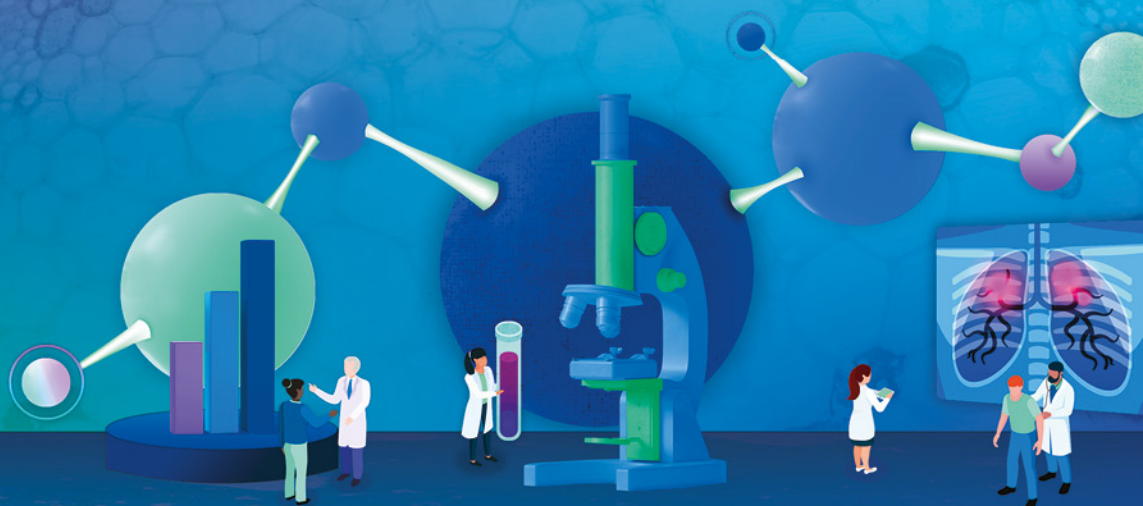


THE AI FOR HEALTH BOOK



2021

Foreword

In recent times we have seen that Artificial Intelligence (AI) is a strong lever to improve healthcare. To build trust and go beyond AI fantasies, we need to collectively learn and understand how it can be implemented to make real change happen on the ground. This starts by bringing together our health community around Data & AI.

After the success of the first edition, the *AI for Health Digital Book* is coming back this year to highlight **how health organizations perceive and apply data & AI** within their value chain and as an ecosystem. This **second edition** underlines evolutions of this fast-changing environment. This is why **Startup Inside** and **Capgemini** have brought their knowledge and passion to this 2021 exercise.

In parallel to the fourth edition of the «AI for Health Global Conference», held on November 17, 2021, this report gathers a large panel of **80+ respondents to an online survey**, along with **20+ deep-dive interviews** with «doers» that bring tangible impact in their respective domains. Key players from private companies (Pharma, MedTech, Start-ups, Insurances) and public institutions (Hospitals, Research Labs) contributed to share their views on the impact of data & AI in the ecosystem.

Similar to last year, the ambition of this work is to help stakeholders **better understand AI strategic stakes** and **main applications**, to get a grasp of the industry's **level of maturity**, while providing them with insights on the main **roadblocks**, **ethical considerations**, and **operating choices** they may face in their journey to implement AI use cases. It also introduces new deep-dive topics such as **patient expectations** regarding AI, **applications for smart Hospitals**, and the transformation of the **Research & Development** paradigm.

Health players are moving from **theory to practice**, deploying even more AI use cases. Along the way, they are making progress in unleashing the potential value of these applications but are starting to face new barriers, hindering delivery at scale. Beyond **feeding and shaking** this rich ecosystem, we see this report as a means for **regulators to respond to the needs and difficulties of stakeholders**, to ensure patients, practitioners, payers, and down the line, society as the whole, to get the most out of the on-going revolution.

We hope you will enjoy reading and using this report as much as we appreciated working on it.

Join us in shaping the future of AI for Health!



**Damien
Gromier**

Co Founder
& CEO

Startup Inside



**Charlotte
Pierron Perlès**

EVP Global Head of Insights
for Intelligent Industry

Capgemini Invent Global



**Stéphanie
Trang**

Managing Director
AI for Health

Startup Inside



**Barnabé
Lecouteux**

Principal Insights for
Intelligent Industry

Capgemini Invent France

Table of contents

●	Executive summary	P.8
---	--------------------------	-----

●	Objectives, methodology & panel	P.10-15
---	--	---------

	Study Objectives	P.10-11
--	------------------	---------

	Methodology	P.12-13
--	-------------	---------

	Study Panel	P.14-15
--	-------------	---------

● Key Learnings	P.16-75
AI strategy and operating model	P.16-35
AI maturity and use-cases	P.36-57
Limits and ethics	P.58-67
Technological choices	P.68-75
● Perspectives from AI doers	P.76-115
Hospital	P.78-85
Research Lab	P.86-87
Insurance	P.88-89
Pharma	P.90-101
MedTech	P.102-103
Startup	P.104-115
● Acknowledgements	P.116-117

Executive Summary



Data & AI come as **high priorities for CEOs and C-level executives** (3/4 on average). Like in 2020, executives appear **mildly acculturated** to data and AI (2.5/4), especially within Pharmas and Research labs. Most private companies within the panel declare having a dedicated department for data, AI and innovation (100% of MedTechs, 86% of Pharmas). Specific roles to steer AI roadmaps exist but are still too far from executive committees.

The overall perception of **medium maturity** regarding data & AI hides **heterogeneities**: Start-ups and Scale-ups still view themselves as highly mature while Pharma companies, Hospitals and Research labs consider their maturity to be lower. Start-ups also show a **greater confidence in their ability to scale fast** (3.4/4), while Pharmas and Research labs seem more doubtful (resp. 2.4/4 and 2/4).

Data scientists and **data engineers** remain the most represented profiles within data teams, followed by product owners, data managers/architects (for non-Start-up companies) and front-end developers (for Start-ups).

Healthcare organizations continue to leverage AI to **deliver better care for patients** (77% – key for Hospitals, Start-ups, Pharmas and MedTechs), and to **enhance patient & Healthcare practitioner (HCP) satisfaction** (51% – key for Pharmas & MedTechs). Most of them (63%) adopt a **user-centric approach** to build their AI use cases.

The proportion of healthcare players working on AI use cases has increased compared to last year. Perceived value from these use cases generally increased, while perceived accessibility remained stable. Applications fall into three main value chains:

- **Pharma and MedTech:** AI to accelerate drug/device R&D and improve product life-cycle management.
- **Hospital management:** AI to improve care management, improve patient flows and better allocate resources.
- **Risk management:** AI for risk-based patient monitoring, claims & payments management and customer services.

We also notice that a perception shift is under way in the sector. Indeed, as their engagement in AI projects increase, healthcare players start to face **more difficulties**: on average, the listed roadblocks were considered at 67% as barriers, up from 50% in 2020. **Data quality and accessibility is still the main concern** (a barrier for 90% of the panel), but **lack of budget and difficulties to drive change** also arise as issues, depending on the players.

Privacy dimensions are now systematically taken into consideration by most actors (81%). Issues of **explainability, fairness, and acceptance** of AI also seem to have become **harder to deal with** than in 2020 but are not considered systematically in projects for the moment, in a context in which those dimensions are not yet well defined by regulators.

Data sovereignty is an important topic for most players (94%) and seems to be of particular importance to Hospitals and MedTech companies that are directly exposed to the topic due to their position as data producers.

From a technical standpoint, **data cleaning and storage** concentrates the most effort (60% of the players). **Machine learning/deep learning** and **data visualization** seem to be widely used across the board (resp. 90% and 80%) while novel techniques like **Natural Language Processing (NLP)** drive more and more use cases. **Quantum computing** looks like a longer shot for the industry.

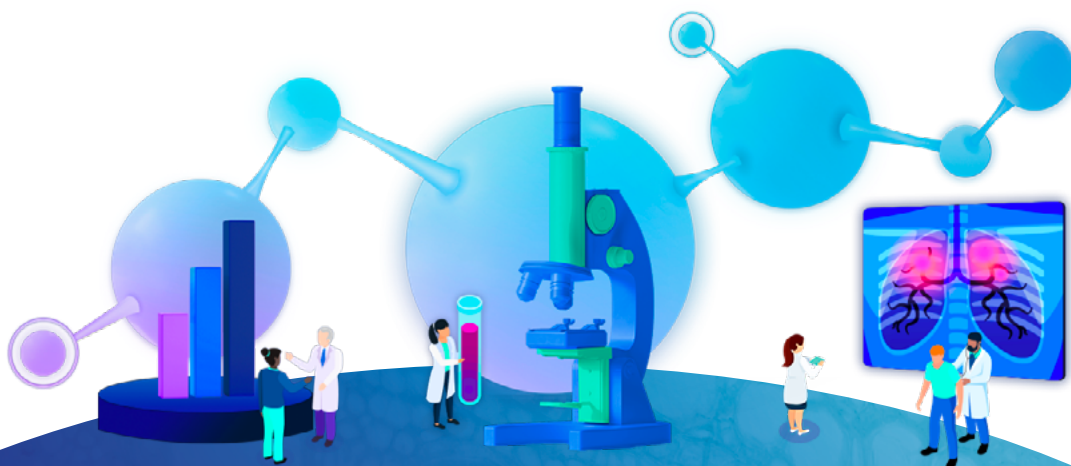
Collaboration with cloud providers is generally adopted or planned (69%). Regarding partnerships, 80% of the panel declared relying at least sometimes on these. **Scientific collaborations** with academics are the most common (70%). When it comes to tech partnerships, **Pharma and Research labs are more prone to partner with tech giants** (resp. 72% and 63% declare working at least “sometimes” with them).

Finally, we notice that **doctors and patients begin to find their way to a modus vivendi with AI**. For doctors, it translates into AI becoming a friendly companion so that they feel more confident to deliver a qualitative care, while patients on their side would need trust in their doctors and in the system to share their data for their personal benefit and for the broader community.

Study Objectives

SCOPE AND INTENT OF THE 2021 AI FOR HEALTH BOOK

Artificial Intelligence (AI) is defined as the attempt to replicate human cognitive capabilities through advanced technology, and to reach goals in an autonomous way by considering constraints and obstacles of the environment.



AI for Health refers here to **data and AI issues** aiming to **transform the healthcare sector** through use cases development and deployment. Therefore, not only does this study comprise **AI use cases**, but it also considers **data services and use cases**.

As with the 2020 edition, the aim of this book is to provide a **system-wide view** of how data and AI are being used today in the healthcare sector at large. It also highlights **opportunities** for greater use and **barriers** to further adoption.

The following key items of AI development in healthcare are covered:

- **AI strategy and operating model**
- **AI maturity and use cases**
- **Limits and Ethics**
- **Technological choices**

It also encompasses key players involved in the development of AI for Health:

- **Pharma and biotech companies**
- **MedTech companies**
- **Start-ups**
- **Insurance companies**
- **Hospitals**
- **Research labs**

This second edition also provides additional deep-dives on tangible use cases and compares with the results of the previous edition.

Methodology

THEMES



AI strategy & operating model

Strategies and operating models related to AI for Health implementation and development



AI maturity & use-cases

Maturity KPIs and segmentation, use cases of interest (today and tomorrow) in AI for Health



Limits and Ethics

Roadblocks to greater development of AI in healthcare, focus on privacy and ethics considerations



Technological choices

Infrastructure and solutions to support data ingestion, storage, cleansing, algorithm build and visualization

Types of organizations

- Pharma companies
- MedTech companies
- Start-ups specialized in AI for health solutions
- Insurance companies
- Hospitals
- Research labs
- Patient organization

Method

Quantitative online survey with 83 respondents
1.5-hour interviews with 22 key opinion leaders & doers from the AI for Health ecosystem

Interviewee profiles

- CEO
- Chief Data Officer
- Chief Scientific Officer
- Chief of Innovation
- Hospital Department Lead

FOCUS ON USE CASES OF INTEREST



What's in it for the patient ?

Data, Digital and AI use cases with a direct impact on patients care and quality of life across the whole patient journey

TOPICS

- Patients' expectations vis à vis of AI
- Digital health
- Chronic disease monitoring
- Early disease diagnosis
- Telemedicine / virtual care
- Personalized medicine
- Minimally invasive devices
- Data & health Insurance policies

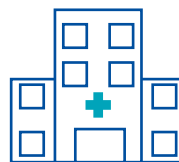


R&D and Real-world Data

Data driven research and development of new molecular entities for new indications

TOPICS

- AI-based drug discovery (target identification / validation, lead identification / optimization)
- Future of clinical trials (decentralized trial, « intelligent » trial » from design to execution)
- Real world data: generation / evidence



Smart Hospitals

Use cases focused on technically augmenting care organization and optimizing resources in Hospitals

TOPICS

- Care organization (resources management)
- Smart imaging
- Surgery
- Emergency room
- Ambulatory care
- Medical devices management (tracking, maintenance)

Study panel

This study is based on insights provided by 83 respondents to an open online survey, together with deep-dive discussions conducted through 22 one-to-one interviews.

RESPONDENTS TO THE ONLINE SURVEY

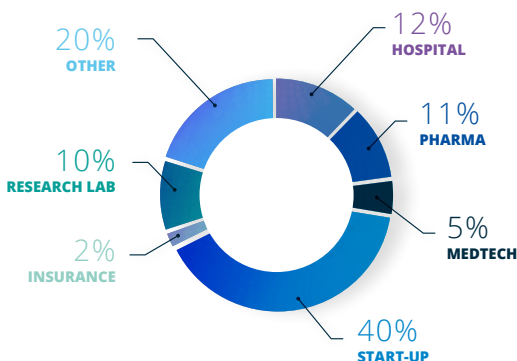
83 survey respondents

77 companies surveyed

Scope



Categories (n=83)



Size (n=83)



INTERVIEW PANEL



KEY LEARNING

AI strategy & Operating model

This first section provides insights on how healthcare players get structured to tackle AI projects.

Because they are prerequisites for effective AI delivery, primary focus is given to the level of executive engagement and acculturation regarding Data & AI, as well as to the presence of dedicated roles and departments. Then, we try to better understand their strategy: what are their business priorities? Do they partner with external actors? Do they prioritize usage over technology? How can patients benefit concretely from the AI revolution?

A specific focus will be put on Startups to provide a detailed view of their different business strategies.

Finally, the variety of Data & AI profiles across health organizations will be analyzed.





AI STRATEGY & OPERATING MODEL

KEY TAKE-AWAYS

1

Level of executive engagement & acculturation

AI comes as a high priority for CEOs and C-level executives (3/4 on average). The priority level correlates with the acculturation of executives. Like in 2020, executives are mildly acculturated (2.5/4), with Pharmas and research labs lagging behind (resp. 2.2/4 and 2/4). Yet only 57% of respondents have launched acculturation initiatives around data and AI.

2

AI leadership

Most private organizations claim to have roles to steer their AI roadmaps (100% of MedTechs, 53% of Pharmas), together with departments dedicated to data, AI and Innovation (100% MedTechs, 86% of Pharmas). But Data & AI topics are still not steered at top management level, with only 29% of AI champions being ExCo members.

3

Business priorities

Providing better care delivery comes first for most of the panel (77%), especially for hospitals (90%), start-ups (85%), Pharma and MedTechs (77%). Enhancing patient and HCP satisfaction comes second.

4

Partnerships

The vast majority of respondents (80%) say they [rely at least sometimes on partnerships](#) to deliver Data & AI use cases. Pharma companies are more likely to work with external actors (63% work often with them). [Scientific partnerships with academics prevail in the ecosystem](#) (70%) whether it is for private organizations or research labs themselves.

5

Usage-centric vs techno centric

Organizations tend to [usage-centric](#) approaches to build their AI use-cases (63%). However, pharma, insurances and large companies still declare to have a significant number of techno-centric projects (43%, 50% and 50% respectively).

6

Business model focus on start-ups

Start-ups in the panel go for [SaaS and PaaS service models](#) (70%). They tend to address major private companies (64%) and public sector organizations (61%) as their main clients.

7

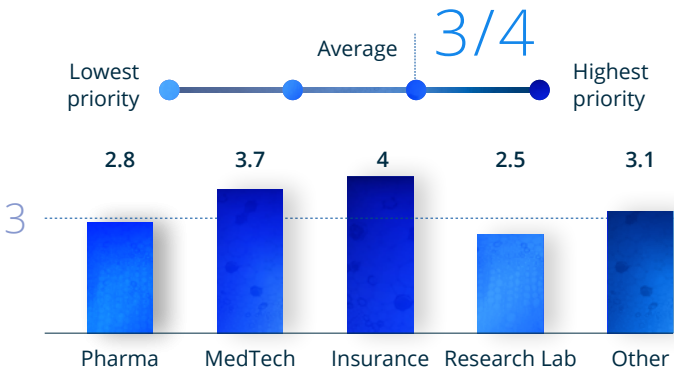
Profiles

Unsurprisingly, [data scientists](#) and [data engineers](#) are revealed to be the most represented profiles among data teams : resp. 80% and 55% declared hiring such profiles. On their side, [Start-ups focus on building full-stack teams](#) while [large companies prefer to hire data expert profiles](#) to help manage organizational complexity.

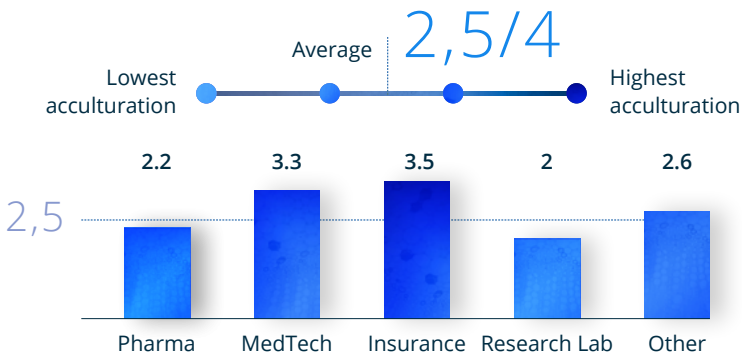
Level of Executive engagement and Acculturation

AI is recognized as a strategic priority by executives. This recognition is correlated with the level of acculturation of executives, which still suffer from a lack initiatives.

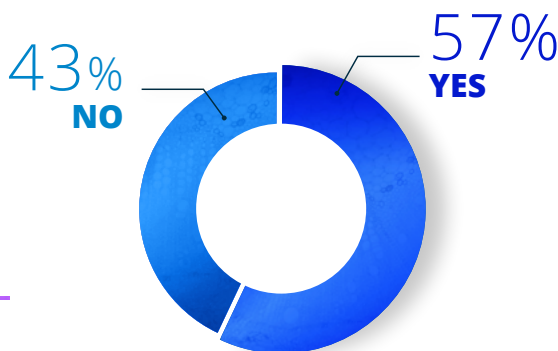
On a scale from 1 to 4, would you say that AI is considered as a strategic priority for your CEO and other C-level executives?



On a scale from 1 to 4, how would you evaluate the current data and AI acculturation of your executives (ExCo & C-level)?



Did you launch any initiative to secure your executives' acculturation? (acculturation plan, training, reverse mentoring, data university/MOOCs...)?



Based on a set of 28 respondents (incl. 7 Pharma companies, 3 MedTech companies, 2 insurance companies, 6 research labs, and 10 others).

AI is identified as a strategic priority

Among CEOs and other C-level executives, AI is considered a strategic priority with an average of 3/4 over the respondents. AI tends to be less of a priority for executives in Pharma companies (2.8/4) and research labs (2.5/4), which may see less direct return on investment from AI use cases than MedTech (3.7) and Insurance (4/4) companies.

We observe that the level of AI acculturation of executives correlates with their sense of strategic priority for the subject.

Intermediate level of acculturation from executives

With an average level of acculturation of 2.5/4, executives seem to remain partially aware of AI topics. Again, acculturation tends to be lower for executives from Pharmas (who might need it) and Research labs (who might not need it).

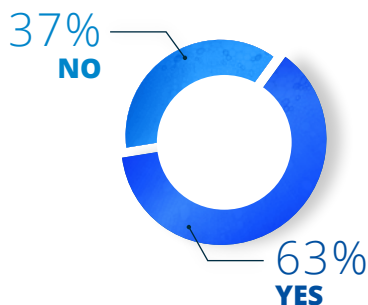
Relatively limited number of initiatives launched

Despite an intermediate level of AI acculturation, only 57% of the respondents declare having launched initiatives.

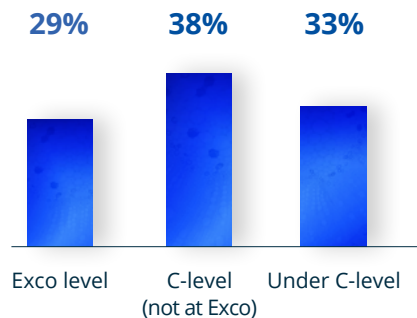
AI leadership

Private organizations have started to define roles and departments in charge of data, AI and innovation, but stakeholders have still to find their way up to the Exco.

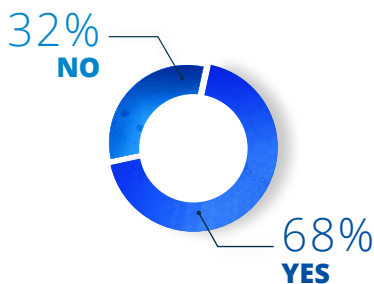
Is there one (or two) dedicated role(s) in your organization to steer data & AI roadmap?



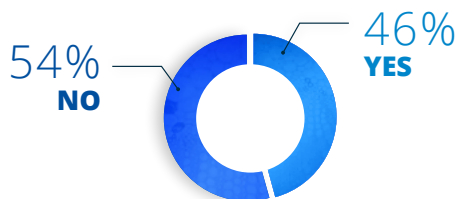
If yes, where is she/he positioned in the organization?



Do you have a dedicated department and / or team in charge of data, AI & innovation ?



Have you set up an organization to collect, qualify and prioritize the use cases ("demand management")?



Based on a set of 28 respondents (incl. 7 Pharma companies, 3 MedTech companies, 2 Insurance companies, 6 research labs, and 10 others)

AI-dedicated roles exist but their presence differs between private companies & research labs

Across 2/3 of the panel, we observe dedicated roles for data, AI and innovation. Private companies usually have such roles in place (Pharma 53%, Insurance and MedTech 100% of respondents). However, academics tend not to have one (37% of Research labs).

AI roles are still far from the decision center

Executive committee members steering data and AI roadmaps only account for a third of responding organizations. Data & AI representatives are still mostly positioned at C-level (38%) or under C-level (33%).

Having a department dedicated to AI is commonplace among private companies

86% of Pharmas respondents and 100% of MedTech respondents have such departments in place. On the contrary, Research labs tend not to have such department (33% answering yes).

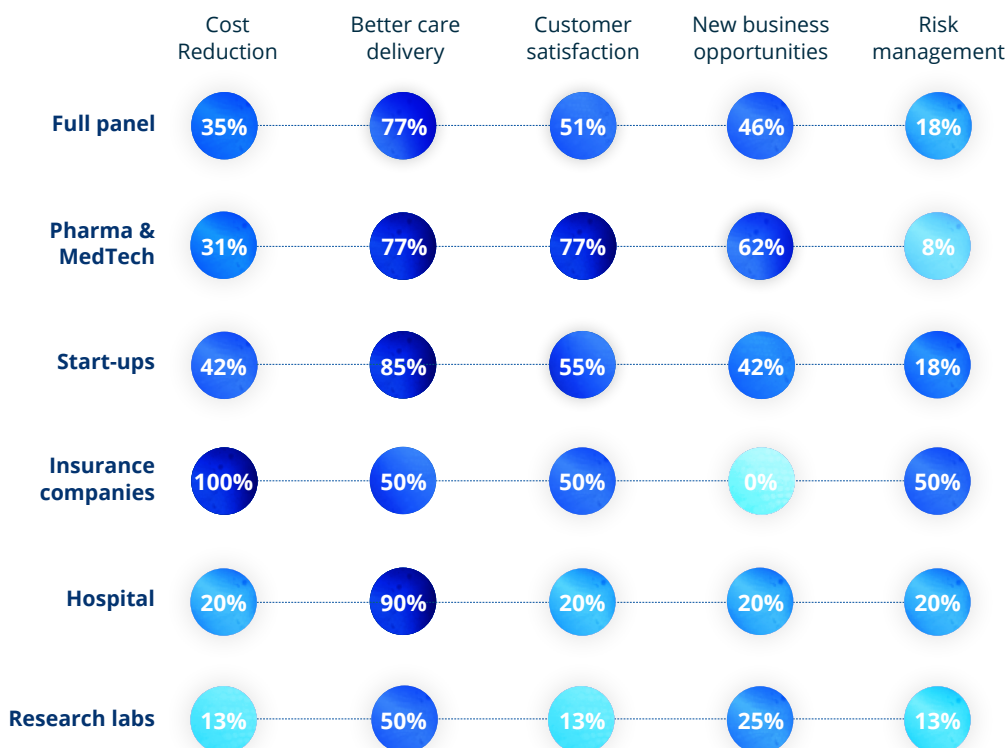
Half of the respondents have engaged in demand management

Nearly half of the respondents have set up a «demand management» process to identify and qualify use cases. We also observe a negative correlation between the size of the company and the presence of a demand management process.

Business priorities

Providing better care and enhancing patient and HCP satisfaction come on top of the agenda.

What are the main business objectives of the projects/products you deliver?



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)

Improving care delivery is a primary business objective

Delivering better care is cited as a main business objective for most respondents (77% of the panel, up from 68% in 2020), with a very strong proportion for Hospitals (90%), Start-ups (85%) and Pharma and MedTech respondents (77%).

Customer satisfaction seems a medium to high priority

Patients and HCP satisfaction is logically a top priority for private companies' respondents, especially Pharma and MedTech (77%). It comes as a low priority in the public sector (Hospitals and Research labs), as they are not incentivized for that.

New business opportunities

Pharmas are the sole category to really engage in exploring new business opportunities, as the era of blockbuster drugs is fading away while and new beyond the pill models starts to pay off.

Cost reduction appears to be a priority for Insurances

Both insurance respondents cited cost reduction as a main objective for their AI projects.

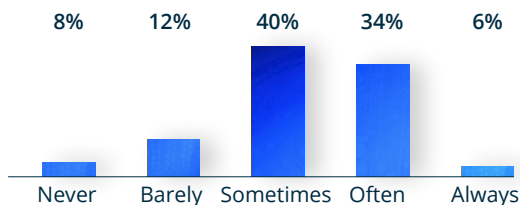
Risk management not prioritized

Risk management was this year was again not identified as a priority topic.

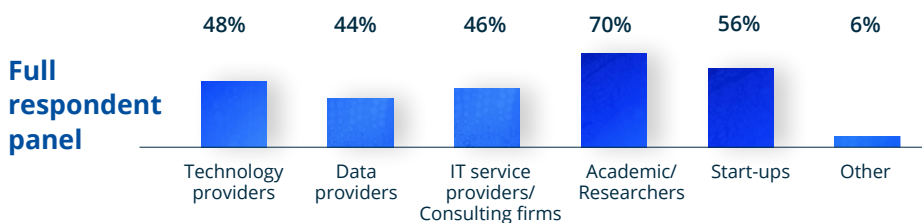
Partnerships

Collaboration is frequent in the ecosystem, with a focus on scientific partnerships.

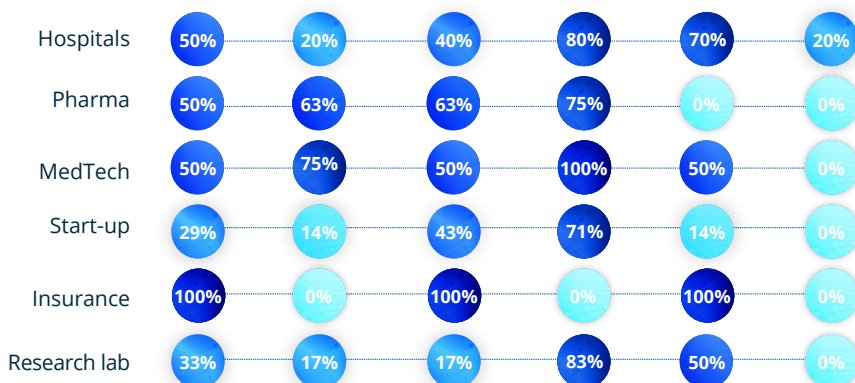
Do you work with external actors to deliver data / AI use cases?



If yes, with which actors?



Split by category



Based on a set of 50 respondents (incl. 7 start-ups, 8 Pharmas, 4 MedTech companies, 2 Insurances, 6 research labs, 10 Hospitals, and 13 others)

Collaboration is frequent in the ecosystem

Most of the panel (80%) declare relying on partnerships at least sometimes to deliver data use cases, and 40% answer doing so often or always.

Pharma respondents in particular show a high interest in building partnerships (63% often work with external actors), as do Hospitals (40%). Only 25% of MedTech respondents declare collaborating « often », which tends to show a greater level of independence.

Start-ups seem to rely less on partnerships for delivery

Among Start-up respondents, 43% declared working « barely » with external actors for use case delivery, and the rest only « sometimes ». Indeed, Start-ups / Scale-ups specialized in developing AI products may have more expertise to deliver use cases autonomously as part of their *raison d'être*.

Prevalence of scientific partnerships

Collaboration with academic/research is the top source of partnerships for MedTech (100%) and Start-ups (71%), but also for Hospitals (80%) and Research labs (83%) themselves.

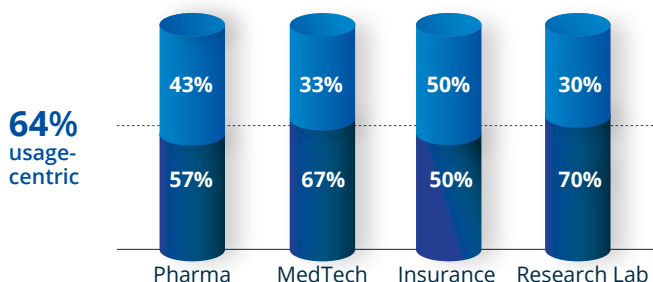
Pharma tends to partner more with Start-ups (75%) but seem also happy to engage with other actors like IT & Data providers (63% each).

Usage-centric vs Technology-centric

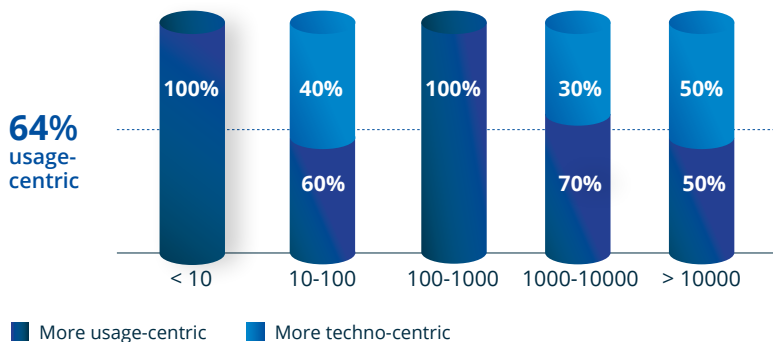
Usage-centric approaches prevail over techno-centric approaches, with Pharma, Insurance and large companies lagging behind.

Do you consider that you adopt usage-centric approaches when delivering your use cases? (vs. more technology-centric approaches)?

Split by category



Split by size



Based on a set of 22 respondents (incl. 7 Pharma companies, 3 MedTech companies, 2 Insurance companies, and 10 others)

Pharma and MedTech companies focus more on usage-centric approaches

Among the panel, MedTechs seem to be the most usage-centric companies (67%), i.e. 10 points beyond Pharmas (57%). Insurance companies, at 50%, are halfway between usage and technology.

Usage centrality erodes with size

Usage-centric approaches are unanimously preferred in very small companies (<10 FTEs) together with scale-ups (100-1000 FTEs). When growing, companies seem to rebalance techno-centricity over usage centrality (17 pts of difference between 1000-10000 FTEs and >10000 FTEs).

PATIENT EXPECTATIONS



Patient apprehensions about the use of artificial intelligence in healthcare, Nature, 2018

Abstract (full study)

"Few research studies have sought to assess patient perspectives on these technologies. [...] Patients have multiple concerns, including concerns related to the **safety of AI**, threats to **patient choice**, potential increases in **healthcare costs**, data-source **bias**, and **data security**. [...] Patient acceptance of AI is contingent on mitigating these possible harms. **Proactively addressing these concerns** is critical for the flourishing of ethical innovation and ensuring the long-term success of AI applications in healthcare."



So when this intelligence is built we have to test it, right? We have to test it to make sure that it's helping correctly, We've gotta be very careful there.



What's in for the patient ?

STRATEGIC DEEP-DIVE

#1 Patient expectations and their impact on relationship patient / HCP

Patient do not voice expectation on the topic as long as they keep trust in the system, with privacy in particular. COVID 19 acted as a catalyst bringing awareness on data and AI usefulness. Adopting AI solution does not seem to impact the patient/HCP relationship and HCP will prevail as ultimate accountability owner. HCP with the proper understanding of tools and techniques will certainly improve their medical practice (esp. in radiology).

“ We saw in 2020 the power of data to save lives. ”

Department of Health and Social Care (2021)

“ We must unleash the creation of value without compromising on confidentiality of data due to the citizen. ”

Pierre-Antoine Gourraud,
Pr. at University of Nantes (France)

#2 Digital health

Digital health, defined as technologies, platforms, and systems that engage patients and HCPs for wellness and health-related purposes is considered a key priority for all Pharmas. Nonetheless, the vision has not been defined yet and moving beyond the POC stage is the next step ahead. For start-ups operating in that field, Digital health plays a central role, and they act as an ecosystem catalyst.

30%

65 + in 2050
vs 20% in 2019
(EU-27, Eurostat)

10

start-ups
supported for 1 year
by InnoVaccins



#3 Early diagnosis and monitoring

Oncology patients are benefiting the most from the progress of medical imaging and tracking of vital signs. More broadly, chronic conditions monitoring, post transplantation, and post acute follow-up are enhanced by the use of AI (esp. cardiology and neurology).

Biomarker approaches and genomic sequencing pave new ways for a more personalized care.



CE marked class I software medical device (class I), allowing remote monitoring and optimization of the management of complex chronic pathologies, foremost among which is cancer.

#4 Personalized medicine

With no doubt, personalized medicine, defined as the possibility to adjust care (drug, digital health, human digital twin) to patient sub-groups down to unique patients is now a key stake. Patient, recruitment can sometimes be a barrier.



Personalized physiological model of the patient heart at similar dimensions, electrical and muscular activity, fluids dynamics

#5 Telemedicine / Tele-expertise

With COVID-19 and the surge of telemedicine, we entered a new era. It would be particularly relevant for rapid and systematic visits (e.g. drug refill). Tele-expertise (i.e. interaction with HCP) is particularly useful in areas like radiology or resuscitation. With digital, HCP can focus on what matters the most - patient care.

“ **Telemedicine changed my life. I have managed to reduce by two-fold the burden of physical visits to the doctors.** ”

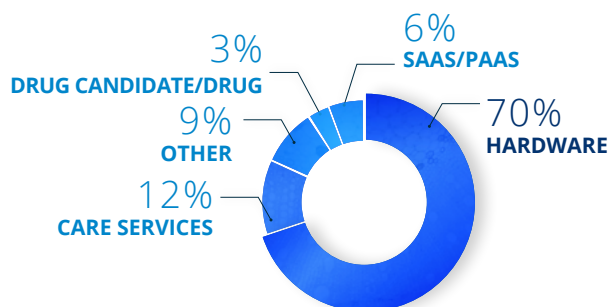
Patient expert, 3 times under cancer

Business model

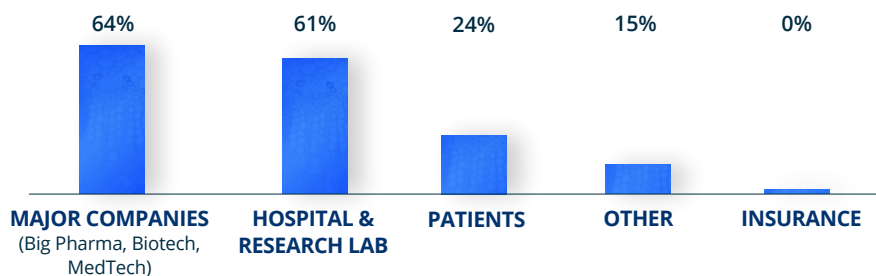
focus on Start-ups

Start-ups go for SaaS and PaaS service models, addressing major private companies and the public sector as main clients.

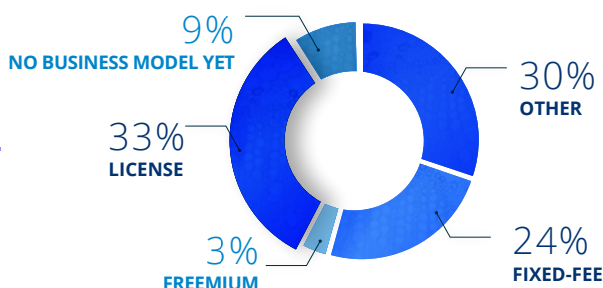
How would you define the product or service you are developing/selling?



Who are your main type(s) of clients / prospects?



What is your business model?



Based on a set of 33 respondents (incl. 26 start-ups, 1 research lab, 1 Pharma, and 4 other)

A large majority of service providers

Most of the Start-up respondents to this survey (70%) declare that they are selling or developing a Software/Platform as a service (SaaS/PaaS).

Targeting major companies and public institutions

Most respondents target either big companies (64%) or hospitals and research labs (61%), while direct to patient businesses are far less represented in the panel (24%).

Business models vary depending on the product

Overall, we see that license-based models and fixed-fee models stand out. PaaS vendors mostly adopt license models (67%) while software vendors are more diverse (43% selected fixed-fee and 21% a license model).

A third of the respondents also declared having other, possibly more complex, types of business model.

BUSINESS MODEL ILLUSTRATION



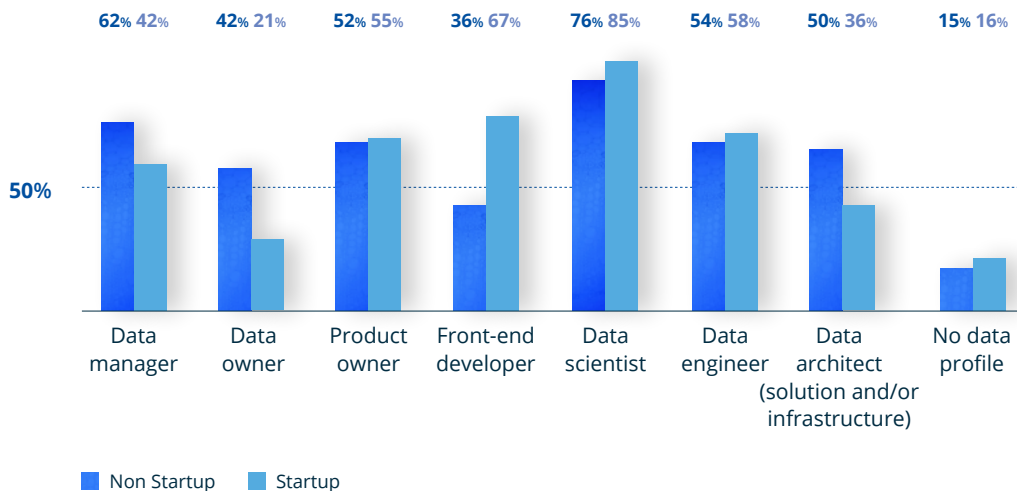
Lifen provides digital solutions (both software & platform) to allow healthcare professionals and developers to instantly access relevant medical data. The company leverages AI to analyze millions of medical documents and making them available through third party apps for doctors and hospital staff.

“ Lifen works with **570 Hospitals** and clinics gathering **240.000 doctors** and handling more than **2 million medical documents** per month. ”

Profiles

Data scientists and data engineers are still positioned as must-have profiles across all organizations, as large organizations open new roles to cope with complexity.

Do you have the following profiles in your data department (if applicable)?



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others).

Data scientists and data engineers continue to be central to data departments

Unsurprisingly, data scientists (80%) and data engineers (55%) are the most represented profiles, with no surprise. Data manager (54%) come right after a rising interest around data governance and data management considerations. The coverage was similar in 2020. Interestingly, the product owner (53%) representation is decreasing vs. 2020 (68%). Data architects (45%) and Data owners (34%) are more scarce resources across organizations. Only a very limited portion (16%) of the panel does not have a data profile at all, probably due to externalization.

Full stack integration for Start-ups, roles to scope with complexity for bigger structures

Start-up respondents appear to integrate all the stacks from back-end (58% hire data engineers) to model (85% data scientists) and front-end (67% have front-end developers). This allows small structures to rely on integrated teams to build end-to-end applications. On the other hand, Start-ups tend to have less profiles focused on infrastructure, data management, data ownership and architecture than non-Start-up. As for infrastructure, we assume that it is because it is considered noncore. As for data management, data ownership and architecture, the lower complexity of organizations, functional and technical scope may account for this gap.

KEY LEARNING

AI maturity & Use cases

Defining a strategy and operating model to deliver use cases is one thing, getting it done is another.

In this section we go from theory to practice. First, by decoding the patterns of maturity of respondents regarding AI. Then, we analyze the activity, perceived value and accessibility of the use cases presented for different value chains: Pharma/MedTech, Hospitals, and Risk Management. We provide a hands-on deep dive on R&D and Real-World Data together with some illustrations of Smart Hospital.

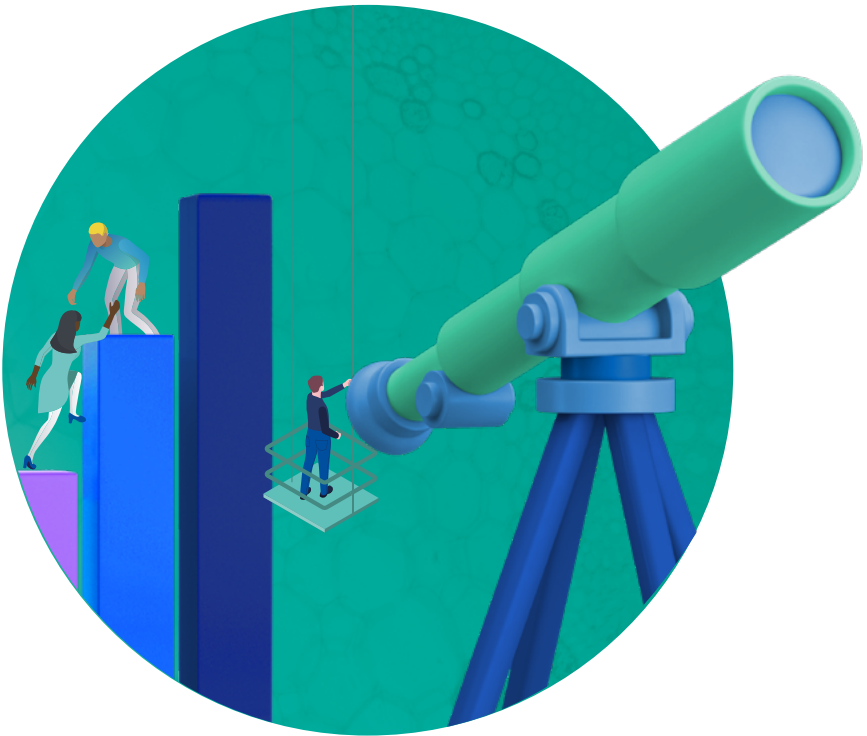
The capacity to bring AI projects into production is becoming critical, which is why we eventually detail the respondents' perceived capacity to scale-up AI projects.





AI MATURITY AND USE CASES

KEY TAKE-AWAYS



1

AI maturity

Perception of maturity regarding data & AI subjects is still medium (2.8/4 on average) hiding heterogeneity across the panel. Indeed, Pharmas, research labs and Hospitals consider their maturity to be low (resp. 2.3/4, 2.5/4 and 2.7/4) while Start-ups/Scale-ups evaluate themselves as highly mature (3.3 and 3.6 respectively).

2

Use cases of interest

Pharma and MedTech value chain

2021 has seen a greater activity in the delivery of use cases vs 2020, with a particular focus on drug/device development (83%). Perceived value is generally increasing and remains high for epidemiology and R&D use cases, while perceived accessibility remains stable compared to 2020.

Hospital value chain

Efficient management of patient flows and resources appear to be prioritized. Respondents unanimously declare working on care management use cases (91%), which seem to hold high value (77%) and to be accessible (68%). Surgery related use cases also hold great promises (valuable for 50% of respondents) but seem difficult to access and therefore currently represent a small proportion of use cases as of now.

Risk management value chain

Population health management is considered by far the most valuable application (86% of respondents) but is still difficult to access. Although more use cases around claims and payments and customer services, seem under way this year, respondents claimed to have greater difficulties to deliver.

3

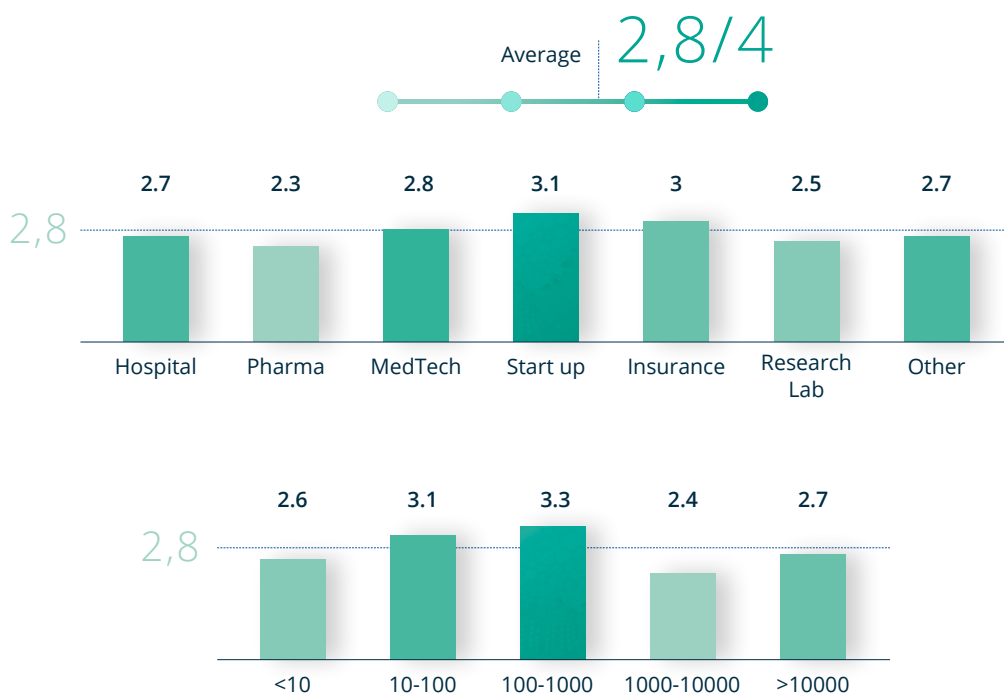
Ability to scale

Pharmas are still doubtful on their capacity to scale up fast (2.4/4) while other players (be it private or public) feel more confident. Start-ups and insurances companies show the greatest confidence with respectively 3.4/4 and 3.5/4.

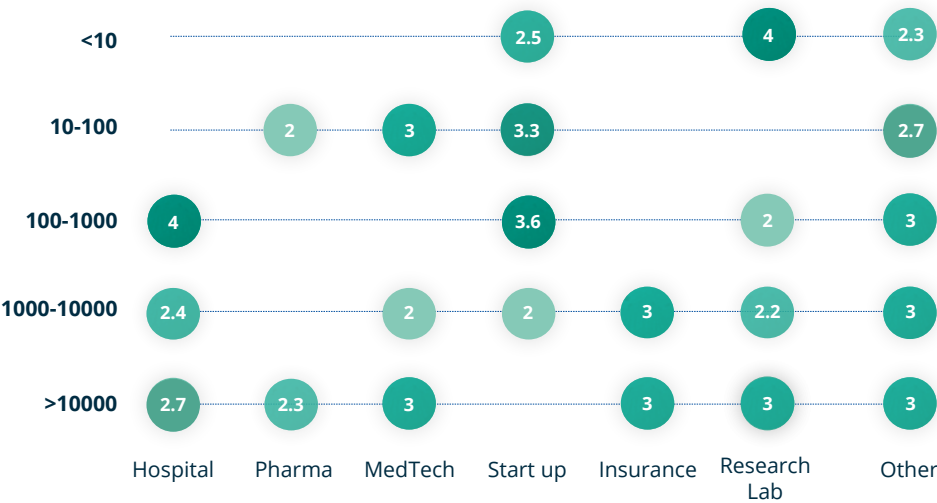
Perception of data and AI maturity

Overall perception of a medium maturity, with significant discrepancies between Pharma (low) and Start-up / Scale-up (high).

How would you evaluate the current data and AI maturity of your organization? (number of initiatives, acculturation of business and IT, robustness of data organization, data and AI technological capabilities...)



Average maturity by company category & size



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)



Medium maturity regarding AI

On average, respondents evaluate the maturity of their company as medium+ (2.8/4), a figure that hides discrepancies depending on an organizations profiles and size.

Start-ups consider themselves as mature

Respondents from mid-size (10-100 FTEs) to Scale-ups (100-1000 FTEs) tend to show a high level of maturity (3.3/4 and 3.6/4 respectively). Indeed, as the company grows, so is its experience on technical foundations and use cases delivery, which reinforces the sense of maturity. On the contrary, small Start-ups with less than 10 FTEs tend to be younger and have less visibility, hence the medium level of maturity (2.5/4).

Pharma, research labs and Hospitals seem slightly less mature

With an average maturity of 2.3, Pharma respondents evaluate their companies' maturity as the lowest within the panel, surprisingly behind Hospitals at 2.7/4. Research labs auto-evaluate themselves probably as with high standards at 2.5/4.

MedTech companies appear more mature than Pharma, data and AI being closer to their value chain.

As for Insurance companies, maturity seems quite advanced, but the size of the panel does not allow for the drawing of solid conclusions.

Maturity steps

Mature players show that top executive engagement and return on experience are key differentiators.



Learners

Learners are in the early stages of their AI journey, with first use cases launched in production, at best. They are in majority small companies but are in fact a very heterogeneous group. They generally feel over-confident in their AI capacities, as they may experience the early excitement of first working projects.



In transition

In transition respondents have set up core capabilities to deliver AI-powered projects. As they try to bring more use cases to production they experience more setbacks, which may alter the confidence in their capacity scaling-up. Most Pharma respondents seem to belong to that category.

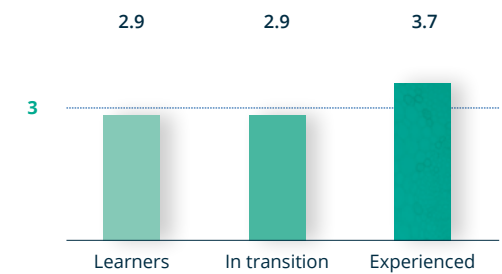


Experienced

Experienced are able to roll out a constant flow of AI-powered projects, with a capacity to bring them to industrial level. They have executives steering up AI roadmaps and tend to rely a lot on cloud providers. They plan to bring more use case. Small companies (10-100 FTEs) account for the major part of this category.

Experienced companies show a higher level of executive engagement

On a scale from 1 to 4, would you say AI is considered a strategic priority for your CEO & other C-level executives?

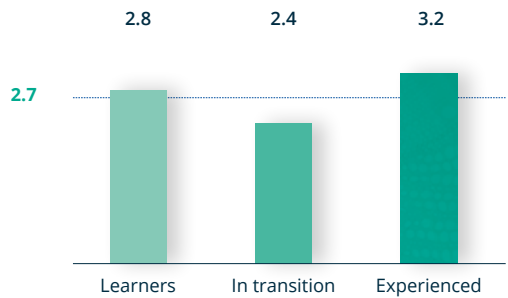


Based on a set of 28 respondents (incl. 7 Pharma companies, 3 MedTech companies, 2 Insurance companies, 6 research labs, and 10 others)

Executives from experienced companies seem to put AI as a higher priority than those from learners and in-transition companies (3.7/4 on average for experienced resp.). They also show a greater proportion of dedicated AI representative role (90% of experienced resp. vs 69% of In transition resp. and 40% of learners), with these roles being positioned closer to Exco levels (44% vs. 27% for in-transition and 33% for learners).

Confidence in scaling up

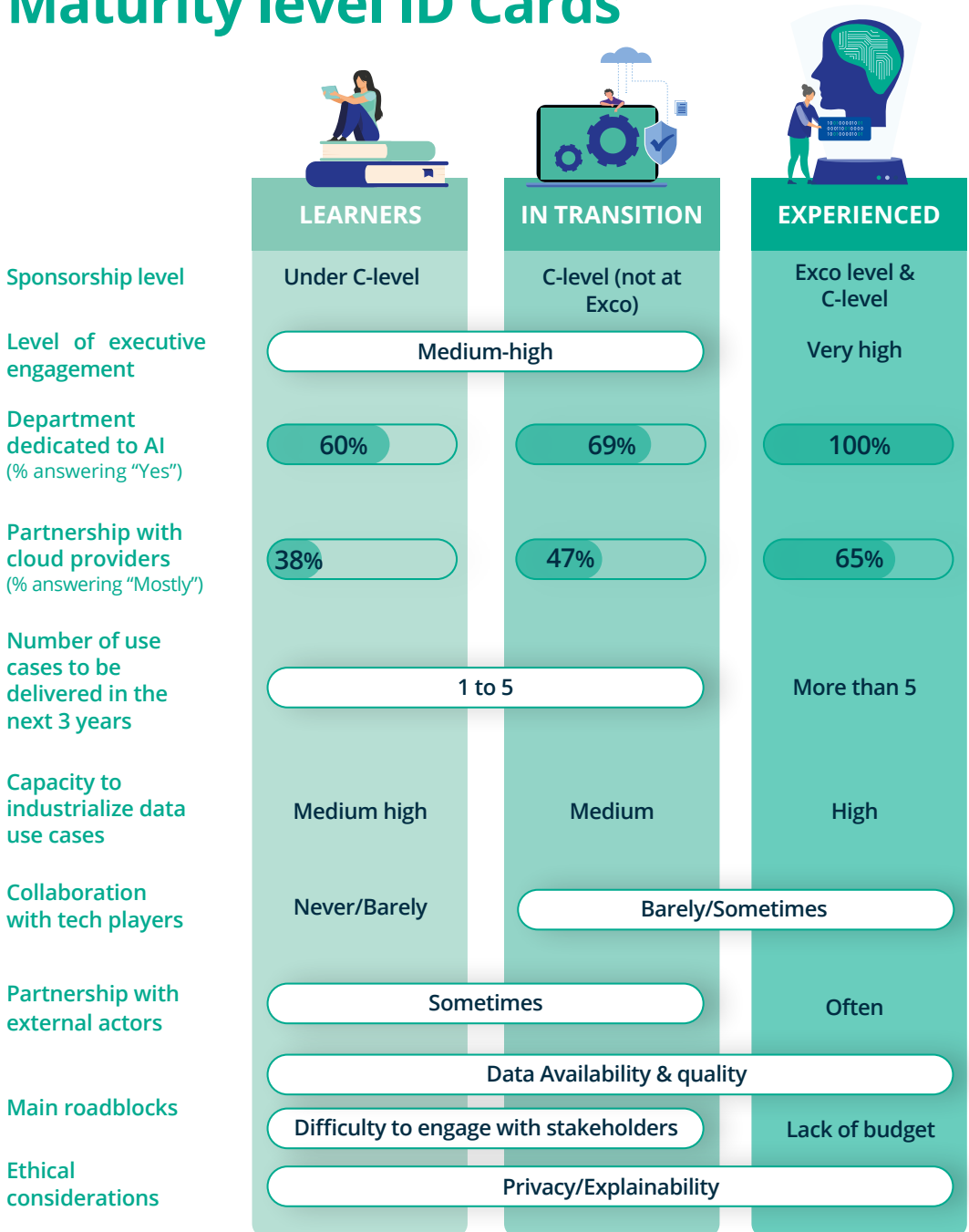
Evaluate on a scale from 1 to 4 your organization's capacity to scale-up (cf. page ...)



Based on a set of 36 respondents (incl. 7 start-ups, 7 Pharmas, 3 MedTech companies, 2 Insurances, 6 research labs, 1 Hospital, and 10 others)

The Learners have more confidence in their ability to scale up than In transition players do (2.8 vs. 2.4 respectively). One reason could be that companies in transition experience setbacks that learners have not yet encountered, which may alter their confidence. Experienced players feel even more confident when scaling up (3.2/4 on average), as they probably already went through these difficulties over the years and brought several use cases into production.

Maturity level ID Cards

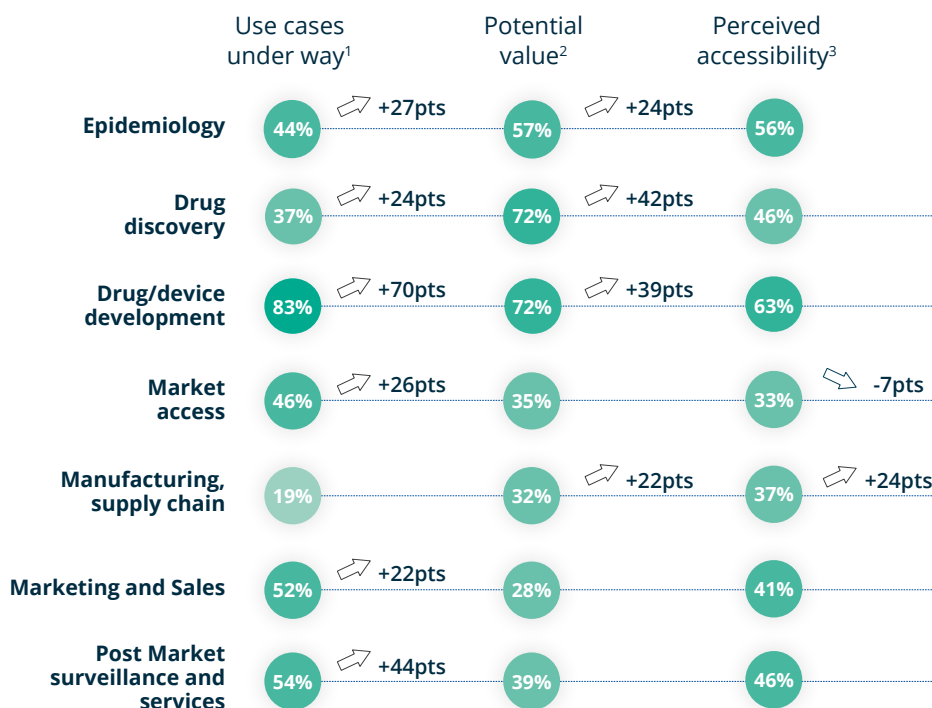


Use cases of interest

Pharma/MedTech

Greater activity of use cases delivery vs. 2020, especially in epidemiology and R&D, with higher perceived value and stable accessibility.

Macro repartition of uses cases currently under way, their potential value, and their perceived accessibility



Variation in percentage points versus AI for Health 2020

↗ Increase vs 2020 ↘ Decrease vs 2020

Based on a set of 54 respondents (incl. 25 start-ups, 9 Pharmas, 3 MedTech companies, 1 Insurance, 4 research labs, 3 Hospitals and 9 others)

¹ % of companies with 'some projects' and 'many projects'

² % of companies rating as 'rather high value'

³ % of companies rating as 'rather accessible'

More use cases under way in 2021

Compared to 2020, the proportion of this year's respondents declaring having AI use cases under way at least doubled for all types of use cases. Drug/device development and post-market surveillance and services show the greatest take off with respectively +70 pts and +44 pts, showing a growing interest for data-driven clinical trials. Epidemiology, drug discovery, market access and marketing and sales all took 20+ pts vs. 2020.

High value & high accessibility for epidemiology and R&D use cases

AI use cases for drug discovery (e.g. lead/target identification), drug/device development (e.g. clinical trial recruitment, trial design) and epidemiology stand out in terms of perceived value and accessibility. This is in line with the results of the 2020 study.

Less perceived value on other use cases in the Pharma / MedTech value chain

Market access shows stability in terms of value and accessibility vs. 2020. On marketing, sales and post market surveillance, use cases are perceived intermediate in terms of accessibility with lower perceived value vs. epidemiology and R&D.

As in 2020, manufacturing and supply chain use cases are not under the spotlights in the surveyed panel, hence results have to be taken into consideration with caution. Nevertheless, we observe an increase in both value and accessibility vs. 2020.

R&D and Real-world Data

STRATEGIC DEEP-DIVE

#1 AI-based drug discovery

Thanks to unprecedented computing power and immense data libraries, AI is becoming a strong support for the research of targets and leads that happen more and more in silico. Pharmas tend to internalize this effort but collaborations in that space are required, mostly with the extensive presence of Start-ups / Scale-ups in the domain. Management of dataset standardization and resources for high performance computing are the two main potential barriers.



**Insilico
Medicine**

**3 steps
to get actionable like
molecules**

- 1 **Ligand/Structure-based Drug**
Design design novel molecules
- 2 **Guide the generation**
define properties novel
molecules should satisfy (e.g:
shape, stability...)
- 3 **Molecular annotation:**
annotate all the properties of
new compounds generated

#2 Future of clinical trial (intelligent, decentralized)

Intelligent clinical trials (defined as the use of data and digital to improve trial design and execution) are now a key priority for Pharmas, in a context of decreasing R&D productivity. Protocols can be fine tuned using real world data or through a secondary use of past clinical trials, investigator sites can be down-selected to meet recruitment needs, a large portfolio of trials can be monitored



David Coman
CEO, Science 37

Science 37

to detect early signs of deviation, and soon control arm can be synthesized, reducing trial size by half. Decentralized clinical trials (defined as clinical trials no longer at the sponsor site but switched to patient's homes) is emerging as the next frontier. New platforms for clinical trials are emerging, challenging legacy players.



Oct 7th, 2021

- Debut on Nasdaq as a publicly traded company
- Reception of \$235 million total cash
- Investments targeted to enhance Science 37 Operating System to decentralize clinical trial execution and enable more agile clinical trials

#3 Real World Data (RWD) generation and usage

RWD are generated by Hospitals (eHR), Insurance (claims) and more and more patients (digital health). However, interoperability can sometimes limit the interaction between stakeholders though.

Private companies and Research labs show a great interest in quality RWD for designing clinical trials, supporting drugs in front of regulators and managing drug LCM until Loss of Exclusivity (LoE) with extension to new indications or drugs combos.

To reach scale, players can go for Pharma-sponsored platforms, gathering public and private actors at a single marketplace offering high standards of data quality, data services, data privacy, and cybersecurity.

- JV between Merck and Palantir Technologies to advance cancer research
- To empower scientists and research centers with the leading data integration and analytics technology
- To allow users to collaborate to drive scientific discovery, while ensuring control, ownership and traceability of their data

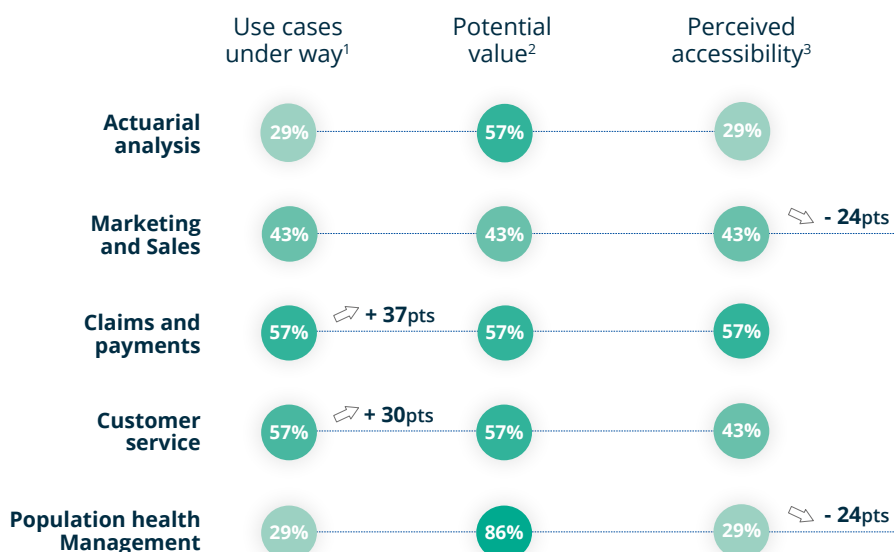


Use cases of interest

Risk management

Population health still being considered as the top value driver but still not a reality in Europe.

Macro repartition of uses cases currently under way, their potential value and their perceived accessibility



Variation in percentage points versus AI for Health 2020

↗ Increase vs 2020

↘ Decrease vs 2020

Based on a set of 7 respondents (incl. 1 Insurance company, 1 start-up, 1 research lab, and 4 others) 1. % of companies with 'some projects' and 'many projects' 2. % of companies rating as 'rather high value' 3. % of companies rating as 'rather accessible'

Higher proportion of use cases under way in 2021 on claims and payments and customer service

Computing patient data to improve risk management have generated a greater momentum than last year, with an increase of 16 to 37 pts in the proportion of uses cases under way, depending on the type of application.

Value of use cases stable, greater difficulty to deliver them

Perceived value can be considered stable vs. 2020 while perceived accessibility has decreased in almost all use cases, especially for Marketing and sales and population health management.

Population health: very high but still significant hurdle to go for it

A large majority of respondents see value in stratifying and monitoring patient populations based on their risk level (86%), though the perceived accessibility is lower than with other applications.

Results from this section should however be taken with caution due to the limited numbers of respondents.

MACSF



Being the first Insurance company for healthcare practitioners in France, MACSF follows a specific approach to leverage data/AI at HCP level. The company works, among other topics, on the prevention of medico-legal risk for HCPs (e.g., interpretation risk of medical images). Increasingly involved in the ecosystem, MACSF already collaborates with medical unions and invests in digital health start-ups/MedTech.

10+

minority investments
in digital health
& MedTech start-ups

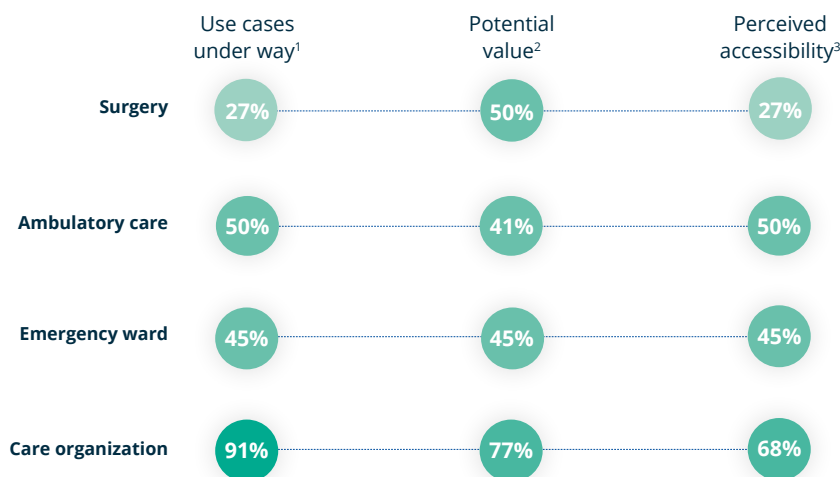
“Processes are more and more automatized, while keeping at the same time a human control on critical aspects.”

Use cases of interest

Hospital

Efficient management of patient flows and resources are prioritized; surgery augmentation holds great promise for the future

Macro repartition of uses cases currently under way, their potential value and their perceived accessibility



No reference vs. 2020

Based on a set of 22 respondents (incl. 7 Hospitals, 7 Start-ups, 3 research labs, 1 MedTech company and 3 others) 1. % of companies with 'some projects' and 'many projects'/ 2. % of companies rating as 'rather high value'/ 3. % of companies rating as 'rather accessible'

Care management applications seem low hanging fruits

A vast majority of players focus on improving Hospital care organization (91%), a segment considered highly valuable (77%) and rather accessible (68%).

Augmenting surgery could prove a huge breakthrough

High value lies in augmenting operating rooms with data and AI tools (e.g., OR utilization, surgeon AR/VR...). Nevertheless, several years may be needed in order to transform the OR and prove its incremental value vs. standard surgery practices and break the POC ceiling.

Emergency ward

Intermediary status on penetration/value/accessibility hides that this field is quickly evolving. Some initiatives (e.g. patient triaging, linkage with primary care/home care...) are delivering value and we may expect them to take off in the coming years.

Ambulatory care

As for ambulatory care, we also notice the same intermediary status, even though Hospitals need to transform to accelerate. As an illustration, 4 out of 10 surgeries are done in ambulatory in France (vs. 8 out of 10 in the US).

Smart hospitals

STRATEGIC DEEP-DIVE

#1 Care management

Care in hospitals gets organized around personnel (doctors, nurses and admin). Data & AI do not rule, in a context where hospital IT foundations should still be improved, and resources are under intense pressure. Meanwhile, healthcare systems fix ambitious ambulatory care targets.

In that domain, we observe a series of POCs with huge heterogeneity between countries and hospitals.



CENTRE HOSPITALIER
DE VALENCIENNES

Valenciennes Hospital

This hospital center in the north of France deployed a machine learning tool to predict 8 days ahead the number of patients to be admitted to the emergency room. Based on data collected over a two-years period, the algorithm is also capable of predicting patient split into 5 pathologies.

#2 Surgery

We are still in the early days of the « augmented surgeon ». Systems that would guide practitioner in surgery bringing greater trust and replicability are called for, mostly by early adopters in complex and/or precision surgeries. To manage these transformations, surgeons would need to convince hospital management to make necessary investments.



SURGAR
Surgical Augmented Reality

SurgAR surgery

A few expert companies are paving the way, such as SurgAR surgery. The French company is developing a plug-and-play augmented reality software for minimally invasive surgery, for which is targeted to obtain CE marking by mid-2022.

#3 Smart imaging

Care in hospitals gets organized around personnel (doctors, nurses and admin). Data & AI do not rule, in a context where hospital IT foundations should still be improved, and resources are under intense pressure. Meanwhile, healthcare systems fix ambitious ambulatory care targets.

In that domain, we observe a series of POCs with huge heterogeneity between countries and hospitals.



Siemens Healthineers

Siemens Healthineers started early to embed AI modules in the softwares they develop for MRI/scanners. Applications include automatic radiation calibration or high-risk-zone contouring. The company aims at building “digital twins” by modelling organs, firstly on the heart and liver.

#4 Emergency room/Acute medical unit

Within the next few years, we can expect a revolution in the domain. Being able to predict patient flows, manage the triage in and out of hospital, dynamically manage resources accordingly, support decision making, connect the dots vs. general practice: many use cases emerge and some of them begin to materialize on the field.

Some geographies (e.g., Israel) have developed an interesting maturity in the domain.



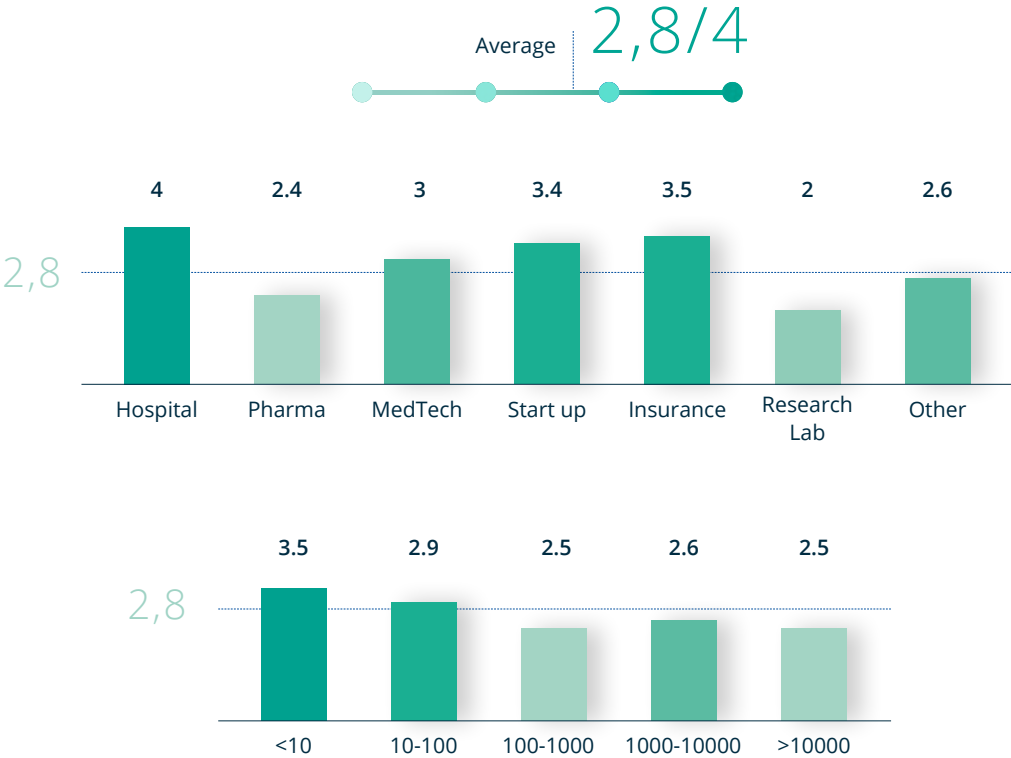
Traumatrix

In France, teams from Traumabase, APHP, EHESS, CNRS, Ecole Polytechnique and Capgemini Invent jointly developed Traumatrix, a decision-support tool for critical care teams to improve in real time the care of patients with major trauma during their first 24 hours after admission. The tool leverages machine learning models and a register of 14000+ trauma cases.

Ability to scale

Pharmas are still doubtful on their capacity to scale up while other players (private, public) feel more confident.

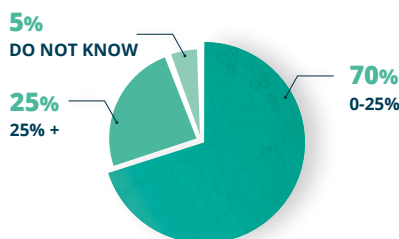
On the scale from 1 to 4, how would you evaluate your organization's capacity to scale up/industrialize data use cases (i.e., getting from POC to a deployed tool with live end-users)?



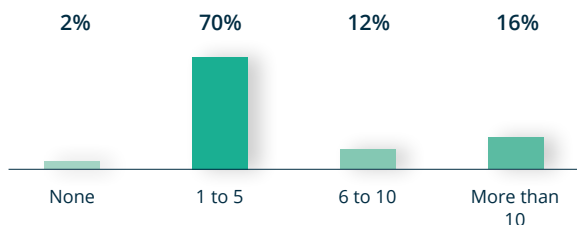
Based on a set of 36 respondents (incl. 7 start-ups, 7 Pharmas, 3 MedTech companies, 2 Insurances, 6 research labs, 1 Hospital, and 10 others)

Which proportion of your POCs has been industrialized?

(industrialize: optimize and supervise the deployment of a product/application/software in an infrastructure for end-users)



How many use cases do you plan to deliver at scale in the next 3 years (order of magnitude)?



Based on a set of 19 respondents (incl. 5 start-ups, 3 Pharmas, 2 MedTech companies, 1 Insurances, 2 research labs, 0 Hospitals, and 6 others)" pour le premier graphique, et "Based on a set of 57 respondents (incl. 27 start-ups, 4 Pharmas, 2 MedTech companies, 1 Insurances, 4 research labs, 7 Hospitals, and 12 others)

Pharmas acknowledge that scaling is going to take years

Within the panel, Pharmas show the lowest level of confidence, which can be explained by the perception of time required to reach such scale and the need to federate a vast ecosystem around their goals. Research labs also have a similarly low level but with no surprise vs. their model. Other private players (Med-Tech, Start-up, Insurance) together with Hospitals outperform Pharmas.

Small companies feel more confident in their capacity to scale up

Companies with less than 100 employees (essentially start-ups) show strong confidence in their ability to industrialize data use cases, while large firms have estimated their capacity to be intermediate. Consequently, we observe a negative correlation between organization size and capacity to industrialize use cases.

Best in class players

Such players would have a proportion of POCs that have been industrialized beyond 25% and focus on a limited number of impactful use cases.

KEY LEARNING

Limits & Ethics

Pipelines of health data & AI initiatives are growing. As use cases progress, the hurdles stakeholders face to deliver evolve, and so is their awareness on ethical issues (privacy, fairness, accountability, explainability). In that sense, this section assesses the roadblocks and ethical issues faced by the industry, as well as its position on the topic of data sovereignty.





LIMITS AND ETHICS

KEY TAKE-AWAYS



1

Roadblocks to launching AI initiatives

Actors seem to face more difficulties, suggesting a perception shift of the players as they move forward in delivering: the 8 categories of roadblocks were not identified as barriers by 33% of respondents on average, down from 50% last year. **Data quality and accessibility is still the main concern**, evaluated as an intermediate to strong barrier by 90% of the panel. Other roadblocks also appears on the way to a lesser extent: **lack of budget** (Start-up and public institutions), **difficulties to manage change** (Pharmas).

2

Privacy and ethics considerations

Privacy dimensions are now systematically taken into consideration by most actors (81%). Issues of **explainability**, **fairness**, and **acceptability** of AI also seem to become harder to deal with than in 2020 but are not considered systematically in projects for the moment. Those dimensions can come with different interpretations if regulators do not provide clear guidance.

3

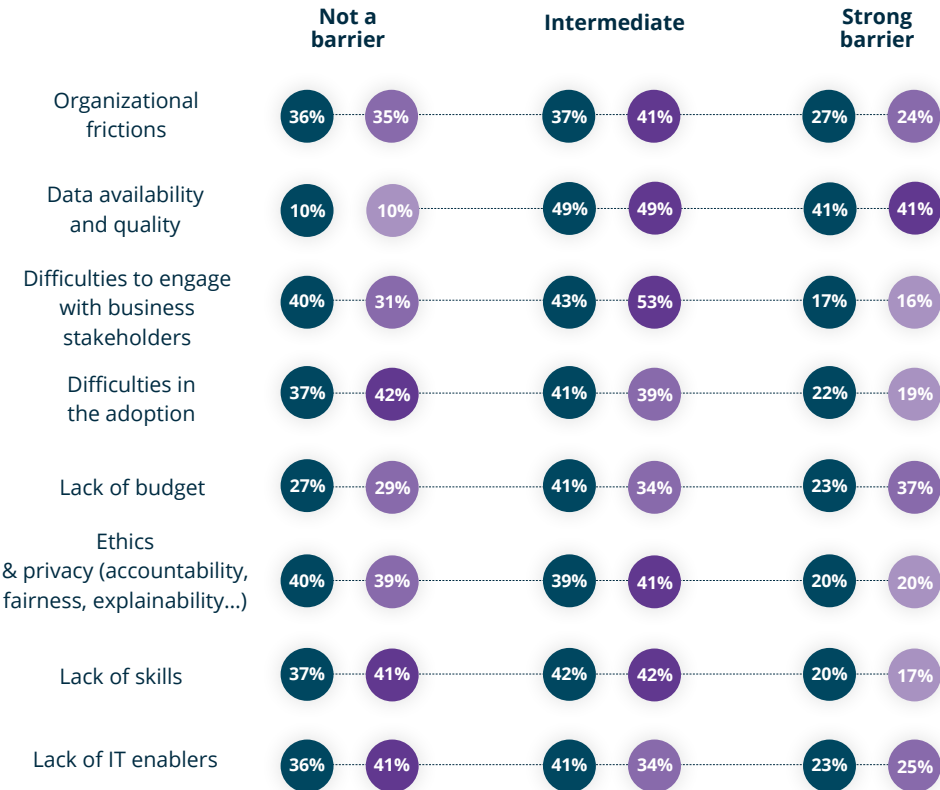
Data sovereignty

Although almost **all respondents agree on the importance of data sovereignty** (defined as the application on health data of country laws and governance structures), Hospitals and MedTech companies put a lot more efforts on it than Pharmas and Research labs. Indeed, **70% of Hospitals** and **75% of MedTechs** declared having launched/planning to launch initiatives on data sovereignty, while only 22% of Pharmas and 25% of Research labs declared so.

Roadblocks to launching AI initiatives

Actors start to face more barriers as they progress on delivery, with data availability and quality coming top of the list.

What are the main barriers you overcome before starting the delivery your AI initiatives? (Regulatory constraints, etc.)? During delivery?



Barrier before starting delivery (dark teal circle) Barrier slowing down delivery (purple circles)

Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)

Data availability and quality is still the main barrier

Again in 2021, respondents agree that accessing data with the right level of quality is a difficulty (41% of them consider it a strong barrier, up from 24% in 2020).

Lack of budget in start-ups and public institutions

More than a third of the respondents find lack of budget a strong barrier to delivering their data/AI projects. This is especially true for Start-ups and public institutions (Hospitals, Research labs).

Difficulties to drive change in large companies

Large companies such as Pharma players seem to struggle more with organizational frictions or stakeholder engagement.

The end of the euphoria

Overall, the proportion of respondents declaring identifying a factor as not being a barrier has decreased vs 2020 for each of the 8 potential barriers listed in the survey. Though the panel differs from last year, this suggests a perception shift of the players as they move forward in delivering more AI use cases at scale and face new barriers.

DATA GOVERNANCE

Data governance (the definition of strategies and process to manage how data is ingested, stored, and used) is a crucial step to limit organizational frictions and data availability and quality hurdles.

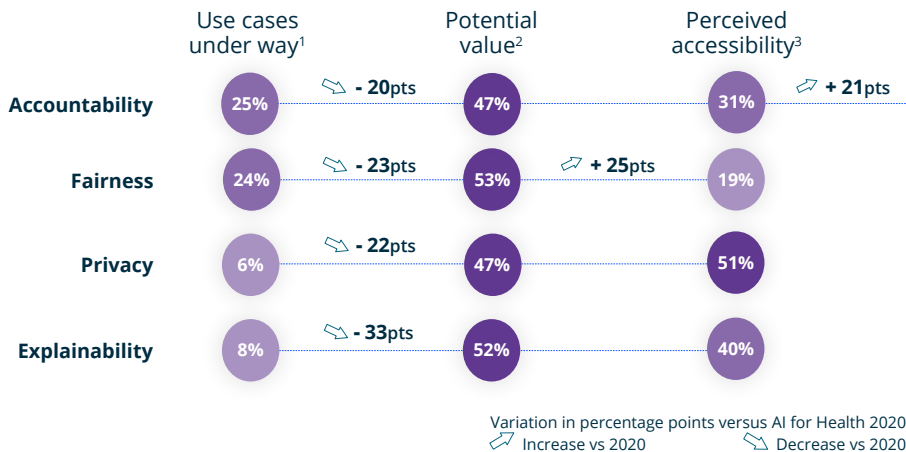
It involves :

- 1 Defining a clear trajectory and organization with roles and responsibilities
- 2 Documenting and Implementing semantic models of data
- 3 Defining quality standards and establish processes
- 4 Using tools to manage products metadata & data platform

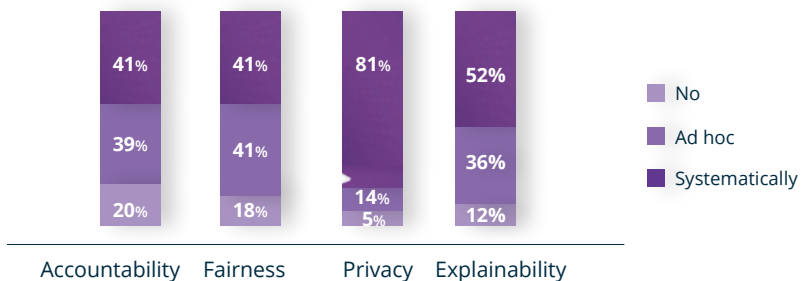
Privacy and ethics considerations

Players are now aware of privacy considerations and start facing other ethical dimensions for which the regulations are not yet in place.

Rank the following dimensions of ethics in AI according to the barrier they represent according to you?



Are the following dimensions systematically analyzed during your projects framing?



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)

Increasing difficulties regarding privacy and ethics

Overall, a larger share of respondents find difficulties implementing privacy & ethics considerations in their projects compared to 2020.

Privacy is a primary concern

Privacy (personal/sensitive health data management) is considered as a barrier by 94% of the respondents (strong barrier: 51%), regardless of the actor's size & category, with 81% of respondents saying they systematically analyze this dimension in their project framing.

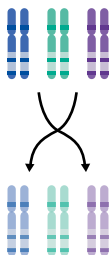
Explainability, fairness & accountability are barriers but are not systematically considered

The ability to explain algorithms decisions is also considered as a barrier by 92% of respondents (strong barrier: 40%).

On fairness, avoiding bias and discrimination in data sets and algorithms is an intermediate to strong barrier for 75% of respondents, with a higher concern for Hospitals & Research labs. Similarly, accountability also stands out as a barrier for the same players.

Like in 2020, fairness, explainability and accountability are in majority not taken systematically into consideration when framing projects. A reason is that those dimensions are still prone to interpretation due to lack of guidance from regulator.

SYNTHETIC DATA



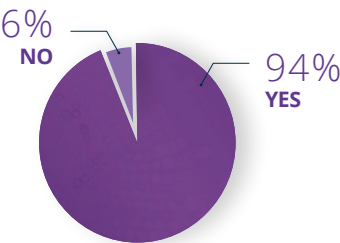
An example of a lever to protect patient privacy could be the use of synthetic data (es.g., biomedical data simulated from data from a pool of real patients). The advantage of generating such data: there is virtually no risk of re-identifying original patients from synthetic data, while keeping enough statistical relevance.

Data Sovereignty

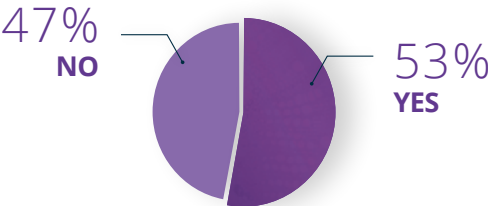
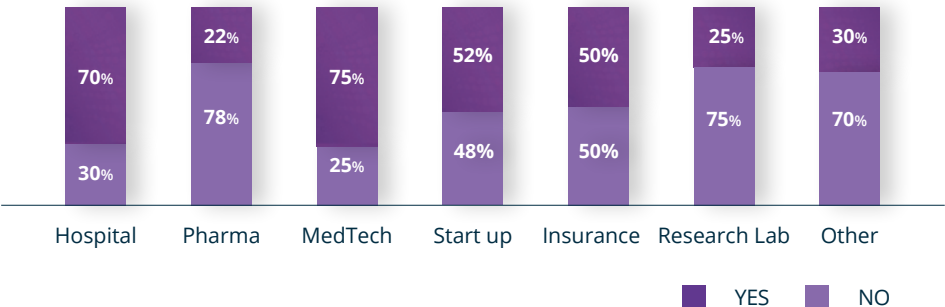
This priority issue is not yet tackled by every actor.

Do you consider data sovereignty as an important topic to address?

Data sovereignty in healthcare means that health data is subject to laws and governance structures of the country where it is collected).



Have your organization planned/implemented initiatives on data sovereignty?



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)

Agreement on the importance of data sovereignty

An overwhelming majority of respondents (94%) agree that complying with national laws and governance structures to health data is key, especially in Europe.

Hospitals and MedTechs put more efforts in data sovereignty than other categories

Most Hospital respondents (70%) declare to have planned or implemented data sovereignty initiatives, as they are in the front line with patients. The “other” category, which encompasses CROs, shows similar results. A majority of MedTechs (75%) have also planned/implemented initiatives on data sovereignty, as their products must follow the standards of their clients (primarily Hospitals). Efforts seem less important for Start-ups and Insurances, for which about half of the respondents answer yes.

Pharmas and Research labs lag behind

Conversely, only 22% of Pharma respondents say their company implemented or is planning to implement initiatives on data sovereignty, probably because they are not directly exposed to these issues and would leave it to the data producers (CROs, Hospital, solution provider etc...). Finally, few of the reviewed Research Labs (25%) implement data sovereignty initiatives.

CLOUD ACT / PRIVACY SHIELD

Organizations dealing with health data, which are personal data by excellence, are subject to data sovereignty rules more than any others. Regulations vary between regions, especially between both sides of the Atlantic.

In 2020, the European Court of Justice invalidated the Privacy Shield, a framework for protection requirements regarding data transfers between the EU and the US, declaring it was not meeting GDPR standards. The decision was made on the grounds that US law enforcement could, under the American CLOUD act, access more data than necessary. This meant sufficient data protection standards were not provided when personal information entered and/or left the EU.

KEY LEARNING

Technological choices

To gain in maturity as well as to overcome current and future challenges, players would focus on a couple of data priorities (ingestion, cleaning, data computing and AI, end-users exposure).

Depending on their maturity and type of use cases, players pick up preferred data science technique(s), which are detailed hereafter.

We will also look at what it means for the players in the ecosystem to engage in partnerships with tech companies, be it for a move to cloud approach, or for business or research purposes.





TECHNOLOGICAL CHOICES

KEY TAKE-AWAYS

1

Data techniques and priorities

Companies in the panel dedicate their efforts in **priority to data cleaning, storage and API** (60% of respondents). The use of parent families of AI techniques such as **machine learning /deep learning** and **data visualization** seems to be widespread across the panel (resp. 90% and 80% of respondents).

On the other hand, the use of **more specific methods** such as **Natural Language Processing (NLP)**, **computer vision**, or **causal inference** vary between categories of respondents. MedTech companies for instance tend to focus more on computer vision (for imaging), while biostatistics and causal inference are more frequently used in Pharma, Hospitals and Start-ups.

Quantum computing, though promising, is perceived as a technology that will deliver value in healthcare in a 5-10 years timeframe.

2

Tech partnership strategy

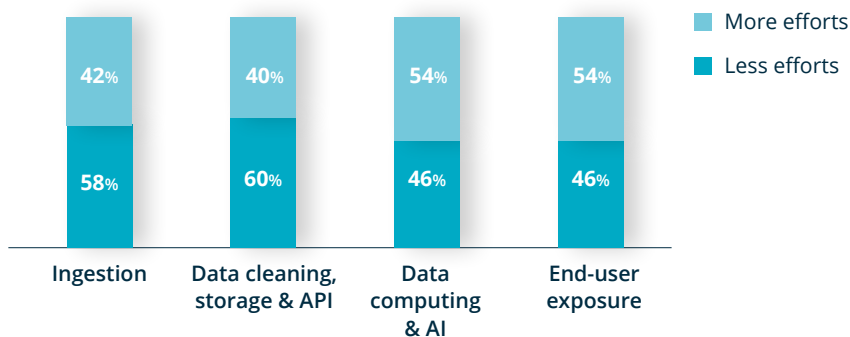
Collaboration with cloud providers is generally adopted or planned (69%), in particular among private companies (100% of MedTechs, 89% of Pharmas and 70% of Start-ups).

When it comes to **partnership with tech giants**, **Pharma and Research labs seem more prone to engage**, with 72% and 63% respectively working at least « sometimes » with such players. Engagement is heterogeneous for Hospitals: some respondents never collaborating (30%) while others stating they often or always partner with them (20% and 10% respectively).

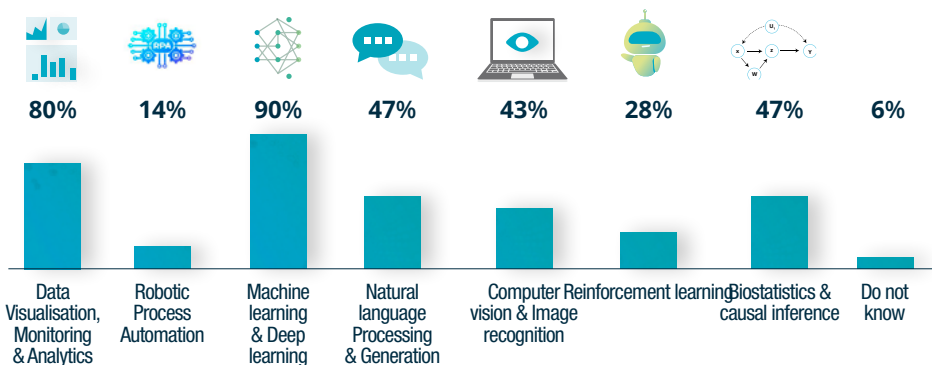
Data techniques and priorities

The priority of data cleaning, machine/deep learning and data visualization

On which category of tasks do you currently focus your efforts?



Which of the following Data Science technique(s) have you leveraged to develop your use cases?



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)



Data cleaning remains key

Respondents focus more their efforts on data cleaning, storage and API (60% of respondents responding “more efforts”). Data computation together with data visualization for end-users concentrate slightly less effort (54% of “more efforts”). Organizations would put on the contrary less focus on the ingestion, which has become a commodity, except when the data is massive and needs frequent/real time updates.

Data science techniques

Almost all respondents (90%) claim to leverage the inevitable fields of machine learning and deep learning. Data visualization also represents a great share of usage. MedTech companies tend to focus more on image-based techniques such as computer vision (100% of respondents) or deep learning (100%), while biostatistics and causal inference are more frequently used in Pharma (60%), Hospital (56%) and Start-up (52%) respondents.

QUANTUM COMPUTING



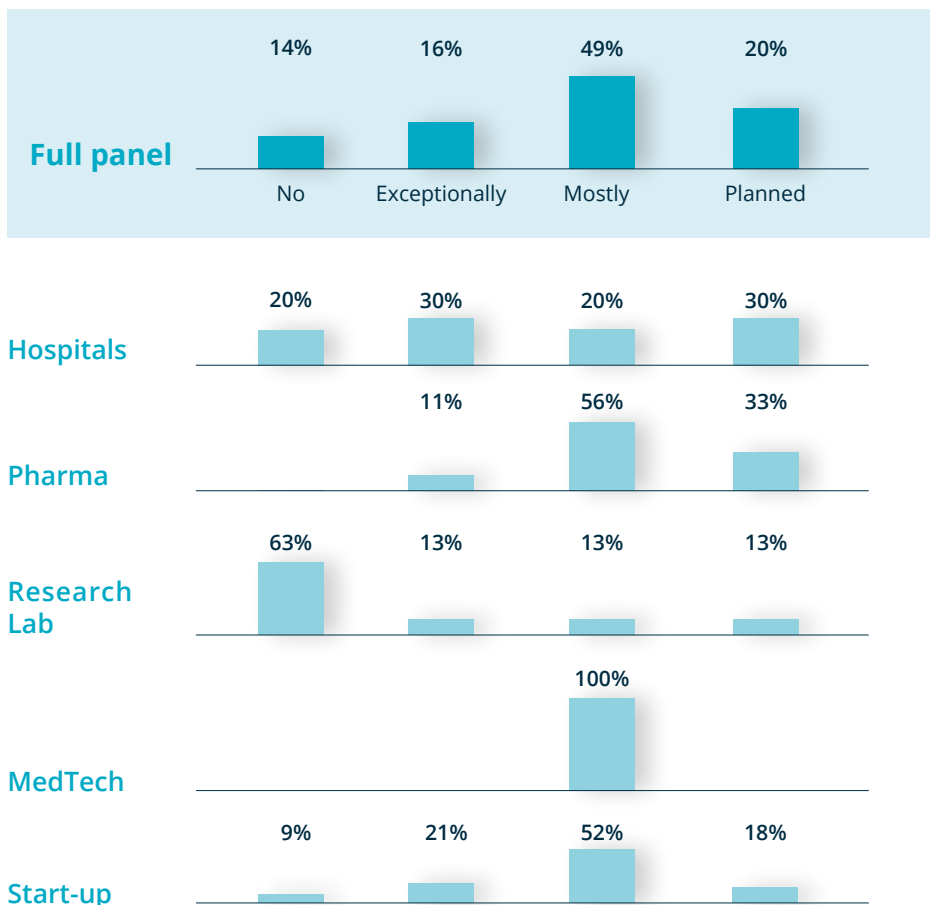
Beyond pure data science techniques, technologies such as quantum computing could prove instrumental in getting the most out of AI in healthcare. By harnessing properties of quantum states (namely, the superposition of binary states), quantum computers could solve problems much faster than classical computers. This could be useful in domains involving very computationally-intensive tasks and high-dimensional research spaces such as drug design.

The technology is however in its infancy and major breakthroughs are not expected in the short term.

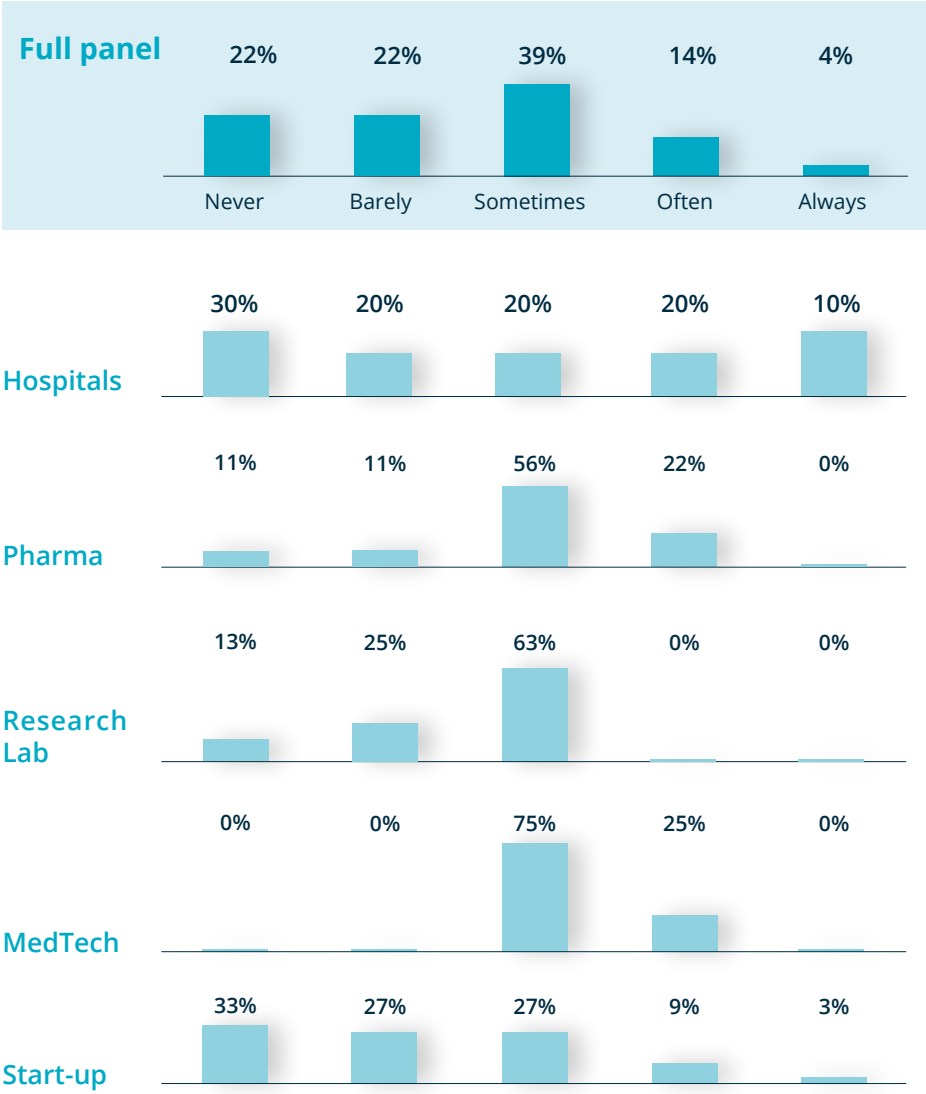
Tech partnership strategy

Cloud is being widely adopted among private players (less so in public) while Pharmas and Research labs are engaging in partnerships with tech giants.

Do you rely on cloud providers for your Data & AI infrastructure needs (ingestion, data cleansing and storage, data computing and AI, end-users' exposure)?



Do you collaborate with Tech companies (Google, Amazon, mid-size players...)? (i.e. partnerships)



Based on a set of 83 respondents (incl. 33 start-ups, 9 Pharmas, 4 MedTech companies, 2 Insurances, 8 research labs, 10 Hospitals, and 17 others)

Private players mostly rely on cloud providers

A majority of respondents from private organizations rely « mostly » on cloud providers vs. on premise (56% for Pharma companies, 100% for MedTech companies and 52% for start-ups) or plan to do so.

Hospitals and Research Labs do not engage in cloud yet

Respondents from Research Labs seem to prefer not to rely on cloud (63%) mostly for historical reasons.

Though results are more balanced for Hospitals, we observe nonetheless that 30% are planning to work with cloud providers which tend to show an evolution.

Pharma and Research labs seem keen to collaborate with tech players

57% of respondents say they engage at least « sometimes » with tech players in partnerships. Pharma and Research Labs are more likely to collaborate with tech players (78% and 63% respectively) than the average panel.

Results are here again balanced for Hospitals with some respondents never collaborating with tech companies (30%) and others stating they often or always partner with them (20% and 10% respectively). Conversely, start-ups seem less likely to work with tech companies to protect value creation capture internally.

Perspectives from AI doers

Actors of the AI for health ecosystem are moving, and they are moving fast.

In this last section, we share the crossed vision and down to earth experience of active players, coming from all horizons. They all have in common to be deeply involved in shaping the future of AI in healthcare, benefiting to patients, care givers, payers and the whole society.







Pierre-Antoine Gourraud

Professor at University of Nantes &
Hospital Practitioner at CHU de Nantes

To what extent will Data/AI impact hospitals organization (emergency room, ambulatory care, care organization)

In a sense, AI projects are the carrots hospitals are chasing to conduct their digital transformation

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Upstream of the data value chain, we are using multicentric Natural Language Processing Algorithms to mine clinical notes and extract relevant information regarding for example glycemic variability or reduced cardiac functions.

Downstream of the data value chain, AI methods can be very powerful to produce synthetic individuals. Synthetic data guarantee the total respect of privacy for each patients and facilitate the publication of both AI prediction open-source algorithms and open data for the learning phase, thus delivering the highest standards of data and algorithms sharing for the sake of reproducibility.

“ The virtual nature of AI and digital tools call for a reinforcement of empathic skills of care givers. ”

How would you evaluate adoption/training/accluturation of end-users with digital tools in Hospitals?

Digital tool adoption is a long and infusive process, which requires the adopting of a user-centric position.

How do HCPs deal with algorithm explainability and perception by patients?

Artificial intelligence will not replace the caregiver, but the caregiver who interacts with artificial intelligence will replace the caregiver who does not interact with it. Thus, the interaction with the algorithms, its parameters, and its learning datasets, are central to its future adoption and rightful position as tool to serve caregivers and patients alike.

What are the limits/risks of Data/AI techniques in your area of interest?

Paradoxically, the virtual nature of AI and digital tools call for a reinforcement of empathic skills of care givers. These are called for more than ever, to mediate and guide access to personal data in the decision-making process.



Tobias Gauss

Shock and Trauma Center
Division Anesthesia and Critical Care
Traumabase.eu

To what extent will Data/AI impact hospitals organization (emergency room, ambulatory care, care organization)

We are still trying to provide evidence that AI can effectively impact day-to-day clinical care. The scientific validation of the benefits of using AI is still ongoing. It is crucial that clear benefits be demonstrated before clinicians can trust AI systems, and for patients to trust their clinician's AI enhanced decisions / recommendations.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

In TrauMatrix, we leverage machine learning models to improve the care of patients with major trauma. Our objective is not only to build a decision-support tool with high-performing models, but more importantly to challenge its results in real time against the evaluation by experienced clinicians. A crucial subject has been how to handle missing data. Our next phase will be to understand how clinicians react when they have a different perception of the situation than the algorithm.

How would you evaluate adoption/training/accluturation of end-users with digital tools in Hospitals?

The AI uptake amongst Hospital staff in general is still low. There is a need for

“ It is crucial that clear benefits are demonstrated before practitioners can trust AI systems. ”

a better instruction of the medical community. Teaching about AI should be part of the medical curriculum. Future generations of HCP should be able to challenge the relevance and the robustness of an AI tool.

How do HCPs deal with algorithm explainability and perception by patients?

We are not yet at the stage of model explainability when it comes to the Hospital: probably many clinicians struggle with the concept. However, like many methods we use, the medical community can accept a level of uncertainty provided the method has been proven to work. Take anesthesia, we still do not really know how it puts the brain to sleep. To accept a lower level of explainability, we can take no trade off with regards to the scientific evidence that these tools are robust and reliable and improve patient care.

What are the limits/risks of Data/AI techniques in your area of interest?

There is an inherent risk of reproducing our own biases when building a machine learning model. A tool may seem efficient at first, but problems will arise when deployed at scale. The risk is that AI tools are deployed too quickly, without enough time and with limited effort to test them and make them more reliable.

**Jean Marc Bereder**

Head of the medico-surgical
digestive center

Artificial Intelligence Deputy

**To what extent will Data/AI impact hospitals organization
(emergency room, ambulatory care, care organization)**

Hospitals need to be able to answer quickly to constantly new situations, while guaranteeing quality of care. This requires access to a range of insights necessary to make informed decisions. Having the knowledge of the different types of data generated and building a structure that allows quick data access and optimal use is in itself a deep transformation of Hospital systems. Data use cases can answer decision support issues (medical, HR, supply) but also process automation, resources management or chronic disease follow up.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

We worked on tool to predict the resectability status of peritoneal carcinoma ([abstract](#) presented at ASCO 2018). On the care management side, we developed a tool to predict activity of Hospital medical units ([paper](#)). We are currently working on a steering tool allowing a deep analysis of activity of medical units and to test restructuration scenarios.

How would you evaluate adoption/training/acculturation of end-users with digital tools in Hospitals?

There is a paradox between a general positive perception of digital tools,

“ There is a paradox between a general positive perception of digital tools, and a low adoption of these tools in Hospitals. ”

and a low adoption of these tools in Hospitals. Main barriers to adoption are data availability and the lack of trained people to interpret them, but also cultural resistance, and security worries.

How do HCPs deal with algorithm explainability and perception by patients?

Beyond explainability, practitioners will focus more on interpretability. A parallel could be made with therapeutic innovation: a breakthrough therapy often involves very complex cellular or molecular mechanisms, whose understanding would fall under the term of « explainability ». Even though these mechanisms are unclear for most people, the therapy can be adopted because it was tested in controlled trials and because we were able to interpret the results on defined performance measures.

Patients will trust prescribers on the use of a therapy/tool, a trust that arises from the practitioner's capacity to inform the patient on medical benefits, as soon as he is himself convinced by his interpretation of the published studies.

What are the limits/risks of Data/AI techniques in your area of interest?

We have to make sure algorithms follow certain values: human benefit, loyalty, responsibility, trackability, interpretability, security, fairness, transparency. Limits and risks will be encountered as soon as we deviate from those values. The risk is to let fear grow which may jeopardize trust (trust being the cornerstone that guarantees access to quality data for solution builders).

**Bernard Castells**

MD at Caen University Hospital
Ex Innovation & transformation director at Valenciennes University Hospital

To what extent will Data/AI impact hospitals organization (emergency room, ambulatory care, care organization)

The impact is real and represents a huge potential in the next 3 to 5 years. This is especially true for operational improvement in Hospital organization – whether it is to improve care management (patient flow and patient journey) and resources management. Aggregating data and avoiding bias is key to fulfill this potential.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

For example, the Valenciennes General Hospital has developed a solution for optimizing income & expenses based on flow management. Our tool made predictions based on an activity hypothesis (beds availability / patient journey orientation / available slots in technical services such as radiology, functional explorations) and a given pathology, to guide patients in real time when they present to the emergency room. We'll also work at the Caen University Hospital on the prediction of Brain strokes and complications.

“ There is a pressing need for acculturation to align the different stakeholders. ”

How would you evaluate adoption/training/acculturation of end-users with digital tools in Hospitals?

There is an urgent need for acculturation to align the different stakeholders: managers and caregivers. This can be done through compulsory initial and continuing training programs for physicians / young physicians, sharing and feedback between physicians and hospital directors, and through the emergence of new hospital profiles (e.g. engineers hospitals).

How do HCPs deal with algorithm explainability and perception by patients?

It is crucial doctors understand they must be able to challenge the level of explainability of AI solutions. We do not have this level of awareness today.

What are the limits/risks of Data/AI techniques in your area of interest?

AI should not relieve practitioners from the responsibility they have towards patients, especially in terms of quality of care. AI should be considered a fully integrated tool into medical practice. Doctors who do not choose to use AI may fall behind in terms of practice.



Jean-Christophe Olivo-Marin

Head of the Biological Image Analysis unit and director of the institut Carnot Pasteur Microbes et Santé

To what extent will Data/AI impact hospitals organization (emergency room, ambulatory care, care organization)

I can speak from my scope of work: physics and maths applied to the field of signal processing of microscopy images. Informatics and AI are going to revolutionize care practices especially in the field of anatomic pathology, a medical specialty that involves analyzing biopsies to evaluate the presence and the degree of histopathological changes in tissue samples associated with diseases.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

We developed Icy, a free and open-source bio-image analysis software platform that we started in 2011. The source code is directly available and provided in each application download. It comprises ~450 plug-ins (e.g., cell counting and tracking, colocalization analysis) and gathers ~70 contributors.

We also participate in the BIG PICTURE European consortium involving 12 countries, aiming at creating automatic annotation algorithms that will

“

The willingness is definitely there, but we are lacking budgets, infrastructure and staff (bio-informatics engineers, technical staff) in Hospitals to deploy quicker. ”

be used to set up an open distributed software platform to read virtual biopsies slides and cope with the annotation of data, which is a major bottleneck for the deployment of AI in real life.

How would you evaluate adoption/training/acculturation of end-users with digital tools in Hospitals?

The willingness is definitely there, but we are lacking budgets, infrastructure and staff (bio-informatics engineers, technical staff) in Hospitals to deploy quicker.

How do HCPs deal with algorithm explainability and perception by patients?

The demand for explainability is not on the diagnostic by itself but rather on the methods and hypotheses used to reach at it in terms of data sources, data transformations, and algorithm. Users are looking for robustness, reproducibility, and lack of biases.

What are the limits/risks of Data/AI techniques in your area of interest?

The limits are not really in the science nor the technology but rather in the way society sees their generalized use in many aspects of life. This aspect holds particularly true when it comes to data security and data usage/abuse, which have become sensitive topics in recent years.



Thierry Houselstein
Medical Director

Have you defined a vision regarding Data/AI applications in your area of interest?

MASCF is the first Insurance company for HCPs in France. Among other topics, we work on the prevention of the medico-legal risk for HCPs (e.g. interpretation risk of medical imagery), that is a specificity of ours. We do have a specific approach of the use data/AI at HCP level for that reason.

How do you leverage Data/AI when it comes to designing health coverage products?

Practices are quickly evolving (digital health, telemedicine, tele-expertise...), especially since COVID and so are the risks for HCPs in their daily practice. We take it in consideration when designing our products.

What is the level of automation / digitization of your internal processes (marketing and sales, claims management, etc.)?

We are on the same dynamic vs. other insurers here. Processes are more and more automatized, while keeping at the same time a human control on critical aspects.

“ We work on the prevention of the medico-legal risk for HCPs (e.g. interpretation risk of medical imagery). ”

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

MACSF holds minority investments in 10+ digital health and MedTech Start-ups (e.g. Lifem on medical records sharing, Synapse Medicine to support prescription...), with whom we share our expertise on medico-legal risk. We now plan to accelerate. The start-up community now begins to come to us, together with learned societies and professional unions (ex: union of cardiologists).

What are your most important lessons learnt from your experience in the area?

Sharing views of healthcare stakeholders coming from different horizons is key. Also, consider early on the operational considerations of a product embarking AI.

**Tatiana Sorokina**

Solutions Director,
Data Science and Artificial Intelligence

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

We have reached a fairly advanced level of AI maturity at Novartis. We have spent the last 3 years elevating the practice of data science at the enterprise level. We conduct annual One Novartis Data Science and AI conference where we feature data and AI programs our associates work on, and as a Chair of the Abstract Review Committee I have seen the quality of work increasing year after year. We address numerous use cases that have significant business implications and span various stages of AI lifecycle, from idea to scale-up.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

In R&D, we have been using data science to transform the current drug discovery paradigm. With the Nerve platform, we now have an ability to monitor our 500+ clinical trials in real time and identify major bottlenecks and risks ahead of time, thanks to advanced data visualizations and predictive analytics. With the data42 program, we leverage 2 million patient-years worth of data in one of the largest and most diverse datasets in the pharma industry to disrupt R&D. In manufacturing, we are building a Buying Engine that uses AI to automate buying decisions of manufacturing site equipment. On the commercial side, we have developed a Next Generation Engagement program that uses AI-powered recommender systems to turbocharge engagement with our customers and consumers.

“ AI should be fit for purpose,
and the purpose has to serve
customers and have an impact. ”

Where do you see that RWE has the most value on the value chain (R&D, launch & growth / maturity)?

Mostly in R&D to achieve the best potential outcomes. Finding new indications when drugs are getting close to the loss of exclusivity is also a strong use case for AI application.

Are you planning to collaborate with ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Collaboration is key in the field of drug discovery, and especially in the intersection of R&D, medical devices and digital health, where we need to have a well-orchestrated team-work and cross-functional expertise.

Do you consider Smart/Small Data as the next trend to come after Big Data?

Once you form a hypothesis (and you know what you are looking for), you usually do not need big data. During exploration phases though (e.g., use of RWD to identify patient sub-groups) you are still boiling the ocean and looking for early signals. This is where big data can be helpful.

What are your most important lessons learnt from your experience in the area?

We have gone through a challenging but exciting learning curve with AI over the last few years. Personally, the biggest lesson for me was that AI should be fit for purpose. And the purpose has to serve customers and have an impact. We usually rush too quickly into building AI-centric solutions. We should not forget that a simple solution can come out of a box without AI but it has to always tie back to the customer and have a tangible business impact.



Pascal Bouquet

Head of Technology, Data42

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

At Novartis, we are convinced that Data and digital will change the paradigm of the Pharma industry. More specifically, in Pharma R&D. Indeed, Novartis launched the data42 initiative whose goal is to capture the hidden insights from the massive amount of research and clinical data of Novartis, tapping into powerful technology trends. We cleaned in the last years 46 billion data points, and we have unified 3000 trials representing 1 million patients. This enabled us to reduce the friction between data scientists and data engineers, bringing cleaned and connected data to their fingertips. We see already a huge value in this effort being able to optimize clinical trials, reducing their cost and duration.

Could you further develop on what data42 is bringing in terms of tangible results?

Trials optimization is the 1st direct tangible value. This is achieved through supporting clinical teams in defining better inclusion/exclusion criteria, leveraging years of historical clinical data and patients' genomics profiles. Patient recruitment is also a key topic for large Pharma and we have many solutions to optimize patient recruitment time. In one instance, we had colleagues running into difficulties recruiting patients for one trial. We

“ Starting a project with a vision like data42 requires a modern technological approach that is a very new addition to the DNA of a big Pharma. ”

were able to show that the patient population in the trial setup was too narrow, and this helped the team to refocus the trial.

We have also developed a template to perform Virtual Proof of Concept in record time, which helps in simulating potential novel indications for our drugs. We have also started this work to include preclinical in our approach with the objective of predicting safety signals in humans from our pre-clinical data.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth/maturity)?

The company started to invest in a RWE platform in 2015 and we are migrating now all the RWE datasets and applications to our data42 ecosystem. We use RWE in clinical development, as well as in launch and growth. We are quite excited about the tokenization technologies enabling us to connect RWE and clinical data. This is early days, but this is promising to enrich our view of the patient journey prior to trial or to have longer-term follow-up and outcomes (as examples).

What are your most important lessons learnt from your experience in the area?

Cleaning, unifying, harmonizing, and connecting data is a necessary step toward value creation. As shared in this Medium article: “starting a project with a vision like data42 requires a modern technological approach that is a very new addition to the DNA of a big Pharma and allows for many of the benefits of a tech Start-up mentality while leveraging the time-tested backing of the enterprise. This balance is sometimes difficult, but almost invariably, is always worth the effort”.



Isabelle Laforgue

Head of Digital, Transformation
& Innovation at AstraZeneca France

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Our innovation organization is structured in such a way as to enable us to listen to and better understand the needs of patients and healthcare professionals within our therapeutics areas, to explore innovative solutions that would meet their needs at each stage of the care pathway, and to support their deployment. It brings together digital, technological and data expertise, a good knowledge of the ecosystem, and support for the transformation.

We are exchanging around and supporting 15+ projects from start-ups at the end of 2021, all focused on improving the patient care's pathway. Examples of solutions include data mapping to optimize healthcare pathway, or an AI-based solution to help reduce diagnosis delay.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

I would mention two. First, the Innovation hub - part of our organization - is structured around 3 pillars (collaboration and partnerships, action oriented around patient journey and care system, transparency and impact with a clear roadmap up to 2025), helping us to be integrated within the ecosystem and proactive in listening to patient needs.

Speaking of concrete projects, we have participated in Microsoft AI Factory for Health (2020 edition) in which start-ups have been able to draw on AstraZeneca's expertise in diseases and in the needs of patients and health-

“ We do believe that AI and data – well managed and organized – are game changers in the way we can optimize the patient journey at every step, starting from diagnosis. ”

care professionals, as well as its legal skills, and its access to healthcare establishments and health data across all the countries in which it operates in Europe.

Second, the INNOVaccins initiative that we started recently with Janssen France, DPDgroup and AG2R La Mondiale, and where 10 start-ups have been selected to join Station F and are now supported (see [list](#)).

Where do you see that RWE has the most value on the value chain (R&D, launch & growth/maturity)?

In 2021, we launched Agoria Santé with Docaposte and Impact Healthcare. It aims to bring together a consortium of actors in health and data science (hospital structures, academic actors, Pharmas, MedTechs, Start-ups, etc.), who pursue a common objective: the quest for efficiency for the patients, improving the performance of health systems and evaluating the use and impact of health products in real life. So, to the question and as far France is concerned, the focus is on launch and growth/maturity.

Are you planning to collaborate with ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Innovation does not live in a silo. We interact in particular with the French healthcare start-up ecosystem that we know very well and also private or institutional partners. It's part of our strategy and commitment to go and meet innovation where it is, and to be aware of the initiatives that could help optimize the patient journey. It means discussing and interacting with specific communities such as start-up incubators, VC, or think tanks, wherever they may be in France.



Rémi Chossinand

Analytics Products Lead
for GenMed at Sanofi

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

What we are experiencing today is a transition from craftsmanship and the industrial era of AI. As of today, several punctual experiments were made on a large variety of subjects, enabling early outcomes and many learnings. The current transformation aims at scaling us promising experiments and accelerating our Analytics Product development.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth/maturity)?

The most immediate value lies within drugs that have already reached an advanced maturity stage, as more data can be collected in a real-life medical setting. This allows the monitoring of medical adherence, safety, efficacy, and also to work on indication extension to help more unaddressed patients.

But we also leverage RWE in earlier phase of our lifecycle by improving knowledge of disease evolution and existing treatments.

“ What we are experiencing
is a transition from
the “artisanal” application of AI
to “industrial” application. ”

Are you planning to collaborate with ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

We are continuously building partnerships with MedTech and tech players to explore and develop new opportunities. We are currently adding an extra effort to finalize our foundations, which should enable us to extend further our AI external outlook on a medium-term schedule.

What are your most important lessons learnt from your experience in the area?

It is urgent to educate leaders and the whole company on what AI is, together with what it is not. AI is subject to many myths and fantasies, even though it can be very well explained. Disappointment occurs when expectations are set too high or simply not well managed. Pedagogy around the subject should be a priority, even more for the biased ecosystem of hyper-specialized start-ups that can forget vulgarization and sometimes over-sell their solutions.



Joern-Peter Halle

EVP, Global Head of Research
at Merck KGaA

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

For a Pharma company of our size, we are in a pretty good state with AI. We are really well positioned on RWD, as e.g., our investment in Syntropy (JV Merck/Palantir) shows, into which we put a greater effort at the moment than the secondary use of our clinical data patrimony.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Our drug Tepmetko was approved in Japan and in the U.S., based on a single arm trial (see ASCO publication) complemented with a virtual control arm based on RWD.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth/maturity)?

I see value in new target and biomarker discovery together with the design of clinical trials. RWE complements clinical trial data. A good clinical trial would be a solid hypothesis that you can answer with a minimal amount of patients and minimal cost.

“ Think big but have
reasonable expectations. ”

Are you planning to collaborate with ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

We have many collaborations with specialized Start-ups and academics. We collaborate notably in the area of AI and drug discovery. We are especially expecting outcomes from AlphaFold. Also, we have acquired RWD cohorts on which we have huge expectations.

Do you consider Smart/Small Data as the next trend to come after Big Data?

I strongly believe in big data and advanced analytics. Not that much in Small data. I doubt you can extract meaningful insights from small data without a strong hypothesis upfront.

What are your most important lessons learnt from your experience in the area?

Bring complementary expertise together. Give them time. Think big but have reasonable expectations.



Nicolas Wolikow

Chief Digital Officer at IPSEN

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

From top management to affiliates, Ipsen is aware of the importance of data as a fundamental means for support to decision making and go to market efficiency. No one questions its usefulness, but opinions may differ on use cases, how to move toward industrialization and who should be responsible for data. We do not currently have a single department with a 360° ownership on data.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

At Ipsen we built Explorare, an in-house intelligent combinatorial tool for rare diseases. It had a very high uptake among our teams, especially within the medical department, and has already accelerated our processes.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth/maturity)?

First, solutions that help refine patient segmentation (e.g., cohort definition) hold tremendous value. The more qualitative data we have, the more value we can bring to patients and HCPs. We need a convolution product that mixes volume and quality. We need data with longitudinal and biological profoundness. Then, data & AI for better drug combo de-

“ A clear data governance
is a prerequisite to
progress in this area. ”

sign could also be mentioned, to control drug toxicity. There is also value in the capacity to predict drug response based on patient individual characteristics, as well as to predict disease evolution, though we have still a long way to go on those topics.

Are you planning to collaborate with ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

We are willing to partner with tech experts. I am also an advocate of consortiums around data, whether it is with tech or with pharma partners, which can provide economies of scale.

Do you consider Smart/Small Data as the next trend to come after Big Data?

If smart data means data that is qualified, or manually annotated by medical experts, then yes. With big data there is always a risk of being overwhelmed by raw data from which no relevant insights can be derived.

What are your most important lessons learnt from your experience in the area?

A clear data lineage is a prerequisite to progress in this area. We can also mention collaboration between departments, combined with a clear decision process. In addition to that, I would stress the importance of good balance between internalized and outsourced projects, to build and maintain in-house expertise as well as being supported by trusted partners.



Agnès Malgouyres

AI Lead France at Siemens Healthineers

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Our maturity is very high for several reasons. First, we have a dedicated team. Second, we have our own supercomputer and therefore significant computing capacity. Third, we set up multiple partnerships with Hospitals. We started early to launch softwares embedded in for example MR (Magnetic Resonance) and CT (Computed Tomography) scanners, which we improved with AI capacities. We acted as market shapers on certain aspects.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

In 2020, to support the fight against COVID19 we developed an AI tool to analyze pneumonia on CT. The project started in March 2020 and, by July 2020 our tool was CE, FDA and MDR marked – a very short timeline. As other examples, we worked on a 3D camera to calibrate radiation, but also on a software to contour more than 70 organs at risk; this input can be used for further processing in a radiation therapy treatment planning system. Finally, around personalized medicine, our objective is to model organs to build a patient's digital twin. We already have existing models for heart and liver.

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

We are very selective in the start-ups we choose to partner through our

“ Artificial intelligence is not a new medical technology but it is a very powerful mathematical and digital technology to make medicine evolve ”

own ecosystem. Our objective is to open our ecosystem platform to players that propose functionalities that we ourselves don't offer that have an expertise that can complement ours. By the way we have a lot of very fruitful collaborations with high level Hospitals and Research centers all around the world.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth / maturity)?

I would mention the use of RWE to train models for personalized medicine, though issues exists on bias and the representativeness of cohorts.

Do you consider Smart/Small Data as the next trend to come after Big Data?

We use both small and very big dataset it depends if the pathology we want to study is a rare or widespread disease. In both cases we need medical expert comments on the images (and sometimes pathology and/or biology results and/or ...) to train the algorithms.

What are your most important lessons learnt from your experience in the area?

Artificial intelligence is not a new medical technology but it is a very powerful mathematical and digital technology to make medicine evolve. Building efficient tools for the practice of medicine requires both the scientific expertise of artificial intelligence researchers and the medical expertise of physicians. It is a fascinating subject, which involves many different domains. I encourage those who may be interested in this subject to go for it!

**Clément Goehrs**

CEO

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Synapse Medicine is the first medication intelligence platform that allows healthcare professionals to obtain reliable medical information in real time. In 4 years, we have reached a certain maturity with a product maintained 24/7 across with high SLAs across many clients (e.g., 31 regional Pharmacovigilance centers, leader of support to prescription in telemedicine).

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

The Synapse platform was used during the COVID-19 pandemic by the National Agency for the Safety of Medicines and Health Products (ANSM). The platform called «Medication Shield» facilitates the management of adverse drug reactions reports from the vaccines against COVID-19. Thanks to an ML system, it is able to code these reports in real time according to the «MedDRA» classification (medical dictionary for regulated activities) and to prioritize them in order of seriousness.

“AI was still a promise a few years back ago. Now, concrete solutions come out of the ground.”

Where do you see that RWE has the most value on the value chain (R&D, launch & growth / maturity)?

We do have projects in oncology leveraging RWD, which are still early in the process.

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Synapse Medicine partners with public Hospitals and research centers in France and abroad (Berlin, Harvard...). In France, we can mention the collaboration with AP-HP Sorbonne University to provide their Hospital departments with a platform dedicated to medication reconciliation.

Do you consider Smart/Small Data as the next trend to come after Big Data?

What's key is to get a sense of what we want to do with data. For some uses cases, a small volumetry of qualitative data will be sufficient. For others (e.g., adverse events), a vast amount of data would then be necessary.

What are your most important lessons learnt from your experience in the area?

AI was still a promise a few years back ago. Now, concrete solutions come out of the ground, at scale and everywhere. Stakeholder are more and more willing to engage, we see limited barriers. In the healthcare sector, cycles can be lengthy, and you need to be comfortable with that.



Franck Le Ouay
CEO

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Lifen creates digital solutions that allow every healthcare professional and developers to instantly access the most relevant medical data and innovations. Lifen works with 570 Hospitals and clinics gathering 240,000 doctors and handling more than 2 million medical documents per month.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Our Artificial Intelligence has been trained on more than 24 million medical documents. Our AI can detect all the following key information (nature of documents, patient information...). We use that AI to automate the sending of medical documents in our solution Lifen Documents and use it to retrieve specific medical information needed by the third-party apps connected to the Lifen Platform.

“Lifen works with 570 Hospitals and clinics gathering 240,000 doctors and handling 2 million medical documents per month.”

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

By design, Lifen deeply collaborates with its ecosystem. Our objective is to host 200+ partner applications in its platform in the coming years. Beyond this number, we want to maximize the impact of our solutions for patients and HCPs.

Do you consider Smart/Small Data as the next trend to come after Big Data?

We actually make use of both. The transformation pipeline of medical documents to extract relevant information has been trained on a large dataset. We also make use of small data, for instance when we need to get the single source of truth of the list of patients that are present at a given point in time in a Hospital, for which we have developed a service that is accessible through API.

What are your most important lessons learnt from your experience in the area?

Stay focused on your key strengths, where you can make a real difference, get rid of the rest.

**Nicolas Bourdel**

CEO

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

SurgAR surgery is a plug-and-play augmented reality (AR) software for minimally invasive surgery. We are mature enough for clinical trial. We target a CE marking of the technology in June 2022, where we concentrate most of our effort in recent months. More generally, the field of AR in surgery is still a greenfield domain to explore.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

SurgAR suite focuses on two uses cases: preoperative 3D model from MRI/CT scan and Real time AR on the surgeon screen. We focus on specific organs at this stage: uterus, liver and kidney.

“ Medical practitioners
should work hand in hand
with entrepreneurs
in the context of Hospitals. ”

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

SurgAR is a spin-off from EnCoV, a research group located at the Faculty of Medicine in Clermont-Ferrand. We collaborate with academic players, Hospitals and MedTech.

Do you consider Smart/Small Data as the next trend to come after Big Data?

Small data is useful to start with at problem statement/hypothesis generation. Big data comes after that when scaling.

What are your most important lessons learnt from your experience in the area?

First, you should gain trust of your data producers. In the specific context of France, we must improve on IP sharing and modes of cooperation with public Hospitals to fight against preconceived ideas. Medical practice should work hand in hand with entrepreneurs to keep things moving in the context of Hospitals.

**Evgeny Putin**

Associate Director,
Advanced Analytics

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Almost everything we do in the company is data-driven in one way or another and it is literally impossible to overestimate the importance of the correct data processing, organization and manipulation. Therefore, we designed and developed our own internal protocols to assess, pre-process and work with data. Because in our case data goes inseparably with AI, we've spent a lot of time to create a reproducible, reliable and ease-of-use AI stacks for both research and development.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Yes, there are three tangible examples: PandaOmics, Chemistry42, and InClinico. PandaOmics is an AI-based platform that allows the finding of novel biological targets, and we are always enhancing its predictive models. Chemistry42 is a platform focused on finding novel lead-like molecules through its automated AI-driven de novo drug design and we are constantly improving its generative engine. Lastly, InClinico predicts clinical trials success rate and recognizes the weak points in trial design.

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Absolutely. For us collaborations with Pharma/MedTech or research labs is a permanent process. We already have a large networks of

“...if you are a mathematician and should work on generative chemistry, take an introduction course to medicinal chemistry or/and drug design.”

partners across different segments, including Big Pharma. For example, Pfizer, Taisho, Teva in Target Discovery; Janssen, Arvinas, Merck, UCB in Generative Chemistry. We strive to innovate and empower our partners with the platforms we have built. Another example: this year we had a collaboration with Intel regarding identification of risk factors associated with COVID-19 severity based on multi-modal meta-transcriptomic data analysis ([link](#)). Going forward we will continue to seek strategic and disruptive partnerships to push the industry forward.

Do you consider Smart/Small Data as the next trend to come after Big Data?

Yes, small data is already an emerging trend. A lot of AI-based solutions in healthcare that utilizes Big Data can easily fail in a lot of circumstances like adversarial attacks. Thus, in order to create fully reliable and accurate personalized medicine, we must consider the best of both worlds.

What are your most important lessons learnt from your experience in the area?

Because modern drug design and development is a very interdisciplinary process, it is very important to understand that you have to get the relevant knowledge and backgrounds in order to effectively communicate with your colleagues. For instance, if you are a mathematician and should work on generative chemistry, take an introduction course to medicinal chemistry or/and drug design.

In my opinion the higher the technology the more profitable the industry should be. Because modern AI is something that will last very long in healthcare and there will be much more novel unique scenarios of AI application in the field, it will unprecedentedly boost the industry's attractiveness in the next years.



Benoît Brouard

CEO & co-founder

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

We have a good level of maturity. The quality of our work was also rewarded with the obtention of the ISO 27001 (manage information security) accreditation.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Within our application, we have the capacity to deploy NLP (Natural Language Processing) algorithms in multiple languages (French, English, Italian, Spanish, German, Portuguese) in order to understand a patient's request but also to understand if the patient has a crisis, or a side effect. This helps us to reduce clinical inertia.

“ I strongly believe in collaboration between technical & medical teams. ”

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Our objective is to partner with University Hospitals. We need to validate our algorithms to shift from a tool that provides information to a tool providing recommendations.

What are your most important lessons learnt from your experience in the area?

It would be an error to see technology as a goal. We need to understand the patient's problem and find how to answer it. Top-notch technology is not necessarily needed to answer a given question. I also strongly believe in collaboration between technical and medical teams.



Michael Blum

Director of clinical trial solutions
R&D at Owkin

How would you evaluate the status of Data & AI maturity of your organization? (number of initiatives, acculturation of Business and IT, robustness of data organization, Data & AI technological capabilities...)?

Data and artificial intelligence is at the core of our business for years now.

If relevant, could you state some tangible examples of how you leverage Data/AI in your area of interest?

Among many others, some of our projects include:

- Prognosis model based on medical images (Hematoxylin and Eosin slides, radiology...)
- Clinical trial optimization using external data.

Where do you see that RWE has the most value on the value chain (R&D, launch & growth / maturity)?

RWE is highly valuable for regulatory submissions. A report by Aetion, a RWE solution provider, states that 53% of FDA-approved applications included a RWE study to provide evidence of safety and/or effectiveness. There is a high demand for RWE from regulators.

“ The technological aspects of AI are mostly ready and are in a sense the easiest part. ”

Are you planning to collaborate with the wider ecosystem (tech players, Pharma/MedTech, research labs, etc.) to develop data/AI solutions in the next 3 years? If yes, what are the next steps?

Deep collaboration is by nature our way of working on our projects. We collaborate with Hospital networks (e.g., Unicancer), research centers (Institut Gustave Roussy, Léon Bérard), University Hospitals. We also collaborate with Pharma companies.

Do you consider Smart/Small Data as the next trend to come after Big Data?

The data we work on at Owkin is AI ready. It went through a thorough curation effort from researchers to build a high-quality research cohort. Leveraging raw data will require more efforts.

What are your most important lessons learnt from your experience in the area?

The technological aspects of AI are mostly ready and are in a sense the easiest part. Other dimensions such as regulatory aspects, usage (how to integrate AI in daily practice, what is the objective) also need a lot of attention.

Acknowledgements



Capgemini and Startup Inside are very grateful to the following organizations and people we had the opportunity to interview during this study:

Hospitals

- **CHU de Caen**
- **CHU Grenoble Alpes**
- **CHU de Nantes**
- **CHU de Nice**
- **NHSx**

Pharma

- **AstraZeneca**
- **Ipsen**
- **Novartis**
- **Merck**
- **Sanofi**

Start-ups

- **Feedback Medical**
- **Insilico Medicine**
- **Lifen**
- **Owkin**
- **Surgar Surgery**
- **Synapse Medicine**
- **Wefight**

Research Labs

- **Institut Pasteur**

Insurance

- **MACSF**

MedTech

- **Siemens Healthineers**

Patient expert

- **Eric Balez**
- **G rard LeGoff**

... and to the respondents to the AI for Health online survey.

About the authors & contributors from Capgemini and Startup Inside:



Charlotte Pierron-Perlès

EVP AI & Data Services

Barnabé Lecouteux

Principal

Mariam Ikkem

Senior Consultant

Guillaume Rémont

Consultant

startupinside

Damien Gromier

Co-Founder & CEO

Stephanie Trang

Managing Director AI for Health

Alexandre Raucroy

Innovation Projects Manager

About the contributors



About Capgemini Invent

As the digital innovation, design and transformation brand of the Capgemini Group, Capgemini Invent enables CxOs to envision and shape the future of their businesses. Located in more than 36 offices and 37 creative studios around the world, it comprises a 10,000+ strong team of strategists, data scientists, product and experience designers, brand experts and technologists who develop new digital services, products, experiences and business models for sustainable growth.

Capgemini Invent is an integral part of Capgemini, a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of 270,000 team members in nearly 50 countries. With its strong 50-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering, and platforms. The Group reported in 2020 global revenues of €16 billion.

Visit us at www.capgemini.com/service/invent

About AI for Health and Startup Inside

AI for Health is the reference ecosystem collective that brings together more than 200 French and European players in AI for health: start-ups, research laboratories, Hospitals, manufacturers and patient associations. The initiative is led by the Startup Inside group, a major player in the transformation of large organizations through AI and entrepreneurial spirit. Startup Inside mobilizes French and European players in artificial intelligence by leading the AI for Health, AI for Finance, AI for Industry, and AI for Good ecosystem initiatives.

Visit us at www.startupinside.com and www.aiforhealth.fr

Press

✉ damien.gromier@startupinside.com

✉ stephanie.trang@startupinside.com

Follow us on Twitter

🐦 [@aiforhealthfr](https://twitter.com/aiforhealthfr)

and on LinkedIn

in [@Alforhealthfr](https://www.linkedin.com/company/aiforhealthfr)

AI for Health | Capgemini  **invent**
by startupinside