverse combinations of constants and variables, domain integrity is crucial. By using a data retrieval procedure and leveraging data integrity in the appropriate scenario, such constants and variables may be distinguished. If a mistake occurs when collecting and processing the appropriate data in the system allocated by the appropriate departments engaged in maintaining domain integrity, it may be easily found and solved [24].

5. **Physical Integrity (PI):** There are several ways in which different elements might impact the data integrity process and storage. One of the elements outside of one's control is one's

wishes. Earthquake, flood, tsunami, tornado, and hailstorm are a few examples of natural disasters that might interfere with how data integration is stored and retrieved. Data storage and protection can greatly benefit from the application of physical integrity and its operating principles. The method of maintaining physical integrity includes duplication and the multiplication of data stored in the system. In order to safeguard against many unanticipated natural events, data storage facilities can be built with concrete walls and other types of physical barrier protection [25].

XVIII. COMMONLY FACED DATA INTEGRITY ISSUES ARE

1. **User privileges:** Because the program's setup does not appropriately identify or separate client levels, individuals obtain exposure to inappropriate software rights such as method modification and integration.

2. **Common passwords:** When analysts share passwords, it is impossible to determine who generates or modifies records; therefore the A in ALCOA is ambiguous.

3. **IT management:** Laboratory personnel have failed to establish adequate information control s, allowing illegal users to edit, destroy, or improperly restore digital files; the document may thus not be unique correct, or comprehensive.

4. **Audit Track Capture:** The FDA advises reviewing audit trails documenting changes to esse ntial data with every document prior to the final authorization of the recording.

5. Changes to final product test findings, sampling running patterns sample identity, and essential process variables should all be audited on a regular basis to overcome the
   - Overwriting
   - Aborted runs
   - Compliance during testing
   - Data deletion
   - Backdating
   - Data modification

6. **Incomplete Data:** In this instance, the record remains incomplete. The term "complete data" is accessible to interpretations. For a full study of FDA 483 observations on complete data (21 CFR 211.194 and subparts) [25].

XIX. ALCOA CONCEPT

The FDA guidelines define ALCOA as shown in [Fig. 3][27].

A	**Attributable:** Who performed the action and when?
L	**Legible:** Easy to understand, record and preserved in original form
C	**Contemporaneous:** Data should be recorded on time
O	**Original:** Preserves information in its raw form or the authorized true copy
A	**Accurate:** Data should be free from error and as per the protocol

Figure 3: ALOCA

1. **Attributable:** It is necessary to preserve a mark record to identify the marks, initials, or assumed identities of people who finish paper documents. It is recommended that you use permanent ink after the document is done. When editing an entry, one particular sentence is always selected over the initial record. This approach ensures that the record is still readable. It should be persistent and readable in all scenarios. [26]

2. **Legible:** The data of records involved in maintaining the data integrity must have appropriate accessibility during the entire duration of action [26].

3. **Contemporaneous:** All the data are documented during the entire course of action. It generally determines the accumulation of the all the data, records and important information from several sources into the proper useable data in chronological series [27].

4. **Original:** The genuine or accurate copy of the raw data must be given. Example: The original data becomes lost during the processing of a series of raw data into usable binary number formats, tables, columns, etc [28].

5. **Accurate:** Data must include complete meaning. Use an observation check for the purpose of basic record collecting to confirm the correctness of the information. Take into account electronic techniques for data collection and verification. Include accuracy checks in every aspect of the design of the electrical framework. For instance, verify the manual information flow; temperature data must be reported within the predefined range of 0-100 °C [29].

Alcoa Plus: To further clarify the characteristics of legitimate contemporaneous attributable original accurate excellent documentation practice, more terms were added. As follows: Simple to get, practical to utilise, already existent, or ready to use

- **Accessible:** Capable of being reached, sought for, used, or acquired
- **Complete:** Nothing is lacking, Consistent: Doing or acting in the same way again
- **Credible:** Capable of convincing someone or doing something
- **Corroborated:** To support the evidence with further data or information [30].

XX. GLOBAL DATA INTEGRITY REGULATION GUIDELINES

1. **USFDA: 21-CFR:** The Code of Federal Regulation (CFR) is a codification of the general and permanent rules that the executive departments and agencies of the federal government have published in the Federal Register. Title 21 of the Code of Federal rules contains the rules of the Food and Drug Administration. For every title/volume, the CFR is updated once a year on or around April 1st [31].

2. **MHRA:** The MHRA's GMP data integrity criteria for the pharmaceutical industry guidance are intended to enhance the EU's current GMP standards for dosage. The pharmaceutical quality system, which guarantees that medications are of the requisite quality, is fundamentally dependent on data integrity [31].

3. **TGA:** The Therapeutic Goods Administration (TGA), an Australian regulatory organization, specifies the need for data integrity as a deficit. A flaw in a procedure that has resulted in or might lead to a considerable risk of creating a user-harmful product. Also, it happens when it is discovered that the producer has cheated, lied about, or fabricated items or data [31].

4. **WHO:** Vital drugs and medical supplies, WHO releases data integrity recommendations to safeguard patients worldwide. In order to lessen instances of manufacturers providing inadequate data or purposeful data fabrication, has WHO produced a guideline on worldwide best practices for regulatory bodies and inspectors while we are creating a medication and marketing it. Several people and things are involved, and the reliability and quality of the information manufacturers provide to national regulatory agencies is important at every stage. To guarantee the caliber of research supplying requests for medications to be placed on the market, that data must be extensive, thorough, exact, and truthful. Moreover, it must adhere to a variety of requirements, including: excellent manufacturing procedures (GMP), good clinical practice (GCP) and good laboratory practices (GLP) [31].

5. **EME:** To ensure the generated data integrity at the time of testing, manufacturing, packaging, distribution, and monitoring of medicines, the European Medicines Agency (EMA) has published new Good Manufacturing Practice (GMP) guidelines. These data are used by regulators to assess the effectiveness, safety, and quality of medications as well as to track the benefit-risk profile of such medications over their entire life cycle. Effective data record management enables regulatory agencies and pharmaceutical producers to make informed decisions by ensuring that the data produced are correct and consistent.

XXI. DOCUMENTATION – GMP REQUIREMENT

1. GMP is that part of quality assurance. It is aimed primarily at diminishing the risk inherent in any pharmaceutical production.
2. The quality must be designed into the process and cannot be achieved only by testing remains a central tenet of current good manufacturing practice (cGMP).
3. Documentation is the key to GMP compliance and ensures traceability of products
4. Documentation provides the route for auditors to assess the overall quality of operations within a company and the final product [32].

XXII. DATA LIFECYCLE

Data life cycle management is very much useful for any enterprise or application where data is being used and processed for producing results. The data life cycle presents the entire data process in the system. The lifecycle of data starts from creation, store, usability, sharing, and archive and destroy in the system and applications as shown in Fig.no.4 [33].
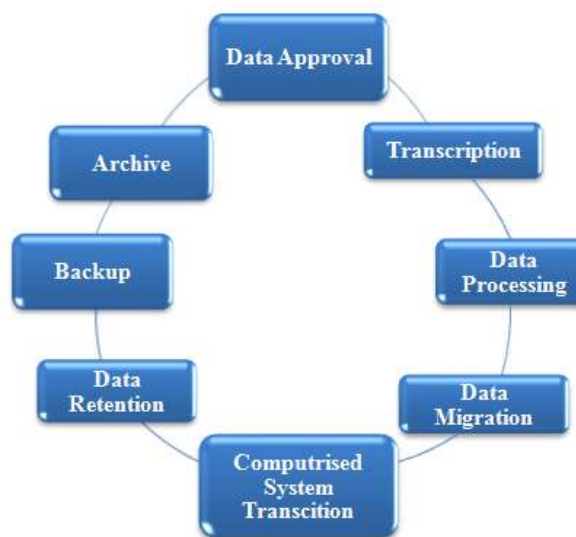
Figure 4: Data Lifecycle

XXIII. GAMP STANDARDS FOR VALIDATION OF AUTOMATED SYSTEMS

1. The Good Automated Manufacturing Practice (GAMP) Forum was created in 1991 in the United Kingdom by pharmaceutical industry professionals to address the industry's need to better knowledge and expectations of regulatory bodies. The organization also advocates for computer system validation in the pharmaceutical business.

2. GAMP assists manufacturers in providing a quality product and pharmaceutical sectors in delivering quality goods through verified methods. The following are the advantages of using GAMP for both manufacturers and suppliers:
3. Cost and time savings in achieving compliant systems
4. Reduced time and resources for revalidation or regression testing and remediation
5. Lower certification costs
6. Improved compliance with regulatory standards
7. Established accountability for every participant involved [34]

XXIV. 'V' FOR VALIDATION

GAMP recommends the V-Model SDLC since it is a widely used design; however there are others that may be employed. The V-model demonstrates how the three primary qualification activities (installation, operational, and performance) are related to the design process.

The left side of the V- model represents the user specification or requirements, functional specifications, hardware and software design along with the modular specifications. The right side of the model represents the system testing stream against the specifications while bottom indicates the code modules. [35]

This model is helpful in validating the various aspects of the process, procedure and equipments as well as computer system by keeping in mind about the various points and aspects of the validation system. Regulatory bodies suggest a key model as per provision for the validation [35].
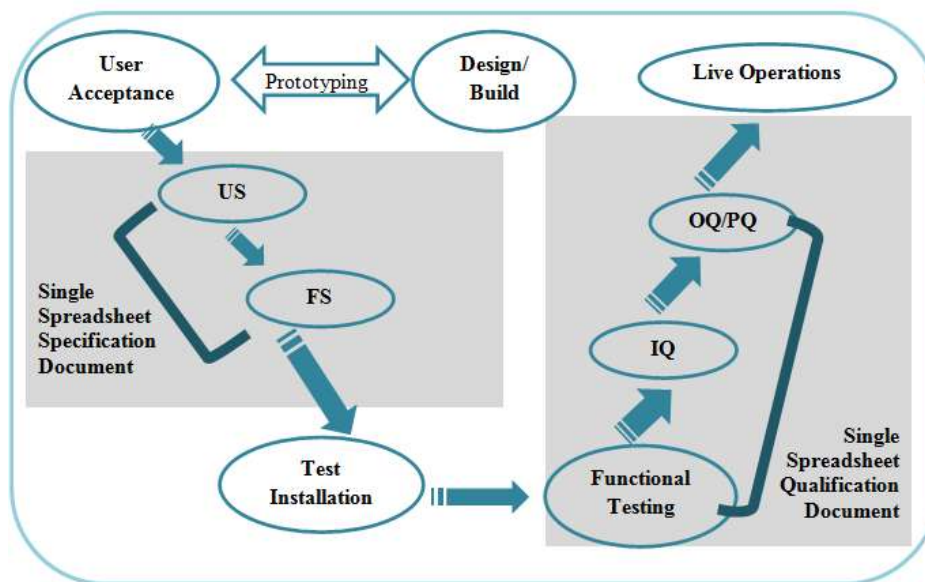
Figure 5: V- model for excel sheet validation

XXV. CONCLUSION

Data integrity and management are critical to the pharmaceutical industry's operation, production, and manufacturing processes. To get the greatest outcomes, the pharmaceutical industry employs data integration techniques such as preservation, protection, duplication, storage, and retrieval. In the pharmaceutical industry, audit trails, as well as the appropriate preservation of data obtained across various departments, must be properly organized as specified in standard operating procedures and comply to regulatory organisations' rules. We discussed data integrity, its benefits and downsides, the difficulty the pharmaceutical industry experiences in integrating data, the causes for improper data management, a warning letter on the matter, and a possible fix in the review article cited above. The basis for the company's trust in using accurate data to operate in compliance with regulatory standards is quality data. Authority's priorities data integrity for a variety of reasons, including patient safety, business process, and product quality. The data's dependability and correctness serve as the foundation for regulators' evaluation of the company. The manufacturer is also responsible for avoiding and detecting improper data integrity practices caused by inefficient quality control techniques. When data is gathered and used to make manufacturing and quality decisions, the Quality Risk Management (QRM) method may avoid, detect, and control risks while also ensuring that the data is trustworthy and dependable.

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