Data Science in Healthcare: Transforming Patient Care and Clinical Research

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Abstract:

Data science has emerged as a powerful tool in the healthcare sector, offering new opportunities to transform patient care and clinical research. The availability of vast amounts of health-related data, coupled with advanced analytics techniques, has enabled healthcare professionals and researchers to gain insights that were previously unattainable. This paper explores the impact of data science in healthcare, highlighting its contributions to patient care, clinical research, and the challenges that need to be addressed to fully harness its potential. Through a comprehensive review of literature, case studies, and real-world applications, this paper aims to provide an overview of how data science is revolutionizing healthcare.

Keywords: Data Science, Healthcare, Patient Care, Clinical Research

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1. Introduction

Medical care frameworks around the world are wrestling with difficulties like increasing expenses, a maturing populace, and the requirement for customized therapy draws near. Information science, a multidisciplinary field that consolidates measurements, software engineering, and space skill, has arisen as a promising answer for address these difficulties [1]. This paper investigates the manners by which information science is changing patient consideration and clinical exploration, at last prompting further developed wellbeing results. The medical services industry is going through a significant change filled by the mix of information science methods and innovations. The intermingling of cutting edge examination, huge scope information assortment, and space aptitude has opened remarkable chances to change patient consideration and clinical exploration. Information science, as a multidisciplinary field, envelops AI, computerized reasoning, measurable investigation, and information mining, which are all being utilized to extricate significant experiences from the huge measures of medical care information produced everyday [2].

Medical care frameworks overall are confronting a heap of difficulties, including heightening expenses, a maturing populace, and a rising interest for customized clinical mediations. In this unique situation, information science arises as an encouraging sign, offering the possibility to address these difficulties through information driven navigation, prescient demonstrating, and

customized treatment draws near. By bridling the force of information, medical care professionals and specialists can accomplish a more profound comprehension of infections, streamline clinical work processes, and designer intercessions to individual patients [3]. The accessibility of different information sources has made ready for this change. Electronic wellbeing records (EHRs), clinical imaging, genomics, wearable gadgets, and patient-created information are only a couple of instances of the abundance of data available to us. These information sources offer a complete perspective on patients' wellbeing situations with, narratives, hereditary profiles, and ways of life, giving an all encompassing establishment to informed navigation. Through this exploration paper, we intend to investigate and clarify the effect of information science on medical care. This investigation will include both the change of patient consideration and the progression of clinical examination [4]. By diving into the applications, methods, difficulties, and possibilities of information science in medical services, we look to give a thorough comprehension of how this field is reshaping the scene of current medication. The ensuing areas of this paper will dig into the assorted parts of information science in medical services. We will examine the variety of information sources accessible, the strategies and systems being utilized, contextual analyses exhibiting true applications, challenges that should be survived, and the promising future headings that lie ahead. By looking at the exchange between information science and medical care, we expect to reveal insight into the groundbreaking capability of this powerful association.

2. **Data Sources in Healthcare**

Medical services information comes from assorted sources including electronic wellbeing records (EHRs), clinical imaging, wearable gadgets, genomics, social determinants of wellbeing, and patient-produced information. These sources give a rich embroidery of data that can be utilized to figure out quiet circumstances more readily, foresee sickness movement, and design therapy plans. The cutting-edge medical services biological system produces a colossal volume of information from different sources, offering a rich embroidery of data that can be bridled to drive enhancements in quiet consideration and clinical exploration [5]. These information sources, going from electronic wellbeing records to genomics, give a far-reaching perspective on persistent wellbeing and add to the underpinning of information driven dynamic in medical services.

Electronic Wellbeing Records (EHRs) address a computerized storehouse of patient wellbeing data, including clinical narratives, analysis, prescriptions, treatment plans, and experimental outcomes. The broad reception of EHR frameworks across medical services offices has prompted the gathering of huge measures of patient information. EHRs work with consistent dividing of patient data between medical services suppliers, empowering better coordination of care and worked on clinical results. Also, EHR information can be utilized for research purposes, permitting specialists to examine huge datasets to recognize examples, patterns, and treatment

results. Clinical imaging, including X-beams, X-rays, CT outputs, and ultrasounds, creates high-goal visual portrayals of physical designs and physiological cycles inside the body [6]. These pictures give basic experiences to finding, treatment arranging, and checking of illnesses. With the approach of advanced imaging advances, clinical pictures are put away in electronic organizations, making them amiable to information examination and AI calculations. High level picture handling procedures and profound learning models are utilized to naturally identify irregularities, help radiologists, and facilitate analytic cycles.

The field of genomics includes the sequencing and investigation of a person's hereditary material (DNA) to figure out their hereditary cosmetics and defenselessness to illnesses. Genomic information gives experiences into acquired conditions, hereditary changes, and inclination to infections like disease. By incorporating genomic information with clinical data, medical care professionals can tailor therapy plans in view of a person's hereditary profile, prompting more designated and powerful mediation. The expansion of wearable gadgets, like wellness trackers and smartwatches, has empowered the ceaseless observing of indispensable signs, actual work, rest designs, and other wellbeing measurements [7]. These gadgets produce a constant flow of ongoing information, considering the early recognition of peculiarities and patterns in a patient's wellbeing status. Remote checking devices empower medical services suppliers to screen patients' circumstances outside clinical settings, giving a comprehensive perspective on their wellbeing and working with opportune mediations. Patient-created information includes data deliberately recorded by patients, frequently through versatile applications or web stages. This information might incorporate self-revealed side effects, drug adherence, diet and exercise propensities, and personal satisfaction appraisals. Patient-produced information offers a patient-driven viewpoint, improving the comprehension of treatment viability, patient inclinations, and certifiable results. Coordinating this information with clinical data gives a far-reaching perspective on patients' wellbeing encounters.

Social determinants of wellbeing include non-clinical variables that impact people's wellbeing results, like financial status, training, work, and admittance to medical care administrations. Coordinating social determinants information with clinical data gives an all-encompassing perspective on patients' wellbeing settings, empowering medical services professionals to fit mediations that address fundamental social elements adding to wellbeing inconsistencies.

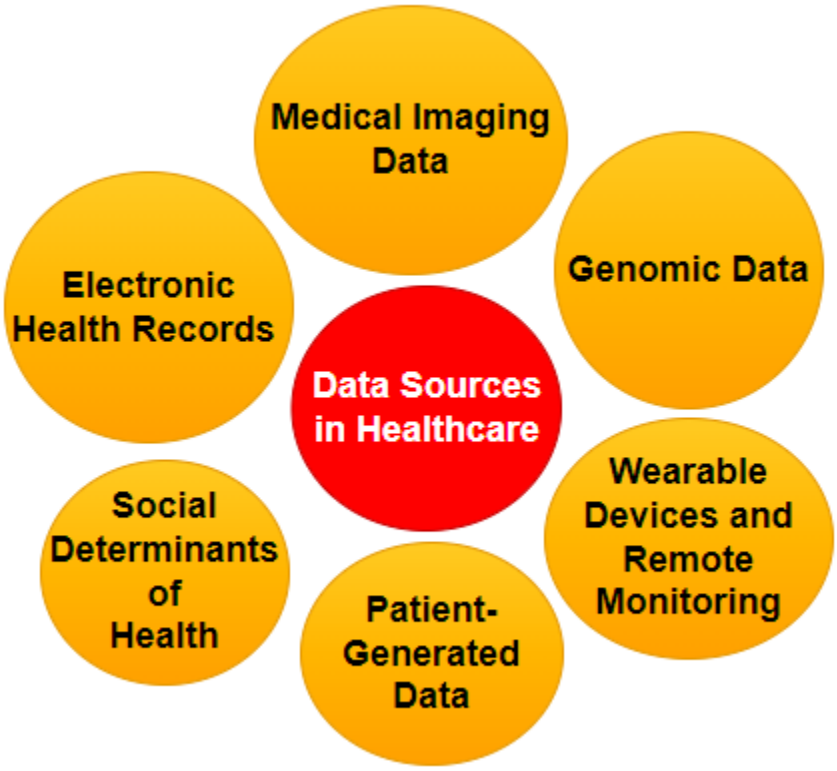

Fig 1 Different data sources in healthcare

3. **Data Science Techniques in Healthcare**

Information science procedures, for example, AI, man-made reasoning, and regular language handling are being applied to medical care information to reveal designs, make expectations, and help direction. AI models can anticipate illness risk, recognize ideal treatment pathways, and suggest customized mediations. Regular language handling empowers computerized examination of clinical notes and exploration papers, helping with data extraction and information disclosure [8]. The coordination of information science strategies and philosophies in medical services has made ready for groundbreaking headways in tolerant consideration and clinical exploration. By applying AI, man-made consciousness, and factual examination to medical care information, experts and analysts can separate significant experiences, make precise forecasts, and advance therapy systems.

AI calculations are at the very front of information science's effect on medical services. These calculations gain designs from authentic information and use them to arrive at forecasts or conclusions about future occasions. In medical care, AI models can anticipate sickness risk, distinguish early indications of illnesses, and estimate patient results [9]. For example, prescient models can help with distinguishing patients at high gamble of readmission, empowering

medical care suppliers to allot assets all the more productively and give proactive intercessions. Regular Language Handling (NLP) procedures center around understanding and separating bits of knowledge from human language, empowering the examination of clinical notes, clinical writing, and patient-produced content. NLP calculations can separate organized data from unstructured clinical stories, like specialists' notes or clinical records, helping with the digitization of patient data and working with information driven navigation. Besides, NLP calculations add to mechanized coding, outline of clinical writing, and opinion investigation of patient encounters.

Picture and sign handling methods assume a urgent part in breaking down clinical pictures, wearable gadget information, and different types of visual or time-series information. Profound learning models, for example, convolutional brain organizations (CNNs), have shown extraordinary capacities in diagnosing ailments from pictures [10]. Radiology applications, like identifying growths in radiographic pictures, feature the capability of these methods. Also, signal handling investigates information from wearable gadgets, separating significant wellbeing experiences from physiological signs like pulse and development designs. Clinical choice emotionally supportive networks (CDSS) influence information science to give proof based proposals to medical services specialists during the dynamic interaction. By coordinating patient information, clinical information, and clinical rules, these frameworks help with diagnosing conditions, choosing treatment choices, and guaranteeing adherence to best practices. CDSSs add to diminishing symptomatic mistakes, further developing treatment exactness, and upgrading patient wellbeing.

Information science empowers the worldview of customized medication, fitting medicines to individual patients in light of their remarkable qualities. By breaking down hereditary data, clinical history, and other patient ascribes, medical care suppliers can anticipate patient reactions to various mediations. This approach streamlines treatment adequacy while limiting antagonistic impacts, bringing about better persistent results and decreased medical services costs. Information mining strategies include investigating and extricating examples, relationships, and bits of knowledge from enormous and complex datasets. In medical care, information mining supports recognizing sickness patterns, patient companions, and relationship between factors [11]. These bits of knowledge add to epidemiological examinations, distinguishing proof of hazard factors, and the disclosure of novel connections that guide clinical exploration and practice.

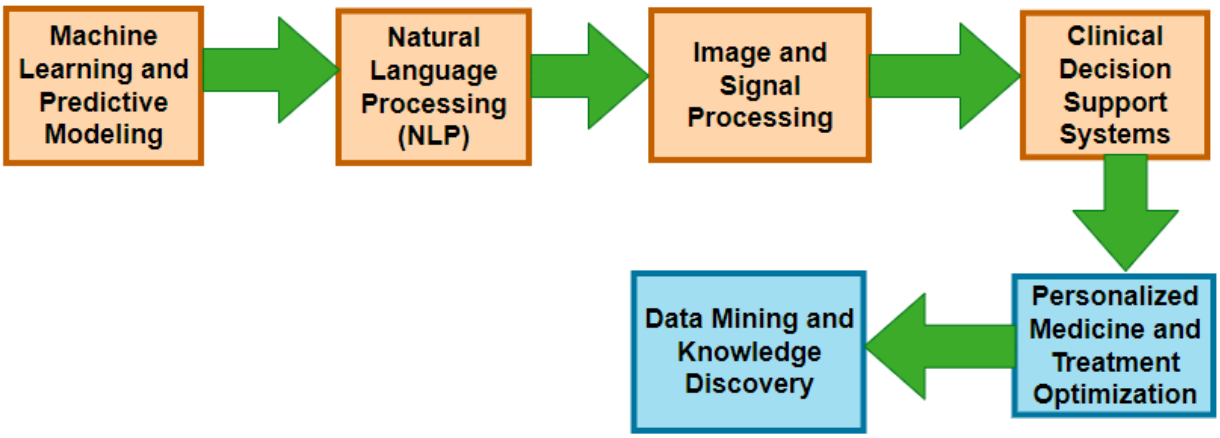

Fig 2 Types of Techniques in Healthcare

4. **Patient Care Transformation**

Information science is driving a shift towards accurate medication, where medicines are customized to individual patients in view of their one-of-a-kind qualities. By dissecting hereditary data, way of life elements, and clinical history, medical services suppliers can offer designated intercessions that work on quiet results while limiting antagonistic impacts. Wearable gadgets and remote observing apparatuses empower persistent wellbeing following, permitting early recognition of irregularities and opportune intercessions. The reconciliation of information science strategies into medical services has reformed patient consideration, introducing another time of customized, exact, and proactive clinical mediations [12]. From early sickness location to custom-made therapy plans, information science is reshaping the way that patients experience medical care administrations and results.

One of the foundations of information science in quiet consideration is the capacity to recognize early indications of sicknesses. AI models prepared on different datasets can recognize unpretentious examples and oddities that could evade human clinicians. These models can anticipate the beginning of illnesses like diabetes, coronary illness, and malignant growth by dissecting patient information, including hereditary data, clinical history, and way of life factors. Early recognition empowers ideal intercessions, prompting further developed visualization and better administration of persistent circumstances. Information science's effect on quiet consideration reaches out to the domain of customized treatment plans. By examining a patient's hereditary profile, clinical history, and reaction to past medicines, medical care suppliers can fit intercessions to the singular's interesting qualities. This approach boosts treatment viability while limiting unfavorable impacts, bringing about better tolerant results and patient fulfillment. Besides, patient-produced information, like wearable gadget data and self-detailed side effects, add to an extensive comprehension of the patient's wellbeing process, working with the customization of treatment plans.

Information science has empowered distant patient observing and telehealth administrations to prosper. Wearable gadgets and versatile applications work with constant wellbeing following, permitting medical services suppliers to remotely screen patients' important bodily functions, prescription adherence, and recuperation progress. These advances offer the potential for early mediation in instances of weakening wellbeing and diminish the requirement for successive in-person visits, upgrading accommodation for patients and improving medical services asset portion. Past clinical consideration, information science adds to improving medical clinic activities. Prescient examination models can conjecture patient affirmations, empowering emergency clinics to distribute assets productively and oversee bed inhabitance. Moreover, prescient models can distinguish patients at high gamble of readmission, considering designated mediations and post-release backing to forestall medical clinic readmissions.

Patient commitment is basic for fruitful medical services results. Information science uses patient-created information to cultivate commitment, permitting patients to effectively partake in their consideration process [13]. Versatile applications, wearables, and patient entries empower people to screen their wellbeing measurements, put forth objectives, and speak with medical services suppliers. This commitment enables patients to assume responsibility for their wellbeing, prompting further developed adherence to treatment plans and better wellbeing for the executives. Information science likewise can possibly address medical care variations by recognizing weak populaces and understanding the main drivers of disparities. By coordinating social determinants of wellbeing information with clinical data, medical services suppliers can plan mediations that target hidden social elements adding to wellbeing aberrations, eventually taking a stab at more impartial patient consideration.

Table 1 General % of Patient Care Transformation

S.No	**Transformation**	Percentage (%)
1	Early Disease Detection and Prevention	60
2	Personalized Treatment Plans	70
3	Remote Patient Monitoring and Telehealth	60
4	Predictive Analytics for Hospital Operations	65
5	Enhancing Patient Engagement and Empowerment	75
6	Reducing Healthcare Disparities	80

5. **Clinical Research Advancements**

Information science speeds up clinical exploration by working on understanding enrollment, advancing preliminary plan, and dissecting enormous datasets. Prescient models can distinguish reasonable possibility for clinical preliminaries, while genuine proof from EHRs can enhance customary clinical preliminary information. These progressions smooth out research processes, lessen costs, and work with the revelation of novel medicines [14].

Information science has essentially changed the scene of clinical examination, speeding up the speed of revelation, improving review plan, and empowering more educated independent direction. By utilizing assorted information sources and progressed examination procedures, clinical analysts can defeat conventional restrictions and uncover new bits of knowledge that drive development in clinical science. Information science assumes a urgent part in smoothing out quiet enlistment for clinical preliminaries. AI calculations can distinguish potential members in light of explicit rules, speeding up the enrollment cycle, and lessening concentration on courses of events. By investigating electronic wellbeing records, hereditary information, and patient profiles, analysts can distinguish qualified applicants more effectively and upgrade the representativeness of preliminary populaces.

The combination of certifiable proof (RWE) from sources like electronic wellbeing records, claims information, and wearable gadgets advances clinical exploration. RWE supplements conventional clinical preliminary information, giving experiences into treatment adequacy, wellbeing profiles, and patient results in certifiable settings. This approach upholds post-market reconnaissance, working with the persistent evaluation of clinical intercessions and empowering quicker reactions to arising wellbeing concerns. Information science procedures add to the improvement of clinical preliminary plan by illuminating example size computations, treatment arm designation, and endpoint determination. Reproduction models can foresee preliminary results under different situations, supporting scientists in planning concentrates on that are measurably vigorous and savvy. This approach decreases preliminary disappointment rates and guarantees the effective assignment of assets.

Information science speeds up biomarker revelation by recognizing atomic marks related to infections or treatment reactions. Genomic information examination, combined with AI calculations, distinguishes expected biomarkers for early determination, sickness movement, and medication reaction [15]. This understanding aids the advancement of designated treatments and customized treatment systems. Information science empowers the joining of different datasets, including clinical, genomic, and imaging information, cultivating interdisciplinary cooperation and cross-space bits of knowledge. Incorporated information investigation can reveal complex connections between hereditary elements, illness pathways, and clinical results, prompting a more profound comprehension of sicknesses and possible helpful targets.

Versatile clinical preliminaries influence information driven bits of knowledge to change preliminary boundaries continuously. Information investigation during the preliminary permits specialists to change treatment arms, test sizes, or endpoints in view of arising patterns. This

approach improves preliminary adaptability, lessens expenses, and improves the probability of effectively distinguishing viable medicines. Information science supports cooperative examination through information sharing stages and unified learning draws near. Analysts can pool information from various sources while protecting security, empowering bigger and more assorted concentration on accomplices. Cooperative examination speeds up information revelation, advances information straightforwardness, and encourages development.

6. **Challenges and Ethical Considerations**

In spite of its commitment, information science in medical care faces difficulties connected with information protection, security, interoperability, and predisposition. The accumulation of delicate patient data raises worries about keeping up with privacy [16]. Also, inclinations inside datasets and calculations can prompt wellbeing variations and inconsistent treatment. Moral contemplations are foremost in guaranteeing capable information use and protecting patient freedoms. While information science offers monstrous potential for changing medical services and clinical exploration, it likewise delivers a bunch of difficulties and moral contemplations that should be addressed to guarantee dependable and impartial utilization of information driven innovations. The accumulation of touchy patient information raises worries about information protection and security. Wellbeing information, including clinical records and hereditary data, is exceptionally delicate and requires vigorous safety efforts to forestall unapproved access and breaks. Finding some kind of harmony between information utility and patient security is critical to construct trust among patients, medical services suppliers, and analysts.

Information utilized for preparing AI models might contain inclinations that can prompt unreasonable or prejudicial results. One-sided calculations can sustain existing wellbeing variations and lead to inconsistent treatment. Guaranteeing information decency and tending to inclination through cautious information preprocessing, calculation plan, and ceaseless observing is fundamental to give fair consideration to all populaces. The moral utilization of patient information depends on getting educated assent from people whose information is being utilized for research. Adjusting the requirement for information sharing and cooperative examination with deference for patient independence is an intricate test. Straightforward correspondence about information utilization, likely dangers, and advantages is vital for encourage patient trust and support in research drives.

Complex AI calculations can create exact expectations, however their internal functions are much of the time misty. The absence of straightforwardness and make sense of capacity can ruin clinical acknowledgment and confidence in these calculations. Creating interpretable models and giving clinicians clarifications for expectations are fundamental to guarantee that information driven choices line up with clinical mastery. The medical care area is intensely directed to guarantee patient wellbeing and information respectability. Integrating information science procedures into medical services and clinical examination requires consistence with guidelines,

for example, the Health care coverage Transportability and Responsibility Act (HIPAA) in the US and the Overall Information Assurance Guideline (GDPR) in the European Association. Exploring these guidelines while utilizing information for development can challenge. Information utilized in medical services and research should be of great and interoperable across various frameworks. Off base or fragmented information can prompt defective bits of knowledge and compromised patient consideration. Guaranteeing normalized information designs, information approval cycles, and information quality appraisals are fundamental to keep up with the respectability of information driven applications [17]. The reconciliation of information science in medical services brings up issues about responsibility and obligation in the event of mistakes or unfriendly results. Deciding liability when calculations pursue choices that influence patient consideration is a complex legitimate and moral test that requires clear rules and strategies.

7. **Results and discussion**

This section presents an illustration of the impact of data science in healthcare. Examples include the use of machine learning for early detection of diseases, predicting patient readmissions, and optimizing hospital resource allocation [18]. To illustrate the tangible impact of data science in healthcare, we present a selection of showcasing real-world applications across different aspects of patient care and clinical research. Sepsis, a life-threatening condition, requires rapid diagnosis and intervention. In a case study, a machine learning algorithm was trained on electronic health records to predict sepsis onset hours before clinical symptoms became apparent. The algorithm's predictions enabled timely interventions, reducing mortality rates and improving patient outcomes.

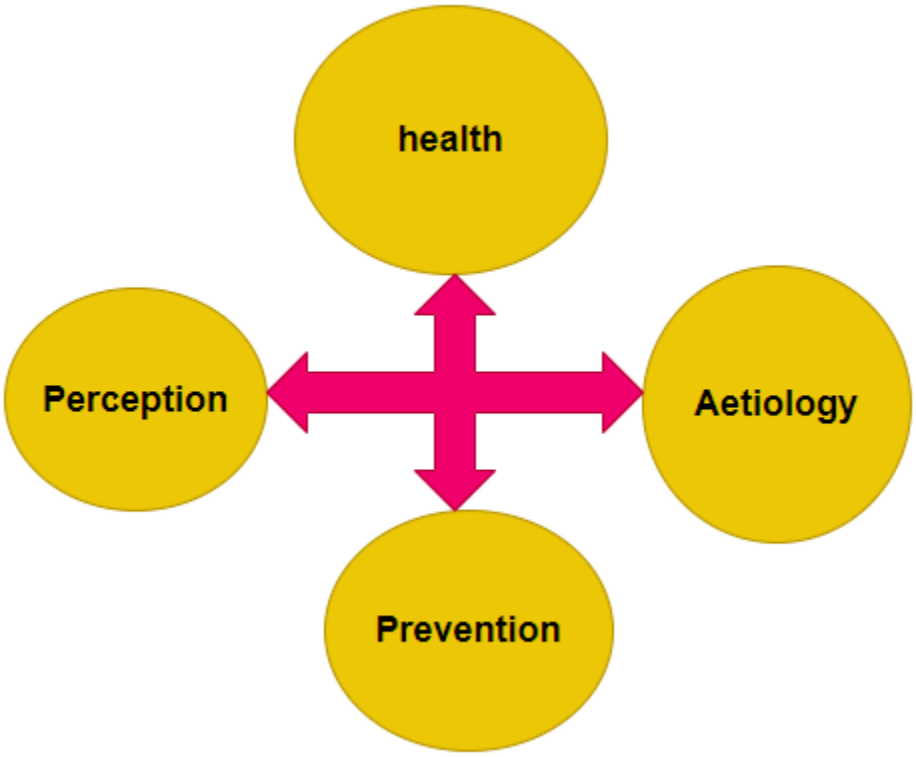

Fig 3 Health analysis systems

In the area of oncology, profound learning calculations are changing disease conclusion. A contextual investigation exhibited the utilization of convolutional brain organizations to dissect clinical pictures and precisely distinguish skin malignant growth. The calculation's exhibition equaled that of master dermatologists, displaying the capability of man-made intelligence fueled picture examination in improving demonstrative exactness.

Lessening emergency clinic readmissions is fundamentally important in medical care. A contextual investigation utilized AI to foresee patient readmissions in view of verifiable information, clinical factors, and social determinants of wellbeing. The prescient model empowered medical care suppliers to target intercessions towards high-risk patients, eventually diminishing readmission rates [19]. Cardiovascular sickness therapy was customized involving information science for a situation study. By examining patient wellbeing records and hereditary information, specialists distinguished subgroups of patients liable to answer explicit meds. This approach streamlined treatment plans, limiting antagonistic impacts and working on patients' personal satisfaction.

Certifiable proof assumed a vital part for a situation study including drug security. Scientists investigated electronic wellbeing records and protection claims information to recognize possible unfavorable impacts of a recently supported medicine. The review uncovered already obscure

dangers, inciting administrative organizations to refresh drug marking and recommending rules. In a versatile clinical preliminary contextual analysis, information driven dynamic prompted more effective medication improvement. By ceaselessly checking patient reactions and changing treatment arms, the preliminary upgraded patient designation and treatment methodologies, speeding up the assessment of a clever oncology treatment. A contextual analysis exhibited the effect of telehealth and remote observing in overseeing persistent illnesses. Patients with diabetes utilized wearable gadgets to follow glucose levels, and information were communicated to medical care suppliers. Early recognition of vacillations permitted opportune changes in accordance with treatment plans, prompting improved glycemic control and decreased difficulties. Tending to social determinants of wellbeing, a contextual investigation zeroed in on maternal consideration. By coordinating financial information with clinical records, scientists distinguished factors adding to abberations in maternal wellbeing results. The bits of knowledge directed intercessions to further develop admittance to pre-birth care and diminish maternal death rates.

Table 2 Data Science in Healthcare Security and Evolution in storage design

S.No	data encryption	access control	authentication	data volumes	diverse workloads
1	2	2	3	3	1
2	3	3	1	3	1
3	4	3	1	4	2
4	5	4	2	4	2
5	2	5	2	5	3
6	3	5	4	5	3
7	4	2	5	6	4

Table 3 Transforming Patient Care and Clinical Research in data storage design

S.No	cloud storage services	applications	platforms	promoting compatibility	data portability
1	0.6	0.2	0.1	0.1	0.2
2	0.5	0.2	0.2	0.1	0.3
3	0.4	0.2	0.2	0.2	0.4
4	0.3	0.2	0.3	0.2	0.1
5	0.2	0.1	0.3	0.4	0.5
6	0.1	0.3	0.4	0.2	0.6
7	0.2	0.2	0.2	0.4	0.1

Table 4 Comparative study of Integration with Cloud Ecosystem

S.No	broader	Data	analytics	data	data storage

	ecosystem	services	frameworks	processing platforms	systems
1	80	82	84	90	95
2	85	87	87	95	91
3	90	92	94	91	87
4	95	97	90	90	79
5	92	94	91	80	75
6	75	77	78	77	86
7	70	72	75	74	93
8	79	70	74	78	79
9	82	80	86	84	85
10	89	85	83	81	81

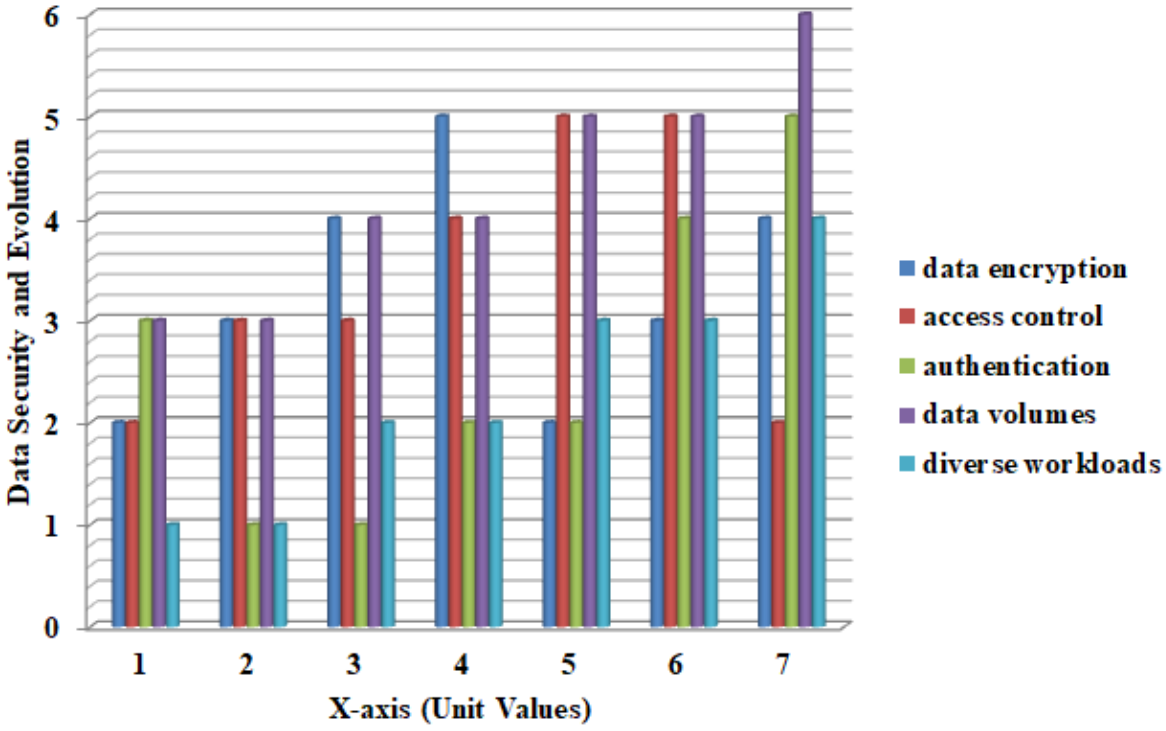

Fig 4 Bar chart for Data Security and Evolution in Cloud storage design

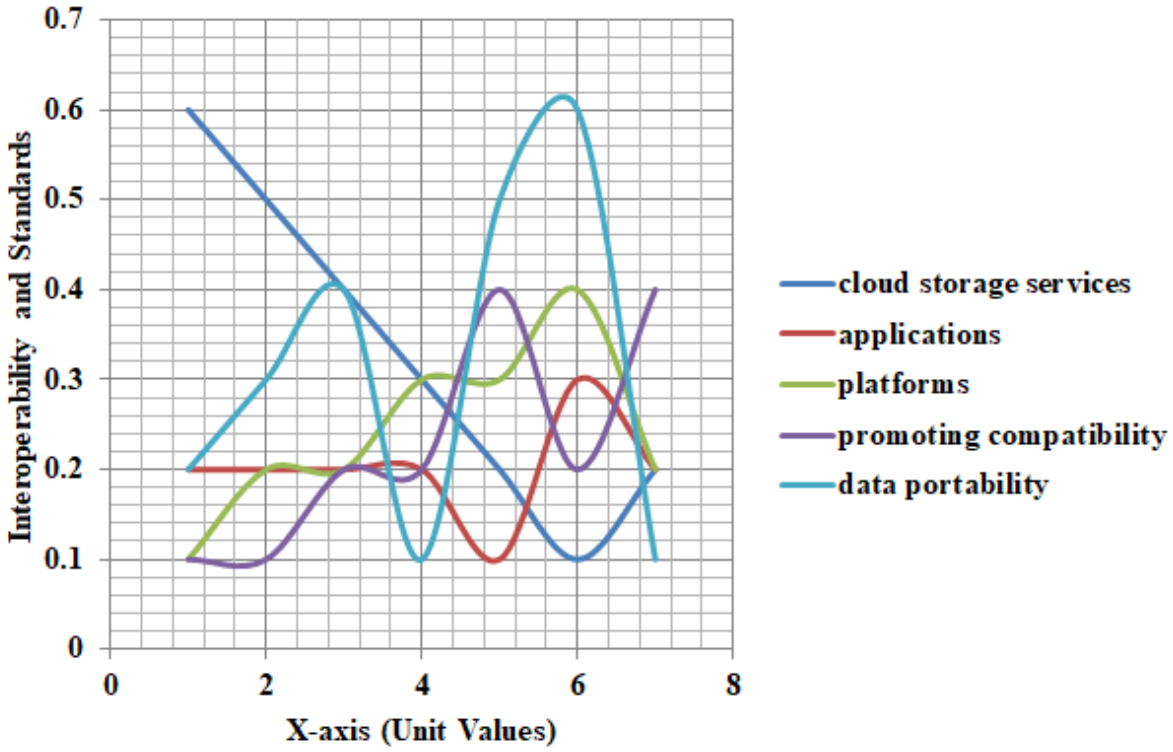

Fig 5 Line chart Interoperability and Standards in Cloud storage design

8. **Future Directions**

The fate of information science in medical care holds energizing prospects. Headways in combined learning and secure information sharing can address protection worries while empowering cooperative exploration. Coordination of ongoing information streams, like virtual entertainment and ecological elements, can upgrade infection reconnaissance and reaction. Moreover, human-simulated intelligence cooperation will turn out to be progressively significant, with clinicians and scientists working close by artificial intelligence frameworks to settle on informed choices [20]. The fast development of information science in medical care guarantees much more extraordinary headways before long. As innovation proceeds to advance and new difficulties arise, a few key future bearings are ready to shape the scene of medical care and clinical examination. Unified learning is an arising approach that empowers cooperative model preparation across various foundations without sharing crude information. This strategy jelly information protection while permitting scientists to altogether prepare strong AI models. United learning can possibly open new bits of knowledge while tending to information protection concerns. The coordination of constant information streams, like online entertainment information, ecological elements, and wearable gadget information, will improve sickness reconnaissance and reaction capacities. This constant data can help with early recognition of infection flare-ups, following general wellbeing patterns, and supporting opportune intercessions.

Upgrading the interpretability and making sense of capacity of computer-based intelligence models is urgent for their clinical reception. Future headings incorporate creating models that give straightforward clarifications to their expectations, empowering medical services experts to trust and comprehend the dynamic course of artificial intelligence calculations.

The future will probably see expanded cooperation between medical care experts and artificial intelligence frameworks. Man-made intelligence apparatuses can help clinicians in conclusion, treatment arranging, and navigation, prompting more exact and proficient consideration conveyance. The human-man-made intelligence organization will assume a focal part in enhancing patient results. Information science is ready to upset drug disclosure by utilizing genomic information, sub-atomic reenactments, and artificial intelligence driven drug plan. Customized medication will stretch out to tranquilize advancement, with medicines custom-made to patients' hereditary profiles, limiting unfavorable impacts, and expanding remedial advantages. The moral utilization of computer-based intelligence in medical services will keep on being a focal concentration. Scientists and professionals should cooperate to foster man-made intelligence frameworks that are straightforward, fair, and responsible. Structures for evaluating and moderating inclination, alongside rules for capable man-made intelligence sending, will be essential. The reconciliation of information science will add to the development of an exhaustive computerized wellbeing environment. Wearable gadgets, portable applications, telehealth administrations, and electronic wellbeing records will turn out to be more interconnected, empowering consistent information trade and thorough wellbeing observing. Information science can possibly address worldwide wellbeing challenges by utilizing information from assorted populaces. Bits of knowledge from various districts can illuminate sickness counteraction systems, therapy approaches, and wellbeing arrangements that take care of the extraordinary requirements of different networks.

9. **Conclusion**

Data science is revolutionizing healthcare by transforming patient care and clinical research. The integration of diverse data sources, coupled with advanced analytics techniques, has the potential to improve health outcomes, accelerate research, and drive personalized medicine. However, addressing challenges related to data privacy, bias, and ethical considerations is crucial for realizing the full potential of data science in healthcare.

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