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A Review on –Artificial Intelligence in Pharmacy

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ABSTRACT
Inmanycapacities,intelligentmachinewilleventuallyreplaceorimprovehumantalents.Theintelligencedisplayedbysoftwareorrobotsisknownasartificialintelligence.Recently,AIplaysanimportantroleinvariousfieldsofpharmacylikedrugdiscovery,drugdeliveryformulationdevelopment,polypharmacology,hospitalpharmacyetc.Indrugdiscoveryanddevelopment,variousartificialneuralnetworks($_{ANNs}$)likedeepneuralnetworksorrecurrentneuralnetworksarebeingemployed.Thequalityandefficiencyhaveincreasedinthesectorsusingartificialintelligencetechnologies.

Key Word:-Artificial intelligence, Pharmacy, Research, Technology,DrugDiscovery,Machine,Networks.

I. INTRODUCTION

A.Iisthecapacityofacomputerorароboticssystemthatiscomputerenabletoprocessinformationandcreateresultsthatarecomparabletohowahumanmightthink while learning, making decisions, and solving problems. [1] There areopportunities for AI to explore further in the field of pharmaceutical andhealthcareresearchbecauseofitsabilitytoinvestigateenormousdatafrom various modalities.[2]. AI technology is exercised to perform moreaccurateanalyses aswellastoattainusefulinterpretation.[3]Recently,AItechnology becomes a very fundamental part of the industry for usefulapplicationsinmanytechnicalandresearchfields.Reflectingonthepast25pharmacy has done a great job ofaddressing the growing demand forprescriptions,evenwhenfacedwithpharmacistshortages,growingoperatingcosts, and lower reimbursements. Pharmacy has also done a great job ofleveraging enabling technology automation to improve workflow efficiencyand lower operating costs while promoting safety, accuracy, and efficiency inevery pharmacy setting. Automated dispensing gives pharmacists more timeto engage with a greater volume of patients while also enhancing their healthoutcomes.[4]

ObjectiveofA.I
Theoverallresearchgoalofartificialintelligenceistocreatetechnologythatallowscomputersand machinestoworkintelligently.

AdvantagesofA.I[5]

- A.Icansignificantlyreduceerrorsandincreaseprecision.
- A.I is able to helppharmacists providepersonalizedmedicineto theirpatients.
- A.Icanenhancecommunicatebetweenpatientsandhealth careprovide

DisadvantagesofA.I[5]

- A.Ihasbeentaskedwithcreatingeverythingfromcomputercodetovisualart,itlacksoriginalthoughts.
- AI technology needs to be extensively trained with curated data sets inordertoperformasexpected.However,duetoprivacy concerns,itcanbedifficulttoaccesssomeofthedatanecessarytoprovideAIlearningwiththebreadthanddepthofinformationitneeds.
- Thedisadvantagesarethingslikecostlyimplementation,potentialhumanjoblossandlackof emotionandcreativity.

AIclassification
AIcanbeclassifiedintwodifferentways:-
a) accordingtocaliber
b) accordingtothepresence

a) Accordingtocaliber

1. **WeakintelligenceorArtificialnarrowintelligence(ANI)**:Thissystem is designed and trained to perform a narrow task, such as facialrecognition,drivingacar,playingchess,andtraffic signaling.E.g.:AppleSIRIvirtualpersonalassistance,taggininsocialmedia.
2. **Artificial General Intelligence (AGI) or Strong AI**: It is also calledHuman-Level AI. It can simplify human intellectual abilities. Due to this,whenitisexposedtoanunfamiliartask,itcanfindthesolution.AGIcanperformallthethingsashumans.
3. **Artificial Super Intelligence (ASI):** It is brainpower, which is

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moreactivethansmarthumansindrawing,mathematics,space,etc;ineveryfieldfromsciencetoart.Itranges fromthecomputerjustlittlethanthehumantoatrillionmessmarterthanhumans.[6,7]

ArendHintze,anAIscientistclassifiedtheAItechnologybasedon itspresence andnotyetpresent. They are asfollows:

b) Accordingtothe presence

- **Type1:**ThistypeofAIsystemiscalledaReactivemachine.E.g.DeepBlue,theIBMchess programwhichhitthe chesschampion,Garry Kasparov, in the 1990s. It can identify checkers on the chessboard andcan make predictions; it does not have the memory to use pastexperiences.Itwasdesignedfornarrowpurposesuseandisnotusefulinothersituations.Another exampleisGoogle'sAlphaGo.
- **Type2:**ThistypeofAIsystemiscalled aLimitedmemorysystem.Thissystem can use past experiences for present and future problems. Inautonomousvehicles,someofthedecision-makingfunctionsare designed by this method only. The recorded observations are used torecordtheactionshappeninginthefuture,suchas changingthelanesbycar.Theobservationsarenotinthememorypermanently.
- **Type3:**ThistypeofAIsystemiscalledas"theoryofmind".Itmeansthat all humans have their thinking, intentions, and desires whichimpactthedecisionstheymake. Thisisanon-existAI.
- **Type4:**Thesearecalledself-awareness.TheAIsystemshaveasenseofselfandconsciousness.Ifthemachinehasself-awareness,it understandstheconditionandusestheideaspresent inothers'brains.Thisisanon-existingAI.[8]

RoleofA.IinDifferentareas

- **Diseasediagnosis;**
- **Digitaltherapy/personalizedtreatment:**

RadiotherapyRetina
Cancer
Otherchronicdisorders

- **A.Iindrugdiscovery**

AIinDiseaseDiagnosis:-

Disease analysis becomes pivotal in designing a considerate treatment andsafeguardingthewellnessofpatients.Theinaccuracygeneratedbyhumanscreates a hindrance for accurate diagnosis, as well as the misinterpretationof the generated information creating a dense and demanding task. AI canhavevariedapplicationsbybringingaboutperasssuranceinaccuracyandefficiency.Afteravividliteraturesurvey,theapplicationsofvarioustechnologies and methodologies for the purpose of disease diagnosis havebeen reported. With the evolution of the human population, there is alwaysan ever-increasing demand for the healthcare system, according to variedenvironmental manifestations [9]. It is important to categorize the patientsbased upon whether he/she is severely affected by the diseases, and the AIcan gain importance in diagnosis.[10] It is always advised to maintain everypatient'shealthreport forms,soastocollectthemajorityofreviewsthat areobtainedviaperformingexaminationsandtesting. Upongatheringinformation,theappropriateoutcomes aremainlyconcerningthehealthcareneeds for a timely diagnosis. The analysis is the sole discretion of the stateofthecliniciansandmayfluctuate.[11]

AIinDigitalTherapy/PersonalizedTreatment
Radiotherapy

Automatedtreatmentplanningisarecenttechnology,whichishighlybeneficial in radiotherapy treatment planning. Automated treatment planningis efficiently improving the plan quality, consistency, and error rate. Thetreatment workflow can be organized into three categories, i.e., automatedruleimplementation,reasoningmodelingofpriorknowledgeinclinicalpractice and multi-criteria optimization.[12] A simple automated computerprogramwithstructurescanimplementtheclinicalguidelines.Thetreatmentplanningsystemcananalyzetheanatomyandphysiologyofthepatientandcanalsomimicthereasoningprocess,whichisgenerallyfollowedinmanualtreatment planning. Three-dimensional dose distribution and dose modelsforspatialdosehaveshownpromisingaccuracy.[13]Radiomicscangivein-depthinformationabouttumorswiththehelpofseverali magingbiomarkers.Radiomics can be implemented for the prediction of outcomes and toxicityforindividualpatients'radiationtherapy.[14]

Ratina

The high-resolution imaging of the retina has given the scope to assesshumanhealthremarkably.Fromasinglephotographoftheretina,onecanextract highly personalized data; with high-definition medicines,

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theophthalmologist/retinologist can define a personal therapy and establish acontinuouslyimproving learninghealthcaresystem.[15]

Cancer

With the huge applicability of AI, it has gained importance in the fields ofdiagnosing and treating various cancers. The lymphoma subtypes of non-Hodgkin lymphoma were predicted by using gene expression data in amultilayer perceptron neural network. The neural network has 20,863genesastheinput layer andlymphomasubtypesastheoutputlayer.

Lymphoma subtypes includes mantle cell lymphoma (MCL), follicularlymphoma, diffuse large B-cell lymphoma (DLBCL), marginal zonelymphoma and Burkitt. An AI neural network has predicted the lymphomasubtypeswith high accuracy.[16]

InDrugDiscovery

The drug discovery process is limited or resisted due to the lack of advancedtechnologies. Drug discovery process is the costly and time-consumingprocess.**[17]** WiththeimplementationofAIinthisfield,itwillelimin atethesomeadditional steps like it can easily and quickly shows the drug target as well aspredict the drug structure.[18] It also faces some problems in the growth, variety,and doubtful or incomplete data, it is unable to deal with such data whereas suchdata can behandled inthe industry.

QSAR-based computer model (Quantitative structure-activity relationship) can behelpful in the quick prediction of physicochemical properties of unknowncompound as well as their stability, efficacy and ADR of compound in thebiological environment but this model has some problems such as experimentalerrors in the handling of small training sets, lack of validations etc. To solve thisproblem, there are DL (deep learning) and relevant modeling studies, new AIinnovations, which is devised for the predictions of safety and efficacy evaluationparametersofdrug compounds intheresearches.

There are many tool which act as virtual chemical space and predict theenvironmental distribution of the molecules by illuminating the properties of drugmolecules. Examples of such virtual chemical space are: PubChem,ChemDBChemBank, etc. the reason behind the virtual chemical space is theilluminationthedistributionofcompoundandtheco llectionofdatatoexplorethebioactivecompounds.[19]

Application of A.Iinhealthcare

There are several applications of AI in hospital-based health caresystem.[20,21]inorganizingdosageformsforindi vidualizedpatientsandselecting suitable or available administration routes or treatmentpolicies.

- **Maintaining of medical records:** Maintenance of the medicalrecords of patients is a complicated task. The collection, storagenormalizing,andtracingofdataaremadeea sybyimplementing theAIsystem.GoogleDeepMindhealthproject[22](de velopedbyGoogle)assiststoexcavatethemedicalrecor dsinashortperiod.

Hence,thisprojectisausefuloneforbetterand fasterhealthcare theMoorfieldsEyehospitalNHSisassistedbythisproje ctfortheimprovementofeyetreatment.

- **Treatment plan designing:** The designing of effective treatmentplans is possible with the help of AI technology. When any criticalcondition of a patient arises and the selection of a suitabletreatmentplanbecomesdifficult,thenthe AIsystemisnecessarytocontrol the situation. All the previous data and reports, clinicalexpertise,etc.,areconsideredinthedesigni ngof thetreatmentplan as suggested by this technology. IBM Watson for Oncology[23]the software as a service, is a cognitive computing decisionsupportsystemthatanalyzespatientdataa gainstthousandsofhistoricalcasesandinsightsgle anedfromworkingthousandsofhourswithMemor ialSloanKetteringCancerCenterphysiciansandp rovidestreatmentoptionstohelponcologyclinicia nsmake Informed decisions. These treatment options are supported byliterature curated by Memorial Sloan Kettering, and over 300medicaljournals and200textbooks,resultinginalmost15millionpa gesof text[23]
- **Health support and medication assistance:** In recent years, theuses of AI technology are recognized as efficient in health supportservicesandalso,formedicationassistanc e.Molly[24](astart-up-designedvirtualnurse)receivesapleasantvoiceal

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ongwitha cordial face. Its aim of it is for helping patients to guide thetreatmentofpatientsaswellassupportthemwithheirchronicconditionsduringdoctor'svisits.AiCure[25]isanappexistinginaSmartphone webcam, which monitors patients and assists them tocontrol their conditions. This app is useful to patients with severemedicationsituationsandforpatientswhoparticipateinclinicaltrials.

- **Accuracy of medicine:** AI shows a good impact on genomics andgeneticdevelopment.DeepGenomics[26]an AIsystemisusefulforobserving patterns in the genetic information and medical recordstoidentifythemutationsand linkagestodiseases.Thissysteminforms doctors about the events happening within a cell whenDNAisalteredbygeneticvariation.An algorithmisdesignedbythefatherofthehumangenomeproject,CraigVenter[27]thatgives information on patients' physical characteristics based on theirDNA. "Human Longevity" AI technology is useful to identify theexactlocationofcancerandvasculardiseasesintheirearlystage.

- **AIhelpspeopleinthehealthcaresystem:** The"openAIecosystem"[28] was one of the top 10 promising technologies in2016. It is useful to collect and compare the data from socialawarenessalgorithms.Inthehealthcaresystem,vastinformationisrecorded which includes patient medical history and treatmentdata from childhood to that age. This enormous data can beanalyzed by the ecosystems and gives suggestions about thelifestyleandhabitsofthe patient.
- **Healthcare system analysis**: In the healthcare system, if all thedata is computerized then retrieval of data is easy. Netherlandmaintains 97% of invoices in digital format [29]which containtreatmentdata,physiciannames,andhospitalnames.Hence,thesecan be retrieved easily. ZorgprismaPubliek, a local companyanalysestheinvoiceswiththehelpofIBMWatsoncloudtechnology.Ifanymishapoccurs, itrecognizesitimmediatelyandtakes the correct action. Because of this, it improves and avoidspatienthospitalization

II. CONCLUSIONS

ThescopeofArtificialintelligenceandmachinelearninginthePharma industry looks very promising in the future. Pharmaceuticalindustries are in constant advancement with their technologies and AI willbeanopportunityforminimizingthecostandtimefordrugdevelopment.AIcan play a key role in clinical trials in reducing the total duration and cost oflaunchingadrugtomarket.TheuseofAIapplicationsinpharmawillensureoperationalexcellenceacrossdrug structuredesign,drugdevelopment processes, selecting patients for clinical trials,monitoringdrugperformance, identifyingproperdosage,etc.

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