Supercharge *healthcare* through *GenAI*

Capgemini

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EXECUTIVE SUMMARY

Generative AI (GenAI) and Large Language Models (LLMs) have been around for several years. Yet, their massive adoption has taken the world by surprise, creating a tidal wave of expectations. Its adoption by the general public has been massive and unprecedented, with ChatGPT reaching the 100 million users bar in the space of three months only.

Gartner predicts that by 2025, GenAI will be a workforce partner for 90% of companies worldwide.[1] In healthcare in particular, defined as Life Sciences (Pharma, Biotech, MedTech), Care (hospital, general practice, specialist center) and Insurance (public and private coverage), it is now acknowledged that AI and its more recent form GenAI – as opposed to the traditional "discriminative AI" – will revolutionize the domain, which goes together with an imperative to ensure its development and deployment keep patients' interests and safety at the core.

GenAI has the potential to disrupt the Life Sciences industry, particularly in drug discovery, where it shortens cycles, maximizes probability of success, and tailors treatments for ultra-personalized medicine. NVIDIA, with the launch of its dedicated cloud services BioNeMo, has placed a big ticket in that space.[2] GenAI also introduces efficiency in medical, legal, and regulatory affairs through automated content generation and sales by leveraging Copilot companions. Additionally, it brings incremental improvements across the value chain, enhancing efficiency in clinical development or operations. Looking ahead, GenAI signals a shift for pharmaceutical companies towards a unique blend of therapy and technology, fostering collaboration with a broad ecosystem made of pure techs, academics, and startups.

In the Care space, the move towards GenAI and LLMs is slightly slower but the wave of change coming from the US would most probably prevail. Microsoft began discussions with Epic, a major provider of the software used for electronic health records (eHR), about how to integrate LLMs into daily practice.[3] Google recently partnered with Mayo Clinic.[4] VCs have invested US$50m in Hippocratic AI, which is developing an LLM for healthcare.[5] Potential benefits span from the practioner up to the care provider. At doctor level, the opportunities such as clinical notes, assisting practioners in their daily practice, or acting as a specialized chatbot for a surgeon will free up a lot of administrative work and enable more time with patients. At provider level, GenAI will be supporting real-time and contextual patients steering in the hospital or broader care network (e.g., for generating summaries of the medical history of patients arriving at the emergency department in order to facilitate their care).

Among the sectors having adopted GenAI early, Finance and Insurance were ahead. GenAI can reinvent health insurance processes by automating tasks, interpreting regulations, and improving customer relationships. They can enhance personalized insurance development, streamline claims and reimbursement processing, and detect fraud. Conversational agents with GenAI inside empower policyholders with personalized health information and guidance on their best coverage.

Deploying models necessitates a special attention to ethical and regulatory concerns. Challenges include safety, transparency, unbiased decision-making, and environmental impact. Ongoing human oversight, especially in healthcare, is crucial. We believe that humans must stay in the loop. Sustainability guidelines are vital due to GenAI's carbon-intensive nature. In Europe, aligning with the coming AI Act's risk-based approach will soon be the common grammar beyond the old continent, with GenAI being under particular scrutiny for its most sensitive applications. In the US, new FDA guidelines on LLMs are coming.

This report shares Capgemini perspective of the particularities of GenAI and LLMs in healthcare, as well as state-of-the-art use cases in the field of innovation, practice, and cost related to care within the boundaries of a desirable future where patient superior interest is at the very center. We hope that this publication will trigger interest for that space and provide clear guidance for you on decision making around the following questions:

Where to invest in GenAI? For what purposes? Under which guardrails?

INTRODUCTION TO GEN AI AND LARGE LANGUAGE MODELS (LLMs) IN HEALTHCARE

GEN AI AND LLMs: WHAT IS THIS ALL ABOUT?

Artificial Intelligence (AI) is a capability of machines to mimic human intelligence, where machines analyze large sets of data and learn from them in a supervised or unsupervised way to extract insights and enable informed decision making.

Generative AI (GenAI) is a new field of AI with capability to learn characteristics, patterns of data and to create text, images, videos to personalize to a specific query called as prompt. GenAI opens a new horizon of possibilities for machines to perform repetitive tasks with better efficiency and creative tasks that were until now performed exclusively or mainly by humans. GenAI uses foundation models that are trained on large sets of unlabeled data that are tokenized, and potentially 'fine tuned' based on the bespoke use case. The prediction algorithms – namely the Large language models (LLMs) for text data – deploy complex math and draw massive computing power to churn the data resources and produce human-like response to natural language queries.

Healthcare organizations are taking the shift towards generative AI even if there is still a long way to go.

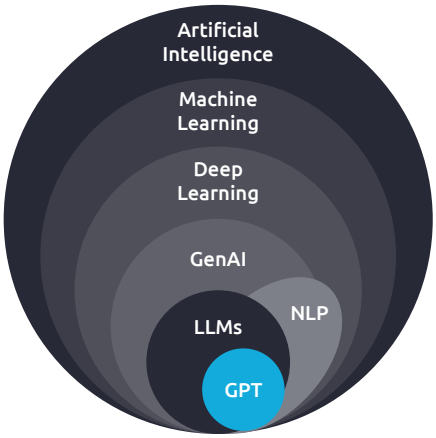


Figure 1: LLMs, at the heart of GenAI itself, are a subset of Artificial Intelligence

"98% of pharma and healthcare organizations interviewed have GenAI as a topic of discussion in their board room. 58% feel their leadership is a strong advocate of it but still only 21% feel GenAI can strongly disrupt the industry."

When it comes to taking action, *"56% have started exploring the potential of GenAI, 37% have begun working on some pilots and only 7% have enabled GenAI capability in some of their locations/ functions. It approximately corresponds to the average of all interviewed sectors."*

Capgemini Research Institute survey, April 2023 [6]

[1] Gartner, 2023
[2] NVIDIA, 2023
[3] Microsoft, 2023
[4] PR Newswire, 2023
[5] Forbes, 2023
[6] Capgemini Research Institute, 2023

GEN AI IN HEALTHCARE: FOR WHAT PURPOSE?

Among the plethora of GenAI use cases that pop up in the healthcare space, we recommend to focus on five categories with high stakes, where previous experiences demonstrate feasibility.

1 DOCUMENT AUTHORING

Healthcare industry being dependent of large amount of regulated documentation, producing, translating, summarizing, adapting, or generating documents (technical, regulatory, quality, commercial etc.) are tasks where LLMs are particularly efficient and accurate.

2 MULTIPURPOSE ASSISTANTS

Assistants can creatively combine text and images without distorting the message to provide a transformational user experience. In healthcare, it can take the form of a virtual coach to manage chronic conditions, like for diabetic patients for instance.

3 ASSISTANCE WITH SEARCHING AND NAVIGATING LARGE BODIES OF TEXT, ARTICLES, OR DATA

LLM's search capabilities can help navigate databases that are out of bounds for conventional search engines. Literature summary can be obtained from clinical and scientific studies/literature databases such as PubMed, Clinicaltrial.gov or proprietary data repository.

4 ACCELERATING RESEARCH INTO HEALTHCARE PRODUCTS

Genomics is accelerating drug discovery, protein language models, prediction of the binding structure of a small molecule ligand is only a few clicks away and have a potential to disrupt the value chain.

5 AUTOMATE PRODUCTION OF COMPUTER CODE OR DATABASE

This is the capability to write or transform code or build datasets. As the healthcare industry is more and more data driven with strict regulated standards to comply with, this category holds great promises. It can open the door to address rare disease and reduce the loss of chance for some patients.

Throughout this publication, use cases of GenAI for Healthcare will be described in a nutshell and three different go-to-market use cases will be detailed. Last part will address key limitations such as regulatory, ethics, and acceptability.

1 INNOVATING FOR CARE
GEN AI IN LIFE SCIENCES

USE CASES IN A NUTSHELL

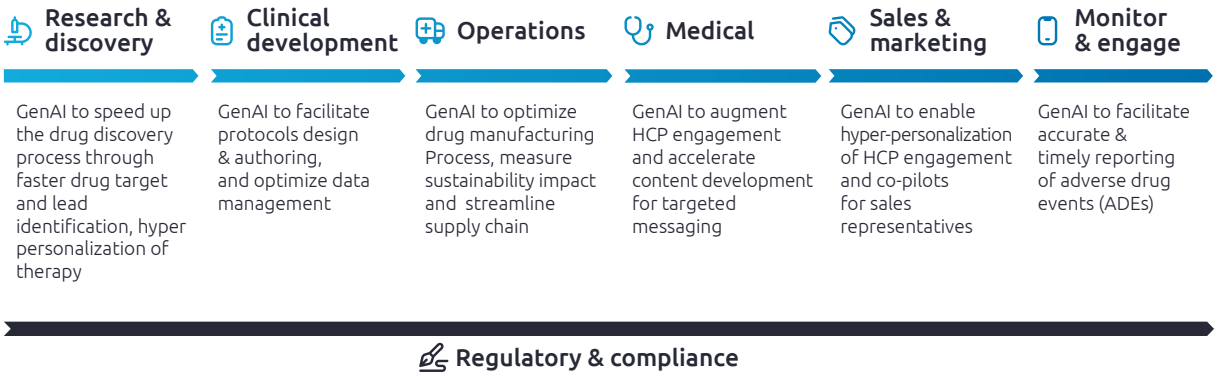


Figure 2: Where GenAI can play a role in the Life Sciences value chain

GenAI is poised to significantly accelerate the transformation of the Life Sciences industry. First, it has a real disruptive potential in some areas of the value chain, where its adoption may result in providing significant competitive advantage to its early adopters, justifying significant investment upfront in training or fine-tuning models.

1 **GenAI can accelerate the drug discovery processes, unveiling novel molecular structures with unprecedented speed and accuracy.** The current Design/Make/Test/Analyze paradigm should soon be replaced by shorter Predict/Analyze cycles. GenAI also paves the way to ultra-personalized medicine by analyzing extensive patient data to tailor treatments based on individual characteristics. AI techniques traditionally have taken several months to discover a new drug candidate. GenAI could achieve this in a matter of weeks.[7] Combined with a rejuvenation of Pharma pipelines, that is the strongest indicator of their wealth.

2 **GenAI can also bring the next revolution in medical, marketing & sales.** First in content generation: while creating more personalized content fitting HCP specific profiles, we at Capgemini Invent believe that headquarters can bring up to 80% of such content to local entities in an automated way, keeping human in the loop at the edge. Copilot companions will also support the transition of sales reps and MSL job desks in the years to come, bringing significant efficiencies to a system that has not evolved significantly for decades.

Similar to other sectors, it comes with incremental improvements throughout the value chain too, where off-the-shelf models can deliver: (1) in Clinical Development or Operations, with a potential to increase efficiency or decrease cycle times and (2) in Regulatory and Corporate functions, with use cases leveraging Information synthesis and classification, search and knowledge management, or document generation.

Down the line, GenAI can speed up the transition of Pharmas from therapeutics to unique blend of therapy and technology where organizations will be collaborating more and more with tech players, academics, and start-ups.

[7] Elaia, 2023

Table 1: Life Sciences use cases

	Information synthesis & classification	Search & Knowledge Management	Documentation & technical data production	Code & data generation & optimization	Generative Product Design
Drug discovery					
Identification of potential drug targets using literature mining and knowledge extraction. *ArcaScience is a literature review platform that provides insights on market insight discovery and clinical benefit-risk guidance.*	✓				
Identification and optimization of leads through virtual screening to develop new molecules. *AbSci validated de novo antibodies in silico with GenAI.*					✓
Personalization of immunotherapies for targeted therapy for better patient outcomes. *Etcembly is using GenAI in the discovery and bioengineering of TCR candidates for immunotherapy.*					✓
Clinical development					
Authoring of protocol to optimize clinical trials.			✓		
Generation of insights to design clinical trials by scanning large amount of scientific literature or databases.		✓			
Personalized messaging to engage trials patients and estimation of enrollment rates to boost patient recruitment.		✓			
Generation of code transforming clinical data for expedite regulatory submission.				✓	
Operations					
Interpretation of telemetry from machines to preempt predictive maintenance.		✓			
Generation of recommendations based on past experiences in case of equipment issue detection or safety event and generation of lessons learned content to drive efficiency and safety.		✓			
Acceleration of life cycle analysis automating matching and generation of recommendations to design sustainable products.		✓			
Data augmentation to improve quality control models (adding images, texts, tabular data).				✓	
Improvement of supplier risk assessment based on historical data.	✓				
Sales and Marketing					
Generation of hyper-personalized content for customer engagement with medical content tailor-made to Healthcare Professionals persona.			✓		
Generation of custom sales pitches based on sentiment analysis through rep-Copilot. *Sensei GenAI from Adobe Cloud Services delivers brand specific messages.*			✓		
Regulatory					
Summaries of latest medical literature to keep pharmacovigilance professionals up to date.	✓				
Detection of safety weak signal from social media or patient forum.		✓			
Support in regulatory report generation. *Yseop is a platform using natural language generation to automate CSR.*			✓		
Generate responses with a smart companion to engage with regulatory authorities during document submission.		✓			

THE GO-TO-MARKET EXAMPLE:
HYPER-PERSONALIZATION OF CUSTOMER ENGAGEMENT TO IMPROVE LEAD TIME

GenAI can bring in precision and timing to the customer engagement strategies. The hyper-personalization can provide better customer experience and hand hold the customer from aspiration to proposal to prescribing action.

GenAI can perfectly sync up internal business data, with customer analytics, external market and competitor information to orchestrate a lead activation campaign targeting segmented customer groups with bespoke messaging and rebates to trigger a behaviour. GenAI can first generate qualitative medico-marketing content in a modular form (i.e., adapting to specific contexts). It also enables to go in hyper-personalizing the omnichannel marketing by recognizing patterns and correlations from customer libraries learning from previous campaigns. The generation of this marketing content is hyper-personalized as it is adapted by target persona, adoption ladder, and by channel. It is medical, legal, and regulatory compliant by design to improve lead time by 60 to 80%.

2 QUALITY OF CARE
GEN AI IN DOCTORS PRACTICE

USE CASES IN A NUTSHELL

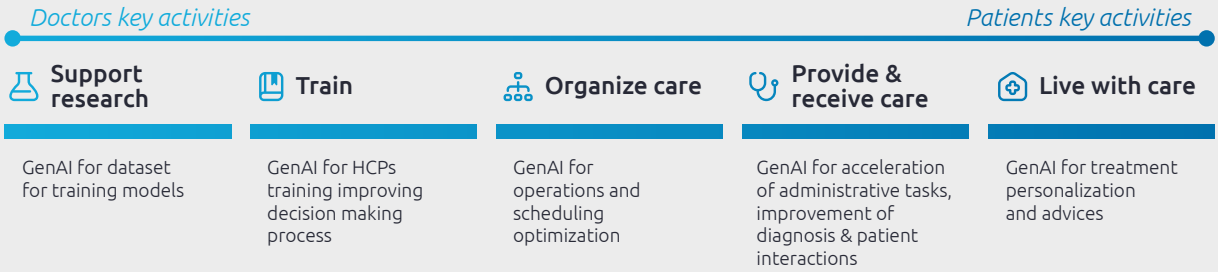


Figure 3: GenAI value across doctors-to-patients value chain

Generative models in public sectors are promising for many usages, going from supporting research, to healthcare professional training, care organization or care delivery. It requires to train LLMs on medical data implying going through complex restrictions and to ensure relevance and truthfulness of outcomes. To overcome that, it is possible to train an open-source generalist LLM on opensource medical data and develop an evaluation platform that can be used by hospitals on their own data but would only share open-source performance scores of the algorithms. In that manner, GenAI can empower healthcare professional in different ways that can disrupt their way of working.

1. First, copilots have emerged to guide healthcare professionals in their tasks, giving time for patient care. Opportunities such as clinical notes, assisting practitioners in their daily practice, or acting as a specialized chatbot for a surgeon will free up a lot of administrative work and enable more time with patients.

2. Doctors could use AI models during diagnosis phase to support their decision making. Those models should be trained on images generated by AI to augment training data and finally to considerably improve models, leading to breakthrough outputs.

3. GenAI can support training of HCPs, allowing them to play scenarios to reduce the risks and time of interventions.

4. GenAI will be supporting real-time and contextual patients steering in the hospital or broader care network. For instance, it could generate summaries of the medical history of patients arriving at the emergency department, in order to facilitate their care.

5. GenAI personalized treatment plans will be the last use case to come but will bring considerable value, as focus on patient well-being.

Table 2: Public health use cases

	Information synthesis & classification	Search & Knowledge Management	Documentation & technical data production	Code & data generation & optimization	Generative Product Design
HCPs training					
Generation of realistic patient scenario for training HCPs on various medical procedures and ease their decision making incorporating latest medical knowledge patrimony.			✓		
Drugs response prediction using digital twining. *GSK and King's College London are building digital replicas of tumors using various data to test drug efficiency.*		✓			
Generation of synthetic patient data to be freely shared for research and collaboration between HCPs.				✓	
Patient flows & administrative management					
Streamlining hospital operations with flow twining and predictive models and personalized schedules generation for patients and HCPs. *Ochsner Health has implemented AI scheduling system increasing anesthesiologists' engagement scores.*				✓	
Automation of HCP notetaking during consultations to focus on patients and therapeutic education. *Nabla Copilot automatically generates a highly structured medical report following a medical consultation.*	✓				
Diagnosis, treatment & follow up					
Augmentation of medical datasets like images to train machine learning models used in medical imaging and diagnostic. *Mayo Clinic, Nvidia and MGH & BWH Center for Clinical Data Science explore how to use MRI images generated by AI to train deep leaning model identifying clinical abnormalities.*				✓	
Generation of personalized treatment plans considering patient data, genetic information and medical history.		✓			
Dosage adjustment or better alternative recommendations based on patient monitoring of patients.		✓			
Patient support through medical chatbots to answer questions, facilitate appointment scheduling and provide advices on managing health conditions.		✓			

THE GO-TO-MARKET EXAMPLE: HCPS ADMINISTRATIVE WORKLOAD REDUCTION TO SOLELY FOCUS ON CAREGIVING

Generative models can aid doctors during notetaking to enhance interactions with patients. Thus, physicians have more time to focus on patients and therapeutic education rather than administrative work. Patient data history is guarantee to enhanced end-to-end patient care.

GenAI allows significant improvements of a patient's care. By automating notetaking during medical consultations, models can generate detailed summaries of interactions between healthcare professionals and patients, thus enabling efficient and accurate documentation. These pieces of information can also be stored and be used during future encounters between the patient and the healthcare system to better personalize his or her journey. For instance, the French startup Nabla has launched a reliable tool for healthcare professionals, named Nabla Copilot. Blending GPT-3 (and subsequent versions) with other more traditional artificial intelligence models, Nabla Copilot automatically generates a highly structured medical report following a medical consultation, seamlessly integrating these pieces of information within the medical software used by physicians or by the structure they belong to.

3 COST OF CARE
GEN AI IN HEALTH INSURANCE

USE CASES IN A NUTSHELL

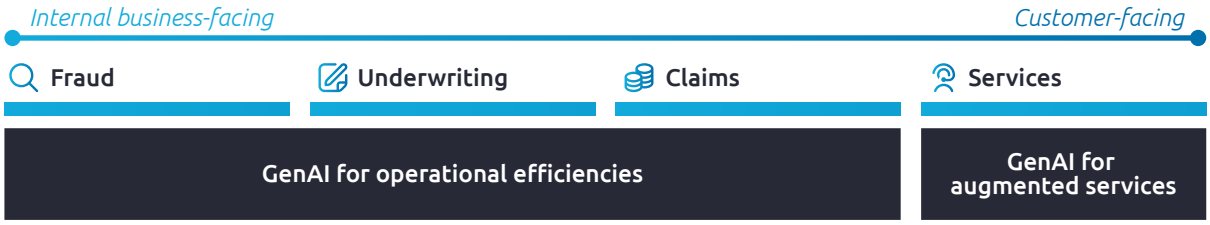


Figure 4: GenAI value across health insurance value chain

GenAI applications for health insurance are mainly incremental, giving efficiency in operations and engagement of patients thanks to augmented services.

1. First users will certainly be insurance advisors. For applications regarding reimbursement policies or better understanding of health coverage, the go-to-market is fast. These use cases attract interest of the market. GenAI could considerably improve patients' engagement.

2. Use of GenAI to accelerate operations such as fraud detection, claims or underwriting processes also has great potential, leading to cost savings for health insurers and better customer satisfaction.

3. Use of conversational agents to support health insurer recommending preventive actions to some patients' population is an opportunity to reduce end-to-end health costs in countries where regulations allow it. Those recommendations could be done also patient per patient, focusing on healthy behaviour and preventive health. Insurer can become a strong partner for patient well-being.

4. Patients as consumers of insurance services powered by GenAI will arrive in a second phase as it is a more regulated space. Patient empowerment will be tenfold with GenAI.

Table 3: Health insurance use cases

	Information synthesis & classification	Search & Knowledge Management	Documentation & technical data production	Code & data generation & optimization	Generative Product Design
Operations: fraud detection, underwriting, claims management					
Identification of potential violations related to operational procedures by interpreting policies and regulatory documents.		✓			
Detection of potential fraudulent behaviors to spot fraud or identify suspicious claims earlier by analysis patterns and inconsistencies in historical data.	✓				
Creation of personalized insurance plans by improving risks assessment and underwriting augmenting training data and generating scenarios on coverage and pricing.					✓
Verification of claim completeness and coverage by scanning documents.		✓			
Automation of data entry for claim management.			✓		
Patient services					
Automatic filling of questionnaire or symptom checker of patients to reduce drop out .			✓		
Redirection of patient guided by a chatbot.		✓			
Providing specific information on health coverage or reimbursement rate using virtual agent.		✓			
Promotion of preventive health and healthy behaviors to empower patients using conversational agent. *Generali paved this way with Vitaly app proposing prevention programs.*		✓			
Patient segmentation for insurers to launch adequate prevention actions generated by a virtual agent.		✓			

THE GO-TO-MARKET EXAMPLE: GIVING IMMEDIACY AND FULL TRANSPARENCY TO ENGAGE POLICYHOLDERS

Generative models can be used to keep patient informed on their coverage and to provide recommendations in an interactive and personalized manner.

Clear and transparent communication is essential for policyholders to understand their coverage, benefits, and any changes in policies. It is crucial to be able to answer to patient questions, with a high level of confidence. A patient can for instance ask for a reimbursement rate before or just after a medical appointment. GenAI can be used to calculate this amount and directly give it to the patient so that the treatments can be started in a timely manner.

Customer service representatives can be equipped with relevant customer data, like preferences and actions. They can then use GenAI to provide tailored recommendations based on those data, offering immediate responses to patients. Giving clients full transparency and immediacy will foster trust and confidence in the insurance provider, so that the latter would become a strong partner of patient care.

4 HOW TO DEAL WITH LIMITATIONS OF GEN AI IN THE HEALTHCARE SECTOR?

Deployment of generative models in pharmaceutical industries, MedTech, hospitals or insurance requires careful consideration of ethical and regulatory aspects, while ensuring sectors acceptability. Legal aspects are also key, as there are grey areas around IP regarding training data and generated content.

Regulations are moving forward. In June 2023, the European Parliament approved the AI Act, aiming to protect people regulating the use of AI in EU.[8] They recommend analysing and classifying AI systems according to the risk they present to users, going from unacceptable risk to minimal risk. That determines the level of regulations applied. While GenAI was not included in the AI Act in the first place, the EU council amended the act by saying that GenAI should comply with the following transparency requirements: disclosing that the content is generated by AI, designing the model to not generate illegal content and publishing summaries of copyrighted data used for trainings. Even if Europe is a pioneer in framing AI usage, the regulatory trend is global with the Algorithm Accountability Act in the US or the Artificial Intelligence and Data Act in Canada.

Nevertheless, Capgemini Research Institute reports that, for Pharma and healthcare sectors, 80% of executives believe that benefits of utilising GenAI outweigh the associated risks.

THE LIMITATIONS: MANY ETHICAL CHALLENGES HAVE ARISEN WITH AI SYSTEMS AND MORE RECENTLY GEN AI SYSTEMS

There are challenges around data and system outcomes. First data privacy: patient health data is highly sensitive and must be handled with extreme caution, leveraging cybersecurity. Then, the bias of data used for training that could lead to unfair outputs, as well as quality of those data. Transparency and explainability of system outcomes must be considered as well as a limitation to overcome. We need to make sure that GenAI models are not making poor decisions based on biased data for all stakeholders, such as patients, healthcare professionals but also institutions that would leverage such generative models. This can pose a challenge as AI/GenAI models can sometimes be perceived as black boxes where the internal structure and mechanism cannot be observed nor understood.

Challenges are also around people. This refers to the safety of people using those systems, resources needed to develop and use AI systems requiring upskilling and finally acceptability of such solutions that is particularly true in healthcare. It is acknowledged that healthcare professionals or health institutions need to raise their awareness on generative AI, and more globally on AI itself to increase acceptability of the technology. Moreover, healthcare processes are governed by highly complex regulatory and quality requirements, creating a fear that GenAI change would further increase the number and complexity of what is established.

Finally, challenges arise concerning the environmental impact. Training and use of GenAI is highly carbon intensive and raise energy consumption, there is a need to establish sustainability guidelines. A single generative query is estimated to be 4–5-times higher in carbon emissions than a search-engine query.[9] Capgemini Research Institute evaluates that nearly 80% of interviewed companies are conscious that there is a need to implement and scale GenAI in a sustainable way.[10]

[8] European Parliament, 2023
[9] Euronews, 2023
[10] Capgemini Research Institute, 2023

HOW TO COPE WITH THOSE LIMITATIONS?

We must drive GenAI, dealing with all these limitations. From a data standpoint, companies that offer generative AI solutions should clarify data ownership with partners, improve cybersecurity and also look beyond existing data to the development of synthetic data. Then, building trust and responsibility in GenAI systems means notably to cover the lack of clarity on underlying data used to train GenAI programs, the inability to explain the results from GenAI algorithms and the bias in GenAI models. Learning how to know and remove bias from the AI/GenAI models is a key aspect of improvement and adoption of generative models. To prevent potential technology drifts and unsafe outcomes, it is recommended to have experts overseeing genAI behavior rather than going into full automation. It means that it is crucial to collaborate with healthcare professionals and ask for ongoing validation to eliminate potential bias. It is a necessary step to make sure that GenAI systems in health are reliable and effective in real-word medical applications, but also ease acceptability.

Ensuring acceptability from the healthcare community requires a massive awareness campaign. The Healthcare sector needs to be aligned on the facts that GenAI solutions must answer real business needs and must always be developed with two guiding principles: (1) facilitate better patient care and journeys and (2) save medical time. Moreover, hospitals, clinicians, and payers should clarify how specific solutions should be used, with clear messaging that AI-generated insights are recommendations rather than mandates.

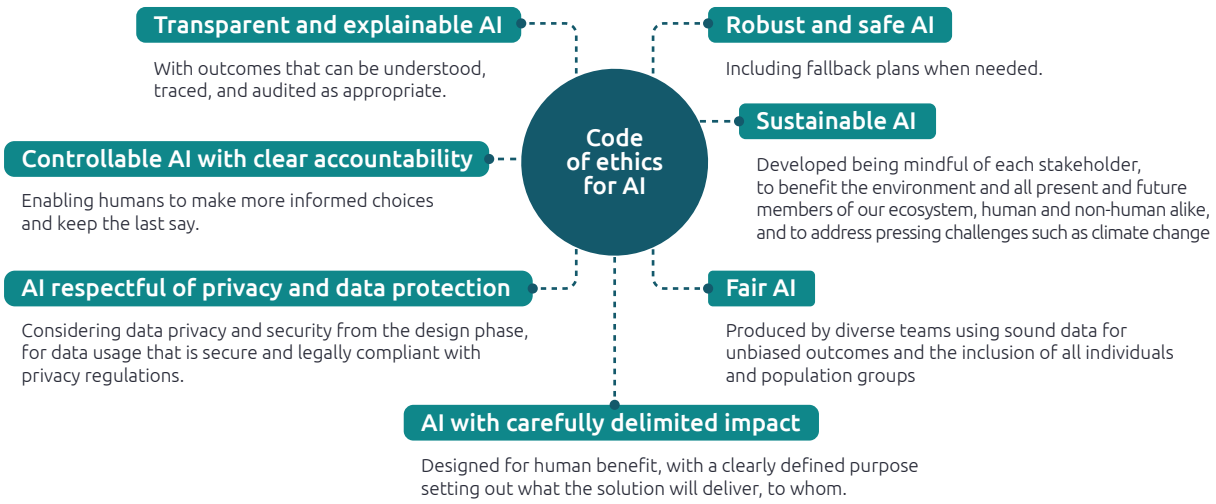
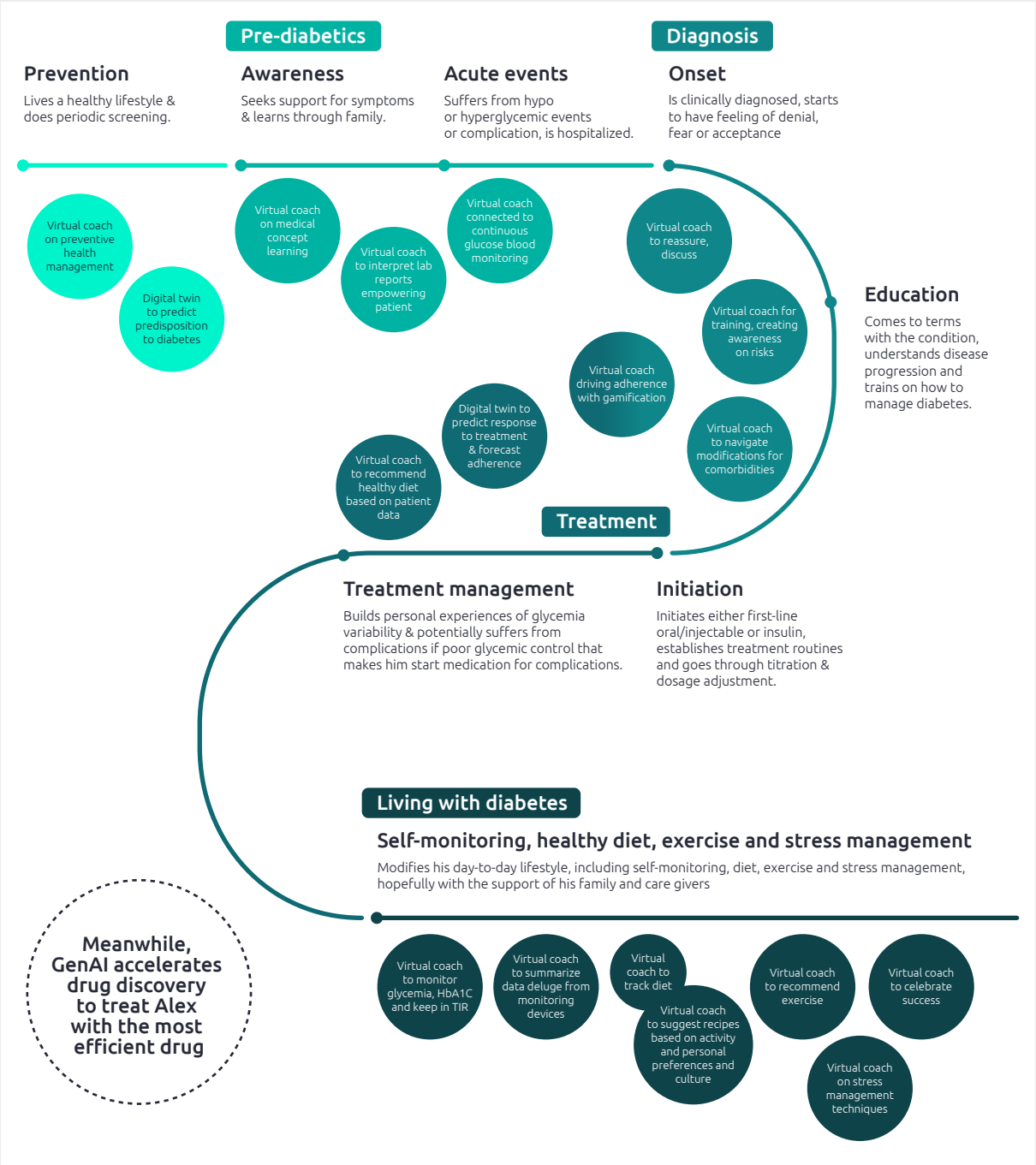


Figure 5: Capgemini code of ethics for AI framework on how to build trust and responsibility

GEN AI IN PATIENTS' LIVES BY 2030

Follow Alex, a type-2 diabetic patient that is empowered by GenAI to manage his chronic disease. A virtual coach is always by his side completing healthcare professionals to transform feeling of failure in motivation and properly help going through all stages of his disease in the simplest way.



CONCLUSION
A CALL TO ACTION

GenAI is highly promising for many applications in healthcare domains, such as drug discovery, personalized medicine, medical imaging improvement, resource optimization, automation of document authoring, or virtual patient assistants. The question today is no longer about the relevance for generative models for the sector but how to engage this journey as an organization, where to start depending on your strategy, and your level of maturity.

Strategy must be defined according to use cases. Make or buy choice depends on solutions to implement. We have defined a three-tiered strategy:

1. On-the-shelf solutions with limited impact on existing governance and core business, and technical backbone with a broad reach.
2. Tailor-made models with negligible CAPEX but requiring dedicated pool of expertise and mass training for functional skills.
3. Moonshot base models with significant impact on architecture, CAPEX effort and the necessity of organization adjustment and upskilling on new tech capability and advanced LLM topics, bringing a game changing competitive advantage.

Capgemini supports clients on the implementation of LLMs at multiple steps of the journey.

- **GenAI data strategy**: Maturity assessment, roadmap definition, use case portfolio, and target operating model design.
- **GenAI-based product development**: Data acquisition strategy, data structuring text-embedding tokenization, and training strategy.
- **GenAI tech and backbone**: Design of technical stack, choice of partner, existing cloud landscape integration, and MLOps practices on training.
- **Trusted GenAI:** Identifying best practices, condition of LLMs use, audit prompt tuning implementation around LLMs, and benchmark prompt implementation performance against use case-specific KPIs.
- **Workforce impact assessment:** Re-engineering of business process around LLMs, workforce training on LLM usage best practices, data scientist and engineer upskilling on NLP-specific algorithms, and LLM implementation and change management.

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