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Opportunity and Challenges in Pharmacy During  
COVID-19

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# INFORMATION COMMUNICATION TECHNOLOGY: OPPURTUNITY AND CHALLENGES IN PHARMACY DURING COVID-19

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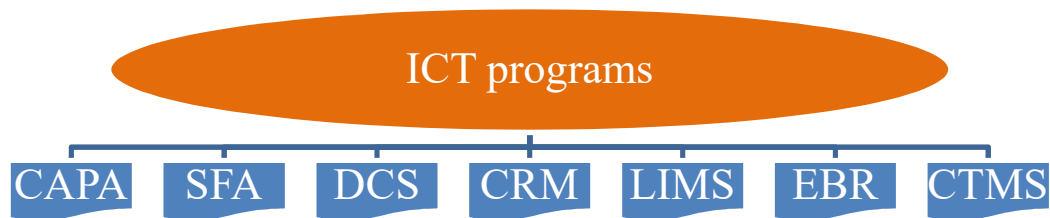
## ABSTRACT

There has been a tremendous rise of using information communication technology (ICT) such as computers and telecommunication equipments worldwide. In pharmaceutical sector, information technology is focused on the optimal use of drug information, data, knowledge, for problem solving, promote safe pharmaceutical care. During COVID-19 pandemic, there has been augmentation in information communication technology usage in pharmacy teaching, research, industrialized training sector including clinical research as well. Clinical trials in clinical research are being managed by clinical trial management system in biotechnology and pharmaceutical industries. Clinical trial management systems are cost and time effective and software includes budgeting, patient management, compliance with government regulations, project management, financials, patient management and recruitment, investigator management, regulatory compliance and compatibility with other systems such as electronic data capture and adverse event reporting systems. Clinical trial management system allows easy access to centralized data to reduce the number of delayed trials and helpful in present scenario. ICT help in industries to enhance efficacy and quality of drugs and product production. Information and communication technologies help industries in maintaining records more efficiently with increased accessibility, customer services and customer interaction. In the present paper, we have discussed the applications of ICT in teaching, research and pharmaceutical sector during and after COVID-19 pandemic.

**Keywords:** COVID-19, clinical research, pharmaceuticals, teaching and research.

## Introduction:

During COVID-19 pandemic, information communication technology(ICT) programs are used in pharmaceutical industries and in pharmacy teaching to increase accessibility, customer services, maintaining records, online teaching, online assignments, online examinations etc. There are various ICT Programs as shown in Figure 1.



**Figure 1. Various categories of ICT programs**

**1) Corrective action and preventive action (CAPA):**  
 Corrective action and preventive action could be a management tool employed in quality system in pharmaceutical and medical tool trade .CAPCA could be a part of internal control system. It provides an easy general procedure for action like verification, correction and interference. The main objective of this program is to research deviation, defaults, and failures and with preventive actions future incidence will be prevented. The result are going to be an entire, well documented investigation and answer which will satisfy regulative needs and kind the idea for a good continuous improvement set up for any company. The risk-based CAPA needs demand a well documented system that determines the basis explanation for nonconformance’s, system failures, or method issues, corrects the issues, and prevents them from revenant.

**2) Sales division automation:**  
 Sales force automation area unit the software system apps that area unit developed for sales management. SFA provides an automatic platform for work that makes general sales method for business lead, sales forecast and team performance management. SFA system is interlinked the contact management, chance management along with email integration and task management. With the assistance of contact management system software system you'll track your communication with customers; knowledge will be generated of all interaction, sales and activities in order that you'll assess the information. With SFA you'll produce task, remainders for your sales leads. SFA records all stages in a very sales method. Pipeline management software system provides sales lead trailing from associate initial inquiry through to a closed sale. It allows you to track every sales chance through your pipeline,

applying likelihood coefficient and prediction.

SFA is sometimes a vicinity of a client relationship management (CRM) system that mechanically records all the stages in a very sales method. The concept is to trace all contact that's been created with a client, beside the aim of the contact, and any follow up that will be required. This may embrace phone calls, emails and conferences. Having this info at your fingertips means that you'll cut back the chance of irritating your customers as sales efforts aren't duplicated.

### 3) **Distributed management system:**

DCS could be a system that managements sizable amount of management method within which there's a central operator supervisory control. Directed system includes blessings like improvement of responsibility, reduction in installation by localizing management functions in method plants and remote watching and oversight. Its aim is to alter the plant operation includes management and watching. DCS involves the multiple controllers in plant that area unit interconnected via a network to a central console.

Distribute management systems (DCS) use de-centralized or subsystems to manage distributed processes or manufacturing systems. They supply flexibility, extended instrumentality life, simplicity of latest instrumentation integration, associated centralized maintenance once utilized in an industrial atmosphere.

### 4) **Client relationship management:**

Company interaction with current and potential clients will be managed with the assistance of customer relationship management. This programs store and analysis knowledge concerning history of consumers to boost relation to extend the sales growth. CRM helps firms to develop client relationship in order that they become loyal to company and guarantee property revenue and profits, sales will increase and company's market growth takes place as a result of they supply repeat business. CRM employs info technology to enforce and execute relationship promoting approaches. CRM isn't solely IT for promoting, sales and service; it's a cross purposeful, client driven, business method management strategy that maximizes relationships and encompasses the complete organization mistreatment the technology obtainable. Firms that succeed the total practicality of a CRM system get a crucial business tool to contend in their international market with a well-planned strategy. info systems that implement client orientation methods area unit most promising to attain and sustain competitive advantage.

### 5) **Laboratory info management system:**

To manage and support laboratory operations like track specimens,

workflow, mixture knowledge for analysis functions laboratory info management system will be used. It ensures that every one works and operations area unit up to standards and rules. Laboratory info management system is additionally called laboratory management system (LMS).

Bulk knowledge will be analyzed of collected outcomes of a drug or chemical product, screening and multiple tasks for daily operations. LIMS provides essential testing tools for each stage of labor method by promoting electronic internal control method.

**6) Electronic batch records:**  
Electronic batch records area unit accustomed make sure the current sensible producing follow rules follow rules by government agency in pharmaceutical firms.

EBR helps to handle each drug product of each batch properly and helps in maintain and storing knowledge properly. EBR helps to calculate and assess sales, producing, transporting of product.

The master record stores all the materials, processes and activities that were needed for production of a given product. Electronic batch records give the structure and means that for mechanically collecting batch production knowledge into a formatted electronic document, reducing paper and manual records for a lot of correct record keeping. Data is recorded and hold on in encrypted kind, guaranteeing knowledge privacy.

**7) Test management system:**  
Clinical trials in clinical analysis area unit managed by test management system in biotechnology and pharmaceutical industries, This system helps in managing the look, performing, reporting, functions, and phone info concerning the participant, trailing the steps of trials and storing knowledge. Test management systems area unit cost- and time-effective. Software system includes budgeting, patient management, compliance with government rules, project management, financials, patient management and enlisting, investigator management, regulative compliance and compatibility with different systems like electronic knowledge capture and adverse event coverage systems. Test management system permits easy accessibility to centralized knowledge to cut back the amount of delayed trials. [1]

### **Advantages of ICT programs:**

**Communication** - Speed/time - money can be saved because it's much quicker to move information around. With the help of ICT, it has become quicker and more efficient.

**Globalization** - Video conferencing saves money on flights and accommodation. ICT has not only brought the countries and people closer together, but it has allowed the world's economy to become a single interdependent system to contact either a business or family member.

**Cost effectiveness** - It feels free to send an email (although it isn't); it's without doubt cheaper than phone calls. ICT has also helped to automate business practices, thus restructuring businesses to make them exceptionally cost effective,

**Greater Availability** - ICT has made it possible for businesses to be automated giving client's access to a website or voicemail 24 hours a day, 7 days a week

**Bridging the cultural gap** - Greater access to technology has helped to bridge the cultural gap by helping people from different cultures to communicate with one another, and allow for the exchange of views and Ideas, thus increasing awareness and reducing prejudice. [1]

**Creation of new jobs** - Probably, the best advantage of ICT has been the creation of new and interesting jobs.

**Education** - Computer's along with their programs and the Internet have created educational opportunities not available to previous generations.

Through ICT, images can easily be used in teaching and improving the retentive memory of student. [2]

### **Role of information communication technology in pharmacy education:**

Computer and related technologies have been used in distance learning through various ways such as Teleconferencing, video-conferencing, audio graphics, Teletext, video text, multimedia and hypermedia, eBooks, online database, online discussion, on-demand call in course etc. Virtual classrooms play a crucial role in distance learning. Students can raise their doubts and teachers can provide the solutions without getting to one's place.

ICT enables self-paced learning through various tools such as assignment, computer etc as a result of this the teaching learning enterprise has become more productive and meaningful.[2]

ICT helps facilitate the transaction between producers and users by keeping the students updated and enhancing teacher's capacity and ability fostering a live contact between the teacher and the student through e-mail, chalk session, e-learning, web-based learning including internet, intranet, extranet, TV audio-video aids, CD-ROM

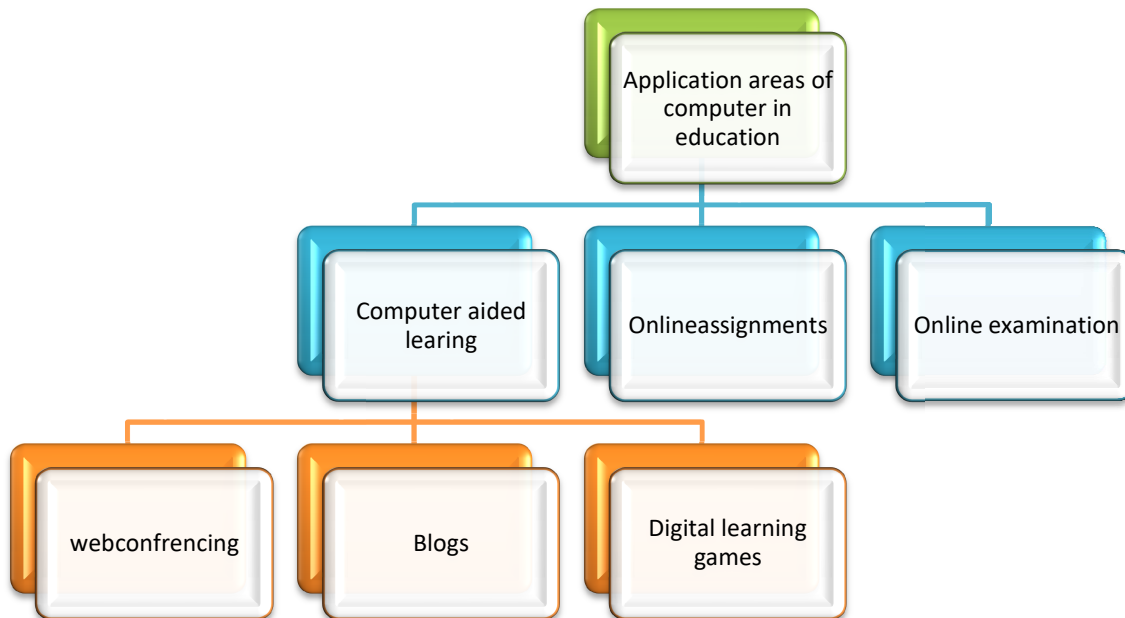
Edusat technology has become very powerful media for interactive participation of experts and learners and it reaches the unreachable. [3]

The following are the various benefits of using technology in distance learning:-

- Cost effective

- Independent of your time and place

Some of the applications of ICT in pharmacy education are given in Figure 2.



**Figure 2. Role of ICT in pharmacy education**

### **On-Line examination and monitoring**

Online examination and monitoring system have completely changed thanks to the event of modern education technology. [4] These systems ensure about the fairness and impartiality within the examination. Various researchers have been developing online examination system supported web. Today, various exams like GRE, GMAT, SAT, CCNA, MCSE and much more have been conducting computers in all over the world. [5] There are following benefits of using the web examination and monitoring systems:-

- Security
- Fairness and impartiality
- Save time and price

### **Computer-Aided Learning**

Today, computers have improved the standard of teaching and enhance the training process with the assistance of varied tools like multimedia projector, PowerPoint presentations etc.[6] Traditional methods of teaching are often monotonous, boring and students start getting frustrated. But information technology make learning process more interested through games, animated graphics etc.[7]

There are the subsequent benefits of computer-aided learning:-

- Interest and motivation
- Individualization
- Compatible learning style
- Optimal use of learning time
- Immediate feedback
- Error analysis
- Repetitive practice
- Pre-determined to process syllabus

### **Digital games:**

Digital games square measure “applications mistreatment the characteristics of video and pc games to form partaking and immersive learning experiences for delivery of such learning goals, outcomes and experiences”. [8] Digital games typically serve the twin purpose of promoting the accomplishment of learning outcomes whereas creating learning fun by providing simulations of real-world eventualities moreover as role play, problem-solving, and drill and repeat activities. [9] Additionally, gamified parts, like digital badges and leader boards, is also integrated into instruction to produce extra motivation for finishing appointed readings and alternative learning activities. It provides opportunities for college students to move with tutorial content in an exceedingly virtual setting through decision-making, problem-solving, and reward mechanisms.[10]

### **Web-conferencing**

Web-conferencing software provides a digital virtual meeting space laboratory where users login simultaneously and communicate a couple of given topic.[11] While each software application is exclusive, many share similar features like audio, video, or instant messaging options for real-time communication; screen sharing, whiteboards, and digital pens for presentations and demonstrations; polls and quizzes for gauging comprehension or eliciting feedback; and breakout rooms for little group work. Of the technologies included during this literature review, web-conferencing software most closely mimics the face-to-face classroom environment, providing an area where instructors and students can hear and see one another in real-time as typical classroom activities (i.e., delivering lectures, discussing course content, asking/answering questions) are meted out. Studies on web-conferencing software deployed Adobe Connect, Cisco WebEx, Horizon Wimba, or Blackboard Collaborate and made use of multiple features, like screen sharing, instant messaging, polling, and get away rooms. Additionally, most of the studies integrated web-conferencing software into courses on a voluntary basis to supplement traditional instructional methods.[11]



## Blogs

A diary could be an assortment of non-public journal entries, published, to which individuals might respond by providing extra feedback. As luck would have it, several diary applications square measure free, and lots of learning management systems (LMSs) provide a blogging feature that's seamlessly integrated into the web schoolroom. The convenience of blogging has attracted attention from educators, UN agency presently use blogs as associate tutorial tool for the expression of concepts, opinions, and experiences and for promoting dialogue on a good vary of educational topics.[12]

Some of the promising technologies which have been repurposed against COVID-19 related problems and their potential solutions are mentioned in Table 1.

**Table 1. Different types of exciting and promising technology have been repurposed for fighting different COVID-19 related problems and potential solutions**

Problem faced	Potential solution
Lack of equipment to treat COVID-19 patients	3-D printing
Not enough testing kits	All medical imaging[13]
How do the virus function	Protein structure computing
Vaccines take years to be produced	DNA medicine, recombinant vaccine
Therapeutically treatment of patients	Antibody treatment

## M-Health Technologies

Nowadays, Mobile computing and communication technology interventions for improving health care and service outcomes referred to as M- health which is used in a broad range of data collection and information transmission to support health behaviour change.

Some of the M-health services advantages are as under:

Messaging can promote safe medication

Improving knowledge of patients and pharmacist,

Pharmacist – patient interaction

Pharmaceutical care

Some technology involved in pharmacy and health care sectors are mentioned in Table 2.

<b>Table 2. Some technology involved in pharmacy and health care sectors</b>
Inpatient computerized provider order entry(CPOE) systems
Clinical decision support integrated with computerized provider order entry CPOE
Outpatient CPOE systems
Health education.
Drug therapy management services.
Use of bar-code technology during the inventory, preparation, compounding, and dispensing process
Collect and report pharmacy metrics, outcomes data, and pharmacists value
Integration of intelligent infusion devices into a closed loop medication use process i.e., CPOE, eMAR (electronic medication administration), BCMA (Bar coded medication administration) [14]

### **Different modes of Telehealth technology**

As with all new technologies, it is important to consider how barriers to health care access may affect the growing use of telehealth. There are three primary forms of telehealth technology, including telephone calls, video and instant messaging, including Messaging Chat mechanisms (EMR real-time, Cureatr, Voatle, Skype for Business), EMR messaging functions, Email, Virtual visit capabilities (e.g., webcam), Audio call resources (Jabber phone, blocked calls from personal line), Zoom/Webex/Skype.

Videoconferencing platforms may be preferred, have emerged as the go-to technology keeping governments and businesses running even as social distancing is being maintained. If the technology is available, virtual visits with webcams can be implemented, allowing for audiovisual capabilities. Pharmacists should collaborate with their Information Technology departments to identify options. The ability to bill for these remotely provided services varies widely depending on individual state laws.

### **Some apps & equipments developed for tackling COVID-19 in India**

FALCON app, Virus Tracking and Surveillance System

Humans AI, a Data Labelling App, as a means of steady income

Remotely operable and scalable mechanical ventilator: Big Bang Boom Solutions

Look Out App to help the government sustainably reallocate resource

AI-powered digital hospital & coronavirus laboratory: COVID Care

ASHA, an App, connecting people with psychologists digitally and categorising mental health

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concerns due to the pandemic

Portable and Affordable Ventilator with Assist Control Mode for Novel Coronavirus Victims (PAVAN)

NAADI Platform – National Analytical Platform for Dealing with Intelligent Tracing, Tracking and Containment of COVID-19 Pandemic along with 2 Mobile apps

Hack the Crisis – INDIA Online Hackathon[15]

### **Digital technologies for tackling COVID-19**

The digital technologies include the internet of things (IoT) with new- generation telecommunication networks (e.g., 5G), big-data analytics, artificial intelligence (AI) that uses deep learning and blockchain technology. They are highly inter-linked: the expansion of the IoT in hospitals and clinics facilitates the developed highly interconnected digital ecosystem, enabling real-time data collection at scale, which could then be used by AI and deep learning systems to understand healthcare open access system, model risk associations and predict outcomes. This is enhanced by blockchain a network of distributed computers in different organizations, with modified algorithms to ensure data are secured. Digital technology having two public health strategies for COVID-19:

Monitoring, surveillance, detection and prevention of COVID-19 are given in Table 3.

**Table 3. Mitigation of the impact to healthcare indirectly related to COVID-19 [16]**

<b>Digital technology</b>	<b>Public health measures</b>	
	<b>Monitoring, surveillance, detection and prevention of COVID-19</b>	<b>Mitigation of the impact to healthcare indirectly related to COVID-19</b>
Internet of things	real-time tracking and live updates in various online databases in the USA, UK and China  Live tracking	Virtual clinics (pingAn, China)  Virtual e-learning platforms
Big data	Modelling of the preparedness of countries in fighting a disease outbreak  Modelling of disease activity, potential growth and areas of spread	Business modelling on pharmaceutical supplies for various medications  Modelling of the utility of operating and clinics with manpower projections
Artificial Intelligence (AI)	Prognostication of disease progression via clinical data, imaging and AI  Detection of COVID-19 from chest imaging (X-ray) (Beijing Hospital)	Diagnose medical conditions unrelated to COVID-19 (Zhongshan Ophthalmic Eye Center, China)  Medical ‘chat bots’ to address public inquiries on COVID-19  Phone based software
Block chain	Distribution and Manufacturing of COVID-19 vaccines  Insurance claims from COVID-	Collaboration with blockchain companies and pharmacies to deliver patients’ medication to their doorsteps.  Timely delivery of medications with

	related illness and death	accurate tracking
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### Guidance to people, Public Outreach and Communication

Mobile health app **Aarogya Setu** is launched through National Informatics Centre (NIC). The app will help people assess themselves the risk for their catching the Corona Virus infection by tracking infected cases in the vicinity. Aarogya Setu Tracks through a Bluetooth & location generated social graph, your interaction with someone who could have tested Covid-19 positive. Launch of Citizen App technology platform to help citizens and government in combating this pandemic. The symptoms of COVID-19 could be used as screening tool to help identify people with potential mild cases who could be ensuring isolation where required. It has gained public acceptance with more than 50 million users within two weeks of its launch. This app will be very useful, including, understanding role of digital health in controlling epidemics. [16]

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