HOUSTON'S FUTURE

— AI IN HEALTH CARE —

2024

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ABOUT CHF

Center for Houston's Future is a nonprofit that works to understand future global trends and their impact on the Houston region. We focus on issues that are critical to the long-term success of Greater Houston. In short, we aim to ensure Houston remains a great place to live and work for all its residents. We bring business, government, community, and academic stakeholders to engage in planning, research, consensus building and action.

CENTER FOR HOUSTON'S FUTURE FURTHERS THE REGION AS A TOP GLOBAL COMMUNITY IN WHICH TO WORK AND LIVE.

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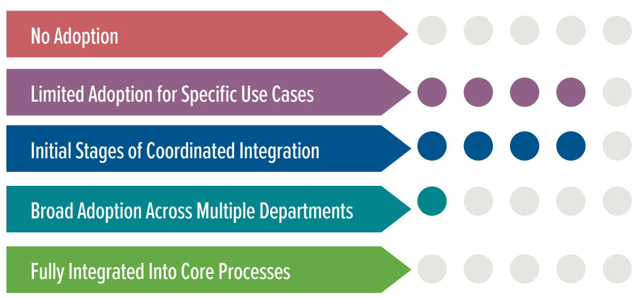
EXECUTIVE SUMMARY

As artificial intelligence reshapes modern medicine, Houston's world-renowned healthcare institutions are harnessing its power to pioneer cutting-edge innovations in diagnostics, personalized treatments, and patient care, leveraging the city's diverse population and robust medical ecosystem. This report "Houston's Future: AI in Healthcare" explores AI's transformative role, current applications, challenges, and strategic recommendations for the region's healthcare leaders.

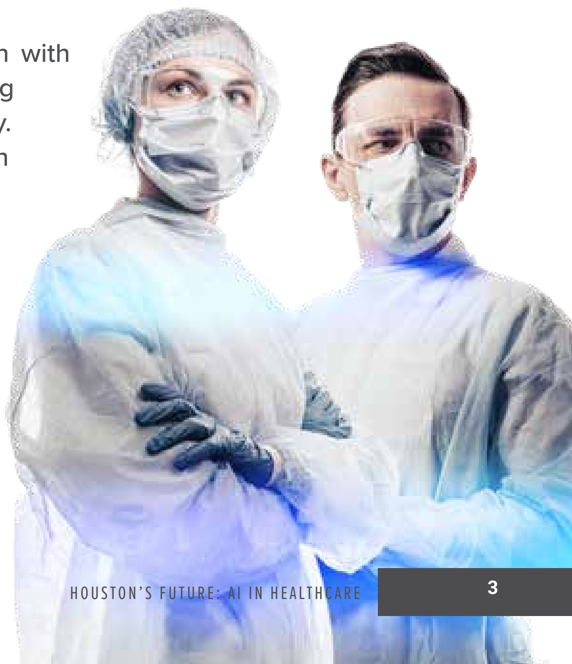
AI ADOPTION LEVEL: Rate the current level of AI adoption at your healthcare institution. (AI includes generative AI, predictive AI, and robotic process automation.)



Source: Center for Houston's Future survey of local healthcare systems

KEY POINTS

- **AI's Role in Healthcare:** AI is already revolutionizing healthcare by enhancing diagnostics and automating administrative tasks. It is making significant strides in areas such as medical imaging, predictive diagnostics, and clinical documentation. Generative AI is expanding possibilities in personalized treatment planning and drug discovery. It is also being explored for ambient listening in clinical charting and various surgical applications. These examples, while illustrative, are not exhaustive, as AI continues to unlock new potential across the healthcare landscape.
- **Houston's Leadership:** With world-class medical institutions and a thriving research community, Houston is well-positioned to lead in medical AI. The city's diverse population provides valuable data for developing robust and inclusive AI models.
- **Current Applications:** A survey of 10 major healthcare systems representing 27 million patients identified that AI is in some level of adoption across the board. For instance, AI-powered CT scans at Baylor St. Luke's Medical Center have significantly reduced stroke intervention times, and Houston Methodist uses AI to summarize patient information.
- **Challenges:** Key challenges include data privacy concerns, integration with existing systems, financial barriers, the need for comprehensive training and education among healthcare professionals, and data quality. Addressing biases in AI algorithms is crucial to avoid exacerbating health disparities.
- **Strategic Recommendations:** To improve health outcomes equitably, enhance job satisfaction, and establish Houston as an AI healthcare leader, the report recommends fostering collaboration, establishing a robust data infrastructure, centering equity and algorithmic justice, investing in workforce development, leveraging both small and big data, focusing on fundamental healthcare needs, supporting AI innovation, measuring and communicating impact, engaging with policymakers, and building public trust.



INTRODUCTION

Healthcare stands on the brink of a transformation driven by artificial intelligence (AI), a technology, 70 years in the making, which is rapidly evolving from a futuristic idea into a practical tool reshaping medicine by streamlining workflows and tailoring patient care. Houston, with its renowned medical institutions, is poised to become a national hub for AI in healthcare. This report delves into the current state of medical AI adoption in Houston, explores potential benefits and challenges, and discusses the region's potential to lead in this field.

Our research, which included interviews with 26 AI experts and a survey of 10 major healthcare systems catering to over 27 million patients, reveals that while full integration is not yet the norm, all surveyed systems have started adopting AI. Early applications, which are in widespread use, are showing impressive results. For example, MD Anderson Cancer Center has developed a web-based AI-assisted tool called the Rapid Planning Assistant to support high quality radiotherapy globally -- including for low-income countries, and Texas Heart Institute leverages AI to anticipate and prevent patient deterioration through predictive analytics.

Despite the undeniable promise, continued AI integration requires careful consideration of potential risks. Patient privacy is paramount, as AI systems often rely on vast amounts of personal health data. Robust data security and ethical practices are important to maintaining trust. And algorithms trained on biased datasets can perpetuate existing inequalities. To mitigate these risks and ensure equitable benefits, developers and healthcare providers must collaborate on transparent and fair AI systems.

This report provides a comprehensive analysis of today's landscape, outlines challenges and opportunities, and makes recommendations for success. As with past medical innovations, Houston is well-positioned to help shape the future of AI in healthcare.

TIMELINE OF AI AND AI IN HEALTHCARE

1950

AI's Genesis (1950-1972)

1950: Turing Test proposed

1956: "Artificial Intelligence" coined

1960

1964: ELIZA, first chatbot, created

1970

1972: MYCIN, medical AI for blood infections, developed

1980

1990

AI Milestones (1997-2011)

1997: Deep Blue defeats chess champion Kasparov

2000

2000: FDA approves AI-assisted surgery

2010

AI Goes Mainstream (2011-2016)

2011: IBM Watson wins Jeopardy!

2011: Siri integrated into iPhone 4S

2015: AI surpasses humans in image recognition

2016: Chatbot Mandy automates patient intake

2020

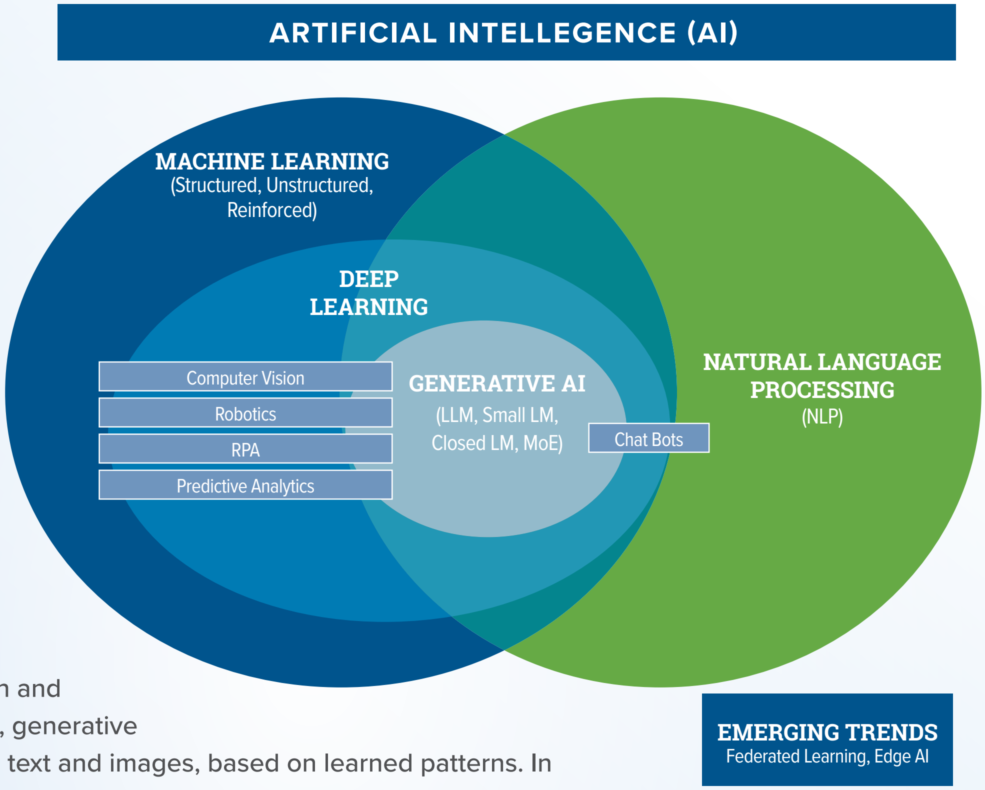
AI in Modern Healthcare (2020-Present)

2020: AI assist COVID-19 diagnosis and vaccine development

2022: ChatGPT released, showcasing advanced language abilities

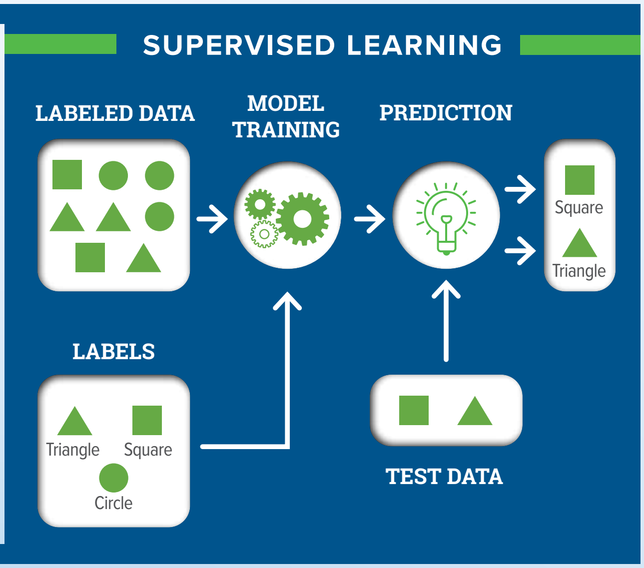
2023: AI accelerates drug discovery and personalized treatments

CONTEXT: AI IN HEALTHCARE



AI has been a part of healthcare for many years, evolving significantly since its early days. Initially focused on solving biomedical challenges in the 1970s, AI has become integral to modern medicine, enhancing diagnostics, personalizing treatments, and automating administrative tasks. Recent advancements, particularly in generative AI like ChatGPT, have brought AI into the public eye. Generative AI is a shift from traditional AI. While traditional AI focuses on tasks like classification and prediction using predefined rules, generative AI creates new content, including text and images, based on learned patterns. In healthcare, these AI forms are applied differently. Traditional AI is widely used for medical image analysis, predictive diagnostics, and identifying patient risk factors. Generative AI is opening new possibilities in personalized treatment planning, medical research literature synthesis, and drug discovery.

- **Traditional AI:** Used in medical image analysis and patient risk stratification.
- **Generative AI:** Opens possibilities in personalized treatment planning and drug discovery.
- **Machine learning:** Enhances disease prediction and treatment recommendations.
- **Deep learning:** Powers complex image analysis and pathology slide automation.
- **Natural language processing (NLP):** Improves clinical documentation and patient communication.



More information on types of AI and their uses can be found in Appendix A.

GENERATIVE AI: BALANCING POTENTIAL WITH CHALLENGES

Large language models (LLMs) powered by generative AI present significant opportunities for healthcare applications, but their integration requires careful consideration of data privacy, accuracy, bias, computational power, and energy consumption. Distinct types of LLMs have their own strengths and weaknesses, and medical institutions must carefully select and implement the appropriate models while ensuring adequate safeguards are in place. AI models "train" algorithms on data sets to recognize patterns and relationships within data, which then enables them to make predictions or decisions on latest information. Open-source LLMs like ChatGPT, trained on vast datasets using deep learning techniques, can inadvertently learn and expose sensitive patient information if not responsibly managed. Additionally, training on extensive internet text can lead to "data pollution," where misinformation, biases, and inaccuracies infiltrate the model's outputs, compromising reliability and trustworthiness. Ensuring the accuracy of LLM outputs is necessary in settings where decisions have significant consequences, necessitating robust data encryption, regular data audits, and clear ethical guidelines for AI development and deployment.

Various language models offer different approaches but come with trade-offs. Closed-source models provide pre-trained solutions but lack transparency, which can be problematic in healthcare settings. Small language models excel in specific tasks like clinical decision support but have limited functionality. Domain-specific LLMs, trained primarily on healthcare data, offer a potential solution to some challenges by focusing on medical terminology, procedures, and patient care, generating more accurate and relevant outputs. However, these models can be expensive to develop and may face challenges related to data scarcity. The use of synthetic or artificial data to address these data shortages and privacy concerns remains a topic of ongoing debate in the medical community.

Another concern with language models is their computational power requirements and energy consumption. Innovative approaches like Mixture of Experts models have emerged, combining specialized models for enhanced efficiency and accuracy in complex scenarios. Simultaneously, Edge AI has gained traction as a solution that deploys AI algorithms and models directly on edge devices, such as sensors, smartphones or IoT devices. This approach reduces reliance on centralized cloud servers, enabling real-time data processing and decision-making at the source. This enhances privacy, saves bandwidth, and reduces latency. By carefully selecting and applying these advanced models and technologies, healthcare providers can address core concerns like data privacy, cost-effectiveness, and the need for specialized AI tools, ultimately enhancing patient care and operational efficiency.

RISKS AND MITIGATIONS

The use of AI can be controversial and carries risks in any situation, but in healthcare, where the stakes are life or death, the need for diligence, privacy and safety is paramount. As such, many organizations are working to address these risks and unlock the full potential of AI nationally and locally. Before delving into the benefits AI is bringing and promises to bring, we will discuss risk mitigation strategies that are common across healthcare use cases.

RISK	DESCRIPTION	MITIGATION STRATEGIES
Data Privacy and Security	AI systems rely on sensitive patient data, making it a target for cyber criminals.	▶ Data anonymization ▶ Compliance with regulations ▶ Transparency and patient consent ▶ Robust cybersecurity protocols and end-to-end encryption ▶ Regular security audits and updates ▶ Staff education on data security practices
Bias and Inequality	AI algorithms may perpetuate existing biases in healthcare data.	▶ Diversified training datasets to include underrepresented groups ▶ Tracked demographics and social determinants of health (SDoH) attributes ▶ Regular audits for fairness and accuracy ▶ Multidisciplinary teams in AI development
Inaccuracy and Errors	AI systems can produce incorrect results, leading to potential patient harm.	▶ Quality assurance and quality control measures ▶ Acceptance testing in local contexts ▶ Clinician oversight to verify AI recommendations
Accountability and Transparency	Excessive dependence on AI may reduce human clinical skills.	▶ Balance AI use with human judgment ▶ Continuous training and education for healthcare professionals ▶ Clinician involvement in AI-driven decisions
Overreliance on Technology	Excessive dependence on AI may reduce human clinical skills.	▶ Balance AI use with human judgment ▶ Continuous training and education for healthcare professionals ▶ Clinician involvement in AI-driven decisions
Unintended Consequences	AI may lead to overdiagnosis or overtreatment.	▶ Thresholds for AI sensitivity and specificity ▶ Clinician oversight to avoid unnecessary interventions ▶ Regular evaluations of AI system impacts

Houston is at the forefront of efforts to understand and mitigate AI risks. For instance, Dr. Bettina Beech, University of Houston's chief population health officer, was appointed to the National Institutes of Health's Artificial Intelligence/Machine Learning Consortium to Advance Health Equity and Researcher Diversity. AIM-AHEAD seeks to increase diversity among AI/ML researchers, prevent biases in AI systems that contribute to health disparities, and improve health equity.[1]

Houston's Dr. Matthew Segar, cardiology fellow at the Texas Heart Institute, is also making significant contributions. His research focuses on using machine learning and AI to improve risk prediction and tailor medical therapies, particularly for heart failure. By incorporating social determinants of health into AI models, Dr. Segar aims to improve the accuracy and fairness of predictions, reduce bias, and improve outcomes for diverse patient populations.[2]

To ensure the safe and effective integration of AI in healthcare, several overarching strategies must be considered. It is imperative to develop diverse training datasets, ensure transparency and explainability in AI models, and integrate clinical expertise with AI-generated insights. Regular audits and performance evaluations are essential to identify and correct biases. And medical professionals must be trained to accurately interpret AI recommendations.

Dr. Caroline Chung, vice president and chief data officer at MD Anderson, is focused on assuring the promise of AI can be realized. To achieve this, she advocates for institutions to look anew at the approach they take to manage their data – the critical component to realize safe and effective AI. Under her leadership, MD Anderson is building a 'metadata supply chain' to assure AI algorithms can accommodate the contextual information that protects against vulnerability in data quality, assures traceability, and allows appropriate governance of the data that is training and driving these technologies.[3]

AI systems demand rigorous validation and testing to ensure reliability, including extensive simulation before clinical deployment. Regular software updates are also critical to maintain accuracy and dependability by integrating new data and algorithms.

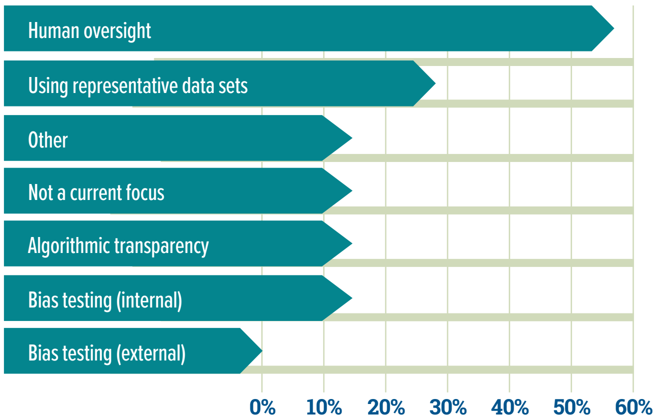
A human-in-the-loop approach is critical to balance AI assistance with clinical expertise. AI systems are designed to support, not replace, the judgment of doctors, nurses, and other medical professionals. Surgeons and clinicians must be able to override AI recommendations to preserve clinical judgment as the primary decision-making factor. Comprehensive training for healthcare teams on AI capabilities and limitations is essential.

Regular audits and performance evaluations help find and correct biases or inaccuracies in AI models. This includes cross-validation with external datasets and continuous monitoring of model outputs. Ongoing evaluation also helps ensure models remain accurate in evolving situations.

Transparency and explainability in AI models are important to foster trust in AI-assisted decision-making processes. Providing transparent and explainable outputs allows clinicians to understand the rationale behind AI predictions, which is essential to effectively integrate AI into healthcare settings.

FAIRNESS AND BIAS PREVENTION IN AI IN HOUSTON HEALTHCARE

How does your organization ensure fairness and prevent bias in AI algorithms? (Select all that apply)



Source: Center for Houston's Future survey of local healthcare systems

While risk mitigation focuses on addressing specific threats posed by AI technologies, governance provides the overarching framework to ensure technologies are developed and used ethically, transparently, and in alignment with societal values. Both elements are essential for the safe and effective integration of AI in healthcare. Governance and ethics will be discussed later, as next we look at some of the specific uses for AI.

CURRENT AND POTENTIAL USES OF AI IN HEALTHCARE

AI is transforming our local healthcare landscape, as hospitals and institutions leverage its potential to enhance patient care and optimize workflows. Our research found that AI, locally, is most widely used in clinical patient care. Surgical care represents a special case with unique needs and risks. As noted in the chart below, while AI is used in surgical applications, none of the healthcare systems we surveyed are conducting experimental or unproven testing of AI in live surgical environments. All AI solutions used in surgery are fully validated and proven, reflecting the rigorous standards and thorough validation processes required before any new technologies are integrated into surgical care. This approach ensures patient safety remains the top priority in surgical applications of AI. Here we delve into the current AI applications and their promising future:

AI ADOPTION BY HEALTHCARE USE CASE	Not Considering	Considering	Testing or Implementation Phase	Limited Use	Broadly Used
Patient Care	1	23	11	15	4
Healthcare Administration/Operations	1	16	5	10	4
Healthcare Customer Experience	2	17	2	6	3
Surgical Care	0	7	0	4	1

Source: Center for Houston's Future survey of local healthcare systems

AI adoption is underway at Houston healthcare organizations across a range of functions.

*Aggregation of responses across specific use cases in a category and institutions.

PATIENT CARE

Houston is rapidly adopting AI to improve patient outcomes, streamline operations, and foster innovation. Locally, AI is most widely used in monitoring and medical imaging. The areas of greatest interest are ambient listening for medical charting and hyper personalized medicine.

PATIENT CARE: Rate the extent of AI use in the following areas (1 - Not Considering, 5 - Broadly Used)	Not Considering	Considering	Testing or Implementation Phase	Limited Use	Broadly Used
Patient monitoring	0	3	0	4	2
Medical imaging analysis	0	5	0	2	2
Synthesize patient risk considerations based on medical history	0	4	2	3	0
Summarize discharge and follow-up information for continuity of care	0	3	4	2	0
Enhanced charting through predictive text or ambient	0	4	3	2	0
Patient diagnosis and prognosis (predictive analytics)	1	4	2	2	0

Source: Center for Houston's Future survey of local healthcare systems

AI adoption in patient care ranges from broad use patient monitoring and medical imaging analysis to limited consideration in patient diagnostics and prognosis.

PATIENT MONITORING

Many Houston hospitals, including St. Luke's Health, Memorial Hermann, MD Anderson, and Houston Methodist, are implementing advanced patient monitoring technologies during hospital stays to enhance care and safety.

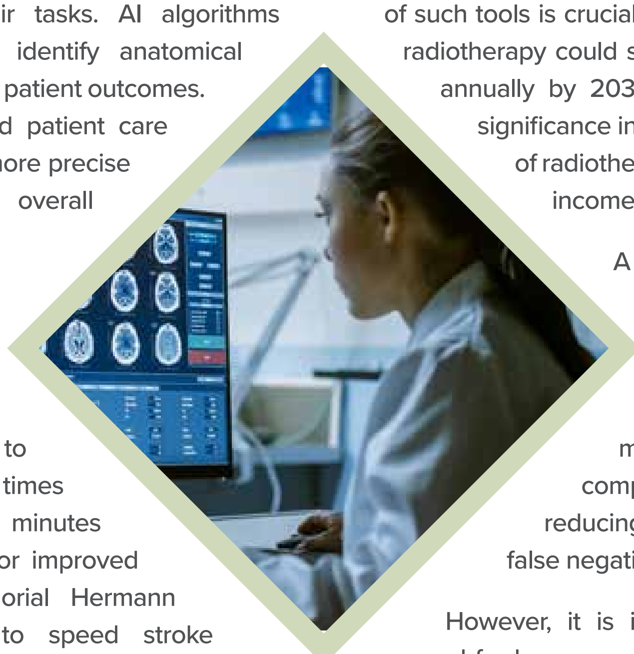
Houston Methodist uses the AI-enabled BioButton device to continuously monitor vital signs and provide early warnings of potential health deteriorations up to 12 hours in advance. This proactive approach allows for timely interventions, such as preparing crash carts before a code blue, ultimately improving patient outcomes. Additionally, ambient visioning is used to detect fall risks. Memorial Hermann is piloting Hellocare, a virtual tool to monitor bed railing status and patient movement to identify fall risks. MD Anderson Cancer Center is exploring in-room technology that allows for both continuous monitoring and remote intervention capabilities aimed at preventing adverse events.

St. Luke's Health employs telemetry monitors to track heart rhythms in cardiovascular patients, providing real-time data for diagnosing and managing cardiac events. These technologies collectively contribute to a broader strategy of leveraging real-time data and advanced analytics to enable proactive healthcare interventions.

It is worth noting that false alarms could lead to alert fatigue among staff, potentially causing them to ignore important notifications. Systems should fine-tune AI algorithms to reduce false positives, implement a tiered alert system based on urgency, and integrate AI alerts into existing clinical workflows to minimize disruption.

MEDICAL IMAGING ANALYSIS

AI is widely integrated into medical imaging, significantly aiding radiologists in their tasks. AI algorithms can detect abnormalities, identify anatomical structures, and even predict patient outcomes. This translates to improved patient care through faster diagnoses, more precise treatments, and better overall coordination.



Hospitals across Houston are embracing AI to improve stroke care. St. Luke's Health, for instance, uses AI-powered CT scans to reduce stroke intervention times from two hours to just 25 minutes – a critical advancement for improved outcomes. Similarly, Memorial Hermann uses Viz.AI technology to speed stroke diagnosis by automatically analyzing images and alerting healthcare teams for swift response.

MD Anderson Cancer Center has developed a web-based AI-assisted tool called the Rapid Planning Assistant to support high quality radiotherapy globally.[6] This innovative system streamlines and automates the planning process, saving time, ensuring consistency, and improving accessibility to quality radiotherapy, especially in resource-limited settings. The introduction of such tools is crucial, as enhancing global access to radiotherapy could save an estimated 1 million lives annually by 2035. This underscores the RPA's significance in addressing the critical shortage of radiotherapy services in low- and middle-income countries.[8]

A recent study by Google Health demonstrates AI's remarkable potential, concluding that its deep learning algorithm detects breast cancer in mammograms with accuracy comparable to experts, even reducing false positives by 5.7% and false negatives by 9.4%.[4]

However, it is important to acknowledge the need for human expertise alongside AI. To mitigate the risk of missed or wrong diagnoses, a two-pronged approach is key. Combining AI analysis and radiologist review offers a safety net. Inconsistencies between AI and radiologist findings can be flagged for further investigation. Furthermore, to ensure AI models stay relevant and address evolving medical challenges, continuous updates with new data and emerging disease patterns are essential.

SYNTHESIZE PATIENT RISK CONSIDERATIONS BASED ON MEDICAL HISTORY

An exciting new field enabled by AI is personalized risk prediction and proactive care management. By analyzing patient medical histories, AI generates comprehensive risk profiles to guide tailored interventions. Houston Methodist reports that its partnership with the Health Data Analytics Institute, based outside of Boston, has produced personalized risk profiles leading to reduced hospitalizations and improved patient outcomes.

An AI-powered risk stratification tool implemented by Kaiser Permanente identified high-risk patients for targeted interventions, resulting in a 10% reduction in hospital admissions and a 7% decrease in emergency department visits over a 12-month period.[5]

To ensure patients do not receive anxiety-inducing risk information without proper context or support, clinicians must develop clear communication protocols for sharing AI-generated risk profiles with patients, including opportunities to talk to providers. They must also offer resources and support for patients identified as high-risk, such as counseling or lifestyle intervention programs.

SPOTLIGHT

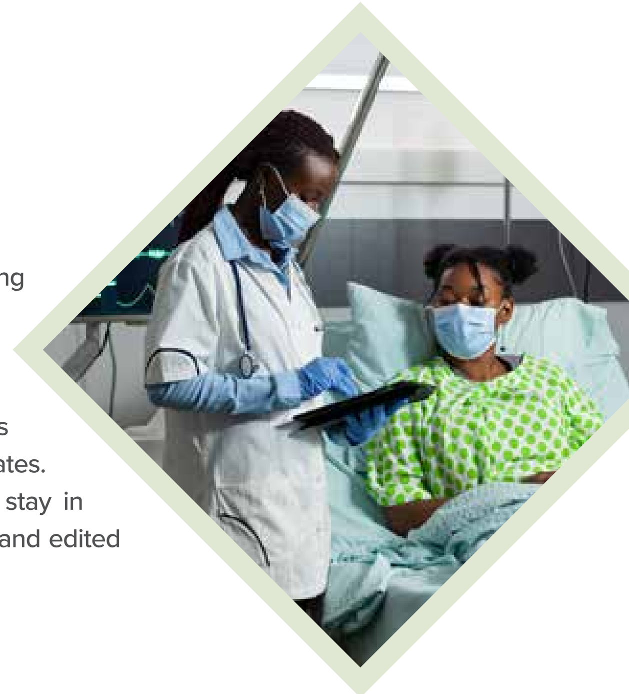
Hyper-personalized medicine improving health outcomes and healthcare efficiency

Hyper-personalized medicine is revolutionizing healthcare by using advanced analytics and comprehensive data sets to address social determinants of health (SDoH) with unprecedented precision. By combining longitudinal health records, credit history, public domain information, and electronic medical record (EMR) data, healthcare providers can create a nuanced understanding of individual patients' circumstances with up to 98% accuracy. This approach transcends traditional demographic or census tract analysis, focusing on specific individuals and their unique needs.

One significant use of this technology is to identify and manage "high utilizers" of healthcare services, particularly those who frequently and often inappropriately rely on emergency departments. These patients, while comprising a small percentage of the population, can account for a disproportionate amount of costs and resources. By accurately predicting which patients are likely to become high utilizers (with up to 91% accuracy), healthcare systems can proactively implement targeted interventions and wrap-around services.

This hyper-personalized approach can improve patient outcomes by addressing their specific health and social needs. And, by redirecting high utilizers to more appropriate care settings and addressing underlying SDoH issues, hospitals can reduce emergency department overcrowding, decrease unnecessary admissions, and better allocate resources. Furthermore, this strategy allows for the development of tailored preventive care programs and community-based interventions that can mitigate health disparities and reduce long-term healthcare costs.[7]

SUMMARIZE DISCHARGE AND FOLLOW-UP INFORMATION FOR CONTINUITY OF CARE



AI-generated discharge summaries and follow-up care plans are streamlining care transitions and improving patient outcomes. Houston Methodist's use of PIECES AI demonstrates how AI can efficiently summarize patient information. AI-generated comprehensive discharge summaries can reduce physician documentation time by 40% and potentially shorten hospital stays by expediting the discharge process, ultimately improving patient discharge rates. To avoid missing important nuances or context from the patient's hospital stay in automated summaries, the AI generated initial summary should be reviewed and edited by the attending physician.

ENHANCED CHARTING THROUGH PREDICTIVE TEXT OR AMBIENT LISTENING

Clinicians are enthusiastic about advancements in clinical documentation, such as predictive text, ambient listening, and task automation. Ambient listening is an AI tool that automatically analyzes, organizes, and transcribes conversations between healthcare providers and patients into the electronic health record. These innovations free time for more meaningful patient interactions. As Dr. Babatope Fatuyi, chief medical information officer at UTHealth Houston, stated: "We did not go to medical school to do charting." Predictive text and ambient listening technologies are easing the burden and reducing errors in clinical documentation.

Memorial Hermann has piloted Ambience, an ambient listening tool that automatically generates chart notes and patient summaries, under the leadership of Eric Smith, senior vice president and chief digital officer. The results have been impressive, with a 24% reduction in provider burnout (Maslach Burnout Inventory), 85% of providers expressing high dissatisfaction at the prospect of losing the tool, a 90% increase in patient satisfaction as providers focused more on conversations, and a 22% reduction in charting time.

Similarly, MD Anderson Cancer Center has piloted ambient technologies from Abridge and Nuance, primarily for note generation. However, their broader goal is to identify a partner capable of scaling to meet additional needs, such as discreet data entry and support for more complex workflows like nurse charting. These advancements highlight the potential of AI to optimize clinical workflows, improve patient care, and enhance provider satisfaction.

PATIENT DIAGNOSIS AND PROGNOSIS (PREDICTIVE ANALYTICS)

Predictive analytics, powered by AI, are revolutionizing how providers identify and manage patient conditions. By analyzing vast datasets, AI algorithms can predict the onset of diseases like sepsis (as demonstrated by research at Johns Hopkins) and anticipate disease progression. Local institutions, such as Harris Health System, St. Luke's Health, and MD Anderson, are employing AI to predict sepsis, patient deterioration, and even detect early-stage pancreatic cancer.

An AI model developed by researchers at Johns Hopkins can predict the onset of sepsis in ICU patients up to 6 hours earlier than traditional methods, potentially reducing mortality rates by 20%.[5]

SPOTLIGHT

MHA Houston's Innovative Use of AI for Behavioral Health Navigation

Mental Health America of Greater Houston (MHA Houston) is integrating AI to help individuals and families better find mental health services in the Houston area. "We want to go from people's last hope to their first choice when they are looking for care," said Renae Vania Tomczak, president and CEO of MHA Houston. Under her leadership and with the support of Chief Strategy and Innovation Officer Andrea Usanga, MHA Houston is employing AI to create a more compassionate and streamlined approach to mental health resource navigation.

MHA is committed to making mental health resources more accessible and user-friendly. The need for improved navigation services is underscored by the significant increase in the use of its online mental health screening tools, provided by MHA National, which saw participation jump from 3,400 in 2019 to approximately 25,000 annually starting in 2021.

The organization plans to map data from the screenings to identify prevalent issues such as depression, anxiety, PTSD, and other mental health concerns in different regions of Greater Houston. The data will help practitioners understand the specific needs using zip codes, enabling more targeted and effective interventions.

MHA Houston's multi-tiered navigation program, launching in late 2024/2025, aims to meet individuals where they are and provide resources and support at various levels of need. The first tier involves providing articles and tips, which may be sufficient for some individuals. The second tier introduces AI-driven virtual navigation, offering empathetic listening and care navigation through a web-based platform. This AI tool will allow users to enter information about their needs and preferences to help them find nearby resources without revealing personal identifying information. The AI may also feature culturally appropriate guides, tailored to demographic information provided by users, to ensure a more personalized and respectful interaction.

The third tier involves tele-navigation and helpline for individuals to speak to those with similar lived experience who can guide them to appropriate providers, both nonprofit and for-profit. This tier will use a detailed and up-to-date database, maintained with the help of AI, to ensure accurate and comprehensive information about available services.

The fourth tier offers personal navigation with in-person meetings, including home visits, for more complex cases involving co-occurring mental health issues, substance abuse, or social determinants of health (SDoH) challenges. Individuals can enter the system at any tier and move between tiers as needed to ensure they receive the appropriate level of support.

MHA Houston is exploring partnerships with vendors like HumeAI, Yanzio, and Vern AI to develop and implement these AI solutions. The organization is also addressing potential risks and governance concerns, including privacy issues, by hiring legal experts to ensure compliance with legal requirements and maintain high-quality, unbiased care.

This innovative approach is designed to address mental health issues early to prevent them from escalating into more serious problems or crises. "This strategic endeavor is our next step toward greater impact in helping vulnerable individuals and families obtain access to the mental health care and supports they deserve," added Vania Tomczak.

SURGERY

AI is enhancing precision, improving patient outcomes, and streamlining workflows in surgical practices. Below are key examples, benefits, risks, and mitigation strategies associated with AI in preoperative, intraoperative, and postoperative care.

AI IN SURGICAL CARE	Not Considering	Considering	Testing or Implementation Phase	Limited Use	Broadly Used
Preoperative planning (personalized surgical plans, risk identification)	0	2	0	2	0
Intraoperative guidance (robotic assistance, computer vision, autonomous actions)	0	2	0	1	1
Postoperative care (automated skills assessment and feedback)	0	2	0	1	0

Source: Center for Houston's Future survey of local healthcare systems

Hospital systems providing surgical care are implementing or exploring AI applications in three key areas of patient care surveyed.

PREOPERATIVE CARE AND AI

Preoperative care is a critical phase in a patient's journey that significantly impacts surgical outcomes and the overall patient experience. By analyzing extensive datasets, including medical history, imaging, and lab results, AI algorithms can predict surgical risks, optimize treatment plans, and enhance patient management. This empowers clinicians with actionable insights and leads to more accurate and efficient preoperative assessments.

Preoperative Risk Prediction

AI algorithms can analyze substantial amounts of patient data to predict surgical risks, optimize patient selection for minimally invasive procedures, and streamline preoperative planning. For instance, patients identified as high-risk may receive more intensive monitoring, preoperative optimization of comorbid conditions, or adjustments in surgical planning to mitigate risks. Additionally, AI can aid in resource allocation by predicting patient length of stay and optimizing operating room schedules.

Imaging Technologies in Preoperative Planning

At Baylor St. Luke's, AI is used by the Texas Heart Institute (THI) affiliated surgeons in planning for complex cardiovascular procedures. By integrating AI with imaging technologies, THI provides detailed anatomical insights that assist in the precise planning of surgeries. For example, in transcatheter aortic valve replacement (TAVR) preoperative imaging helps determine the appropriate size and positioning of the valve prosthesis, ensuring a successful procedure with minimal complications. This approach helps reduce potential complications and improve surgical outcomes by offering surgeons comprehensive data-driven insights before the procedure.[9]

INTRAOPERATIVE GUIDANCE

AI for intraoperative guidance uses machine learning algorithms and computer vision techniques to support surgeons during procedures. This technology analyzes real-time data from surgical instruments, patient vitals, and imaging systems to provide actionable insights and recommendations. It helps identify critical anatomical structures, predict potential complications, and optimize the sequence and execution of surgical steps for enhanced precision and safety.

Houston Methodist employs AI-driven systems that have reduced surgical errors by 30% through real-time feedback and critical structure identification.[10]

St. Luke's Health's da Vinci® Surgical System, has enabled surgeons like Dr. Kenneth K. Liao at Baylor St. Luke's to perform over 500 robotic heart surgeries with high precision, using a 3D high-definition scope and robot-controlled instruments for minimally invasive procedures.[11 12]

MD Anderson's Surgical Data Science Program, led by Jeff Stewardson, Ph.D., is pushing the boundaries further by integrating data science and systems engineering approaches to enhance surgical practices. Its initiatives include using machine learning for real-time analysis to prevent adverse events and surgical process modeling to optimize workflows.[16]

There is, however, a risk of system malfunctions or inaccuracies in real-time data analysis. This can be mitigated with robust validation protocols, regular maintenance, and allowing surgeons to override AI recommendations so that clinical judgment remains integral to surgical decision-making.

POSTOPERATIVE CARE

Houston hospitals, including Houston Methodist, St. Luke's Health, and MD Anderson, are using AI in postoperative care to monitor patient recovery, predict complications, and provide personalized care recommendations.

Houston Methodist has pioneered the use of the BioButton, an AI-enabled device that continuously monitors vital signs, both in-hospital and post-discharge. This technology aims to detect health deteriorations early and reduce hospital readmissions. By identifying issues sooner, the BioButton has contributed to a 37% decrease in code events, such as cardiac or respiratory arrests, that require immediate medical intervention.

Additionally, Houston Methodist has partnered with the Health Data Analytics Institute to generate personalized risk profiles to improve care coordination and reduce mortality rates and lengths of stay.[15] St. Luke's Health is using AI-driven predictive analytics to identify patients at risk of postoperative complications, such as cardiac arrest.[14] This proactive approach enhances recovery outcomes by enabling timely interventions. MD Anderson is using AI to analyze post-brachytherapy MRI studies, optimizing postoperative care by evaluating radiation delivery quality.[13]

By implementing these strategies, Houston's healthcare institutions can effectively leverage AI in postoperative care to improve patient outcomes.

ADMINISTRATION

AI enhances administrative workflows by automating routine tasks like documentation, data management, and appointment scheduling. This frees staff to focus on more critical patient care responsibilities. AI systems also ensure that administrative processes comply with regulations. While AI handles complex decision-making, robotic process automation (RPA) can complement these efforts by managing repetitive, rule-based tasks, further optimizing administrative efficiency.

AI IN HEALTHCARE ADMINISTRATION/ OPERATIONS	Not Considering	Considering	Testing or Implementation Phase	Limited Use	Broadly Used
Task automation	0	3	1	3	2
Claims processing (reimbursement, prior authorizations, and medical coding)	0	4	0	3	2
Workflow optimization (generate clinical workflow materials, schedules, and training)	0	5	2	2	0
Corporate operations (functions for IT, procurement, talent, finance, legal/compliance)	1	4	2	2	0

Source: Center for Houston's Future survey of local healthcare systems

AI adoption is most widespread in Task Automation and least prevalent in Corporate Operations.

ADMINISTRATIVE TASK AUTOMATION

UTHealth Houston and UT Physicians have achieved an impressive 83% accuracy rate in forecasting appointment no-shows, resulting in a 20% reduction in missed appointments.[17] This success extends to operating room management. Houston Methodist's AI system, which analyzes patient data, surgeon availability, and equipment usage, has boosted operating room utilization by 15% and cut patient wait times by 10%.[10] MD Anderson Cancer Center has taken a similar approach, developing computational tools that optimize surgical scheduling and enhance patient access.[16] Its collaboration with LeanTaas has further improved patient flow in infusion centers, surgical scheduling, and inpatient care through machine learning and predictive modeling.[18] These innovations demonstrate the transformative power of data-driven decision-making in healthcare, simultaneously enhancing patient care and operational efficiency. However, as these AI applications handle sensitive information, robust security measures and data privacy protocols remain paramount.

AI IN REIMBURSEMENT, PRIOR AUTHORIZATIONS, AND MEDICAL CODING

Integrating AI into the revenue cycle is complex due to various stakeholders using incompatible systems and having different objectives and priorities. This section explores how AI is transforming reimbursement, prior authorizations, and medical coding.

AI applications in reimbursement processes can streamline complex billing practices and ensure timely payment for services. They can automate eligibility verification, claims processing, and error detection, reducing delays and errors. For instance, AI tools can automatically verify patient eligibility in real-time and generate claims, spot potential errors before submission, and thus minimize claim rejections and denials. A study showed that AI algorithms could improve claim acceptance rates by identifying and correcting billing errors before submission, reducing resubmission times and enhancing cash flow.[20] However, there are instances where AI has increased claim rejection rates due to more stringent claim reviews by payers, as seen in some Medicare Advantage plans where AI algorithms were used to deny claims for extended care.[21]

Prior authorizations have been identified as a significant burden, often leading to care delays and treatment abandonment. AI is automating and expediting the process. For example, Blue Cross Blue Shield of Massachusetts integrated AI into its web portal, reducing the review period from an average of nine days to under one day.[22]

However, AI can also inhibit the prior authorization process. Some insurers have used AI to expedite reviews, leading to increased denials. This rapid processing raises concerns about the thoroughness and fairness of the reviews. Additionally, the administrative burden remains a challenge due to the need for interoperability among electronic health records (EHRs) and the standardization of data exchange protocols.[23] While AI can offer efficiencies in prior authorization, it can also create barriers if not implemented with careful oversight and adherence to ethical standards.

AI is transforming medical coding by automating the extraction and processing of diagnostic and treatment information from clinical notes. This ensures accuracy and compliance with the latest coding standards and reduces reliance on human labor. AI-based medical coding systems have been shown to increase coding productivity by seven times, processing millions of charts daily and achieving a 90% automation rate in chart coding. This translates to a 23% rise in net patient revenue for healthcare systems.[24] That said, medical coding is inherently complex, with constantly evolving guidelines and practices. AI systems must be regularly updated to keep pace. Failure to do so can lead to inaccuracies that affect billing and reimbursement processes.[25]

Healthcare organizations can ensure high data quality through rigorous validation, verification, and training. As always, the best practice is human validation of AI-generated data and decisions.

TRAINING AND CLINICAL WORKFLOW MATERIALS

Generative AI technologies excel at creating educational content and clinical documentation platforms that pull information from various sources to assist doctors, nurses, and others in making informed decisions. For example, the Pieces Inpatient Platform has been integrated into clinical workflows to provide AI-generated working summaries. This integration has led to considerable time savings and improved prediction accuracy for discharge dates.[5,26] Flawed data inputs can lead to errors that may hurt patients and operational effectiveness. This could diminish human oversight, potentially exacerbating issues during system failures or data breaches. Rigorous validation and continuous oversight can address these challenges.[27]

Overall, AI-powered automation can be a valuable tool to improve efficiency, reduce costs, enhance patient care, and support professional development.[28,29]

CORPORATE FUNCTIONS

Corporate functions like IT, procurement, talent management, finance, and legal/compliance, have the lowest AI adoption rate within healthcare administration among the local systems we surveyed. This area still holds significant transformative potential. AI streamlines operations by automating tasks such as IT ticketing, procurement processes, and financial reporting, thereby improving efficiency and decision-making. In IT, AI enhances cybersecurity by identifying threats in real-time, while in procurement, it aids in vendor evaluation and compliance monitoring. Talent management benefits from AI's ability to predict staffing needs and automate onboarding, allowing HR to focus on strategic goals. In finance, AI reduces errors and accelerates processes by automating billing and claims processing. Legal and compliance functions are supported by using AI to monitor regulatory changes and ensure adherence to standards. The primary challenges are cybersecurity risks and integrating AI with existing systems. Mitigation strategies include robust encryption, routine audits, continuous training, and thorough vendor evaluations.

CONSUMER EXPERIENCE

Some of the more intriguing applications of AI are in consumer experience. However, our survey indicates that this area has a lower adoption rate compared to the other three broad use case topics. Consumer experience focuses on patient-provider interactions, including communication, service delivery, and satisfaction, distinguishing it from medical patient care and operational administration. In this domain, AI is employed to analyze customer feedback, enhance chatbots for customer service, automate notifications, and provide multilingual translations of patient information.

AI IN HEALTHCARE CUSTOMER EXPERIENCE	Not Considering	Considering	Testing or Implementation Phase	Limited Use	Broadly Used
Translate patient information into different languages	0	3	0	2	1
Autogenerate notifications and communications	0	3	1	1	1
Improve chatbots for customer service	0	4	0	1	1
Create personalized care instructions, videos, visuals	1	3	1	1	0
Analyze customer feedback	1	4	0	1	0

Source: Center for Houston's Future survey of local healthcare systems

AI for language translation is the most widely adopted in Customer Experience, yet the potential for AI-driven customer feedback analysis remains largely unexplored.

ANALYZE CUSTOMER FEEDBACK

AI can be used to analyze customer feedback and yield valuable insights from diverse sources to help hospitals, clinics and other medical providers better understand patient experiences and improve service delivery.

NarrativeDx, a company specializing in AI-driven patient feedback analysis, employs natural language processing to interpret patient comments, capturing nuances in tone and metaphorical expressions. This lets hospitals translate patient feedback into actionable insights. Notably, NarrativeDx is a graduate of the Texas Medical Center's TMCx accelerator program, which supports healthcare innovation.[30]

In addition, a collaboration between researchers from Penn State and Geisinger applied AI to machine learning algorithms to analyze patient satisfaction data. The study identified key factors impacting patient satisfaction, such as the courtesy and respect shown by providers, effective communication, and pain management quality. These insights allowed hospitals to implement targeted improvements, leading to enhanced patient satisfaction and better health outcomes.[31]

PERSONALIZED PATIENT EDUCATION THROUGH AI

AI can provide personalized care instructions, videos, and visuals to help improve patient understanding and engagement.

Houston Methodist is using AI to create personalized treatment plans and educational materials tailored to individual patients. Using AI to help create personalized care plans has led to improved patient outcomes, including reduced mortality rates and readmission rates. The hospital reports that its initiatives have led to significant improvements in patient satisfaction and care coordination.

Additionally, the Texas Medical Center, a hub for healthcare innovation, is exploring using AI to create educational content that addresses health literacy gaps. AI-driven personalized videos, for instance, could be used to educate patients on their treatment plans and post-discharge care, which can reduce readmission rates and improve outcomes.

The effectiveness of personalized content depends on precise data interpretation and context understanding. Inaccuracies in AI-generated content can have serious consequences for patient health. To mitigate these risks, it is essential to establish clear communication channels for verifying and discussing AI recommendations. These build trust and understanding between patients and healthcare providers. Incorporating feedback loops and continuous learning mechanisms into AI systems allows for ongoing refinement and improvement based on real outcomes and user interactions.

CHATBOTS FOR CUSTOMER SERVICE

AI-powered chatbots are improving customer service by leveraging patient interactions to learn and adapt responses tailored to individual needs while maintaining context throughout conversations. This can enhance user experience by delivering timely and precise information, reducing wait times, and ensuring consistently high service quality. For instance, chatbots developed by Houston Methodist in collaboration with companies like Syllable have played a pivotal role in managing high volumes of inquiries, particularly during the COVID-19 vaccine rollout. Murat Urlakan, Houston Methodist's director of innovation, said these AI-driven systems successfully handled over 9,000 calls per weekday with a 91% automation rate, significantly diminishing the need for human intervention and improving patient experiences with swift and accurate responses.[32] Similarly, Next Level Medical has implemented chatbot features that allow patients to interact with the healthcare system outside of clinic hours, further extending the reach and accessibility of patient support services.

In addition, Nuance's Dragon Ambient eXperience (DAX) has shown a 50% reduction in documentation time, allowing physicians to focus more on patient interaction. A study found that using DAX increased patient satisfaction scores by 23% due to improved physician engagement during visits.[33]

Despite advancements in AI chatbots for healthcare, challenges remain. These systems may misinterpret patient inquiries, leading to inaccurate responses. Such errors can erode patient trust. To address these issues, healthcare providers are enhancing chatbot training with advanced natural language processing techniques. This allows chatbots to learn from interactions and provide more accurate responses. Additionally, clear communication channels are being established to verify and discuss AI-generated recommendations. Implementation of continuous learning mechanisms further refines these systems based on real-world outcomes and user interactions, improving their performance over time.

AUTOGENERATE NOTIFICATIONS AND COMMUNICATIONS

AI-powered communication systems analyze patient history and current health data to deliver timely, personalized notifications via text, email, and mobile apps. These tailored messages support healthcare objectives by providing relevant information and reminders to patients.

Houston Methodist employs AI-driven communication systems to send automated reminders for appointments, facilitate prescription refills, and provide updates on patient care plans. This approach has significantly reduced missed appointments and improved adherence to treatment plans.

Memorial Hermann's AI voice bot, Grace, conducts extensive patient outreach for administrative and clinical follow-up tasks. With over 150,000 calls made and an engagement rate of 40-50%, Grace has significantly improved efficiency. By managing follow-ups for the Nurse Health Line, Grace has saved more than one full-time equivalent, allowing nurses to focus on patient care. The system schedules post-emergency department follow-ups, assists in finding primary care providers, and ensures prescription fulfillment. Additionally, Grace helps schedule Medicare annual wellness visits, monitors medication adherence, and is beginning to assist in managing chronic conditions like congestive heart failure through daily patient check-ins.

A warning flag for any such tool: Excessive reliance on AI for communication tasks may limit opportunities for human oversight, potentially leading to errors in critical situations. As we have mentioned before, it is important to balance AI automation and human oversight, with clearly defined protocols for human intervention in vital communication tasks.

TRANSLATE PATIENT EDUCATIONAL INFORMATION INTO DIFFERENT LANGUAGES

AI-powered translation tools are significantly improving local healthcare accessibility and inclusivity by communicating in patients' preferred languages. Unlike word-for-word translation, AI-based translation uses neural networks to understand context and nuances, resulting in more accurate and natural translations. This capability enhances personalized care, satisfaction, and adherence to medical instructions.

The Texas Heart Institute uses an advanced neural network-based translation service on its websites to make cardiovascular health information accessible in over 100 languages, including Spanish, Vietnamese, Chinese and Arabic. This initiative is designed to improve access to quality health information for non-English speaking patients, which is important to ensure equitable and culturally sensitive education in our diverse community,

Use of neural machine translation has improved the accuracy of translations, achieving scores of 8.3 out of 10, close to human translation accuracy. This enhancement has led to increased engagement with non-English speaking users, with the Institute's Spanish-language pages being among the most accessed resources.[34]

The complexity of medical terminology and cultural variations adds to the challenge of achieving precise translations. As always, continuous evaluation and feedback mechanisms for AI algorithms and human oversight are required to capture cultural nuances and ensure accurate translations.

ETHICS

As AI becomes more prevalent, it introduces a range of ethical challenges, including bias, privacy, accessibility, and algorithmic justice. A comprehensive approach involving collaboration among healthcare professionals, researchers and legal experts is required to address such challenges.

Bias in AI algorithms is a significant ethical concern, as it can lead to unequal treatment and outcomes. Dr. Segar from The Texas Heart Institute emphasizes the need for transparent and inclusive AI models that address racial bias in risk scores -- numerical estimates used to predict a patient's likelihood of experiencing specific health outcomes -- to ensure equitable healthcare outcomes.[35] Organizations are conducting bias testing through internal reviews and external studies, using representative datasets, and maintaining algorithmic transparency to ensure fairness. Roberta L. Schwartz, executive vice president, chief innovation officer at Houston Methodist Hospital Center for Innovation, underscores the importance of iterative testing and human oversight to tailor AI systems to diverse cultural and disease contexts, ensuring equitable healthcare outcomes. Dr. Beech from the University of Houston advocates for algorithmic justice, emphasizing the importance of ensuring that the populations providing data benefit from AI advancements.

Privacy is another critical ethical issue, as AI systems often require access to vast amounts of personal health information (PHI). The Health Insurance Portability and Accountability Act (HIPAA) and the Texas Medical Records Privacy Act provide a framework for protecting PHI, setting standards for its use and disclosure. These regulations are essential for maintaining patient trust and ensuring responsible AI implementation.

Other key ethical considerations are accessibility and equity. MD Anderson's Dr. Chung emphasizes the opportunity to leverage technological advancements for both ambitious innovative pursuits like radical gene therapy and addressing the need to narrow accessibility gaps for healthcare. When it comes to AI, Dr. Chung advocates for focusing on applications that "raise the floor" by improving baseline conditions for a broader population, in addition to pursuing "blue sky" solutions that push the boundaries of what is possible. This approach fosters inclusivity and ensures the benefits of AI are distributed more evenly across society.

The Texas AI Council plays a necessary role in overseeing the ethical implementation of AI in state agencies, focusing on transparency and accountability. Angela Wilkins, the former executive director of Rice University's Ken Kennedy Institute, brings valuable expertise to the council, which is focused on ensuring responsible AI use. It sets guidelines to prevent poor data quality from affecting AI systems' functionality and to safeguard the public.

Ethics refers to the moral principles guiding the development and use of AI technologies. We turn next to governance, which involves the frameworks and policies to oversee and regulate AI's implementation and impact. As Houston's institutions continue to develop AI governance frameworks, it is essential to address these ethical considerations to harness AI's potential effectively. The following section delves into governance structures and lays the groundwork for a future discussion on data bias and other challenges.

SPOTLIGHT

Exploring AI's Ethical Challenges in Healthcare with Ali Candir

The integration of AI into healthcare is reshaping the industry, but it also introduces a complex ethical landscape. While AI promises to revolutionize diagnosis, treatment, and patient care, it raises profound questions about spirituality, human connection, governance, and equity.

Ali Candir, who serves as a staff chaplain at St. Luke's Health and has expertise in AI, explores the nexus between technology and human experience. He underscores the significance of "meaning making" and connection in spiritual care, areas often overlooked in the pursuit of technological advancement. He calls attention to the following issues:

AI's capacity to simulate human interaction challenges our understanding of empathy, compassion, and the irreplaceable nature of human touch, especially in times of crisis. For instance, AI-generated replicas of loved ones might provide temporary solace but could also hinder the grieving process. In addition, it raises concerns about the personal dignity of the individual being simulated and the authenticity of human experience.

Chaplains, by virtue of their presence and empathetic listening, can play a crucial role in patient care. The potential replacement of human interaction with AI-driven efficiency, particularly in tasks like patient discharge, threatens to diminish the quality of care and erode the essential human element of care.

AI-powered mental health platforms like Woebot and Wysa offer accessible and affordable support, especially for those in underserved areas. However, the development of emotional attachments to AI raises ethical questions about the potential for dependency and the displacement of human-to-human therapeutic relationships.

Beyond its interpersonal implications, AI is transforming healthcare data management. Its ability to process vast amounts of information efficiently can accelerate research and improve patient outcomes. Yet, this efficiency comes at the cost of potential job displacement and raises concerns about the loss of human oversight in critical decision-making processes.

Ensuring that AI is developed and deployed ethically is paramount. The U.S. lags Europe in establishing comprehensive AI governance frameworks. Addressing issues of privacy, data ownership, transparency, and bias is essential to build public trust. Moreover, AI must be designed and implemented to reduce health disparities rather than exacerbate them.

AI in healthcare offers transformative potential but also presents complex ethical challenges. The integration of AI must be navigated with a focus on preserving human connections, ensuring equitable access, and establishing robust governance.

The question is not whether AI is good or bad but whether it aligns with societal values and contributes to health equity. AI has the potential to either bridge or widen existing gaps in healthcare access, depending on how it is deployed and governed. As AI continues to evolve, it is imperative to engage in ongoing ethical reflection to ensure that these technologies align with our values and enhance, rather than diminish, the quality of healthcare.

GOVERNANCE

AI governance at the institutional, state, and federal level is a critical focus for Houston's major hospitals, including St. Luke's Health, Houston Methodist, Memorial Hermann, Harris Health, and MD Anderson, as they actively engage with Congress and federal agencies like the NIH to advocate for policies that ensure safe and effective AI integration.

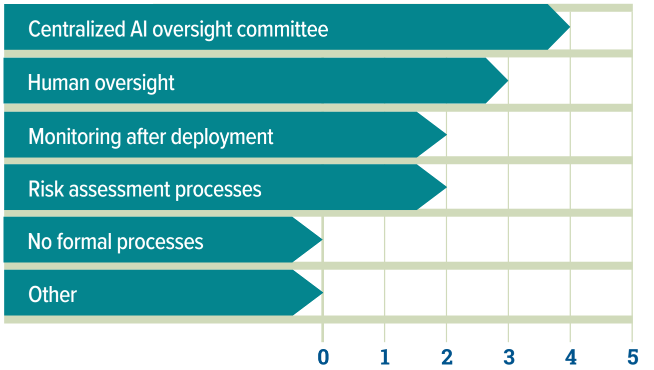
Houston Methodist Hospital aims to improve patient outcomes through predictive tools, while committing to responsible AI use with human oversight. St. Luke's Health and Harris Health have established multidisciplinary AI governance committees to manage implementations and address ethical concerns. Divya Reddy, senior corporate counsel at Houston Methodist, emphasizes the importance of a close working relationship among technologists, clinicians, and attorneys.

MD Anderson has data and AI governance committees to ensure privacy, compliance, and alignment with institutional missions. At Memorial Hermann, Monique Allen, vice president of privacy operations and associate general counsel, emphasizes the importance of vendor and contract reviews to ensure credibility and establish robust data usage safeguards.

Dr. Xiaoqian Jiang, associate vice president of medical AI at UTHealth School of Bioinformatics, highlights an oversight approach involving physicians, researchers, and legal experts. Engaging with federal organizations such as the NIH and FDA is essential, as Dr. Chung from MD Anderson emphasizes the need for diverse perspectives in regulatory discussions.

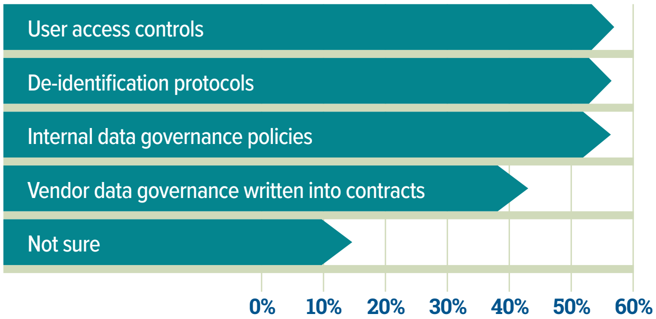
Data governance is foundational to AI-driven healthcare outcomes. Robust data governance policies, de-identification protocols, and user access controls protect patient privacy and ensure appropriate data use. The Health Insurance Portability and Accountability Act (HIPAA) and the Texas Medical Records Privacy Act further reinforce these protections by setting standards for PHI use and disclosure.

AI GOVERNANCE PROCESSES IN HOUSTON HEALTHCARE



Source: Center for Houston's Future survey of local healthcare systems

DATA GOVERNANCE PRIVACY IN HOUSTON HEALTHCARE



Source: Center for Houston's Future survey of local healthcare systems

As part of governance discussions, attention must also turn to issues of data bias. Ensuring fairness and preventing bias in AI algorithms is critical to the ethical and equitable use of AI in healthcare. The next section will delve deeper into data bias and other challenges associated with AI adoption. With robust governance, collaboration, and ethical frameworks, AI can be harnessed to deliver safe, effective, and equitable healthcare.

SOURCES OF BIAS IN ALGORITHMS

Healthcare is increasingly reliant on technological innovation, including data-driven prediction algorithms that use patient-specific data to estimate disease likelihood and outcomes. While these advancements improve diagnostic and prognostic capabilities, they can perpetuate existing health disparities if data scientists do not carefully address and mitigate historical biases.

Beyond unrepresentative datasets, biases can arise from various stages of algorithm development, including problem definition, data collection, preprocessing, model creation, validation, and implementation. It is crucial to consider biases related to race, ethnicity, age, and gender at every stage, starting with problem definition, to ensure equitable AI solutions.

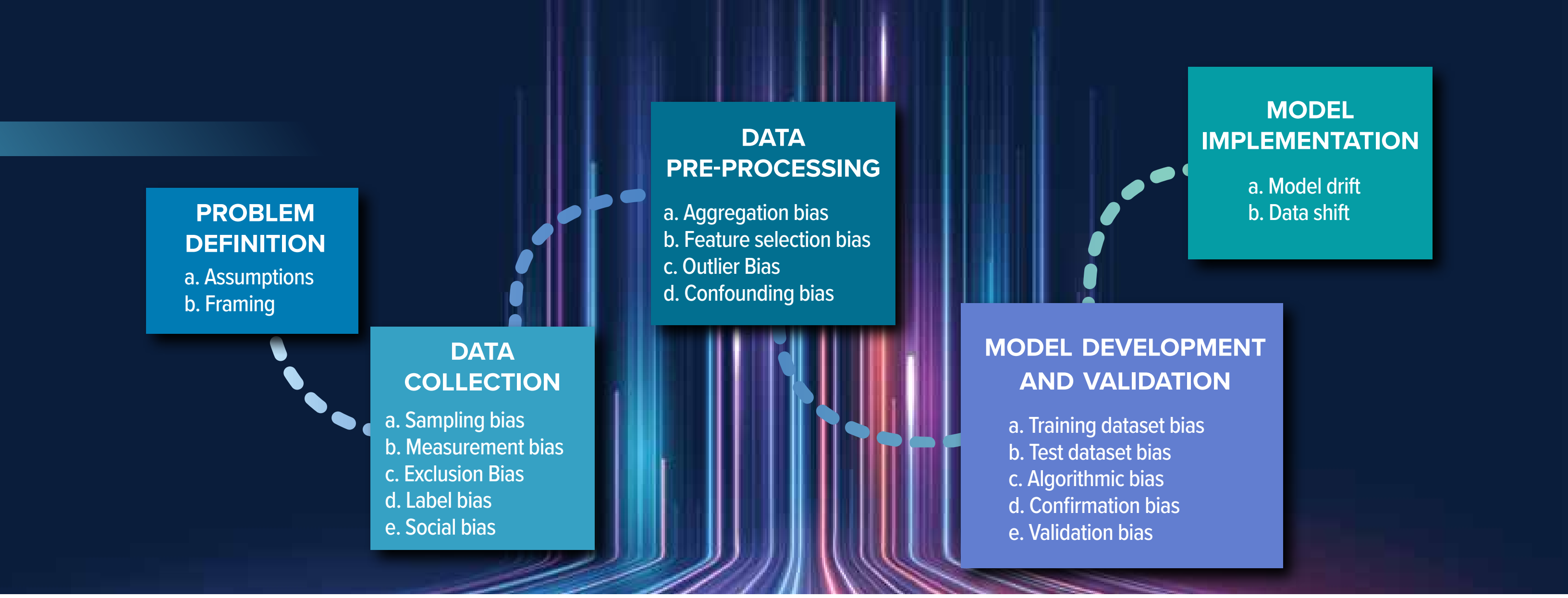
PROBLEM DEFINITION AND INCORRECT ASSUMPTIONS

A study by Isabel Straw et al, published in BMJ Health & Care Informatics, exemplifies algorithmic bias introduced during the problem definition phase. The research found that AI models designed to predict liver disease from blood tests were twice as likely to miss liver disease in women compared to men, with the algorithms failing to diagnose 44% of cases in women versus 23% in men. Despite using a diverse dataset, the Indian Liver Patient Dataset, the problem arose because the models were not designed to account for gender-specific differences in biochemical markers. The study highlighted that women are less likely to be diagnosed with liver disease and more likely to experience severe disease with worse outcomes. This underscores the importance of designing models that consider gender differences from the outset to develop fair and effective healthcare algorithms. [36, 37]

DATA COLLECTION BIAS

When evaluating the quality of a dataset for AI applications, both data collection and preprocessing are foundational. As highlighted by Leo Anthony Celi et al in a global review, biases in AI algorithms can arise from disparities in data sources, representation of specialties, and author demographics. The study revealed that researchers' own clinical specialty, nationality, gender, and expertise can introduce biases into the clinical questions they ask and the data they gather and analyze.[38] Selecting "representative" data is a complex process that can introduce several types of bias:

TYPE	DESCRIPTION	EXAMPLE
Sampling Bias	Data doesn't accurately represent the entire population	Algorithm trained on elderly male veterans may not perform well for younger, female, or minority patients.[39]
Measurement Bias	Inaccurate or inconsistent data collection	Pulse oximeters overestimate oxygen levels in darker skin tones.[40]
Exclusion Bias	Certain groups are underrepresented in the dataset	Lack of data on disabled patients.[41]
Social Bias	Societal prejudices reflected in the data	Using healthcare expenditure as a proxy for illness severity.[42]



DATA PREPROCESSING BIAS

Once the dataset is selected, it must be preprocessed, which can also introduce bias:

TYPE	DESCRIPTION	EXAMPLE
Aggregation Bias	Applying a "one-size-fits-all" model to diverse groups	General diabetes model might overlook complications in Hispanic populations.[43]
Outlier Bias	Improper handling of extreme data points	Excluding patients with exceptional weight loss after surgery can overestimate typical weight loss.[44]
Confounding Bias	Misrepresenting the relationship between variables	Socioeconomic status affecting the link between race and health outcomes.[45]

MODEL DEVELOPMENT AND VALIDATION BIAS

Bias in model development and validation can occur if the dataset is not representative of the population. It can also occur if the model is overfitted to the training data, meaning it performs well on the training set but poorly on new data. For example, an algorithm validated only on data from one hospital may not perform well in different healthcare settings.

MODEL IMPLEMENTATION BIAS

Even after a model is validated and integrated into workflows, it must be continuously monitored to ensure it remains accurate over time. Changes in the world can affect a model's performance:

TYPE	DESCRIPTION	EXAMPLE
Model Drift	The relationship between input and output variables changes over time, affecting the model's accuracy.	For instance, an algorithm trained on pre-pandemic data may not perform well during the COVID-19 pandemic due to changes in healthcare utilization.[46]
Data Shift	The distribution of input variables changes between the training and application phases, leading to decreased model performance.	For example, an algorithm trained on data from urban hospitals may not perform well in rural settings due to different patient demographics and healthcare practices.[10]

THE IMPORTANCE OF A ROBUST METADATA SUPPLY CHAIN

The article entitled "Cancer Needs a Robust 'Metadata Supply Chain' to Realize the Promise of Artificial Intelligence," by Dr. Chung et al emphasizes the importance of a comprehensive and well-maintained metadata supply chain to address biases. A metadata supply chain enhances AI accuracy by providing robust data with context and known provenance, ensuring data quality, integration, and governance. This systematic management of metadata allows AI algorithms to interpret data more effectively, leading to better decision-making and predictions in clinical practice. They argue that a robust metadata supply chain is essential to ensure accurate, reliable, and fair AI models. This involves:

- Standardized data collection: Ensure consistent and accurate data collection methods across different populations and settings.
- Inclusive data representation: Use diverse datasets that reflect the varied demographics and health conditions of the patient population.
- Continuous monitoring and updating: Regularly update algorithms to account for changes in healthcare practices and patient demographics.

By understanding and addressing these sources of bias, healthcare professionals can develop AI-driven solutions that are fair and effective, improve patient outcomes and reduce health disparities.[3]

SPOTLIGHT

The Texas Artificial Intelligence Advisory Council

The Texas Artificial Intelligence Advisory Council plays a key role in overseeing the responsible use of AI by state agencies, established through House Bill 2060 in 2023. Its mission is to ensure AI technologies are implemented ethically and effectively across Texas. Its primary responsibilities include:

- Studying and monitoring AI systems used by state agencies.
- Establishing a state code of ethics for AI.
- Evaluating the risks and benefits of AI implementation.

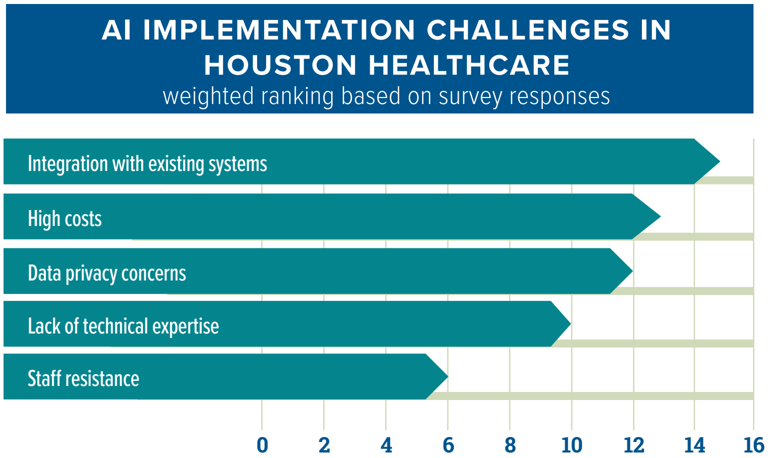
Angela Wilkins, the former executive director of Rice University's Ken Kennedy Institute, has been an influential member, contributing expertise in computational science and interdisciplinary AI research. The council's accomplishments reflect a collective effort to guide AI policy in Texas.

Key achievements include developing an ethical framework for AI systems, setting guidelines for transparency and accountability to protect privacy and civil liberties. State agencies were required to submit inventory reports of their AI systems earlier this year, which the council will review to provide legislative recommendations by December 2024. The council's diverse membership, from fields such as academia, ethics, law enforcement, and constitutional law, ensures a wide range of perspectives. It actively engages with stakeholders to promote responsible AI adoption, encourage independent testing for bias and ensure AI enhances human decision-making. Through these initiatives, the Council is establishing a governance framework that balances innovation with ethical considerations, aiming to position Texas as a leader in the responsible use of AI technology.

CHALLENGES FOR AI IN HEALTHCARE

Adoption of AI into Houston's healthcare system presents numerous challenges that must be addressed, spanning technical, financial, and ethical dimensions.

The greatest challenges to AI implementation in Houston's healthcare systems are integration with existing systems, expense, and data privacy concerns.



Source: Center for Houston's Future survey of local healthcare systems

INTEGRATION WITH EXISTING SYSTEMS

Integrating AI into existing healthcare systems presents significant challenges, including data readiness, application interoperability, and seamless integration with current workflows and infrastructure. Local organizations are actively working to overcome these hurdles. A primary challenge is achieving interoperability between AI systems and existing electronic health record (EHR) platforms.

Many providers rely on proprietary EHR systems that are not easily compatible with new AI technologies, leading to data silos that hinder comprehensive access to patient information. The Greater Houston Healthconnect Health Information Exchange (HIE) plays a pivotal role in facilitating the integration of EHRs with AI applications. By connecting various providers and systems, it enables seamless sharing of medical records and patient data across different institutions. This integration is essential for AI applications, allowing access comprehensive and up-to-date patient information from multiple sources to enhance diagnostics, personalized treatment plans, and efficient data management.[48]

Data sharing and privacy concerns also pose significant challenges. Dr. Beech stresses the importance of adhering to FAIR principles (findable, accessible, interoperable, reusable) in data sharing, particularly for research funded by the NIH. Implementation of patient consent models, like Vanderbilt University's opt-in/opt-out system, is pivotal for ethical data use. Additionally, transitioning to decentralized data models can improve data sharing while maintaining institutional control.[49]

Professor GQ Zhang, vice president, professor, distinguished chair, and chief data scientist at UTHealth Houston, is tackling the interoperability challenge through his work on the EpiToMe platform. Developed by Dr. Zhang's lab, EpiToMe provides a customized interface for neurologists that standardizes data entry and integrates seamlessly with both EHRs and AI applications, such as those predicting rare fatal complications from epilepsy. By eliminating the need for cumbersome data cleaning and reducing redundant data entry, EpiToMe makes data immediately available to AI applications, streamlining the process and enhancing AI integration.[50, 51]

Data readiness remains a critical challenge. Dr. Jiang at UTHealth highlights the need for high-quality, standardized data for effective AI system training. In response, Houston health care institutions are taking proactive steps to enhance data quality and standardization.

Harris Health, led by Chief Health Informatics Officer Anwar Mohammad Sirajuddin, is developing an AI-ready data architecture by addressing foundational issues and standardizing data concepts, a process expected to take up to two years. They are prioritizing "small data" analysis to drive efficiency gains before expanding AI initiatives.

Dr. Fatuyi at UTHealth Houston underscores the importance of collaboration and information sharing for data readiness. With over 20 years of data collection, UTHealth Houston ensures high data quality and diversity, earning Epic Gold Stars for data quality, which is significant for training AI models. "Houston is ready," Dr. Fatuyi asserts, thanks to a robust infrastructure and consistent leadership focused on data quality.

Justin Gnau, chief information officer at St. Luke's Health, points out the challenges posed by variability in data quality and availability across care settings. While clinical data from electronic medical records and biometric monitoring is generally robust, revenue cycle data can be a problem due to data silos. To address this, St. Luke's Health is consolidating data into a centralized "data lake" to enhance interoperability.

Dr. Chung at MD Anderson initiated a data literacy program to enhance staff understanding of data. She emphasizes the importance of capturing the context of care during data collection to ensure accuracy and utility. Dr. Chung also highlights the need for a robust "metadata supply chain" to fully leverage AI in cancer care.[3]

Biases in AI algorithms have the potential to exacerbate health disparities if not actively managed. Harris Health updated its questionnaires to include more comprehensive demographic data, aiming to create more equitable datasets for AI model training. Efforts to stratify data and isolate causal factors are essential for mitigating racial and other biases in AI applications.[47]

While Houston's healthcare institutions are making significant strides in addressing these challenges, full integration of AI into existing healthcare systems remains complex and requires ongoing collaboration among medical providers, technology experts, and policymakers.

FINANCIAL BARRIERS

The financial barriers to AI adoption in healthcare are substantial, particularly given the high costs associated with implementing AI. Dr. Joseph G. Rogers, CEO and president of The Texas Heart Institute (THI), highlights the need for financial support to purchase AI tools and train physicians, emphasizing that "the best AI tools are those that work natively and automatically, without being an additional burden." Many healthcare systems operate on tight margins, making it challenging to justify the costs associated with AI solutions, especially when the return on investment is uncertain. This financial strain is compounded by the need for ongoing maintenance and updates, which can be costly.

Additionally, smaller systems often lack the expertise and resources to develop and maintain AI models in-house. John Schulz, MD, a partner at McKinsey & Company, points out "it's a challenge to think a healthcare system can outcompete tech companies in creating health AI solutions." This disparity means that many institutions must rely on external vendors, which can complicate the customization and integration of AI tools. The reliance on third-party vendors can also lead to challenges in ensuring that AI solutions are tailored to the specific needs of the healthcare system.

In Houston, the importance of identifying the right problems to solve with AI, rather than adopting technology for its own sake, was cited by multiple healthcare leaders. By focusing on areas where AI can provide the most value, organizations can better justify the costs while ensuring AI solutions are aligned with clinical needs. This strategic approach involves not only investing in the right technologies but also ensuring staff are trained to use them effectively.

SPOTLIGHT

Building the Foundation for AI-Powered Healthcare at UTHealth

Dr. GQ Zhang, vice president, distinguished chair, professor, and chief data scientist for UTHealth Houston, runs a digital development lab in the Texas Institute for Restorative Neurotechnologies (TIRN) at UTHealth Houston. They are making significant advancements in data readiness for machine learning, predictive analytics, and AI. Collaborating with state and federal agencies and members of UTHealth Houston, the team is developing innovative tools to streamline data management, improve predictive analytics, and accelerate research. These efforts are pivotal in addressing complex health challenges such as sudden unexpected death in epilepsy (SUDEP), the neurological impacts of COVID-19, sleep disorders, and mental health issues such as epilepsy and Alzheimer's disease.

A notable project from Dr. Zhang's team is the Neuroanatomy-Anchored Information Management Platform (NIMP). NIMP supports the NIH BRAIN Initiative's BICAN brain cell atlas program by facilitating the generation and management of collaborative novel data collection efforts initiated from scratch across institutions. It features specialized portals for tracking tissue samples, genetic and multi-omics data, ensuring all information is accurately linked to its anatomical origins. NIMP promotes collaboration among researchers by providing a framework that supports data sharing and integration at the point of inception, enhancing the reliability and usability of data for downstream advanced research into brain function and disorders.

The team has also developed other specialized systems such as EpiToMe and NeuroPsychToMe. EpiToMe is a bespoke electronic health record system for epilepsy care. It includes a tracker that significantly reduces the time required for managing complete patient care workflow. This system has the capability to integrate with other health records, providing a comprehensive view of a patient's care journey to the providers.

NeuroPsychToMe is designed to streamline the evaluation of memory and cognitive functions. It reduces the time needed to calculate scores from various tests from 40-60 minutes to just 15-20 minutes per patient. Additionally, it offers visual charts that help clinicians quickly assess a patient's performance relative to population benchmarks.

The work of Dr. Zhang's team has significant implications for human health and well-being, directly benefiting patients while also reducing the burden on caregivers, such as physicians, to prevent burnout. For example, better understanding and management of SUDEP can save lives, and insights into COVID-19's neurological effects can improve recovery strategies. Addressing sleep disorders and mental health issues through advanced data analytics and AI can greatly enhance quality of life. The potential to solve these complex problems through AI relies on data readiness an ecosystem level and a foundational informatics infrastructure, which Dr. Zhang's group has created and operationalized, laying the groundwork for future breakthroughs.

> It is clear to me that AI will never replace physicians — but physicians who use AI will replace those who don't.
>
> - Jessee Ehrenfeld, AMA President

TECHNICAL EXPERTISE

Training and education are necessary for the successful adoption of AI in healthcare, yet current medical education often lacks comprehensive training on AI. David Burnett, MSN, RN-BC, from Harris Health, notes that "current attendings are not as flexible about the adoption of new ways… the next generation will be open to adoption and standard of care will require it." This highlights a generational gap in the willingness to embrace recent technologies, underscoring the need to equip future physicians with the knowledge and skills to effectively use AI tools in their practice.

The lack of healthcare professional training and technical expertise presents a significant barrier to AI implementation. Some clinicians are hesitant to adopt AI technologies due to the high stakes for patients. Building trust in AI requires clear communication and transparency about how AI models arrive at their recommendations. Justin Gnau, CIO at St. Luke's Health, emphasizes the importance of transparency: "Transparency around the use of AI models to arrive at recommendations with a final decision by the clinical staff is seen as key to building trust among providers and patients."

Moreover, the current medical education system is not adequately preparing professionals to work with AI. A systematic review highlighted that detailed knowledge of the potential and workings of AI remains rudimentary within the medical community, and considerable AI education and training are needed.[52] This gap extends beyond clinical staff to include the technical expertise required to develop and use AI tools effectively.[53] The lack of standardized evaluation frameworks and expertise to assess AI effectiveness further underscores the importance of comprehensive training programs.[54]

Addressing these educational challenges requires a collaborative effort between healthcare providers, technology developers, and policymakers. Integrating AI education into medical curricula, residency training, and continuing medical education courses can help bridge this gap.

NAVIGATING STAFF RESISTANCE

In Houston, the adoption of AI in healthcare is generally seen as a positive development. Staff resistance is a relatively minor concern according to interviews and surveys conducted by the Center for Houston's Future. Still, the integration of AI into healthcare systems requires careful consideration of how these technologies can be seamlessly incorporated into existing workflows to maximize their benefits.

Despite the overall openness to AI, the hesitancy that does exist is related to the high stakes involved in patient care. This caution stems from concerns about the reliability of AI systems and the potential for these technologies to disrupt established clinical practices. To address these concerns, it is important to build trust through transparency and clear communication about how AI models arrive at their recommendations. Gnau at St. Luke's Health emphasizes that "transparency around the use of AI models to arrive at recommendations with a final decision by the clinical staff is seen as key to building trust among providers and patients."

Integrating AI into clinical workflows is essential for its successful adoption. This involves ensuring that AI tools complement the work of healthcare professionals rather than complicate it. By providing comprehensive training and education, staff can become more comfortable with AI technologies and understand their potential benefits. Additionally, involving clinicians in the development and evaluation of AI solutions can help ensure these tools are tailored to meet the practical needs of clinical settings.

Ultimately, while staff resistance is not a major obstacle in Houston, the successful integration of AI into healthcare requires a collaborative effort among clinicians, technology developers, and policymakers. With a focus on transparency, education, and seamless workflow integration, Houston's healthcare systems can leverage AI technologies to enhance patient care without compromising safety, equity, or trust.

SPOTLIGHT

Balancing Speed, Security, and Fairness: Lessons from COVID-19

The COVID-19 pandemic catalyzed rapid innovation in research, demanding swift data analysis and decision-making. This urgency exposed limits in the traditional federal institutional review board (IRB) process, highlighting the need for streamlined approaches that maintain ethical rigor yet enable faster responses to public health emergencies.[55, 56]

A significant development during the pandemic was the temporary COVID-19 Single IRB, which allowed exceptions to the requirement for a single IRB review for certain multi-site research studies. It provided flexibility for research institutions while prioritizing the health and safety of research subjects and investigators. This enhanced collaboration helped in pooling resources and data, vital for developing robust AI models.

To address the overwhelming volume of data generated during the pandemic, institutions like MD Anderson Cancer Center implemented innovative approaches.[58] Dr. Chung described MD Anderson's "Data Driven Determinants for COVID-19 Oncology Discovery Effort (D3CODE)," a coordinated data collaboration with a single IRB across the institution. This initiative streamlined data access and accelerated research timelines.

The pandemic also spurred advancements in IRB processes with broader implications for AI research. The Department of Veterans Affairs pioneered the development of AI-specific IRB modules, enhancing the evaluation of potential risks and benefits associated with AI projects.[57] Additionally, the establishment of centralized data repositories, such as Houston Methodist's COVID-19 Surveillance and Outcomes Registry (CURATOR), facilitated data access for research with robust data protection measures.[59]

Federated learning emerged as a promising approach to address the complexities of data sharing and privacy in AI research. As UH's Dr. Beech explained, this method trains algorithms across decentralized devices or servers holding local data samples, without exchanging the data itself. Instead, only model updates are shared, preserving data privacy.[60]

Striking a balance between research speed, patient information protection, and mitigation of bias in AI algorithms is important. Implementing streamlined review processes, fostering privacy-prioritizing data sharing initiatives, and continuously evaluating ethical considerations can contribute to the development of more effective and ethical AI-driven healthcare solutions.

The pandemic-driven adaptations in IRB processes have the potential to reshape the landscape of AI research, accelerating innovation while upholding ethical standards. Moving forward, maintaining this delicate balance between speed, security, and fairness will be essential in healthcare research and AI development.

POSITIONING HOUSTON AS A LEADER IN MEDICAL AI

Houston's potential to become a global hub for medical artificial intelligence (MedAI) is both promising and complex. A pivotal idea being discussed among regional leaders is the creation of a high-performance computing-artificial Intelligence (HPC-AI) center. While still conceptual, this center could be a catalyst to drive innovation, attract top talent, and foster collaborations that would solidify Houston's position as a MedAI leader.

The idea of an HPC-AI center in Houston, championed by Professor Zhang, is envisioned as a collaborative catalyst for the region's healthcare AI capabilities. Justin Gnau of St. Luke's Health further emphasized its potential, highlighting how AI can complement the biosciences and healthcare delivery at the Texas Medical Center (TMC) and strengthen Houston's overall healthcare leadership. The center is seen as an incubator for innovative AI solutions that will directly impact patient outcomes.

Recognizing the need to overcome data silos in healthcare, experts have identified the need for a centralized data management strategy. The discussed HPC-AI center could serve as the foundation for a data management zone (DMZ). By standardizing and securing sensitive healthcare data, the DMZ would enable effective data sharing while maintaining privacy and security. This would be a critical step to integrate digital health tools.

Professor Zhang highlights the challenges Houston faces in attracting and retaining AI talent. An HPC-AI center, he argues, would draw top-tier talent to the region. Additionally, it would foster educational initiatives in digital health and build a robust AI workforce.

To stimulate innovation, challenge grants could be implemented. Hospitals would define high-value problems for data science teams to solve, with the best ideas receiving funding.

While the potential benefits of an HPC-AI center are substantial, challenges and considerations remain. Dr. Jordan A. Dale, system CMIO & Hospitalist at Houston Methodist, emphasizes the importance of academic rigor and a clear understanding of AI's practical applications in healthcare. Dr. Khurram Nasir, chief of cardiovascular prevention & wellness at Houston Methodist, stresses the need for a convergence of engineering and clinical expertise to drive meaningful change.

MD Anderson has taken a step in advancing AI in healthcare with the launch of its Institute for Data Science in Oncology (IDSO) in November 2023. This dedicated institute aims to build the talent, culture, and data science ecosystem necessary to fully realize the potential of AI in cancer care. Located in the new TMC3 collaborative building, IDSO is strategically positioned to foster collaborations with co-occupants from UTHealth and Texas A&M. The institute is actively engaging with the broader AI community, co-hosting events with Rice University and UTHealth, and working with the Texas Medical Center to build a robust data science community.

A balanced approach is essential. As Dr. Dale suggests, prioritizing the implementation of existing AI technologies while investing in HPC-AI infrastructure could yield the most significant impact. By fostering collaboration between healthcare professionals, engineers, and data scientists, Houston can overcome challenges and capitalize on its strengths.

Through strategic investment and collaborations, such as an HPC-AI and a DMZ, Houston can lead a new era in healthcare, leveraging its unique strengths to drive transformative change.

RECOMMENDATIONS

Center for Houston's Future recommends the following strategies improve health outcomes equitably, enhance job satisfaction, and establish Houston as an AI healthcare leader:

1. **Foster Collaboration:** Encourage partnerships between providers, AI engineers, academic institutions, and AI technology companies to facilitate knowledge sharing and innovation.

2. **Establish a Robust Data Infrastructure**: Leverage Houston's diverse patient population to create a comprehensive dataset incorporating standardized SDOH data. This infrastructure could include shared data standards, a secure centralized data management zone with robust bias mitigation practices, and a secure data sharing platform to facilitate efficient and protected exchange of healthcare data for research, collaboration, and improved patient care while safeguarding privacy.

3. **Center Equity and Algorithmic Justice:** Prioritize the development and implementation of AI solutions that address health disparities and ensure equitable outcomes for all populations. Incorporate algorithmic justice principles to mitigate bias and discrimination.

4. **Invest in Workforce Development and Well-being:** Create targeted training programs to equip healthcare workers with AI skills and knowledge. Prioritize initiatives that improve job satisfaction, reduce burnout, and foster a positive work environment.

5. **Leverage Small and Big Data:** Use both large-scale and smaller, more focused datasets to address a variety of healthcare challenges. Explore innovative approaches to data collection and analysis that respect patient privacy and confidentiality.

6

Focus on "Raising the Floor": Prioritize AI applications that address fundamental healthcare needs and improve access to care for underserved populations. Complement these efforts with "blue sky" initiatives to drive innovation and long-term impact.

7

Support AI Innovation and Entrepreneurship: Create a supportive ecosystem for AI startups and entrepreneurs by providing funding, mentorship, and access to resources.

8

Measure and Communicate Impact: Develop robust evaluation frameworks to assess the impact of AI interventions on health outcomes, equity, and job satisfaction. Effectively communicate results to stakeholders and the public.

9

Engage with Policymakers: Advocate for policies that support AI innovation, data privacy, and equitable access to healthcare.

10

Build Public Trust: Invest in public education and outreach to build trust in AI technologies and their potential to improve health and well-being.

By following these recommendations, Houston can strengthen its position as a leader in AI-driven healthcare innovation and contribute to improved healthcare delivery both locally and nationally.

CONCLUSION

Houston's healthcare sector is well-positioned to be a leader in AI-driven healthcare. The city's robust medical infrastructure, supported by strong academic and research institutions, provides an ideal environment for the development, refinement, and implementation of AI technologies. Additionally, Houston's diverse population, which mirrors the future demographic landscape of the United States, further enhances its suitability as a hub for healthcare innovation.

The integration of AI in healthcare offers significant potential to improve patient outcomes, enhance diagnostic accuracy, and streamline processes. As AI continues to evolve, it is imperative for healthcare stakeholders in Houston to address challenges such as data privacy, ethical considerations, and the need for comprehensive governance frameworks. By fostering collaboration between healthcare professionals, data scientists, and AI technologists, Houston can set a precedent for the responsible and effective use of AI in healthcare.

This strategic focus will not only position Houston as a leader in healthcare innovation but also contribute to the broader goal of achieving equitable and efficient healthcare delivery nationwide.

APPENDIX

APPENDIX A: TYPES OF AI AND THEIR USES IN HEALTHCARE

TYPE OF AI	USE CASES	EXAMPLE
Machine Learning (ML)	- Disease prediction - Treatment recommendations - Drug discovery	- Texas Heart Institute: Uses ML to improve risk prediction and tailor medical therapies, particularly for heart failure.[61]
Natural Language Processing (NLP)	- Clinical documentation - Patient communication - Symptom assessment	- UTHealth Houston: Uses NLP to enhance patient care by extracting clinically relevant information from medical records and improving communication between healthcare providers and patients.[62]
Computer Vision	- Medical imaging analysis - Surgical assistance	- MD Anderson: Employs computer vision in analyzing medical images to assist in cancer diagnosis and treatment planning.[63]
Generative AI	- Generating synthetic medical images - Developing personalized treatment plans	- UTHealth Houston: Pioneering generative AI to revolutionize patient care and research, focused on creating multimodal models that integrate various data types for comprehensive analysis.[64]
Robotic Process Automation (RPA)	- Automating repetitive administrative tasks - Streamlining scheduling and documentation	- Houston Methodist: AI-driven platforms streamline administrative processes, such as scheduling and documentation, to allow clinicians to dedicate more time to patient interactions.[65]
Predictive Analytics	- Predicting patient outcomes - Identifying high-risk patients - Reducing readmissions	- Houston Methodist: Partnered with Health Data Analytics Institute (HDAI) to provide predictive tools that create personalized risk profiles for patients, to improve care coordination and reduce readmissions and mortality rates.[10]
Wearable AI Devices	- Continuous patient monitoring - Early detection of health deterioration	- Houston Methodist: Introduced the AI-enabled BioButton for continuous monitoring of vital signs, aiding in early detection of deteriorating health conditions and improving patient outcomes.[66]
Virtual Care Models	- Virtual ICU and patient observation - Remote patient monitoring	- Houston Methodist: Implemented virtual ICU and virtual observation programs to enhance critical care capacity and improve clinical outcomes by using AI to guide clinical decision-making.[67]

APPENDIX B: GLOSSARY OF TERMS

Artificial Intelligence (AI) - The simulation of human intelligence processes by machines, especially computer systems. In healthcare, AI refers to the use of complex algorithms and software to emulate human cognition in the analysis, interpretation, and comprehension of complicated medical and healthcare data.

AI Governance - The framework of policies, procedures, and standards that guide the development, deployment, and use of AI systems. Robust AI governance in healthcare ensures responsible and ethical use of AI technologies.

AI Hallucination - When an AI model generates plausible but factually incorrect or nonsensical information. In healthcare, this can lead to potentially dangerous misinformation or incorrect diagnoses.

AI Impact Assessment - A systematic evaluation of the potential effects of an AI system on individuals, organizations, and society. In healthcare, these assessments help identify and mitigate risks associated with AI deployment.

AI Transparency - The practice of making AI systems' decision-making processes, data sources, and limitations clear and understandable to users, patients, and regulators. In healthcare, transparency is crucial for building trust and ensuring ethical use of AI.

APPENDIX B: GLOSSARY OF TERMS CONTINUED

Algorithmic Bias - AI programs that make decisions or predictions systematically disadvantaging specific groups of people. Research has demonstrated that these biases can lead to significant real-world harm. Such bias can arise from various sources, including skewed training data, flaws in the algorithm's design, or biased interpretation of the AI's outputs.

Algorithmic Justice - The principle of ensuring fairness, accountability, and transparency in the development and deployment of AI systems. In healthcare, algorithmic justice aims to prevent discrimination and promote equitable outcomes for all patients, regardless of their demographic characteristics.

Audit Trail - A chronological record of AI system activities, including data inputs, processing steps, and outputs. In healthcare, audit trails are essential for accountability and regulatory compliance.

Black Box AI - AI systems whose internal workings are not easily interpretable or understood, even by their creators. The use of black box AI in healthcare raises concerns about accountability and trust.

Clinical Decision Support Systems (CDSS) - AI-powered tools that provide clinicians, staff, and patients with person-specific information, intelligently filtered and presented at appropriate times, to enhance health and healthcare.

Compatibility - The ability of an AI system to function correctly within a specific healthcare environment or with particular hardware and software systems, without causing conflicts or errors.

Computer Vision - An AI field that trains computers to interpret and understand visual information from the world. In healthcare, it's used in medical imaging analysis for tasks like detecting tumors or analyzing X-rays.

Data Provenance - The documentation of the origins and transformations of data used to train and operate AI systems. In healthcare, clear data provenance is crucial for validating AI model outputs and ensuring patient privacy.

Deep Learning - A type of machine learning based on artificial neural networks. It's particularly effective in image recognition and natural language processing tasks in healthcare, such as analyzing medical imaging or processing clinical notes.

Edge AI - The deployment of AI algorithms on local devices (like smartphones or medical equipment) rather than in the cloud. In healthcare, it enables real-time data processing, enhances privacy, and reduces latency for critical applications.

Ethical AI - The development and use of AI systems that adhere to moral principles and societal values. In healthcare, ethical AI considerations include patient autonomy, privacy, and fairness in medical decision-making.

Explainable AI (XAI) - AI systems designed to provide clear explanations for their outputs or decisions in human-understandable terms. In healthcare, XAI helps clinicians understand and validate AI-generated diagnoses or treatment recommendations.

Federated Learning - A machine learning technique that trains algorithms across multiple decentralized devices or servers holding local data samples, without exchanging them. This is particularly useful in healthcare for maintaining patient privacy while leveraging data from multiple institutions.

Generative AI - AI systems that can create new content, such as text, images, or synthetic data. In healthcare, it's used for tasks like generating medical reports or creating realistic medical images for training.

Internet of Medical Things (IoMT) - The collection of medical devices and applications that connect to healthcare IT systems through online computer networks. AI can analyze data from IoMT devices to provide real-time insights and alerts.

Latency - The delay between input and output in an AI system. Low latency is crucial in healthcare for real-time applications like patient monitoring or surgical assistance.

Large Language Model (LLM) - Advanced AI models trained on vast amounts of text data to understand and generate human-like text. In healthcare, LLMs can assist with medical literature analysis, clinical note generation, and patient communication.

Machine Learning (ML) - A subset of AI that enables systems to automatically learn and improve from experience without being explicitly programmed. In healthcare, ML algorithms can analyze large datasets to identify patterns and make predictions.

Mixture of Experts Model - An AI architecture that combines multiple specialized models or "experts" to handle different aspects of a task. In healthcare, it can be used to create more efficient and accurate diagnostic or treatment recommendation systems.

Model Cards - Standardized documentation that provides essential information about an AI model, including its intended use, performance characteristics, and limitations. In healthcare, model cards can help users understand when and how to appropriately use AI tools.

Model Interpretability - The degree to which an AI model's decision-making process can be understood by humans. Higher interpretability in healthcare AI can lead to better adoption and more informed use by medical professionals.

Natural Language Processing (NLP) - A branch of AI that helps computers understand, interpret, and generate human language. In healthcare, NLP is used to analyze clinical notes, medical literature, and patient-reported outcomes.

Precision Medicine - An approach to patient care that allows doctors to select treatments based on a genetic understanding of the patient's disease. AI plays a crucial role in analyzing genetic data and identifying targeted therapies.

Predictive Analytics - The use of data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes based on historical data. In healthcare, it's used for predicting patient risks, disease progression, and treatment outcomes.

Robotic Process Automation (RPA) - The use of software robots or AI workers to handle repetitive, rule-based digital tasks. In healthcare, RPA can streamline administrative processes, claims management, and appointment scheduling.

Synthetic Data - Artificially generated data that mimics real patient data. In healthcare AI, it's used to augment training datasets, address data scarcity, and protect patient privacy.

Training (in AI context) - The process of teaching an AI model to perform specific tasks using data. In healthcare, this involves exposing the model to large amounts of medical data to improve its accuracy and performance in tasks like diagnosis or treatment planning.

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