

LIMITED BUT IMMERSING: INFORMATION TECHNOLOGY IN PHARMACY**CHANDRAKANT MOD*, ABHISHEK CARPENTER, DEEPAK MEHTA, VISHAL SHARMA****B. R Nahata College of Pharmacy, Mandsaur, Madhya Pradesh 458001**

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ABSTRACT

Objective: In contemporary years, the quantity of medicine and drug treatments has larger extremely that are quite often more strong and extra selective and in addition, the literature relating to medicines has extended at a surprising rate. Pharmacy research revealing exclusive data which is growing day by day. Computer are now a days are more frequently used in pharmaceutical in industries, hospitals and in various departments for drug information, education, evaluation, analysis, medication history and for maintenance of financial records. They have become indispensable in the development of clinical pharmacy, hospital pharmacy and pharmaceutical research. Computers are also useful for patient profile monitoring, medication, database management material management and many other places too. It is useful in providing on drug interactions, drug information services and patient counseling. **Conclusion:** The role of the pharmacist is continuously increased with the development of technology to achieve feasibility in the retrieval of prerequisite information.

Keywords: Literature, Medication Error, Pharma information system, Barcode Technology, Patient monitoring system.

INTRODUCTION

The pharmacist's role in providing information on drugs and medicines is not incipient. When drugs were few in number and generally of relatively low vigor the number of inquiries was minute and could customarily be answered expeditiously by location to pharmacopoeias and formularies. In recent years, the number of drugs and medicines has bigger extremely which are usually more potent and more selective and also the literature relating to drugs has prolonged at a staggering rate. The literature covers riches of information on these more incipient drugs, their actions, clinical uses, unwanted effects, interactions with other drugs, comparative usefulness, etc. An expeditious reference to pharmacopeia and formularies is no longer adequate, in many cases, to provide an ample answer.

Drug information
Information retrieval system
Medication Error
Pharma information system
Pharmacokinetics, Mathematical model in drug design
Patient monitoring system
Automated Dispensing Systems

Drug Information

Availability of official drug information is the key to promote rational use of drugs [1] a well-accepted concept in clinical practice in the developed world. The concept is fast catching up in several developing countries because of the sharp rise in the medical costs and increasing instances of medication errors. An important reason for the rising costs of medical costs in developed countries is the marketing exclusivity enjoyed by pharmaceutical companies for their latest life intimidating drugs. And the drugs continue to be the major part of the total healthcare costs. With high prices of patented drugs and the strong influence of pharmaceutical companies on medical practitioners, the healthcare costs can only rise in future. Both pharmaceutical companies and the medical practitioners contribute to creating a situation like this. For pharmaceutical companies, pushing up their sales is the one and only aim whereas a large majority of the physicians can be easily coaxed into indulges in irrational prescription to serve the interests of these companies. The absence of insurance cover for a large number of poor people both in the developed and developing world also adds to overall healthcare costs. Medication errors by the physicians is another serious problem confronting the patient community today as information level about new drugs and adverse drug reactions

(ADR) is extremely poor along with physicians. Thus, several hundreds of cases of complications and deaths are being reported every year in various parts of the world on account of medication errors. One way to control medical costs and medication errors is to promote the concept of rational use of drugs by providing authentic drug information to doctors, pharmacists, nurses, researchers, other professionals in health care, committees and patients.

Drug information is an essential element in achieving health goals and should, therefore, form a part of any national drug policy. Information is an assist to decision making. The first Information center to be set up was at the University of Kentucky Medical Center, USA, in 1962 [2]. Its objectives were to collect information, to estimate and compare drugs, to provide an education and teaching aid for health care personnel, to assist clinicians in the selection of safe and effective medication and to enable pharmacists and pharmacy students to develop their abilities in provide information on drugs and medicines. Large hospitals have developed and staffed a new division of the department of pharmacy which is commonly referred to as 'Drug Information Center'. This new concept in hospital pharmacy operation is usually located in a separate section of pharmacy, containing large number of reference texts, journals, reprints and brochures. They are also equipped with electronic data processing equipments and have a full time director and adequate secretarial assistance. Now computers have possible networking of regional drug information centers made located in different hospitals. Networking on regional, national, sub continentals, intercontinental levels had placed Drug Information Services at a international level. Pharmacy and drug information are identical. In 1991 Brodie [3] identified a multiple theory concept of pharmacy as a drug-use control system, a facts service, a clinical profession, and as the interface between humankind and drugs. The description of pharmacy practice was expanded from that of pharmacy as a "knowledge system" to "a system (framework) of concepts dealing with the achievement, translation, transmission, and consumption of drug knowledge". As a specific component of pharmacy, the drug information role is characterized by the ability of the pharmacist to perceive, charge, and evaluate drug information needs and retrieve, evaluate, communicate, and apply data from the published literature and other sources as an integral component of pharmaceutical care [4] The ability to accomplish the drug information role is necessary to successful pharmacy practice.

Drug information is both a body of data and information about medications and a set of skills and apparatus that provide

pharmacy professionals with the ability to find, access, understand, interpret, apply and communicate information and obtain knowledge. The body of particulars and information pertaining to medications is generally referred to as “the drug journalism”. The journalism of pharmacy and pharmaceuticals encompasses all aspects of drugs, beginning with isolation or synthesis, including physical analysis, bioactivity, toxicology, clinical research, market research, and economic and social considerations. The drug literature or journalism, reflecting all the individuals who create it and use it, such as chemists, biomedical scientists, all the various health care professionals, attorneys, and patients, is vast and complex. Different kinds of publications are available in the library like journals, abstracting and indexing publications, books, compendia, monographs, patents proceedings, reviews, FDA-approved labeling (package inserts), house organs, newsletters, promotional literature, government documents, and analysis by consulting services.

Drug information skills coupled with the processes and technology offered by informatics are part of the solution to mastering information overload and maintaining the knowledge system that improves patient care outcomes.

Drug Literature

- A clinical drug literature is basically a document containing all the information including (but not limited)
- Side /adverse effects
- Drug interactions
- Uses
- Teratogenicity
- Stability
- Compatibility
- Product identification and availability
- Dosages and administration
- Toxicity
- Pharmacokinetics
- Pharmacodynamics
- Pharmacogenomics
- Health-related quality of life [5]

The concept of drug information accommodation or drug information center is an endeavor to document drugs by abstracting information about them. The information about drugs is accumulated from sundry sources which are available. In 1972 Walton modeled the drug literature as a pyramid with the primary literature composing the base of the pyramid, the secondary literature interfacing and accommodating as a bridge from the primary literature to reference works (tertiary literature) [6]

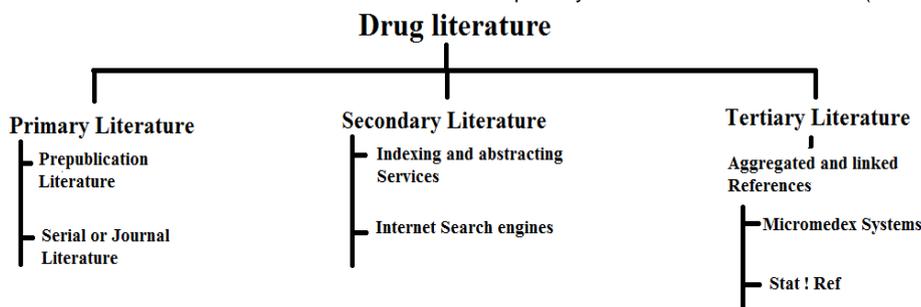


Figure 1: Flow chart of Drug Literature.

Information Retrieval Systems

Information Retrieval (IR) is a branch of computer science that is concerned with the processing of collections of documents containing “free text.”An object is an entity that is represented by information in a content collection or database. User queries are matched against the database information. However, as opposed to classical SQL queries of a database, in information retrieval the results returned may or may not match the query, so results are typically ranked. This ranking of results is a key difference of information retrieval searching compared to database searching[7]Depending on the application the data objects may be, for example, text documents, images, [8]Audio[9] mind maps[10] or videos. Often the documents themselves are not kept or stored directly in the IR system but are instead represented in the system by document surrogates or metadata.

IR began as an offshoot of “information theory,” a field defined in a classic paper by Claude Shannon of Bell Laboratories in 1949. (Shannon and Weaver’s text[11]describes this work for a general audience.) However, “information” was defined in a very broad sense. Some of the work in this field considered practical problems such as how to compress data without loss, (e.g., Ziv and Lempel) [12] and how to add redundant (extra) information so that data transmission or storage would be reliable despite the presence of physical damage to the medium or noisy transmission, (e.g., Reed and Solomon[13]The focus on textual information can be traced to several researchers, most notably the late Gerard Salton of Cornell University, who has written the definitive textbook for IR [14].

The four components of information retrieval [15]

- User(user needs)
- Process

- System
- Data

As a drug moves along the path from discovery to the market and into worldwide use, data and information about the agent are created and accumulate. When this information is published, its value and usefulness to scientific, professional, and patient communities becomes known. Publication of research results at each step of the path is essential. There is tendency particularly in clinical research, not to publish “negative” results. When this happens we are left with only research that is favorable to the drug, resulting in a skewed picture of the drug’s place in therapy.

Traditional IR System

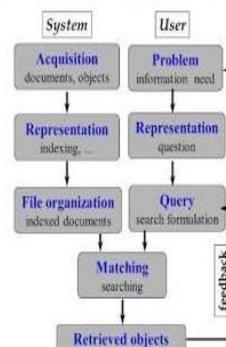


Figure 2: Traditional IR system.[16]

The path of drug development and marketing offers a structure that is useful to scientists and practitioners concerned with compounds of potential therapeutic value. The resources themselves are classified as primary (original research), secondary (indexing and abstracting services), and tertiary (textbooks and evaluated information). Individual resources are now generally available in more than one physical format; for example, a journal may be available as a paper publication or as an electronic publication (either individually or as part of a publisher's electronic journal collection or content collection). Primary, secondary, and tertiary resources are available for each step in the path of drug development, but reporting time increases from each step to the next.

Preclinical Drug information

At this point a compound is well-known and then viewed for capabilities pharmaceutical or therapeutic usefulness; researchers shall be each patron of and contributors to the data-knowledge-potential cycle that characterizes science. Firstly, within the synthesis and purification phase of drug development, know-how concerning the compound's chemistry and bodily residences is also both sought and created. Whether or no longer the compound has been of interest to other researchers is also decided by browsing public files of supply and contract awards and in addition by shopping resources that cover preliminary and early study results. The patent reputation of the compound may just be situated.

Physical and chemical data

- **AIDSDRUGS:** Published by the US National Library of Medicine, AIDSDRUG is a dictionary of chemical and biological agents currently being evaluated in the AIDS clinical trials covered in the companion AIDSTRIALS database.
- **Beilstein:** Beilstein, a structure and factual database covering organic chemistry.
- **CAS Registry:** CAS Registry, is a substance database containing structures and chemical names.
- **Chemcyclopedia:** It is an annual supplement to Chemical and Engineering News (C&EN), provides a listing of chemicals, trade names, packaging, special shipping requirements, potential applications and CAS Registry Numbers.
- **ChemFinder:** ChemFinder WebServer is a WWW search engine that works from a single master list of chemical compounds covering all areas of chemistry and also provides information on the physical property and two-dimensional chemical structures.
- **Chemical Abstracts:** Chemical Abstracts is a collection of chemical information with nearly 16 million abstracts of journal articles, patents, and other documents.
- **ChemIDplus:** Published by the US National Library of Medicine, it's a web-based search engine, <http://chem.sis.nlm.nih.gov/chemidplus/>, that provides free access to structure and nomenclature authority files used for identification of chemical substances cited in National Library of Medicine databases.
- **Chemindex plus:** Database contains 8000 pharmaceutical ingredients linked to 300,000 preparations.
- **Ei CompendexWeb:** It's a comprehensive bibliographic database of engineering research literature containing references to over 5000 engineering journals and conferences.
- **The Merck Index:** The Merck Index is an encyclopedia of chemicals, drugs, and biologicals that contains more than 10,000 monographs.
- **NIST Chemistry WebBook:** The National Institute of Standards and Technology (NIST) Chemistry WebBook provides free access to chemical and physical property data for chemical species via the internet, <http://webbook.nist.gov/chemistry/>.
- **RTECS:** The Registry of Toxic Effects of Chemical Substances (RTECS) is a database of toxicological

information compiled, maintained, and updated by the National Institute for Occupational Safety and Health (NIOSH).

- **The USP Dictionary of USAN (U.S. Adopted Names) and International Drug Names:** The USP Dictionary provides comprehensive information on chemical and brand names of drugs. It includes USAN and International Nonproprietary Names (INN). It also lists drug manufacturers, therapeutic uses, and molecular and graphic formulas.

Patents

Through the granting of a patent the U. S. Patent and Trademark Office (PTO) provides intellectual property protection to the inventor for 20 years. U. S. Patent and Trademark Office Web Patent Databases offer free WWW access, <http://www.uspto.gov/main/patents.htm>, to a bibliographic patent database that uses the most current patent classification system.

The Delphion Intellectual Property Network (IPN) is a research tool for patent information. Derwent World Patents Index (DWPI) is a comprehensive database of patent documents published worldwide. IMSworld Drug Patents International database provides access to the patent status of over 1200 molecules. The database contains information on patents due to expire (over a given time period), patents by therapy class, and patents by country.

Phase IV Studies and Post Marketing Drug Information

During the Phase IV Studies and Post Marketing Drug Information stages an exhaustive literature search is required to find material pertinent to the clinical utilization of the drug. This will require not only probing the rudimental bibliographic databases such as Biological Abstracts, EMBASE, IDIS, IPA, MEDLINE, and Science Citation Index, but withal probing the patent literature, utilizing Patent and Trademark Office Web Patent Databases. The following bibliographic databases provide access to the full span of life-science periodical literature, including all stages of a compound's development from early brief reports to comprehensive assessments after years of clinical use.

- **BIOSIS:** BIOSIS processes approximately 5,50,000 items each year, from primary research and review journals, books, monographs and conference proceedings. It is available in several formats. These include Biological Abstracts/RRM (Reports, Reviews, Meetings), the companion reference to Biological Abstracts.
- **EMBASE:** EMBASE, the Excerpta Medica database is a biomedical and pharmacological bibliographical database that provides access to medical and drug related subjects from over 4000 biomedical journals from 70 countries. The EMBASE database combined with unique MDLINE records back to 1966 are available in EMBASE.com.
- **International Pharmaceutical Abstracts:** IPA published semimonthly, is an abstracting/indexing publication which covers all pharmaceutical literature.
- **MEDLINE:** MEDLINE (Medical Literature Analysis, and Retrieval System Online) contains over 11 million references to journal articles in life sciences with a concentration on biomedicine from 1966 to the present. MEDLINE is available on internet through the National Library of Medicine (NLM) home page at <http://www.nlm.nih.gov> and can be searched free of charge.
- **Pubmed Central:** Pubmed Central (PMC) which encompasses Medline is a web-based archive of journal literature for all of the life sciences. Access to PMC is free and unlimited.
- **Science Citation Index:** Science Citation Index (SCI) provides access to current and retrospective bibliographical information, author abstracts, and cited references found in various scholarly science and technical journals covering more than 150 disciplines.

Table1: Important resources/internet websites for Drugs related Information.

S.No.	Resources/sites for Drug Information and related information	Information provided
1	www.ashp.org/s_ashp/sec_drug_shortages.asp	American Society of Health-System Pharmacy – Shortages: Drug Shortage Resource Center with updates/ management of shortages
2	www.cdc.gov	Centers for Disease Control: Public health guidelines, vaccine and travel information, and CDC publications
3	www.fda.gov	Food and Drug Administration: Drug and Biologics information (approvals, shortages, Orange Book, news, etc.). Be sure to click CBER for biologics and CDER for drug information.
4	www.home.mdconsult.com	Full-text books and journals, drug information, news, CME, and patient leaflets. Requires fee and password
5	www.guidelines.gov	National Guidelines Clearinghouse: Public resource for evidence-based clinical practice guidelines established by the government's Agency for Healthcare Research and Quality.
6	www.health.nih.gov	National Institutes of Health: Information on disease states, research, and federal health programs from the NIH
7	www.ncbi.nlm.nih.gov/entrez	National Library of Medicine: PubMed - a searchable listing of abstracts of medical literature
8	www-medlib.med.utah.edu	Spencer S. Eccles Health Sciences Library: Library catalog, full-text journals, searchable databases, etc.
9	www.uuhsc.utah.edu/pharmacy/druginfo	The University of Utah Hospital & Clinics Drug Information Service: Information about our service, publications, and drug shortage updates. Many links are for internal use only.

Medication Errors

The problem of medical errors, and in particular medication errors, has prompted a strong response by the health care industry, purchasers, and by state and federal governments. Medical errors are the eighth leading cause of death in the United States, with the number of deaths exceeding those associated with motor vehicle accidents, breast cancer, or AIDS. Medication errors represent the largest single cause of errors in the hospital setting, accounting for more than 7,000 deaths annually—more than the number of deaths resulting from workplace injuries. Approximately 1.3 million people have injured annually in the United States following medication errors.

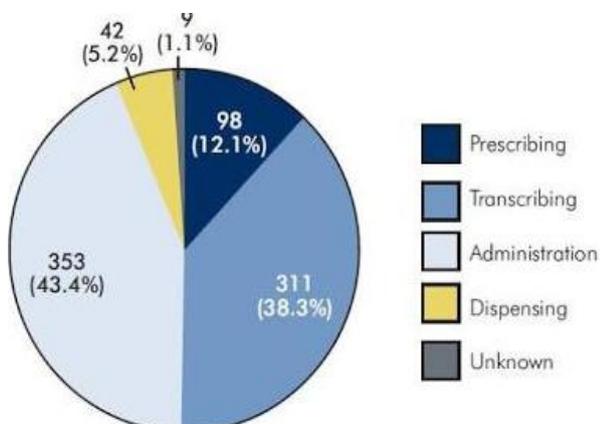


Fig.03: wrong-patient errors by node as reported to the Pennsylvania patient safety Authority, July 2011– December 2011 [17].

The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." The National Coordinating Council for Medication Error Reporting and Prevention is an independent body comprised of 22 national organizations. In 1995, USP spearheaded the formation of the National Coordinating Council for Medication Error Reporting and Prevention. Leading national healthcare organizations are, for the first time, meeting,

collaborating, and cooperating to address the interdisciplinary causes of errors and to promote the safe use of medications. USP is a founding member and the Secretariat for NCC MERP.

In hospitals, errors are common during every step of the medication process—procuring the drug, prescribing it, dispensing it, administering it, and monitoring its impact—but they occur most frequently during the prescribing and administering stages. When all types of errors are taken into account, a hospital patient can expect on average to be subjected to more than one medication error each day. However, substantial variations in error rates are found across facilities. An ADE arising from an error is considered preventable. It is difficult to get accurate measurements of how often preventable ADEs occur. These medication errors are undoubtedly costly to patients, their families, their employers, and to hospitals, health-care providers, and insurance companies, but there are few reliable estimates of that cost.

Drug errors are far from new, but with more than 12 million chemical substances now available, taking medications has become an increasingly dangerous proposition. In 1999, a report called To Err Is Human by the Institute of Medicine of the National Academy of Sciences [18] estimated that as many as 98,000 hospital patients die every year as a result of preventable errors, including medication mistakes. These findings prompted the Clinton administration and Congress to call for urgent reforms. Both academics and entrepreneurs are proposing an array of systems and gadgets designed to prevent errors or catch them before they can harm the patient.

Medication errors that lead to iatrogenic injuries are a well-known worldwide phenomenon and are common, costly, and clinically important (Lesar, [19] Classen [20]. In 1910, Richard Clark published the first study that looked at error rates in clinical diagnosis [21] Since then, several studies have looked at the problem of medication errors. Incidence rates of adverse drug events amongst adults admitted to the hospital have ranged from 2 to 7 per 100 admissions (Bates,[22] Jha[23] Approximately, 28% of adverse drug events are related to medication errors and are therefore judged to be preventable.[24]. This issue has also received considerable attention in the lay press. Over a period of time, there has been a transition from an era where medical practice and its practitioners were revered to a time when doubt and fear is expressed and legal suits are pursued by aggrieved patients[25]Against this background, the Centers for Medicare and Medicaid Services requested that the Institute of Medicine study the prevalence of such medication errors and formulate a national agenda for reducing these errors. The resulting report, Preventing Medication Errors, finds that medication errors are surprisingly common and costly to the nation, and it outlines a comprehensive approach to decreasing the prevalence of these errors. This

approach will require changes from doctors, nurses, pharmacists, and others in the health care industry, from the Food and Drug Administration (FDA) and other government agencies, from hospitals and other health-care organizations, and from patients.

In 1992, the FDA began monitoring medication error reports that are forwarded to FDA from the United States Pharmacopoeia (USP) and the Institute for Safe Medication Practices (ISMP). The Agency also reviews MedWatch reports for possible medication errors. Currently, medication errors are reported to the FDA as manufacturer reports (adverse events resulting in serious injury and for which a medication error may be a component), direct contact reports (MedWatch), or reports from USP or ISMP. FDA receives medication error reports on marketed human drugs (including prescription drugs, generic drugs, and over-the-counter drugs) and non-vaccine biological products and devices.

Common Medication Errors

In a study by the FDA that evaluated reports of fatal medication errors from 1993 to 1998, the most common error involving medications was related to administration of an improper dose of medicine, accounting for 41% of fatal medication errors. Giving the wrong drug and using the wrong route of administration each accounted for 16% of the errors. Almost half of the fatal medication errors occurred in people over the age of 60. Older people may be at greatest risk for medication errors because they often take multiple prescription medications.

Medication errors come in many forms: Patients can be given the wrong drug or dose because of an error in reading or writing a prescription. Doctors can fail to find out if a patient is allergic to a particular drug or has a condition that can be worsened by a medication. Different drugs may interact with each other to trigger a problem. Or, as in my case, two drugs with similar side effects can amplify the extent of that side effect synergistically. These errors are costly, in dollars as well as lives. Prescription errors are the second most frequent and expensive cause of medical malpractice claims, costing \$219 million a year, according to the Physicians Insurance Association of America.

There are many reasons for the growing incidence of prescription errors. Thanks partly to pressure from managed care, doctors have little time to spend with patients, often see patients they don't know, and are forced to make snap judgments. Patients' files are frequently unavailable, especially in emergency rooms and county hospitals. And pharmacists under pressure to fill prescriptions quickly may make mistakes.

Prediction and Prevention of Medication Errors

Information is only part of the problem of improving the safe use of medicines. The psychological theory of errors recognizes that in performing a habitual act we follow a 'schema' that specifies the nature and order of the steps required to perform the act [26] When we tie our shoe laces, or write a cheque, or give an injection of benzyl penicillin, we follow such a schema. Sometimes we err. We write '3 Jan 2006' on our cheques on 3 Jan 2007. Or we are presented with a prescription 'Lamisil' (terbinafine, an antifungal) but read 'Lamictal' (lamotrigine, an antiepileptic agent). Or we automatically draw up penicillin powder and use the potassium chloride solution in the nearest ampoule without realizing it. Such errors, in which steps in the schema are omitted, duplicated, or subverted by those of another schema, are the price we pay for 'automatic', learned, behavior. These slips are unconscious, so that exhortation will not prevent them. Their frequency is increased by distractions, simultaneous and competing demands, and tiredness: just the circumstances of hospital medicine.

To Reduce Medication Errors

When a physician gives a prescription, sufferer have got to ask him or her to tell the identify of the drug, the right dosage, and what the drug is used for. The healthcare professional have to be sure that the sufferer knows the instructions for any medications he may be taking including the correct dosage, storage specifications, and any particular directions. In the clinic, one must

ask (or have a relative or buddy ask) the title and cause of each and every drug that is being given. One must be definite to tell doctor the names of all the prescription and non-prescription drugs, dietary supplements, and natural preparations which can be being taken every time the medical professional writes a new prescription. This will likely support to hinder a different kind of remedy situation, undesirable and possibly serious interactions amongst drugs. Finally, not ever be afraid to ask questions. If the identity of the drug on the prescription looks specific than is predicted, if the directions show up distinctive, or if the capsules or medication itself looks specific, one have to inform the health practitioner or pharmacist correct away. Asking questions if at all is a free and easy option to make certain that one do not become the victim of a medication error.

A Paradigm Shift In The Patient-Provider Relationship

The first step is to allow and encourage patients to take a more active role in their own medical care. In the past the nation's health care system has generally been paternalistic and provider-centric, and patients have not been expected to be involved in the process. But one of the most effective ways to reduce medication errors, is to move toward a model of health care where there is more of a partnership between the patients and the health care providers. Patients should understand more about their medications and take more responsibility for monitoring those medications, while providers should take steps to educate, consult with, and listen to the patients. To make this new model of health care work, a number of things must be done. Doctors, nurses, pharmacists and other providers must communicate more with patients at every step of the way and make that communication a two-way street, listening to the patients as well as talking to them. They should inform their patients fully about the risks, contraindications, and possible side effects of the medications they are taking and what to do if they experience a side effect. They should also be more forthcoming when medication errors have occurred and explain what the consequences have been. Patients or their surrogates should in turn take a more active role in the process. They should learn to keep careful records of all the medications they are taking and take greater responsibility for monitoring those medications by, for example, double checking prescriptions from pharmacies and reporting any unexpected changes in how they feel after starting a new medication. Also, the healthcare system needs to do a better job of educating patients and of providing ways for patients to educate themselves. Patients should be given opportunities to consult about their medications at various stages in their care—during consultation with the providers who prescribe their medications, at discharge from the hospital, at the pharmacy, and so on. And there needs to be a concerted effort to improve the quality and the accessibility of information about medications provided to consumers. The FDA, the National Library of Medicine, and other government agencies should work together to standardize and improve the medication information leaflets provided by pharmacies, make more and better drug information available over the Internet, and develop a 24-hour national tele- ...one of the most effective ways to reduce medication errors, is to move toward a model of health care where there is more of a partnership between the patients and the health care providers and the phone helpline that offers consumers easy access to drug information.

To Err Is Human -- Information Technologies to the Rescue

A second important step in reducing the number of medication errors will be to make greater use of information technologies in prescribing and dispensing medications. Though technology is far from the only answer, a host of new devices have cropped up that promise to help. Leapfrog Smart Products, Inc., of Maitland, Fla., offers a "smart card" the size of a credit card that patients can keep in their wallet. Loaded with a built-in computer chip, the card stores insurance, financial, and medical information, including a patient's medication history, drug allergies, vital signs, cholesterol levels, and more. The card is inserted into a computerized reader and is updated at each medical appointment. Smart-card technology is widely used in Europe and in some Florida hospitals. Where the smart card can really help is with patients

who are unconscious, confused, or who don't speak the same language as the doctor.

In 1999, a database called ePocrates was introduced by a company. This system provides information on side effects and drug interactions for more than 1,600 medications, data that can be downloaded from the Internet to a hand-held computer that a doctor can carry on rounds. The manufacturer claims that more than 80,000 doctors and nurses already use the device at teaching hospitals.

In the future within the near future, computerized systems may be in position at most hospitals and clinics throughout the country, permitting medical professionals to form prescriptions instantly right into a pharmacy-linked pc. Double checks for dosage amounts, drug interactions, and patient allergies will likely be automatic, and there will probably be no errors due to doctors' illegible handwriting. Already in use at one of the crucial nation's hospitals -- including Brigham and ladies's sanatorium in Boston -- these programs have lowered medicine error by means of as so much as 81% as reported within the July-August 1999 predicament of the Journal of the American clinical Informatics association.

Improved Labeling and Packaging of Medications

Another way to reduce medication errors is to ensure that drug information is communicated clearly and effectively to providers and patients. Some errors occur simply because two different drugs have names that look or sound very similar. It is recommended that the drug industry and the appropriate federal agencies work together to improve drug nomenclature, including not just drug names but also abbreviations and acronyms. At the same time, the information sheets that accompany drugs should be redesigned, taking into account research that identifies the best methods for communicating information about medications.

Policy Recommendations

Reducing preventable adverse drug events will demand the attention and active involvement of everyone involved. The federal government should, for example, pay for and coordinate a broad research effort aimed at learning more about preventing medication errors. Various regulatory agencies should encourage the adoption of practices and technologies that will reduce medication errors. Accreditation agencies should require more training in medication-management practices. These efforts will pay off in far fewer medication errors and preventable adverse drug events, far less harm done to patients by medications, and far less cost to the nation's economy. The drug industry and the appropriate federal agencies work together to improve drug nomenclature, including not just drug names but also abbreviations and acronyms.

Many error arise thus of poor oral or written communications. Stronger communication expertise and better interactions amongst participants of the wellbeing care workforce and the sufferer are essential. The informed consent method should be used as a patient safeguard device, and the patient must be warned about fabric and foreseeable serious part effects and be instructed what indicators and signs should be right away reported to the physician before the patient is compelled to go to the emergency division for urgent or emergency care. Last, lowering medication error is an ongoing system of high-quality improvement. Faulty methods need to be redesigned, and seamless, computerized built-in remedy delivery have got to be instituted by means of well being care authorities thoroughly proficient to use such technological advances. Sloppy handwritten prescriptions must get replaced through computerized health care provider order entry, an awfully powerful system for lowering prescribing/ordering blunders, but an additional far much less high-priced but strong exchange would contain writing all drug orders in simple English, as an alternative than carrying on with to make use of the elitists' arcane Latin phrases and shorthand abbreviations which might be subject to misinterpretation. In spite of everything, mighty communication is high quality comprehensive when it's clear and easy.

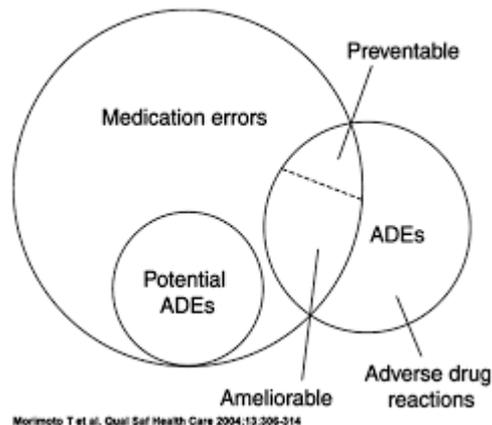


Fig. 4: information technology interventions to improve medication safety [27].

Computerized Physician Order Entry (COPE) and Clinical Decision Support Systems (CDSS) are promising systems, but need to be balanced against an initial expenditure that must be borne for long term benefits, which in turn need to be monitored and measured [Kaushal et.al [28]. Use of standard protocols and guidelines coupled with academic education promote a more consistent approach to patient care and these should be put in place. Breakdown in communication is a common cause of harm to patients [29] and this need to be addressed at several levels. It is vital to evaluate the prescription writing skills acquired by students. The issue of medication errors in India is extremely complex and goes much beyond brand names and phonetics since generic brands offer the considerable advantage of quality combined with cost effectiveness in the treatment of a variety of diseases [30] Much has been done to date and much more is being done. Finally, it is important to work in conjunction with the most important stakeholder- the patients and help them understand the risks involved in healthcare and work with them to reduce harm.[31-32]

PHARMA INFORMATION SYSTEM

Hospital pharmacy supervision is to ensure that medicines are accessed and used safely by patients and professionals both within the environments of a hospital and beyond [33,34,35]. Pharmacy involves information processing, which means retrieving information from one file and using it to compare, update, or display information from another file [36]. The pharmacist could play an essential role in providing accurate data for managing patient care. Information systems are now necessary to help pharmacists to perform their expanding list of daily tasks efficiently [37]. The pharmacy information system collects, stores and manages information related to drugs and supervises the use of drugs in line with patient care [38]. The pharmacy information system [39] can rely on management information system to track and dispense drugs to hospitals and health care organizations [40]. Pharmacy information systems are also among the most widely used clinical information systems today [41].

Pharmacy information systems have regularly been used in the delivery of pharmacy services since the early 1980s. Today's systems perform many clinical decision support functions such as dose range checking, drug-drug interaction checking, food-drug interaction checking and drug-laboratory results checking [42]. Pharmacy information systems could reduce the risks involved in drug dispensation and drug interpretation errors [43, 44, 45].

The chief medical officer, medical staff committee and pharmacy directors can use retrospective data, generated by the pharmacy information system, to identify trends in drug use, and to support formulary or inventory management decisions. The information could also be used to achieve compliance with the relevant guidelines or protocols. Medications use evaluation, adverse drug reaction (ADR) review, and other clinical and regulatory

requirements through the primacy information system [46]. In addition, pharmaceutical firms and pharmacies are communicating everyday to transmit a large amount of information [47]. Comprehensive and updated information transmission of the pharmacies and drug companies have significant role in drug use management. Pharmaceutical companies are commercial and scientific entities, which produce the necessary commercial and scientific information [48]. Pharmaceutical industry spends much more time and a lot more resources on generation, collaboration, and dissemination of medical information than it does on production of medicines. This information is essential as a resource for development of medicines [49]. Pharmaceutical firms collect information about the market, customers and products of the company, evaluate and analyze them, and then they deliver the information to the production, research and development units in order to improve their quality [50]. Pharmacy information system is capable of delivering a list of drugs that need to be ordered. The computer using the program adopted for this purpose often provides reports on drug purchase histories that are invaluable for the hospital inventory control management. Such reports play an important role in fulfilling information needs of pharmaceutical industries [36]. In line with such issues, the current research is intended to investigate the status of pharmacy information systems in university hospitals, on the one hand, and their relationship with pharmaceutical firms, on the other.

The Pharmacy information system is vital in both inpatient and outpatient pharmacy service areas [46]. Most pharmacy information systems both simplify and streamline medication dispensing and inventory control by automatically checking all drug orders and dosages against the patient profiles to ensure the intake of proper dosage, and to prevent contradictions. Such systems generally increase the efficiency of drugs' distribution and improve the monitoring of their proper usage [41]. The information contained in pharmacy information systems is important to the management of the pharmacy [47]. It enables pharmacists to maintain a database of patients, prescribers, and the drugs. The database (information) can also be used to reduce errors and to speed up the handling of subsequent prescriptions and refills [37]. According to Bates' assertions [51], it is essential to consult with specialists like pharmacists and medical informatics if we are to design our databases appropriately. Appropriate databases can reduce medication errors significantly [51]. It can also help to reduce pharmaceutical errors significantly and to manage the inventory of hospital pharmacies effectively. Brown maintains that pharmacy information system must support checking functions such as dose range, drug-drug interaction, food-drug interaction, and drug-laboratory results. Studies have shown that between 6.5% and 23% of adverse drug reactions are attributable to drug interaction and PIS is capable of controlling drug interactions [42]. Regarding the study results, pharmacy information system must support pharmaceutical therapeutic processes. According to Reddy's studies (2004), the precise calculation of medication dosages is the most critical element in providing pharmaceutical care and in achieving optimal patient outcome. Sometimes, even minor dosage calculation errors can be dangerous to the patient and may prove very costly [52]. According to Kaushal's study (2002), bar coding can decrease administration errors up to 80% [53], but only 30.7% of the hospitals under study measure drug consumption dosage. Thus, it is necessary to prevent drug interactions and patient drug therapy issues through pharmaceutical data processing. According to a study carried out by Oraby (2008) on pharmacy information system reports, the system must prepare drug utilization review reports to analyze trends and costs of drug therapy [54]. The pharmacy information system has a key role to play in delivering efficient pharmaceutical services. Its respective information can reduce drug consumption and drug production faults and improve drug therapy procedures. Data elements of drug therapy have important roles not only in reducing pharmaceutical errors and controlling drug interactions, but also in achieving business and economical purposes. Thus pharmacy information system designers are required to design these information databases more accurately by performing user information needs assessment studies. Moreover, as the current

study implies, pharmaceutical firms and hospital pharmacies should be more actively involved in marketing, sales and purchase of drugs. However, the study indicated that many firms and pharmacies had very poor record of information exchange on important issue such as post marketing surveillance, research and development and adverse drug reactions. If pharmaceutical firms communicate more effectively with hospital pharmacies on such issues, they can certainly improve the quality of their pharmaceutical products, reduce drug costs, and develop newer drugs.

PHARMACOKINETICS, MATHEMATICAL MODEL IN DRUG DESIGN

The development of drugs is time-consuming, costly and risky. It is estimated that 90 percent of drug candidates fail during the drug development process. Hence, the pharmaceutical industry is in search of new tools to support drug development. Computational modeling and simulation prove to be a useful tool to improve the efficiency in developing safe and effective drugs.

The complete process of drug development consists of a preclinical and clinical part. In preclinical, different compounds are tested for an effect in animals. The clinical part is divided into three phases

- Phase 1 - the drug is tested in healthy humans for physiological compatibility.
- Phase 2 - the pharmacological / therapeutic effect is investigated.
- Phase 3 - the drug is tested in thousands of patients.

An experiment in drug development consists of two parts. The pharmacokinetics (PK) describes the time course of drugs. The pharmacodynamics (PD) is the study of the pharmacological effect of drugs. In this section, we shall develop mathematical pharmacokinetics / pharmacodynamic models based on preclinical experiments. Such models are used to describe measurements, to categorize the pharmacological effect of different compounds, to stimulate different dosing schedules (e.g. for first in human dose selection) and also to understand underlying mechanisms of disease and drug response. Hence, mathematics has an important impact on drug development and it is commonly believed that the role of mathematical modeling will further increase.

However before we get down to discussing the mathematical model in drug design it is essential to understand the concept of modeling and simulation.

Modeling and Simulation

Modeling and Simulation methods have been adopted by the pharmaceutical industry to reduce attrition rates of drugs. Modeling and Simulation have enabled the industry in identifying and validating target, predicting its efficacy, absorption, distribution, metabolism, excretion, toxicity, and safety of drug candidates. Modeling and Simulation aids better understanding of data, predicting the human dose, developing new formulations and designing safety and efficacy standards.

The models operate on build-validate-learn-refine cycle. In the build stage all the available knowledge that can aid the drug development process is captured. The available knowledge is used for predicting observations in the validation phase and any variance in the predicted and observed is analyzed scientifically in the learning phase. The output of the scientific analysis is incorporated in the model in the refining phase and the cycle is repeated.

Once a model has proved its utility in providing satisfactory results it can be used on a routine basis thereby leaving animal and the use of other expensive tests for final conformation only. Adoption of such methods has led to a sizeable reduction in the cost of drug development. Thus, knowledge based drug development leads to a marked improvement in knowledge management and decision making.

Schematic Overview of Drug Development

As indicated in Fig.5 the average time period for drug development is approximately 12 years i.e. from the research phase to the market. During this period the drug candidate goes through various phases before it is ready to be launched commercially into the market.

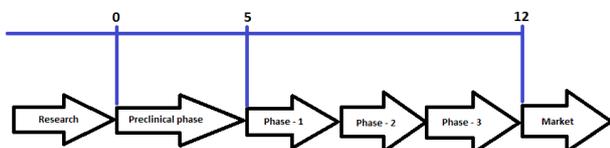


Fig.5:Schematic overview of drug development.

- In the research Phase the compounds will be developed.
- The Preclinical Phase will involve:
 - Animal experiments
 - Candidate selection
 - First in human dose prediction
- The testing phase will involve:
 - Phase 1 – test on healthy humans
 - Phase 2 – therapeutic exploratory
 - Phase 3 – therapeutic confirmation

Principles of Drug Disease Modeling:

Understanding the principles of drug-disease modeling necessitates studying pharmacological assumptions and terms.

The preclinical phase of drug development comprises of the study of two parts.

- The first part shall deal with the time course of the drug concentration in the blood and the distribution of the drug in the body, at this stage one is not interested of the effect of the drug on the disease but merely observes what the body does to the drug. This part is called pharmacokinetics (PK).
- The second part observes the development of drug and the pharmacological effect of the drug on the disease. In this stage one observes the drug response and its effect on the body. This part is called pharmacodynamics (PD).

Combining pharmacokinetics is the driving force of the pharmacological effect of the drug on the disease. Thus a PKPD experiment would involve the study of pharmacokinetics and pharmacodynamic effect on multiple individuals. Naturally, the PK data is sparse as multiple readings at various time points have to be taken from all the individuals who are part of the experiment. On the other hand, the PD data has appropriate readouts of the disease development.

To get a realistic overview of the drug, different doses should be administered. The PD data with an administered drug is called perturbed data. A placebo is also administered to study the development of the disease with no drug effect and is called unperturbed data. The total data, perturbed as well as unperturbed is called a dosing group.

The first step in building a PKPD model is to confirm the PK of the drug. In this section we shall be presenting the modelling of PK in a linear differential equation.

Pharmacokinetic Modelling

Pharmacokinetics is the study of drug and/or metabolite kinetics in the body. In pharmacokinetics compartmental modelling is an important concept. To gain an idea of this concept, take example of human heart. A human heart has four distinct chambers, each with a specific function.

Blood, which has been depleted of oxygen returns through the veins to the right atrium. It is then transferred to the right ventricle. The right ventricle pumps the blood into the lungs and then the blood moves into the left atrium. Finally the body to distribute the

oxygenated blood to all of the organs and tissues of the body. Each chamber of the heart has a specific function, and there is a specific flow of blood involved. The following schematic depicts the four chambers of the heart along with the direction of blood flow.

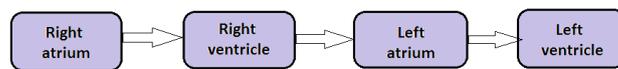


Fig.6: Flow of Blood.

The above Fig.6 represents the flow of blood, from one chamber to another. The flow is unidirectional. In other words, the blood does not move from the right ventricle back into the right atrium (at least it doesn't happen with a normal, healthy heart!), thus chambers of the heart are separate "compartments" that the blood passes through.

Thus, a pharmacokinetics model is a mathematical description of the biologic system which can be used to stimulate the rate processes that describe the movement of the drug in the body. The fundamental and simple type of model used in pharmacokinetics studies is the compartment model. Term compartment represents a group of tissues, that are similar in certain characteristics (e.g. partition properties of rate of blood flow) or specific entries (e.g. fat, plasma proteins, drug affinity). Thus, it does not represent a specific tissue, fluid or particular portion of the body. These compartments are connected to each other by pathways that may be reversible or irreversible. Reversible pathways include weak binding of the drug to plasma proteins while irreversible pathway is the elimination of the drug from the body through urine or excretory pathway.

Compartment modeling is a connote of expressing of expressing mathematically or quantitatively, the time course of the drug throughout the body and compute meaningful pharmacokinetic parameters.

Pharmacokinetic models are referred to as open models, example, one-compartment open model, two compartments open model, etc. the term open means that the administered drug is removed from the body by excretory pathway while the meaning of closed model is that when the drug is not removed from the body, by the excretory pathway. Example one compartment closed model, two compartments closed model etc. but this is not the case for drugs, as all administered drugs are removed from the body, by single or other excretory mechanisms, so all pharmacokinetic models are basically open models. So, even if the term open is not used, it is to be understood that all models are open model, not closed model.

The pharmacokinetic analysis of experimental data is done by three different approaches.

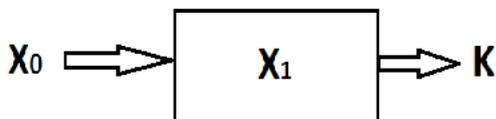
- Compartment model
- Noncompartment model
- Physiological model

Compartment models

Compartment models are termed deterministic because the observed drug concentrations determine the type of compartmental model required to describe the pharmacokinetics of the drug. This concept will become evident when we examine one and two compartment model. It is the most common approach for pharmacokinetic of the drug. To construct a compartmental model as a representation of the body, simplifications of body structures are made. Organs and tissues in which drug distribution is similar are grouped into one compartment. For example, distribution into adipose tissue differs from distribution into renal tissue for most drugs. Therefore, these tissues may be in different compartments. The highly perfused organs (e.g., heart, liver, and kidneys) often have similar drug distribution patterns, so these areas may be considered as one compartment. The compartment that includes blood (plasma), heart, lungs, liver, and kidneys is usually referred to as the central compartment or the highly blood perfused compartment. The other compartments that include fat

tissue, muscle tissue and cerebrospinal fluid is the peripheral compartment, which is less well perfused than the central compartment.

The one compartment model is the most frequently used model in clinical practice. In structuring the model, a visual representation is helpful. The compartment is represented by an enclosed square or rectangle, that symbolize compartments and rates of drug transfer are represented by straight arrows (Fig.-7).



Where : X_0 = Dose of drug
 X_1 = Amount of drug in body
 K = Elimination rate constant

Fig.7:One Compartment Model.

The arrows represent material exchange, as illustrated for the different models below. Theoretical compartments with “unique” names like 1,2,3, central, peripheral, etc. are used. Then we draw arrows between these compartments to show how the drug is put into that compartment and the arrow pointing out of the box indicates that drug is leaving the compartment. This model is the simplest because there is only one compartment. All body tissues and fluids are considered a part of this compartment.

Intravenous bolus dosing means administering a dose of drug over a very short time period. A common distribution pattern is for the drug to distribute rapidly in the bloodstream and to the highly perfused organs, such as the liver and kidneys. Then, at a slower rate, the drug distributes to other body tissues. This pattern of drug distribution may be represented by a two compartment model. Drug moves back and forth between these compartments to maintain equilibrium.

Advantages of Compartment modelling:

- Gives an idea of various rate processes that are involved in drug disposition.
- Gives number of rate constants necessary for describing processes.
- Helps pharmacokineticist to derive differential equations for various rate processes.
- Helpful in development of dosage regimens.

Disadvantages of compartment modeling:

- It is applicable to specific drug under consideration.
- There might be variation in model within study model.
- Basis of this model involves curve fitting of plasma concentration with multi exponential mathematical equations.
- Behavior of drug within body might be able to fit to different models depending on route of administration.

Non Compartment Model

Use the non compartmental approach to parameter estimation. This will be able to define, use and calculate the parameters :

- AUMC (Area Under the first Moment Curve)
- MRT (Mean Residence Time)
- MAT (Mean Absorption Time)
- MDT (Mean Dissolution Time)

In NCA, plasma drug concentration is regarded as a random variable. The so-called statistical moments describe the distribution of this random variable. Statistical moments of n-order are defined by equation (1).

Equation 1

$$\int_0^{\infty} t^n \times C(t) \times dt$$

Where, $C(t)$ = plasma concentration
 t = time

Cl , the total clearance, V_{ss} , the volume of distribution at steady-state, and MRT , the mean residence time are calculated from AUC and $AUMC$;

$$Cl = \frac{Dose}{AUC}$$

$$MRT = \frac{AMUC}{AUC}$$

$$V_{ss} = \frac{Dose \times AUMC}{AUC^2}$$

Limitation of Non Compartment Model:

- While AUC and $AUMC$ are easily generated, they are UNABLE to visualize or predict plasma concentration concentration-time profile for other dosing regimens.
- Requires the kinetics to be linear and stationary (i.e., time-independent) for simple applications.

Physiological Model

These models are known as blood flow rate limited models or perfusion rate limited models. These models are drawn from anatomic and physiologic data. Therefore, these models are more realistic in representing drug disposition in different organs and tissues. A flow diagram for this is as shown below..

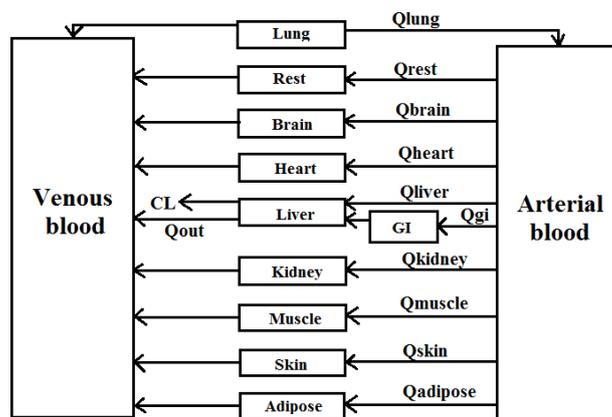


Fig.8: Physiologic Pharmacokinetics Model.

Advantages of physiological model:

- It involves simple, straight forward mathematical treatment.
 - It does not require data fitting because it is possible to predict the drug concentration in different body regions from the organ or tissue volume, perfusion rate and experimental value of tissue to plasma concentration.
 - This model provides accurate description of drug concentration time profile in any organ tissue.
 - It is also able to know the effect of changed physiology or pathology on disposition of drugs changes in various pharmacokinetics parameters because of their analog to actual physiologic and anatomic measures.
 - Data obtained from many test animals can be extrapolated to humans.
- Disadvantages of physiologic model are in getting exhaustive experimental data.

Concepts and their importance in the study of pharmacokinetics

Compartmental methods estimate the concentration time graph using kinetic model. Non-compartmental methods estimate the exposure to a drug by estimating the area under a curve of a concentration-time graph. This non-compartment model are often more versatile in that they do not assume any specific compartmental model and produce accurate result also acceptable for bioequivalence studies.

A compartment model can simulate all the biological process in the body that can lead to better understanding of the pharmacodynamic effects. These can be used to study the transport process between interconnected volumes, as flow of drugs and hormones in the body. It can also be used to study the concentration of the drug in plasma, as a function of time. Compartment models can help in dose calculation, the duration of exposure, routes of administrations, transpositions from animal to human beings. [55]

PATIENT MONITORING SYSTEM

Giving care and wellbeing help to the mattress ridden sufferers at valuable phases with developed clinical services have come to be one of the most important issues within the ultra-modern worrying world. In hospitals the place a huge quantity of patients whose bodily stipulations must be monitored most likely as a part of diagnostic system, [56] the need for a cost mighty and quick responding alert mechanism is inevitable. Appropriate implementation of such programs can furnish timely warnings to the medical staffs and doctors and their carrier can be activated in case of clinical emergencies. Gift-day systems use sensors which

are hardwired to a computer subsequent to the bed. The use of sensors detects the conditions of the sufferer and the data is accrued and transferred utilizing a microcontroller. Medical professionals and nurses have got to discuss with the sufferer ordinarily to evaluate his/her present situation. Additionally to this, use of a couple of microcontroller based wise system provide high stage applicability in hospitals the place a colossal number of sufferers have got to be in general monitored. For this, here we use the proposal of community technology with wireless applicability, delivering each and every patient a distinctive identity by which the health practitioner can quite simply determine the patient and his/her present repute of wellbeing parameters. Making use of the proposed procedure, knowledge can also be dispatched wirelessly to the relevant patient Monitoring process (CPMS), permitting continuous monitoring of the patient. Contributing accuracy in measurements and offering security in correct alert mechanism provide this procedure a higher degree of patron delight and low rate implementation in hospitals. Accordingly the sufferer can engage in his everyday hobbies in a relaxed atmosphere the place distractions of hardwired sensors will not be gift. Physiological monitoring hardware may also be readily carried out making use of simple interfaces of the sensors with a Microcontroller and can quite simply be used for healthcare monitoring. This will likely permit progress of such low fee devices established on traditional human-pc Interfaces. The system we proposed here is effective in monitoring the different bodily parameters of a lot quantity of bedridden patients after which in alerting the worried medical authorities if these parameters leap above its predefined crucial values. As a result far off monitoring and control refers to a subject of industrial automation that's getting into a new generation with the development of wi-fi sensing contraptions.

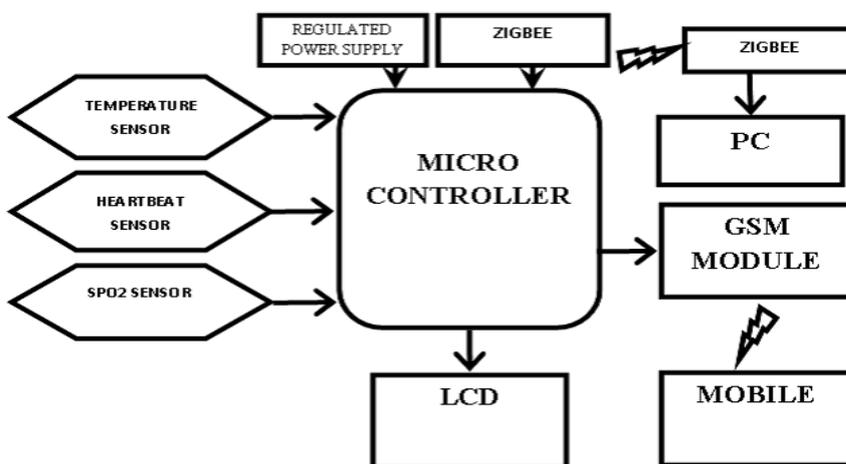


Figure 9: Block Diagram of PMS.

Related Work

As a part of the case study related to the various patient monitoring systems, we found that although there are many products of Patient Monitoring System in the market, few of them implemented active network technology and used mobile interface for the alert mechanism. PMS in [57] deals with the constant monitoring of health parameters using a palm-top like device and informing the service providers when ambulating conditions arise. It acts like a point-to-point system. For multiple patients in hospitals, keeping one such system for each patient will become costlier. In [58] the proposed system has the ability to measure various physical parameters of different patients, but it uses the internet facility for conveying the status of patients to the authorities. Paper [59] mainly deals with the software aspects of designing a system which can access the data base which include various health parameters of the patients.

Working of PMS (Patient monitoring system)

In our proposed system we use various sensors to continuously monitor critical parameters of the patients and report to the

Doctors or Nurses in attendance for timely response in case of critical situations. Our PMS has the following basic components.

- Various sensors attached to the body of the patient.
- Microcontroller for analog signal interface
- Wireless transmitting and receiving system for data transfer.
- A Central Patient Monitoring System (CPMS) observing unit basically a PC.

The sensors are attached to the body of the patients without causing any discomfort to them. Here, we monitor the important physical parameters like body temperature, percentage of oxygen in blood, heart beat rate using the sensors which are readily available. Thus the analog values that are sensed by the different sensors are then given to a microcontroller attached with it.

The microcontroller processes these analog signal values of health parameters separately and converts it to digital values using ADC converter. Now, the digitalized values are sent to the CPMS. At any time any of the doctors or nurses can log on the CPMS and check the history of the observed critical parameters of any of the patient attached to the network. When ever the sensors

detect critical values, the GSM modem automatically sends the detected values to doctor's mobile via SMS. Doctor can reply back to the patient via SMS giving respective suggestions, which will be displayed on the screen.

Internal working

The sensors are connected to the controller. The information detected via the sensors will likely be despatched to the controller. Here the output of sensor is analog. So, so as to convert the analog output into digital, ADC is used. ADC converts analog knowledge to digital information and this knowledge is sent within the form of an SMS to doctor's cellular, using GSM modem. Once the healthcare professional receives the message and exams the abnormal of the sufferer, he can advocate medicines via SMS, which will likely be displayed on lcd, which is attached to the controller.

Modules

In Patient Monitoring System, we use the following technologies and methodologies which will provide an active and user-friendly environment for the working of the system:

- Power supply circuit
- Micro Controller
- GSM modem
- ZIGBEE
- Heart beat sensor
- Temperature sensor
- SPO2 sensor

Power Supply circuit

The general power supply in India is 230v AC. But, we need only 3.3v DC supply for the LPC2148. Hence, we need to convert this 230v AC into 3.3v DC by using a simple circuit. This circuit consists of transformer, bridge rectifier, and capacitor and voltage regulator. First the 230v AC power supply is given as input to the step down transformer (12-0) which step downs the 230v AC into 12v AC and from there we send 12v AC as an input to the bridge rectifier, the bridge rectifier converts the 12v ac into a pulsating 12v DC (still contains some AC components in it). Since the output of the bridge rectifier is not pure 12v DC we need a filter to filter all the remaining AC components so we are using capacitor as a filter. The 12v DC (pulsating) is sent to the capacitor (1000uf) it charges (like it in takes) whenever it finds the AC components and sends the DC components away from it. Then the output of the capacitor is pure 12v DC. Since we require only 3.3v DC then send 12v DC into a voltage regulator (LM317) which regulates the 12v DC into 3.3v DC which is the exact voltage supply required for LPC2148 controller. By this procedure, we are converting the output voltage to our desired voltage. The desired voltage is given to the VCC (pin) & VGND (pin) of LPC2148 microcontroller.

Micro Controller

The controller which has been used here is LPC2148. LPC2148 microcontrollers are based on a 32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support that combine microcontrollers with high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADCs, 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these

microcontrollers suitable for industrial control and medical systems.

GSM

A GSM modem is used to alert the caretakers when there is a abrupt change in the measured parameters. GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in all parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band.

ZIGBEE

The low cost allows the technology to be widely deployed in wireless control and monitoring applications. Low power usage allows longer life with smaller batteries. ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard. ZigBee is targeted at applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device.

Heart Rate

Heart rate is the number of heartbeats recorded per minute typically recorded as Beats per Minute (BPM) as in [60]. In the proposed system, we make use of a technique called Photoplethysmography (PPG). PPG is a simple and low cost optical technique that can be used to detect the blood volume changes in the micro vascular bed of tissues. In this technique, a bright led and a LDR is employed to detect the blood flow at the finger tip or any other peripheral part of the body. The light from the effulgent led gets reflected from the tissues in the body components and the amount of light reflected determines the volume of blood flowing. If more blood permeates it, more light is reflected back. We have to amplify the signal and abstract the unwanted noise signals.

Body Temperature

Temperature sensors in the medical field have been used from time immemorial to quantify the body temperature and monitor the medical condition of patients. With a temperature sensor affixed to the body of the patients, quantification of absolute temperature of the patient will be precise, and the system sanctions for perpetual monitoring of a patient's differential vicissitude in temperature.

Experimental Setup

The modem which we are using is GPRS/GSM modem. GSM/GPRS modem can be used to send messages and also make a call through computer. HyperTerminal can be used to control the modem.

PMS in Future

The scalability of the proposed system opens for a broad variety of applicability in Multispecialty hospitals where many quantity of critical care models is gift. The scalability is carried out by the networking facility which presents multiple Sensor-Microcontroller modules to ship data consecutively to the gateway connected to the laptop. Together with this, increasing the project to enable two method communications between doctors and patients, will probably be beneficiary in many circumstances the place sufferer desires to communicate straight to the health practitioner. This may allow medical professionals to ship messages to the sufferers, and consequently make the consultation and repair provision extra obvious and powerful.

AUTOMATED DISPENSING SYSTEMS

In the 1980's, automated allotting instruments appeared on the scene, a generation after the advent of unit-dose dispensing. The invention and construction of those instruments introduced hopes

of reduced rates of medicine blunders, extended efficiency for pharmacy and nursing staff, equipped availability of medications where they're most traditionally used (the nursing unit or inpatient ward), and extended pharmacy inventory and billing features. Although the ability of such methods to make contributions to patient protection seems nice, relatively few studies have evaluated the scientific have an impact on of these instruments.

Automated dispensing systems are drug storage devices or cabinets that electronically dispense medications in a controlled fashion and track medication use. Their principal advantage lies in permitting nurses to obtain medications for inpatients at the point of use. Most systems require user identifiers and passwords, and internal electronic devices track nurses accessing the system, track the patients for whom medications are administered, and provide usage data to the hospital's financial office for the patients' bills. These automated dispensing systems can be stocked by centralized or decentralized pharmacies. Centralized pharmacies prepare and distribute medications from a central location within the hospital. Decentralized pharmacies reside on nursing units or wards, with a single decentralized pharmacy often serving several units or wards. These decentralized pharmacies usually receive their medication stock and supplies from the hospital's central pharmacy. More advanced systems provide additional information support aimed at enhancing patient safety through integration into other external systems, databases, and the Internet. Automated dispensing systems (ADS) have the potential to reduce certain types of medication errors such as omitted doses, but are less effective in reducing other types of errors. There is some evidence to suggest that ADS assist with storage capacity and stock control, but the evidence is conflicting regarding time saved following installation of ADS. Cost savings are related to better stock control.

The use of automated dispensing systems (ADS), also known as automated dispensing cabinets (ADC), unit-based cabinets (UBC), automated dispensing devices (ADD), automated distribution cabinets and automated dispensing machines (ADM), in hospitals is increasing. In 2011, 40% of US hospital pharmacies had a decentralised inpatient medication distribution system and 89% of those used ADS 1 . There are different types of ADS; ward-based ADS, pharmacy-based ADS and automated unit-dose dispensing systems (Table-2). Theoretical benefits of ADS are improved safety and efficiency, namely through reduced dispensing times, improved storage capacity and stock control, more appropriate allocation of staff to tasks and reduced dispensing errors.

Table 2: Description of the three different types of automated dispensing system including in this review (modified by james) [61]

Pharmacy-based ADS	
• Medication stored on designated shelves	Rowa Speedcase PackPicker
• Dispensing order entered,robotic arm or picking device selects medication from shelf and transfers to delivery station	PillPick consisting of PillPicker(packRing), DrugNest(storage) and
• Checked and labeled by pharmacy staff	PickRing(dispensing)
Ward-based ADS	
• Medication stored in electronically controlled cabinet linked to computer	Pyxis medStationTM MedSelect McLaughlin
• To access medications,nurse enters password and patient details	
• Drawer containing selected medication opened	
• Nurse administers medication	
• System tracks who accessed the cabinet and for whom medications were selected	

Automated unit-dose dispensing

- Medication stored in calibrated canisters Baxter ATC-212
- When dispensing order entered,
- ADS ejects medication from the canister into strip-packing device which labels and seals the strip

Medication safety aspects

Observational studies following implementation of ADS in UK hospital pharmacies have shown significant decreases in dispensing errors post ADS (from 0.64% to 0.28% in one study ; and from 1.2% to 0.6% and from 2.7% to 1.0% in a multisite study).Other studies have found non-significant reductions in dispensing errors following implementation of ADS and one study found no reduction in dispensing errors.

Storage capacity

Compared to traditional storage, installing ADS in hospital pharmacies appears to result in less occupied space and increased storage capacity . One study reported that storage capacity can be increased by 23 % to 123 % compared to traditional storage methods .

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More about ADS

ADS are effective in reducing the number of omitted doses, but are less effective in reducing other types of errors. The evidence for improved patient outcomes with ADS is scarce. Compared to traditional storage of medications in pharmacies, installation of pharmacy-based ADS appears to increase storage capacity and reduce the time taken to fill prescriptions. Studies evaluating time savings following implementation of ward-based ADS report inconsistent findings. Whether these findings translate to the language setting, where individual patient dispensing is common, remains to be evaluated. Most studies were small observational studies evaluating one brand of ADS conducted at a single site without a control groups. These studies have limited generalisability. Qualitative studies evaluating staff attitudes before and after implementation of ADS show improved attitudes over time.

Time savings

Two studies reported significant reductions in median time taken for the pharmacy-based ADS to 'pick' medications compared to staff picking medications off shelves. Other studies have reported non-significant reductions in time taken to fill first dose orders and time taken to dispense medications [61].

BARCODE MEDICINE IDENTIFICATION

A barcode is an optical, machine-readable, representation of data; the data conventionally describes something about the object that carries the barcode. Pristinely barcodes systematically represented data by varying the widths and spacings of parallel lines, and may be referred to as linear or unidimensional (1D). Later two-dimensional (2D) codes were developed, utilizing rectangles, dots, hexagons and other geometric patterns in two dimensions, conventionally called barcodes albeit they do not utilize bars as such. Barcodes pristinely were scanned by special optical scanners called barcode readers. Later applications software became available for contrivances that could read images, such as smartphones with cameras.[62]

Clinical pharmacy is the health science discipline devoted to optimization of medication therapy for promotion of wellness and disease preven- tion.[63]



Figure10: Barcode [1]

How barcode works

A provider places an electronic order that passes through the pharmacy system. The pharmacist reviews the order to ascertain there are no allergy or drug interactions. Once the pharmacist approves the order and schedules the dose, the information is passed on to the electronic medication administration record (eMAR) and a nurse.

On the patient's bedside, a nurse retrieves the product and scans its bar code along with the sufferer's bracelet. As each and every treatment is scanned, the process tells the nurse that the whole thing is veridical or brings up a caveat that anything is inaccurate. "We call it a closed-loop method," expounds Anne Bane, RN, MS, director of medical techniques innovations at Brigham and ladies's health center in Boston. "The medication order is tracked electronically by way of all the steps of the remedy method: injunctively authorizing, dishing out, and administration. There are checks and balances at each and every step to establish the patient receives the right remedy."

The result is better patient safety. "It's a sizably voluminous patient safety initiative," verbally expresses Chris Altendorf, administrative director of nursing informatics at Baptist Memorial Health Care Corporation (BMHCC) in Memphis. "It avails in averting medication errors right at the bedside. The bedside is the last stop afore administration and ergo a critical place to obviate errors from occurring. This kind of technology can make a cyclopean difference with patients."

"at the same time traditional methods would depend on individuals and approaches, more commonly recorded on paper, this technology integrates a third dimension to the approach with the aid of monitoring it on the laptop," integrates Edna Boone, MA, CPHIMS, senior director of healthcare information methods at HIMSS. "You're not relying on a individual by myself to verify a proper medicine handed or a near leave out. In integration, it's paramount to notice that bar coding transcends bedside administration since it encompasses the entire steps that medicine meting out goes by way of, including pharmacy receiving and stock." [64]

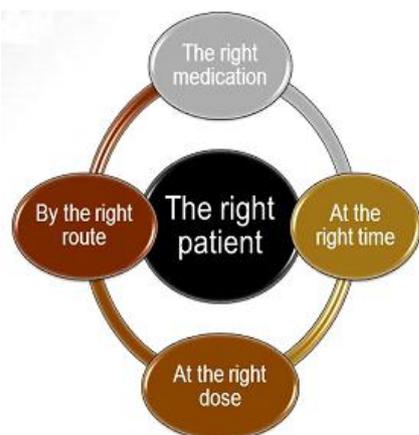


Fig.11:Five Rights of Barcode Medication Administration [65]

Medication- and patient-specific bar codes.

Medications can have each treatment-precise or patients specific bar codes. Each variety result within the desired laptop-readable code that helps the 5 rights of drug administration. Medication-specific bar codes are designated to at least one drug, dose, and dosage form. They most almost always embody the NDC

identifying the brand, drug product, strength, and dosage type, even though exclusive exact identifiers could even be used. There are a couple of strategies to achieving alleviation-certain bar codes on medications. First, the pharmacy must maximize the purchase of merchandise with company-utilized bar coding on immediate containers. 2nd, the sanatorium could opt for to buy medicines in bulk and to repackage these into instantaneous containers by means of utilizing computerized gear capable of printing a bar code on the label. Alternatively, the medical institution may go with to contract with repackaging businesses or overwrapping services or to hooked up medication nover wrapping procedures inhouse that incorporate the bar code on the overwrap label. In the end, some component to the bar-code-labeling work may be accomplished by way of manually making use of labels to extemporaneously prepared unit doses or on the spot containers (ampuls, vials, syringes, etc.) with a bar-code-label-generating software application. In most pharmacies, a combo of these options will be used seeing that of company product availability, existing crew purchasing agreements, equipment and employees availability, and outsourcing choices [66]

CONCLUSION

The role of the pharmacist is continuously increased with the development of technology to achieve feasibility in the retrieval of prerequisite information. Development of Information technology and use of computer enhanced the application of computer pharmacy. There use make the process fast, easy, smooth, effective and error free.

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