Supercharge *healthcare* through *GenAI*

Capgemini

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EXECUTIVE SUMMARY

Generative AI (GenAI) and Large Language Models (LLMs) have been there over several years but 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.

It is estimated that 50% of activities could be supported by AI by 2045, to which genAI will most probably heavily contribute. 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, maximize 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. GenAI also introduces efficiency in medical, legal and regulator 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 LLM 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. Google recently partnered with Mayo clinic. VC have invested US$50m in Hippocratic AI, which is developing a LLM for health care. 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 & 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 human should 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 LLM are coming.

This report shares Capgemini perspective of the particularities of genAI and LLM in healthcare, shares the 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 MODEL (LLM) IN HEALTHCARE

GEN AI AND LLM: 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.

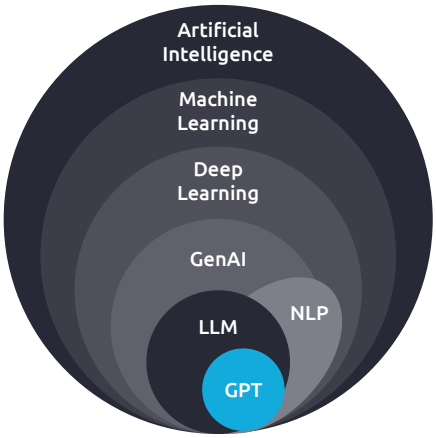


Figure 1: LLM at the heart of GenAI itself a subset of Artificial Intelligence

"98% of a hundred 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

GenAI and LLM can be deployed in three tiered options depending on organization ambition and use cases:

- The most basic form is 'off the shelf' LLM to run semantic searches, improve productivity, data management etc. The use cases are generic and embedded on existing software packages. The solution can be distributed to scale, is low on investment and can provide a productivity gain of 3-5%.
- A relatively advanced system of LLM requires 'fine tuning' demanding high computing power and specialized learning technique. Those models can be 'tailor-made' for specific use cases, that need adaptation to the specific business context. Consequently, the investment is significant and can result in higher productivity gains of 15-20%.
- The last category of LLMs are the fully customized ones or 'moonshot' that support super specialized use cases with a potential of developing a strong competitive advantage. The solution there are CAPEX intensive (more than 500M euros) and not mature. They require collaborations between pharma companies.

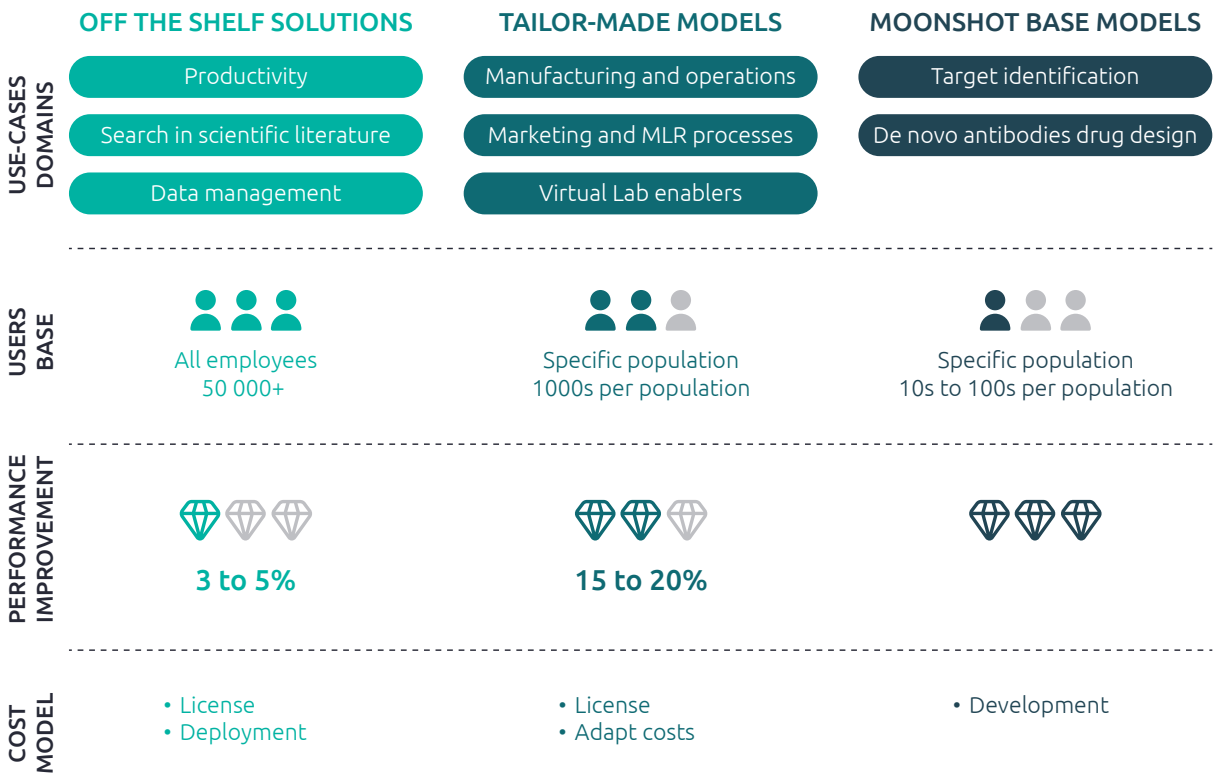


Figure 2: The 3 options to deploy LLM within a company with their key characteristics (Capgemini figures based on studies and literature reviews aggregation)

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 and illustrated. Last part will address key limitations such as regulatory, ethics and acceptability.

1 INNOVATING FOR CARE
GEN AI IN LIFE SCIENCES

GenAI is poised to accelerate the transformation of the life sciences industry and create a competitive advantage across the value chain.

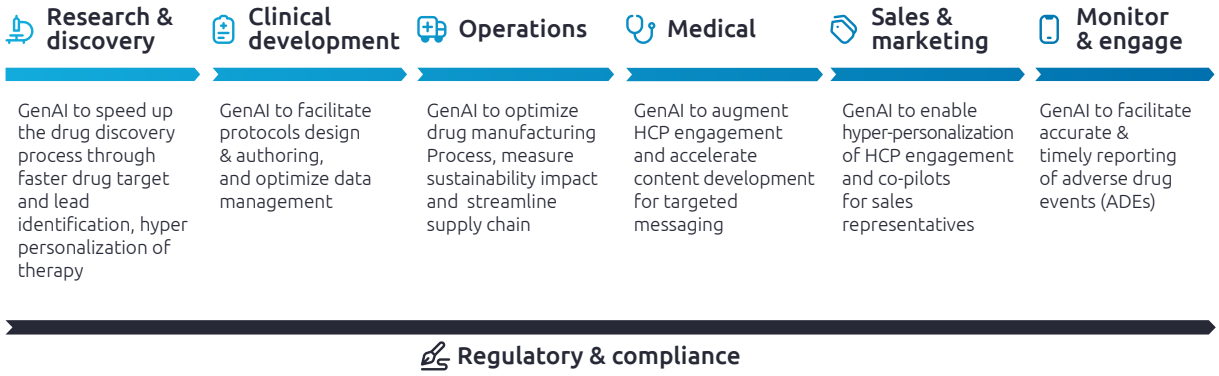


Figure 3: Where GenAI can play a role in Life Sciences value chain

1 GenAI in drug discovery or how to know the unknown: Drug target and leads identification, validation, optimization and tailored personalized immunotherapy

LITERATURE MINING AND KNOWLEDGE EXTRACTION FOR TARGET IDENTIFICATION AND VALIDATION

GenAI can be a great resource in literature mining and knowledge extraction to better understand disease progression and identify potential drug targets.

Conventionally, literature search was done manually and painfully by researchers. While text mining and statistical tools have been available for many years, there were constraints in synthesizing images and graphs. Moreover, the speed and accuracy were a limitation in widespread usage. The novel relations between genes, diseases, drugs, and pathways are to be uncovered for a smooth drug discovery process. For instance, ArcaScience is a literature review platform that provides insights on market insight discovery and clinical benefit-risk guidance.

Scientific literatures LLMs can digest vast amounts of multi-omics data, summarize the content, scan through images, and extract scientific relationships such as protein-protein interactions, biological functions or pathways hidden in the unstructured scientific literatures. All of this unlock valuable insights hidden in tables, graphs, and other unstructured content. It enables to identify drug target candidates with their specificities, effects, predicted efficacy (for instance for rare disease) and to validate molecular mechanisms of a target. AbSci, that recently announced a collaboration with AZ, is the first company to create and validate de novo antibodies in silico with GenAI. GenAI is also key in knowledge graph (KG) analysis to unravel the protein interaction networks to pinpoint the key pathways for drug targets.

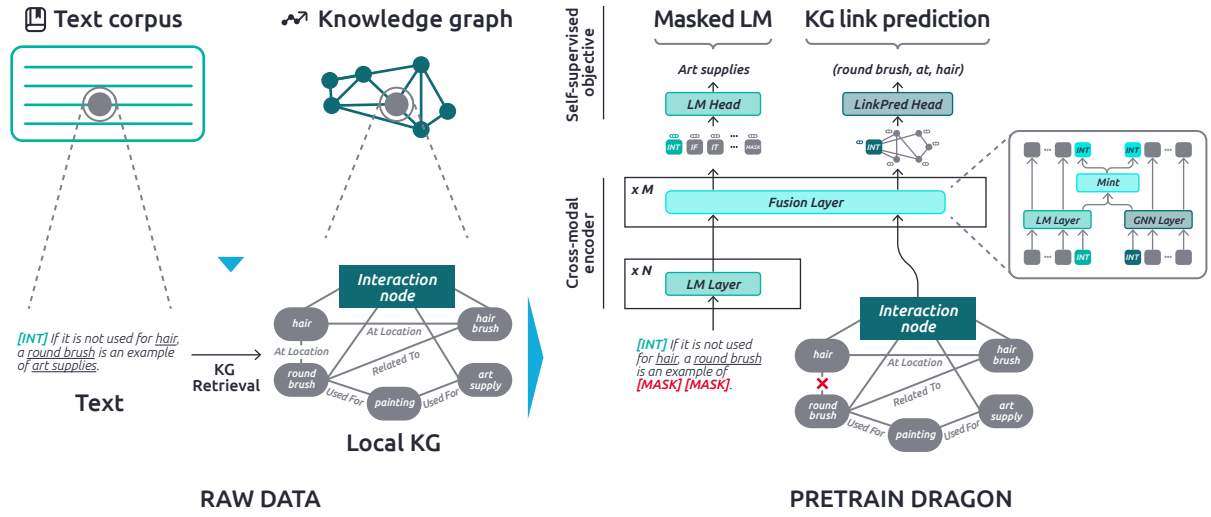


Figure 4: Deep Bidirectional Language-Knowledge Graph Pre-Training

LEAD IDENTIFICATION AND OPTIMIZATION THROUGH VIRTUAL SCREENING AND DE NOVO SMALL AND LARGE MOLECULE DESIGN

GenAI can speed up the lead identification process by screening large libraries of compounds and contribute to generating new molecules with the desired properties to improve biological activity.

A crucial step in the drug discovery process is to identify good candidates for biological activity with the target protein. GenAI can screen large libraries of compounds to predict their binding affinity to target or to develop novel lead molecules with desired biological activity. GenAI can also generate entirely new molecules for specific drug targets such as in rare diseases or oncology. The new molecules characteristics are based on chemical, protein, or antibody space and synthetic feasibility. For example, Deepmind's AlphaFold incorporates physical and biological knowledge to predict 3D models of protein structures.

In the last 12 months, we have seen the rise of many deep generative models for both small and large de novo molecule design. The chart below shows how the deep generative models are distributed based on the type of molecule representation and molecule size.

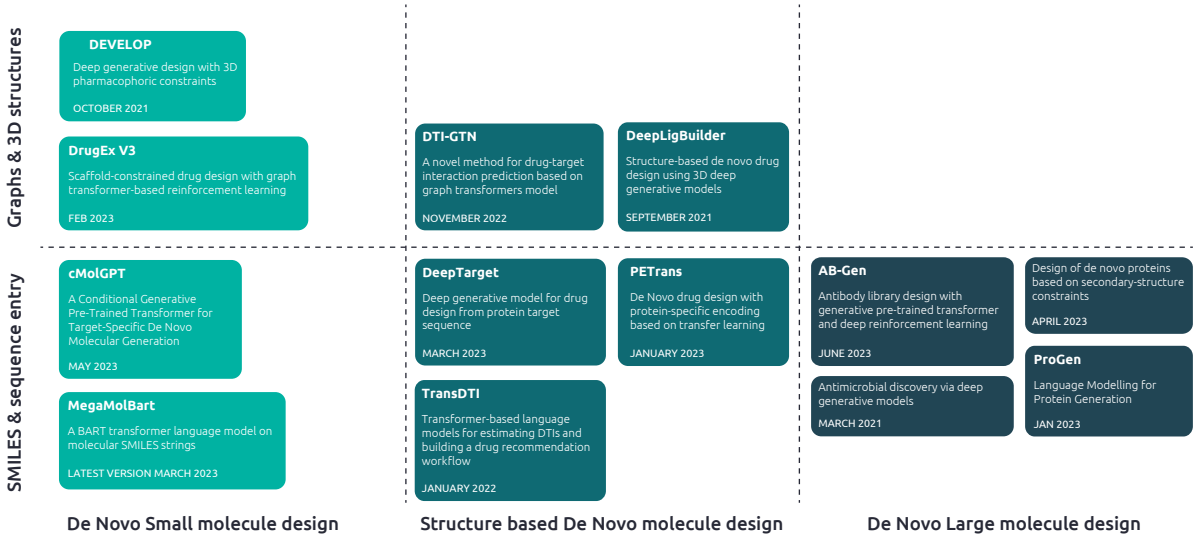


Figure 5: Generative models for de novo molecule design

PERSONALIZATION OF IMMUNO-ONCOLOGY WITH SPEED AND PRECISION

GenAI is relevant for ultra-personalization. Immuno-Oncology is a space that is prone for such approaches.

T- cell receptors (TCR) are molecular carriers that carry instructions to T cells to converge on cancer cells and destroy them. However, a challenge with the system is that TCRs have a poor affinity to cancer cells and are likely to attack healthy cells; GenAI can assist in rewriting the genetic code of the TCRs in order to alter it to improve the potency to suit it for a receptor for a drug target. The TCRs are molecularly reengineered to suit the genetic code suggested by GenAI to create a TCR based drug for targeted therapies that maximize efficacy and minimize side effects. Etcembly, a British biotech company is using Gen AI in the discovery and bioengineering of TCR candidates for immunotherapy.

2 GenAI in clinical development: protocol authoring, boosting patient recruitment and enabling data management

Over the past few years, AI has entered into the clinical trial space, shaking a paradigm that has been established for decades.

EXPEDITING CLINICAL TRIAL PROCESS: DESIGN AND AUTHORING

GenAI can be utilized in getting insights on how to design a clinical trial: study objectives, patient population with their inclusion/exclusion criteria, optimal dosage, indication among other critical information.

GenAI can essentially author the protocols that can further be validated by clinicians as a second step. By scanning through large amounts of scientific literature and databases, GenAI produces insights that maximize the trial probability of success. Analysis of patient history, demographics, and genetic profiles helps identify the right subgroup of patients who will most likely respond to the treatment, further helping in creating tailored protocols for the trial. With the options generated from the insights, clinicians make the process of authoring clinical trial protocols more predictable, clinically relevant, efficient, and safe. More importantly, the key benefit is the improved probability of success of the clinical trial. For example, inClinico - a transformer-based AI software platform has developed a model for clinical trial probability of success that demonstrated 79% accuracy on the outcomes of real-world trials.

BOOSTING PATIENT RECRUITMENT

GenAI has the potential to accelerate the enrollment of patients in trials with quick patient details filling or personalized recruitment messaging.

GenAI has the capacity to tap into historical patient databases of electronic health records (eHR) for the purpose of patient recruitment for clinical trials. By using speech recognition and GenAI, a clinician can record patient's information in real-time during visits, which both assists the visits and follow ups but also supports the effort of patients pre-screening.

Furthermore, GenAI via predictive analysis, can analyze historical data to identify any trend or pattern that will likely influence patient enrollment rates. It can help in personalizing recruitment messages to increase the chances of patient participation in trials. Sponsors of the trial can then estimate time and resources required for patient recruitment accurately, thereby speeding up the patient recruitment process.

ACCELERATING CLINICAL DATA TRANSFORMATION

Using GenAI to streamline statistical programming of clinical data is a huge time saver. Code can be generated to transform clinical data from one state of format to another, leading to comprehensive artefacts that can be reported and automatically explained in the submission report to health authorities. This accelerates time-to-market.

Submission is a mandatory step of clinical trials. To get there, Pharmas have to go through an extensive effort of data management. To provide meaningful results for health authorities to take informed decisions, clinical statistical programming is crucial. It transforms the clinical data in different standard formats up to "tables, listing and figures", that are the core elements of a clinical study report. As of today, it is largely a manual process with existing inefficiencies and numerous routine operations. Generative model can be leveraged to automatically generate code needed to transform raw clinical datasets in the desired output.

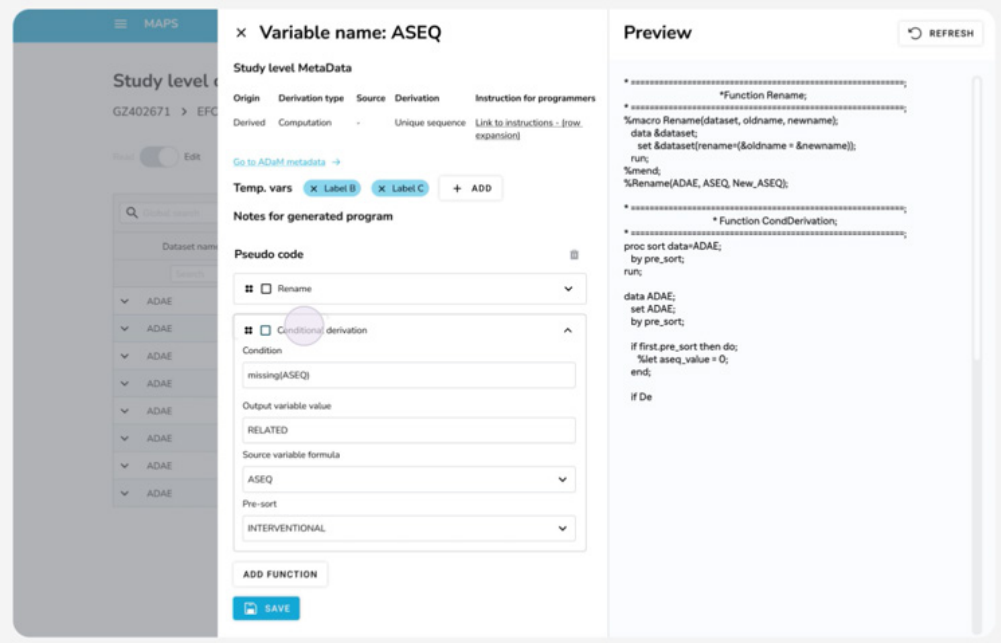


Figure 6: Example of clinical data management code generator by Capgemini

3 GenAI for operations: driving manufacturing and supply chain efficiency with a focus on quality and sustainability

DRIVING MANUFACTURING OPERATIONAL EFFICIENCY AND SAFETY

GenAI has the potential to augment pharmaceutical manufacturing in several ways such as predictive maintenance, improved yield or operator safety.

GenAI helps in significantly reducing the unplanned downtime of equipment by interpreting telemetry from machines. Once an issue is detected, GenAI recommends possible solutions and equips the maintenance teams with corrective actions. The technical team can also interact with the technology using natural language with common inquiries.

GenAI can also be used to simulate different manufacturing conditions to identify optimal conditions to maximize yield. By analyzing vast data sets, GenAI augments the manufacturing process by enabling better inventory management, waste reduction, efficiency improvement, and maintaining strict quality control standards.

Finally, GenAI models can improve workers' safety. A site manager can request for lessons learned (text, presentations, graphs, …) on a specific type of incident through a prompt, to share it with his operators. Those learnings would be based on incidents that happened in various locations and thus prevent the recurrence of incidents across sites. Models can also recommend actions to take when such an event occurs, still based on past experiences.

MEASURING PRODUCT SUSTAINABILITY IMPACT

GenAI can accelerate the Life Cycle Analysis (LCA) that drives eco-design of a product, by automating the matching between products data and environmental impact data. It can also be used to generate parts of the ISO report that is mandatory to disclose results. Ultimately, it can generate recommendations of actions to reduce negative impacts where it is the most significative, finding opportunities for better product design and production.

Identifying and quantifying the environmental impact of a product throughout its value chain can be very painful. The Life Cycle Analysis (LCA) gives the impact across various metrics, such as carbon emissions or water depletion. It consists first of modelling each step of the product life cycle and matching those input data with data from opensource databases that give impacts on environment. This matching is complex as not all data exist in the databases. It may require hypothesis formulation justifying a matching, validated by experts. GenAI can be leverage here to find in one click perfect matches, to suggest matching based on literature if data are missing or to generate data if no match can be considered. Generative models can also guide the sensitivity analysis and propose hypothesis explanations, that must be formulated in the ISO report required to disclose the results. Moreover, GenAI can be used in this latter report, to interpret graph from the analysis and author sections of the ISO report.

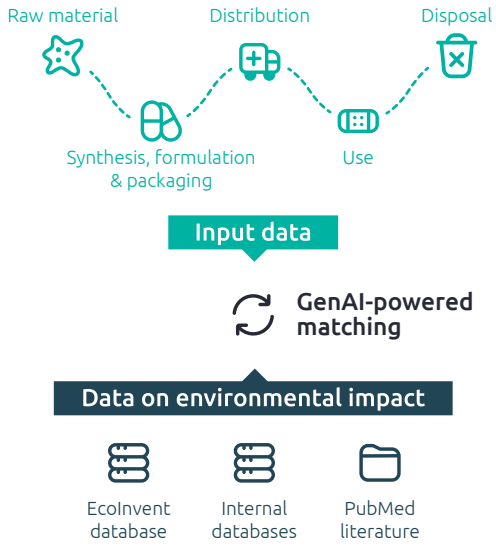


Figure 7: Use of GenAI for LCA data matching

QUALITY MANAGEMENT: EVOLVING APPLICATIONS IN PHARMA OPERATIONS

GenAI for quality can help in designing drug formulation, improve manufacturing process development and enhance quality control.

GenAI can identify bottlenecks and inefficiencies in manufacturing by analyzing process flow and recommend improvements. Tasks such as tracking batch quality or adhering to regulatory documentation can be automated. Deviations from quality standards will be spotted and corrective measures triggered. GenAI is also augmenting quality control models by including various kinds of data such as images, texts, tabular data etc. Image data augmentation in packaging verification, text data augmentation by creating synthetic text data, and statistical analysis in quality control of manufacturing process data by augmenting tabular data are some of the key use cases in the quality space.

RESHAPING PHARMACEUTICAL SUPPLY CHAIN AND LOGISTICS

GenAI has the potential to improve supply chain and logistics workflow by supporting demand forecasting, supply chain optimizing and risk assessment.

By scanning large amounts of historical sales data, patterns can be identified to predict drug demand across different markets. By fine tuning a GenAI model with parameters such as seasonality, economic conditions etc. GenAI can produce more accurate forecasts, helping companies better manage their inventory and gain resilience.

Supply chain optimization is another key area where GenAI can help Pharmas achieve cost savings. The models can analyze various kinds of data such as purchase orders, shipment tracking, invoices etc., and recommend best options to achieve optimization, reduce lead times, improve operational efficiency, and contain costs. GenAI can also help in creating training material and process guidelines for suppliers by identifying and incorporating the best practices and sustainability frameworks.

Supplier risk assessment is also an important parameter where GenAI can be utilized. By assessing historical data on supplier performance, financial reports etc. the model can predict a pattern related to supplier risks. Based on these insights, pharma companies can evaluate reliability and anticipate any disruptions, and plan on mitigating risks.

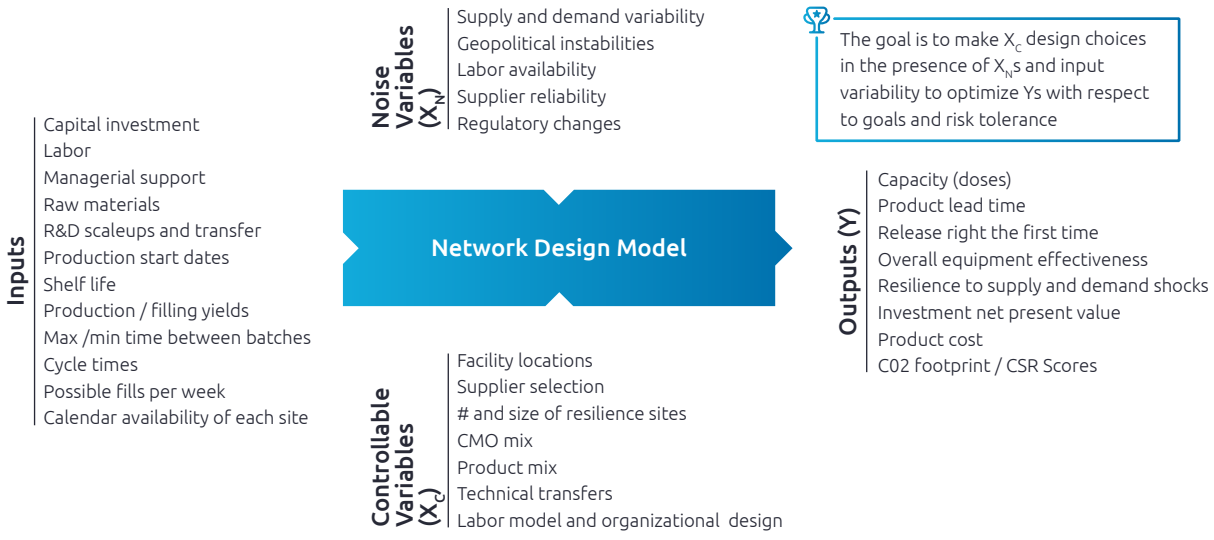


Figure 8: multi-factor supply network design, powered by (gen)AI

4 GenAI for marketing and sales: hyper-personalization and rep co-pilot

HYPER-PERSONALIZATION OF CUSTOMER ENGAGEMENT

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. Juisci is an example of an app that can be utilized to provide relevant content from peer-reviewed medical articles for healthcare professionals.

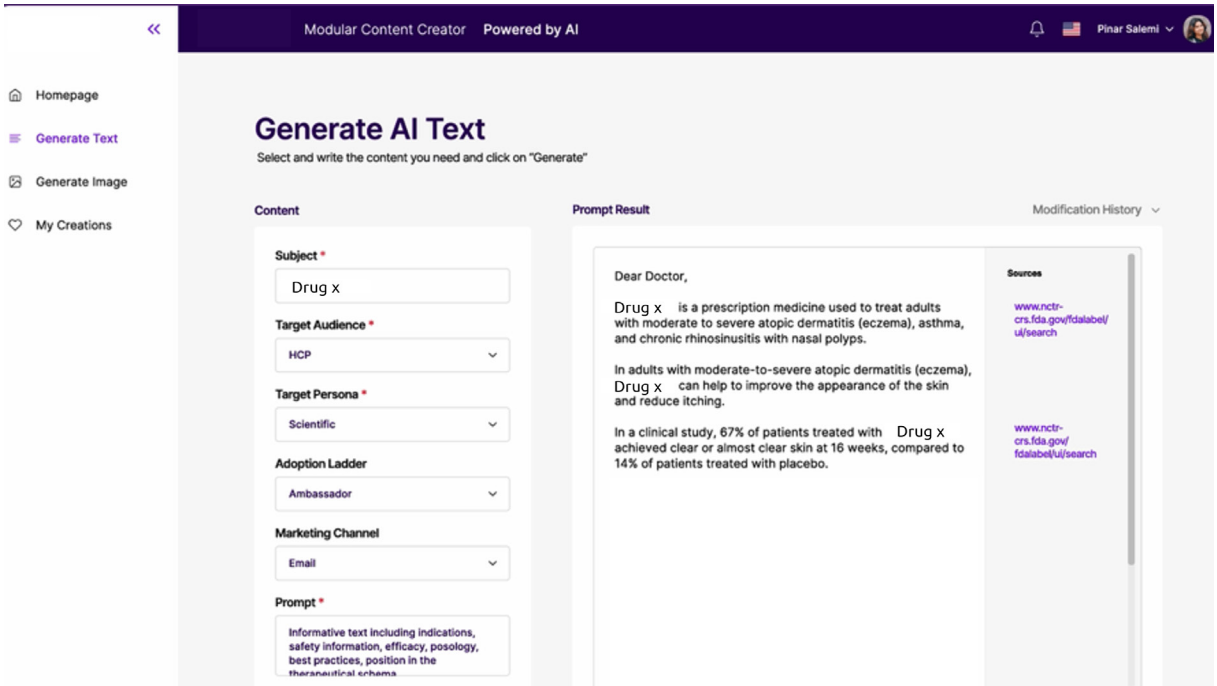


Figure 9: Example of Medico-marketing content creator by Capgemini

REPRESENTATIVE CO-PILOT

GenAI open avenues for personal assistance, Microsoft CoPilot paved the way on that field. It could be applied to the sales representative population.

COVID has changed the face of sales representation in Pharma. Less visit at doctors, more multi-channel, more efficiencies, and more agility are now expected. To add an extra layer of complexity, sales reps are burdened with myriad of micro-tasks and expected to be in multiple places at the same time. GenAI can do just that by becoming a "Co-Pilot" for the reps, by augmenting the sales rep. Aktana CoPilot is a mobile AI assistant for MSL and sales representatives that provides real time intelligence nudges to drive personalized interactions with HCPs'. Sentiment analysis powered by GenAI can assist to steer Pharma campaigns towards popular customer sentiments and to provide remedial measures to sentiments with potential to hurt brand reputation. Technology can also for instance assist in creating custom creative sales pitches by analysing the practitioner trends and historic relationship. Rep Co-Pilot can provide real-time sales assistance by listening in to the sales pitch and provide recommendations on-screen based on the direction of the conversation, mood of the customer to prompt data, media and content that can be leveraged to augment the conversation. Sensei GenAI from Adobe Cloud Services is one such platform that is delivering transformational customer experience.

5 GenAI for regulatory

SHIFT FROM PERIODICAL TO REAL-TIME SAFETY REPORTING

GenAI can analyze in real-time literature and other sources like social media to make pharmacovigilance professionals or trial sponsors manage risks proactively, reinforce safety measures, and prevent adverse events in further trials.

With huge volumes of medical literature available and being published, the pharmacovigilance professionals are facing the challenge of staying up to date with the latest information. GenAI can automate the review and summarization of relevant papers. It can also analyze unstructured data from various sources, notably social media, patient forums, etc. to categorize them as adverse events, reports, and patient narratives, to detect potential safety weak signals or issues. The manual efforts are significantly reduced and lives can be saved.

EFFICIENCY IN INTERACTION WITH AUTHORITIES

GenAI can be a used through document authoring and smart companion to submit qualitative regulatory reports and seamlessly engage with the authorities. Those perspectives optimize and accelerate submissions.

Medical writing involves data collection and reporting periodic reports such as clinical study reports (CSR), risk management plans (RMP), TLFs (tables, listings, and figures), Periodic safety update report (PSUR) that are considered time consuming while repetitive. GenAI can reduce the manual effort required in building the reports and reducing the errors at the same time. Submissions are consequently streamlined: both design and content of the dossier are optimized to reduce number of follow-on queries from health authorities, accelerating overall regulatory process. For instance, the Narrativa Generative AI platform is one such platform that automates the complex regulatory documentation processes. Yseop platform uses natural language generation to automate CSR, the platform is being used by Sanofi for medical writing. Moreover, when interacted with health authorities, for instance during drug authorization process or manufacturing audit, GenAI chatbot plugged on company data patrimony can increase the quality of responses during those critical periods.

TAKE HOME MESSAGES

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:

- **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. It results in a decrease in discovery time (20-30% less), combined with a rejuvenation of Pharma pipelines, that is the strongest indicator of their wealth.
- **GenAI can also bring the next revolution in medico-marketing & sales**. First in content generation: while creating more personalized content fitting HCP specific profiles, we 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.

Besides and similar to other sectors, it comes with significant improvements throughout the value chain, where off the shelf model can bring value:

- **In Clinical Development or Operations**, with a potential to increase efficiency or decrease cycle times
- **In Regulatory and Corporate functions**, with use cases leveraging information synthesis & classification, search and knowledge management or document generation; GenAI will serve in design and content of regulatory dossiers following the formats and requirements required by the regulatory bodies thereby optimizing the time to filing by reducing the follow-on queries.

Down the line, GenAI can speed up the transition of Pharmas from therapeutics to a unique blend of therapy and technology, where organizations will be collaborating more and more with tech players, academics and start-ups. Finally, it is worth noting than GenAI can be used in combination with a control loop in areas like molecule design, trial design, supply chain optimization by pressure-testing created artefacts with the “hard truth” to improve models.

2 QUALITY OF CARE
GEN AI IN DOCTORS PRACTICE

Generative models have several potential use cases in hospitals and healthcare settings. Here are some use cases for GenAI in hospitals.

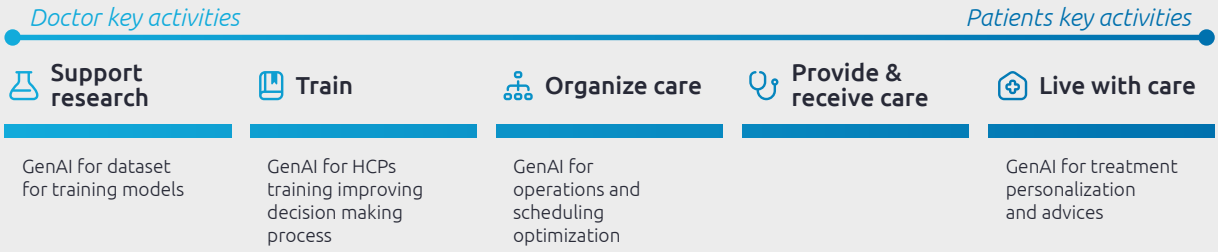


Figure 10: GenAI value across doctors-to-patients value chain

1 Knowing it all: GenAI for training of HCP

HEALTHCARE SIMULATION AND TRAINING

GenAI models can be utilized in healthcare simulation scenarios. For example, they can generate realistic patient scenarios for training HCPs on various medical procedures and decision-making processes.

One notable application of GenAI models is the creation of lifelike patient scenarios for training doctors. These scenarios go beyond traditional scripted simulations, allowing for a dynamic and adaptive learning environment. Generative models can simulate a wide range of medical conditions, presenting practitioners with diverse and challenging cases that mimic real-world situations. For instance, in surgical training, models can generate 3D anatomical artefacts, enabling surgeons to practice procedures on virtual patients before entering the operating room. This not only improves their technical skills but also exposes them to complex scenarios that they might encounter in real practice.

Moreover, these generative models can adapt to the evolving field of healthcare by incorporating the latest medical knowledge patrimony. Training curriculum can remain up to date. The integration of generative models in healthcare simulation not only enhances the efficiency of training but also addresses the ethical considerations associated with traditional training methods. Simulated scenarios allow practitioners to learn and refine their skills without putting real patients at risk, ensuring safer practices.

Thus, the demand for digital twins is enormous. For instance, experts at GSK are working with cancer researchers at King's College London to build digital replicas of patients' tumors by using images, genetic and molecular data, as well as growing patients' cancer cells in 3D and testing how they respond to drugs.

"Advanced technologies allow us to unlock the potential of complex genetic data with unprecedented speed, precision, and scale. We're joining our science, talent and tech to develop a more personalized approach for cancer patients through novel models in the lab that will help inform clinical decision making for the future treatment of cancer patients."

Kim Branson, Global Head of Artificial Intelligence and Machine Learning, GSK

Companies are also using patient-specific heart models to improve clinical outcomes: versus conventional operations, InHeart allows to reduce procedure times by 60% and reduce recurrence by 38 % thanks to its heart digital twin and image-guided VT ablations.[1]

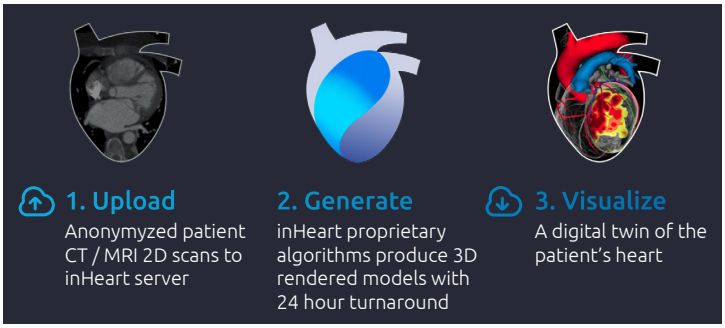


Figure 11: inHeart's heart digital twin (source: inHeart website)

DATA AUGMENTATION FOR ADVANCED MODEL TRAINING

To protect patient privacy, hospitals often face challenges in sharing medical datasets for research purposes. GenAI can generate synthetic patient data that retains the statistical properties of the original dataset without revealing sensitive information. This synthetic data can then be shared more freely for research and collaboration.

The imperative to safeguard patient privacy frequently poses difficulties for hospitals wishing to share medical datasets. The very sensitive nature of medical patient information demands strict measures to protect individual privacy.

The primary advantage of employing generative models is their ability to generate synthetic datasets that closely resemble the statistical patterns of the real patient data while ensuring that no individual's private information is disclosed. For example, if a hospital possesses a dataset of patient records, including demographic information, medical history, and diagnostic details, researchers can produce synthetic datasets that maintain the distribution of ages, genders, and medical conditions observed in the original data, through the application of generative models. This synthetic data, however, contains no identifiable information about specific individuals, ensuring compliance with privacy regulations, such as the General Data Protection Regulation (EU GDPR).

The utility of generative models in this context also goes beyond privacy protection. The synthetic datasets created can be shared more freely for research and collaboration in order to create algorithms, conduct analyses, and develop models, without compromising the privacy of real patients.

[1] https://www.inheartmedical.com/solution

GenAI can be leveraged to augment medical datasets for training machine learning models. By generating additional synthetic data, these models can help improve the robustness and generalization of algorithms used in medical image analysis and diagnostics.

As an illustration, researchers at the Mayo Clinic, NVIDIA, and the MGH & BWH Center for Clinical Data Science are exploring how to use MRI images generated by artificial intelligence to train a deep learning model designed to identify clinical abnormalities in imaging data. The research is aimed at overcoming the perpetual challenge of accessing enough high-quality, variable data to sufficiently train AI algorithms in complex diagnostic tasks.

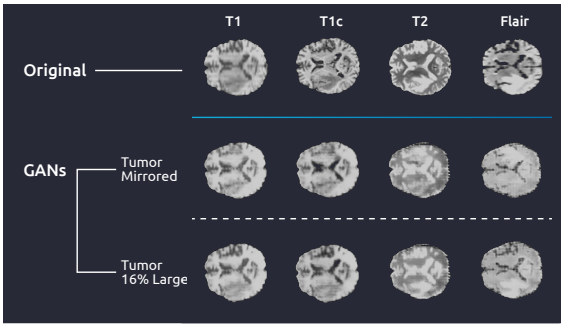


Figure 12: Generation of synthetic MRIs for advance medical research (source: Nvidia website).

Many use cases can thus emerge, such as a computer program that can be trained to identify different types of tumors in medical scans. Generative models then create more examples that the program can learn from. Eventually, the program becomes proficient not only in recognizing the tumors it initially encountered but also in handling a broader range of cases, with potential outliers. In practical terms, this makes the program more effective when dealing with the variety of patient case scenarios.

2 Saving time: GenAI for optimal patient flows & administrative management

IMPROVED SEAMLESS JOURNEY WITH OPTIMIZED OPERATIONS & SCHEDULES

Generative models can be used to optimize hospital operations. The goal is to find the optimal schedule for both administrative and medical workers to reduce vacancies, work exhaustion or intervention rescheduling.

GenAI plays a pivotal role in streamlining hospital operations, particularly in the context of flow twinning and schedule optimization. It can analyze historical data on patient admissions, discharge patterns, and doctor availability to generate predictive models. By forecasting patient inflows, it assists in anticipating resource needs, allowing hospitals to optimize staffing levels and allocate resources accordingly. Moreover, generative models can facilitate the creation of personalized schedules for both patients and healthcare providers, considering individual preferences, treatment requirements, and the availability of medical staff. This not only improves patient satisfaction but also ensures that healthcare professionals can deliver optimal care without being excessively tired. For example, six months after the anesthesiology department at Ochsner Health in New Orleans implemented its new AI scheduling system, the average engagement scores of 60 anesthesiologists increased from 3.3 to 4.2 out of 5, researchers reported.

"On average, the scheduling allows our anesthesiologists to have one or two mornings and one or two afternoons off a month to allow for increased work-life balance, so they are better able to attend events important to them."

Dhruv Choudhry, M.D., lead author of the study and anesthesiology resident at Ochsner Health in New Orleans.

This does not solely apply to hospitals but to most medical structures. Its positive externalities can be of special interest for nursing homes or residential care facilities for the elderly, in the context of a rapidly ageing population and overburdened healthcare staff.

ENHANCED PATIENT INTERACTION & CARE

Generative models can be used to enhance interaction and care for patients. They can aid doctors during notetaking and can lay the ground for patient remote monitoring. Thus, physicians have more time to focus on patients and therapeutic education rather than administrative work.

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.

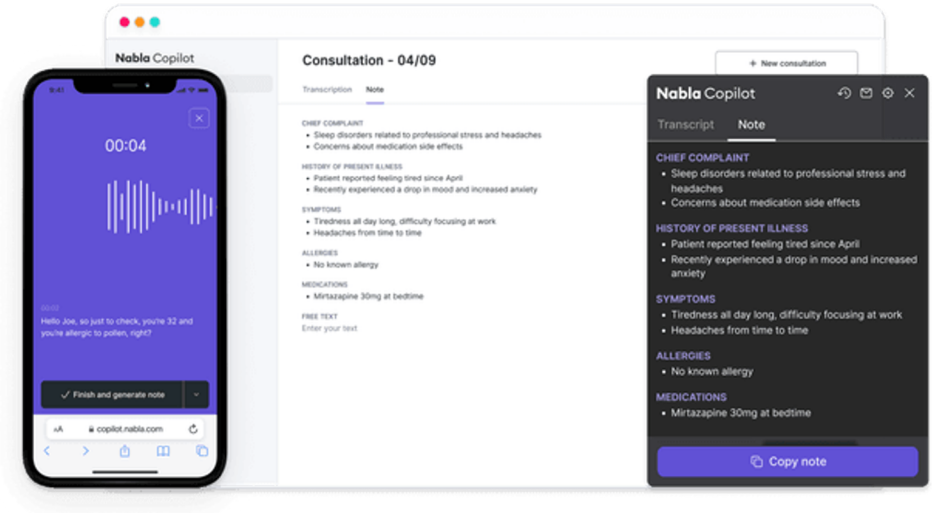


Figure 13: Nabla Copilot to provide consultation reports and patient files updates (source: Nabla website).

In the context of remote monitoring, GenAI can analyze real-time data from connected medical devices, providing continuous monitoring of patients' health status, and facilitating early interventions. Applications based on these models can provide personalized advice, reminders for medication intake, and lifestyle-related suggestions, contributing to the improvement of a patient's life and habits. Medical chatbots, powered by GenAI, are another important application, offering quick responses to questions, facilitating appointment scheduling, and providing advice on managing health conditions. A team of licensed health care professionals compared physician's and chatbot's responses to patient's questions asked publicly on a public social media forum and found that chatbot responses were preferred over physician responses and rated significantly higher for both quality and empathy[2].

These examples demonstrate how GenAI can greatly reduce administrative workloads for physicians to solely focus on caregiving.

[2] Ayers JW, Poliak A, Dredze M, et al. Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum. JAMA Intern Med. 2023;183(6):589–596. doi:10.1001/jamainternmed.2023.1838

3 Enhancing decision making: GenAI for better diagnosis, treatment & follow-up

ANOMALY DETECTION IN MEDICAL IMAGES

AI has been used in the field of medical imaging for years now. GenAI now presents opportunities to automate and further increase the accuracy of medical image analysis. Tasks like image segmentation, image synthesis, predicting patient outcomes and detecting anomalies can now enter a new era.

GenAI presents significant opportunities for enhancing the resolution and quality of medical images. First, it can be employed for image resolution, augmenting the detail in existing images. It can also contribute to reducing noise in medical images, improving clarity, and facilitating interpretation by healthcare professionals. Adjusting contrast is another important application of models: by optimizing the contrast of medical images, it highlights specific features, making the detection of anomalies easier. Plus, it can play a role in restoring degraded medical images, correcting errors. It is essential to ensure the reliability of images used in the diagnostic process. Moreover, AI tools can be designed to detect anormal tissues. As an illustration, a tool designed by experts at the Royal Marsden NHS foundation trust, the Institute of Cancer Research, London, and Imperial College London can identify whether abnormal growths found on CT scans are cancerous. The algorithm performs more efficiently and effectively than current methods, according to a study. In addition, the results showed the AI model could identify each nodule's risk of cancer with an accuracy of 0.87. Plus, the AI model would have suggested early intervention for 18 out of 22 (82%) of the nodules that went on to be confirmed as cancerous[3].

GenAI can be utilized to generate synthetic high-quality medical images. This generation of synthetic images can represent various variations of abnormal tissues, expanding the diversity of examples available for training detection algorithms, improving the ability to identify anomalies. Another crucial application is simulating specific clinical scenarios. By using generative models, it is possible to create medical imaging scenarios with conditions, such as specific disease stages or responses to treatments. This can be extremely beneficial to detect subtle nuances and adapt to specific clinical cases.

PERSONALIZED TREATMENT PLANS

By analyzing patient data, including genetic information and medical history, genAI can contribute to the development of personalized treatment plans. These plans can then be tailored to individual patients based on the predicted response to specific interventions.

GenAI offers remarkable opportunities to create personalized care and adapted treatment for patients. By analyzing extensive sets of medical data, models can extract individual-specific information (i.e., medical history, genetic information), enabling a thorough understanding of their condition. Patients can ask to GenAI to recommend the best care according to their condition, that can change over time. The ability to customize treatment plans, considering patient preferences and reality represents a significant progress.

Down the line, generative models can optimize medications by analyzing individual responses, recommending dosage adjustments or better alternatives. Thus, it is an essential tool for clinical decision-making. With continuous real-time data-driven monitoring, GenAI constantly adapts treatment recommendations based on changes in the patient's condition.

[3] Hunter, B., et al. (2022, November). A radiomics-based decision support tool improves lung cancer diagnosis in combination with the Herder score in large lung nodules. The Lancet. Retrieved December 4, 2023, from https://www.thelancet.com/journals/ebiom/article/PIIS2352-3964(22)00526-6/fulltext#section-3d6acba1-acea-4be2-8dc9-b7e14e5b6583

TAKE HOME MESSAGES

Generative models in public sectors are promising for many usages, going from supporting research, to healthcare professional training, care organization or care delivery.

- Training HCPs, allowing to play scenarios to reduce the risks and time of interventions.
- Generated images to train models can considerably improve diagnosis phase. It falls into the field of data augmentation and could have breakthrough outputs.
- Copilots have emerged to guide healthcare professionals in their daily tasks, freeing time for patient care.
- Personalized treatment plans will be the last use case to come but will bring considerable value, as focus on patient well-being.

LLMs enabling GenAI in the healthcare sector needs to be trained on medical data but it implies going through complex restrictions, notably linked to GDPR in Europe, the massive amount of data needed or the restriction to share algorithms trained on sensitive data. To overcome that, it is possible to train an open-source generalist LLM on opensource medical data. Developed algorithms need to be evaluated to ensure their relevance, accuracy, and truthfulness, and this over time. Solution would be to 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.

3 COST OF CARE
GEN AI IN HEALTH INSURANCE

Generative models catalyse efficiency and innovation within health insurance processes while improving customer relationship, through its capacities to automate tasks, interpret regulatory nuances between markets, streamline document creation, and better answer to patients' inquiries. This enables health insurances to accelerate activities while ensuring compliance and customer satisfaction. Let's explore some use cases.

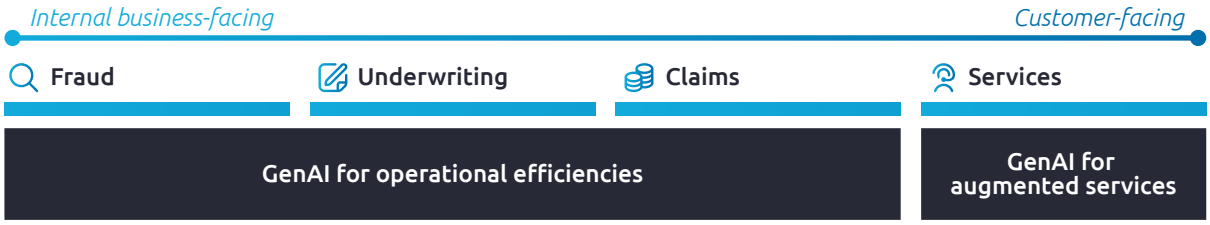


Figure 14: GenAI value across health insurance value chain

1 GenAI for operational efficiency: fraud, underwriting or claims

FRAUD DETECTION

GenAI can detect potential fraud or violations by interpreting policies, regulatory documents and potentially fraudulent behaviours in upcoming claims or billing.

Generative models can be used to ensure compliance. Through the interpretation of policies and regulatory documents, GenAI can identify potential violations related to operational procedures. This ensures that insurers stay abreast of legal requirements and adhere to industry standards. There is also a huge opportunity in fraud detection or early identification of suspicious claims by analysing patterns and inconsistencies in historical data, looking for potential fraudulent behaviours. This could take various forms such as double billing when medical providers submit multiple claims for the same service, phantom billing for something patient never received or upcoding consisting in billing more expensive service than patient received[4]. Leveraging direct reimbursement of patient is another shield to fraud.

"In 2022, public health insurance fraud amounts to €316m in France"

Le Monde

"The financial losses due to health care fraud are in the tens of billions of dollars each year"

The National Health Care Anti-Fraud Association (NHCAA)

[4] FBI, https://www.fbi.gov/investigate/white-collar-crime/health-care-fraud

PERSONALIZED INSURANCE PLANS THANKS TO INDIVIDUAL RISK ASSESSMENT, UNDERWRITING AND MODELING

GenAI ability to analyse vast amounts of data facilitates the creation of personalised insurance plans. Tailoring insurance policies by improving risk assessment and underwriting process not only improves customer satisfaction but also contributes to a more sustainable and cost-effective insurance model.

Underwriting for health insurance involves a risk assessment step that varies according to countries and insurance policies. The price can increase with risk factors. GenAI could help insurers to make more informed decisions on the patient's insurance choice, by training generative models on various data (demographic data, customer applications, risk profiles, real-time third-party data) to improve both risk assessment and underwriting. GenAI can also create scenarios to recommend pricing or coverage, leading to a personalised insurance policies based on this enhanced risk calculation. The applicant is no longer associated to a by default pre-packaged insurance that could be unfairly biased, but to customized health insurance based on his / her specific needs and corresponding to risks quantified with real life data.

This also allows to address better a younger population with new expectations.

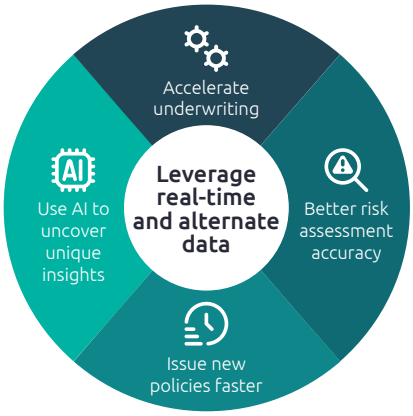


Figure 15: Integrating real-time alternate data from third-party sources can transform underwriting (source: Capgemini Research Institute)

IMPROVED AND ACCELERATED CLAIM PROCESSING

Generative models can be used in claim management to verify claim completeness and coverage. It can also propose a triage of claims. Ultimately it would reduce processing times for greater cost savings and customers speedier payment and resolution.

Health insurance claims are managed in a multi-step process involving administrative procedures and human in the loop (claim submission, verification, classification, approval, payment). Upon receiving a claim, the insurance company verifies the information for accuracy and completeness. Some bottlenecks occur along the way especially when there's missing or slightly miss-aligned information. With GenAI, insurers can automate the reading of policy statements to verify coverage against a specific claim. This could represent a spectacular gain in time. Automation can be largely extended to routine tasks such as data entry (to avoid manual errors), analysis and upcoming claim organisation (proposition of classification, level of severity prioritizing which claims to deal with first).

2 GenAI for patient relationship: augmented patients services

As seen previously, customer satisfaction could be improved with seamless and customized insurance activities. Personalised services remain pivotal in customer relationship, as well as timely and enhanced experience, based on automation of processes such as claims or underwriting. But these are not the only opportunities.

EASE ADMINISTRATIVE TASKS FOR PATIENTS THROUGH VIRTUAL AGENTS AND IMPROVE PATIENT AGENT RELATIONSHIP

Filling out questionnaire or symptom checker tools could be done with GenAI to ease interaction and improve patient engagement.

Virtual agent can also be leveraged to support patients doing administrative tasks that usually need “human-agent” support. This virtual agent can help patient to fill a form, such as a symptom checker, by asking the different questions to patient, step by step, with enhanced interaction to engage patients. This could also reduce drop out of patients not completing the form because they are lacking information or not understanding the questions. Then, redirection could be done through this bot.

Freeing up time could allow agents to have more time to talk to patient, develop empathy and compassion since health issues can also be tricky situations for the patients or their families.

IMMEDIATE ANSWERS, COMMUNICATION, AND TRANSPARENCY FOR PATIENTS

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.

FROM TRANSACTION TO RELATION TO PROMOTE PREVENTIVE HEALTH AND HEALTHY BEHAVIOURS

Creating conversational agents with a focus on prevention in healthcare is about harnessing technology to educate and empower. By offering personalized information, these agents contribute to proactive health management.

Virtual conversational agents based on GenAI can be built to engage conversations with policyholders, to offer various information on prevention and wellness. Policyholders can therefore be empowered by proactive health management. Conversational agents can be desig¬ned to provide information and guidance to users regarding preventive measures, which may include lifestyle choices, wellness practices, nutrition recommendation and other behaviours aimed maintaining good health. This would also include information on preventive care measures such as vaccinations or screenings that promote overall health and well-being. This information and guidance would provide the means to patients to make informed decisions regarding their health. GenAI layer will bring more patient engagement and retention with “human-like” conversation and generate content easily for personalized recommendations.

Positioning as daily wellness partner for a health insurance is already settled and has been seen at Generali. They propose corporate prevention program called Generali Vitality to engage employee being actives (for instance, walking) and reward them.

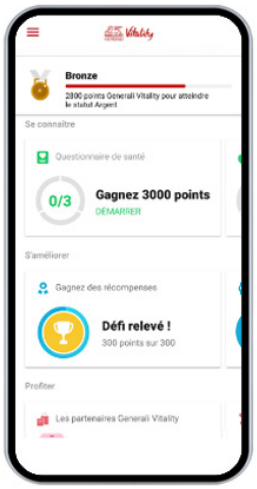


Figure 16: Generali Vitality prevention program (source: Generali website)

Empowering policyholders on their health is a key consideration for insurance companies, as all in all, better preventive health management means end-to-end costs reductions. GenAI can be used as conversational agent for insurer, to define which patients to target for preventive health actions and which recommendations.

Insurance agents can query for patient segmentation using GenAI, based on internal data. These could give them recommendations of patients that might need check-ups or any other preventive actions, along with a summary of patients’ histories. This analysis reveals highly expensive patients and can be anonymized easily. GenAI can be used then to generate those recommendations to patients and hopefully save costs in the long term. This use case has great go-to-market potential for example for the US.

TAKE HOME MESSAGES

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

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

With the increasing use of generative models, safeguarding customer data becomes essential. Health insurers must prioritize robust data security measures and compliance with privacy regulations to maintain customer trust. Unauthorized access to confidential patient data is a real cause of concern for health insurances and could be felt as an obstacle in broad GenAI adoption.

As the health insurance industry relies on established practices and mainly legacy systems, introducing change may create resistance. The high number of existing regulations encourages this hesitation, to avoid any regulatory complications. Moreover, insurance processes are complex, creating a fear that this change would further increase the number and complexity of existing processes. Insurers may feel unprepared for the learning phase that they would need to engage.

To go beyond these fears, it is important to:

- Train people on generative models and communicate properly to gain the buy-in of stakeholders.
- Act on data privacy, security and eradicate bias from models to build understanding and trust.
- Ensure that the quality of service would improve patient care, providing incentives.

4 HOW TO DEAL WITH LIMITATIONS OF GENAI 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.

1 Regulations and levels of risks using generative models

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[5]. One of their targets is to ensure better conditions for the development and use of AI systems that leverage better healthcare. They recommend analysing and classifying AI systems according to the risk they present to users, going from unacceptable risk to minimal risk. The level of risk determines the corresponding level of regulations applied. It is important that users are aware that they interact with AI while systems generate texts, images, audio, or videos contents. 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. Nevertheless, Capgemini Research Institute reports that, for Pharma and healthcare sectors, 80% of executives believe that benefits of utilising GenAI outweigh the associated risks.

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.

LEVEL OF RISK	LEVEL OF CONTROL	EXAMPLE OF CASES
UNACCEPTABLE	Prohibition	Obvious threat to citizens, social rating by public authorities
HIGH RISK	Certification	Critical infrastructures, training, exams, jobs, essential public and private services, migration, justice & democracy
LIMITED RISK	Transparency	IA dialog system, IA-generated image
MINIMAL RISK	Guidelines	Video games, spam filters

Figure 17: The 4 level of control from the AI Act

[5] https://www.europarl.europa.eu/news/en/headlines/society/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence

2 Ethics as a cornerstone of GenAI systems building, especially explainability, bias and environmental impact concerns

Many ethical challenges have arisen with AI systems and more recently GenAI systems[6]:

- the safety of people using them
- the transparency and explainability of their outcomes
- the bias of data used for training that could lead to unfair outputs, as well as quality of data
- the resources needed to develop and use them, with upskilling considerations
- and the environmental impact.

Let's zoom on explainability and bias. One goal is 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. A healthcare company had previously abandoned an AI model developed to diagnose cancers as they did not manage to gain full confidence in the algorithm. Learning how to know and remove bias from the AI/GenAI models is a key aspect of improvement and adoption of generative models.

Being more specific, 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 leading to inaccurate results when used and exploited by customers.

To prevent potential technology drifts and unsafe outcomes, it is recommended to have experts overseeing genAI behavior rather than going into full automation. In the healthcare area, 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.

Focusing on sustainable development, as model training and general 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. Capgemini Research Institute evaluates that 77% of interviewed companies are conscious that there is a need to implement and scale GenAI in a sustainable way. It can be noted that generative models can also be used to support sustainability for the different health stakeholders.

Capgemini Research Institute investigates on how to drive GenAI , listing five key pillars. Among them, there are recommendations on how to embark ethical considerations from the start.

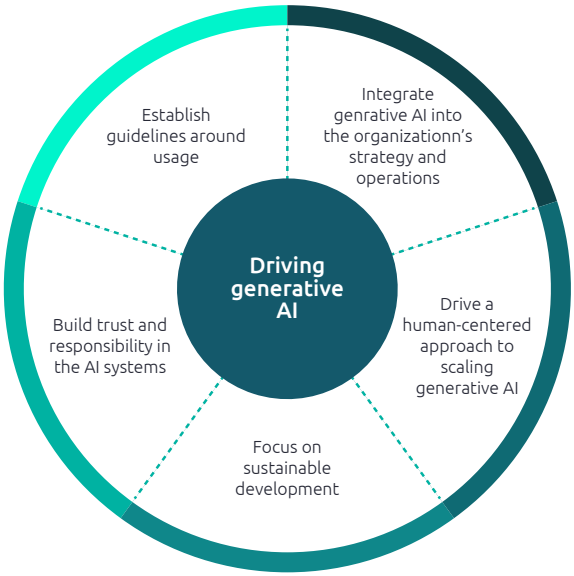


Figure 18: Capgemini driving GenAI framework

[6] https://www.datanami.com/2022/06/13/europes-new-ai-act-puts-ethics-in-the-spotlight/

In health, where data are highly sensitive all along the value chain, from research to patient care, a code of ethics for AI can be adopted.

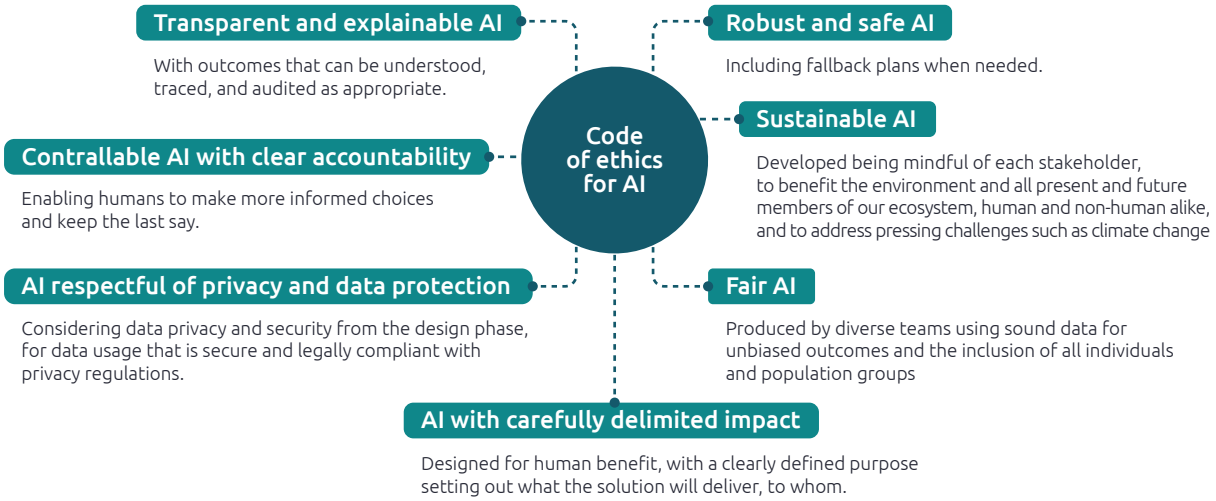


Figure 18: Capgemini code of ethics for AI framework on how to build trust and responsibility

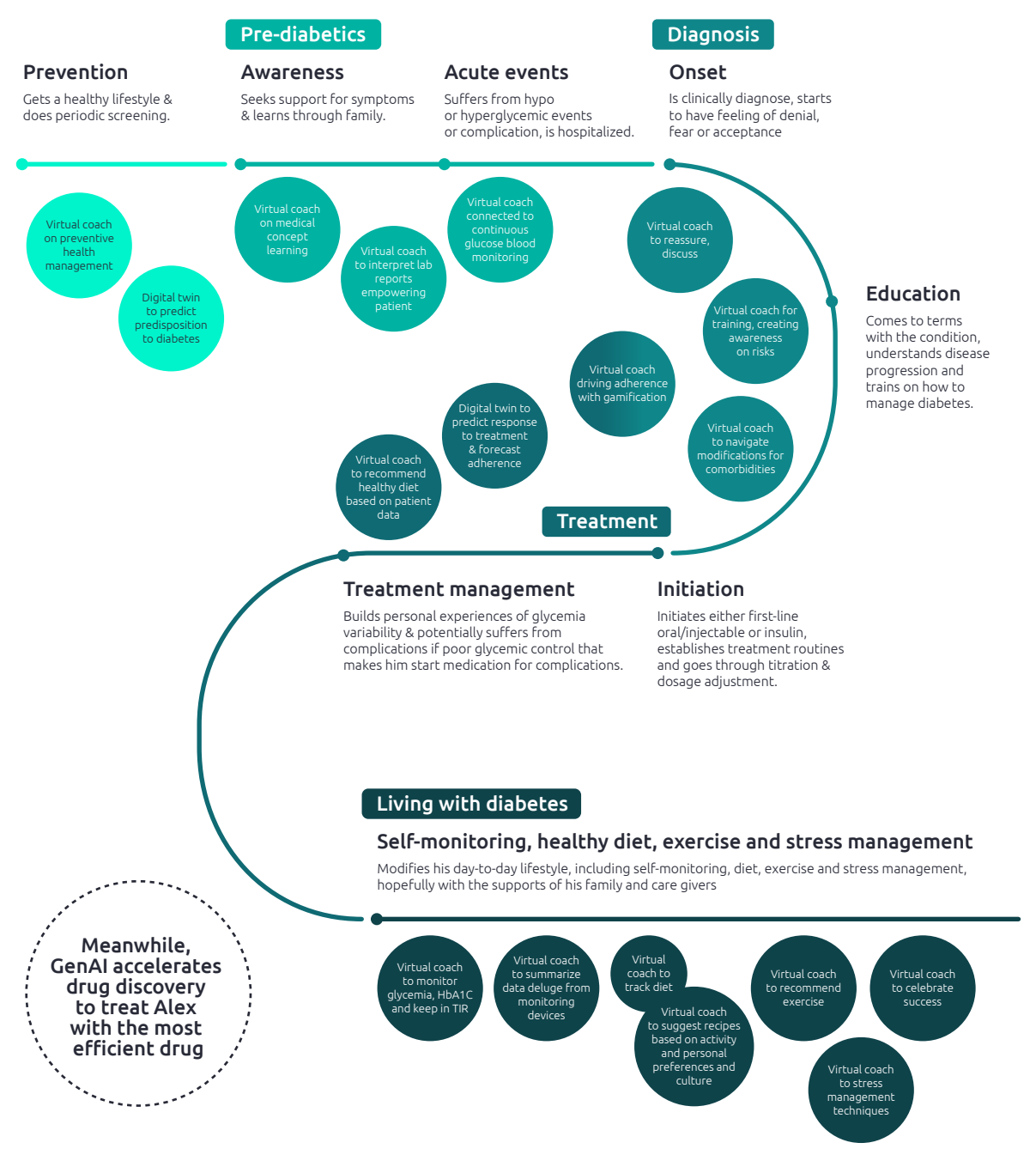
3 Patient privacy and acceptability

Patient health data is highly sensitive and must be handled with extreme caution. 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.

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. To do so, a massive awareness campaign seems unavoidable. Healthcare sector needs to be aligned on the facts that GenAI solutions must be qualified with healthcare professionals to answer real business needs and must be developed with always two guiding principles: facilitate the patient journey and save medical time. GenAI solutions help the making of decision but does not make decision. 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.

GEN AI IN PATIENTS' LIFE 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 3-tired 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, on several steps:

- **Gen AI data strategy** including maturity assessment, roadmap definition, use case portfolio and target operating model design.
- **Gen AI based product development** with data acquisition strategy, data structuring text-embedding tokenization and training strategy.
- **Gen AI tech and backbone** encompassing design of technical stack, choice of partner, existing cloud landscape integration and MLOps practices on training.
- **Trusted Gen AI** 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** with re-engineering of business process around LLMs, workforce training on LLMs usage best practices, data scientist and engineers upskilling on NLP specific algorithm and LLMs implementation and change management.

GLOSSARY

AI	Artificial Intelligence
CAPEX	Capital expenditure
CSR	Clinical Study Reports
CT	Computed Tomography
GDPR	General Data Protection Regulation
GenAI	Generative AI
GPT	Generative Pre-trained Transformer
HCP	Healthcare Professional
EHR	Electronic Health Records
KG	Knowledge graph
KPIs	Key Performance Indicators
LCA	Life Cycle Analysis
LLM	Large Language Model
MLOps	Machine Learning Operations
MRI	Magnetic Resonance Imaging
MSL	Medical Science Liaison
NHCAA	The National Health Care Anti-Fraud Association
NHS	National Health Service
NLP	Natural Language Processing
PSUR	Periodic Safety Update Report
RMP	Risk Management Plans
TCR	T-cell receptors
TLFs	Tables, listings, and figures

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