

# Big Data and Artificial Intelligence Innovation Hub

Sheba Medical Center  
Ramat Gan, Israel



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## Summary

Sheba Medical Center's Big Data and Artificial Intelligence (AI) Hub is the largest health innovation center in Israel. The Big Data and AI Hub is one of six hubs within Sheba's innovation program called ARC (Accelerate, Redesign and Collaborate). ARC is a global ecosystem that has started from Sheba and expanded to include more than 100 members including other leading hospitals around the world, industry partners, academic partners and start-ups. The purpose of this hub, which was established in 2017, is to provide a unified source of medical data and analytics for Sheba to streamline processes, inform decision-making and improve care quality. Sheba has developed a data lake that brings together historically disconnected datasets from across the hospital, which enables the creation of solutions to some of the clinicians' most pressing analytics needs. The hub has a model of partnership with start-ups and commercial organizations that allows their data and clinical expertise to be combined with cutting-edge technological capabilities. This has resulted in financial sustainability for the hub and access to innovative data-driven solutions for the hospital.





## The key problem that required a solution

Sheba lacked the infrastructure to support its data storage and analytics demands. Additionally, data was disjointed and spread across dozens of siloes. This limited Sheba's ability to manage and integrate its data into a unified source that could be used for analytical purposes. Robert Klempfner, Clinical and Scientific Director of the Hub, described the issues with the old hospital operating systems: "If you're dealing with AI, you learn to value data, and the curation of data, and the management of data, and the structuring of data - and similar to other hospitals, I think we found out that we were lacking in a lot of the infrastructure, physical but also conceptual. We were not organized enough."



## Aims of the new system

The vision of the Hub, as described by Avi (Abraham) Tsur, OBGYN expert and Director of the Women's Health Innovation Center, is "to leverage AI, either to improve any aspect of health, either to improve Sheba's brand name, either to develop a new IP [intellectual property]. The part that most interests me, as a physician, is that of course it is improving our patients' health and developing new clinical paradigms."

The need for the innovation hub was further addressed by Nisim Rahman, Data Architect and Team Lead, who stated that it was "to understand how to thoughtfully and diligently, securely involve these tools in patients' care, and to be involved with the AI start-up community in Israel." Robert Klempfner summarized the aims of this project as:

- ▶ Improve patient outcomes
- ▶ Develop and deploy multinational projects with global impact
- ▶ Create revenue to remain sustainable.

"We really are making an effort to show that even if it's not an immediate benefit, we will have some type of financial incentive in these projects. It can be revenues, it can be equity, it can be just hard cash."

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If you're dealing with AI, you learn to value data, and the curation of data, and the management of data, and the structuring of data – and similar to other hospitals, I think we found out that we were lacking in a lot of the infrastructure, physical but also conceptual. We were not organized enough.

**Robert Klempfner**  
Clinical and Scientific Director of the Hub

# 01

## Innovation description

### Context/background

Sheba's data from interactions with patients is held across 40+ disparate sources. The innovation program aims to aggregate them into a unified data lake that can be used for research, including the development of machine learning models that can support clinical decision-making and lead to improved care. The projects pursued by the innovation program involve clinicians in the early design phase. In some cases, clinicians are paired with start-up companies or companies focused on analytics. They establish a mutually beneficial relationship in which Sheba shares its data and clinical expertise and the industry partner brings the technical skills.

### Innovation components/approach

Sigal Sina, ARC's Chief Data Scientist, described the process of launching an analytics project within the hospital: "We define the pattern, define the methodology, try to define the deployment methodology, and once we have a model, we test it internally, then externally, then we think about how we transfer it to the clinicians." She also explained the importance of first aligning the clinician's expectations to what the data can actually achieve. They will often start by running a small proof of concept trial to achieve this.

Extracting the information needed from the data can be a long and arduous task. Once expectations are aligned, a validated and unified dataset is used for the project and placed in Sheba's data lake in case it can be used for future projects.

### Target population

The innovation program's target population is Israeli citizens and patients, but they see the potential for their solutions to uncover better care standards that can benefit patients across the world.



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**Sigal Sina**  
ARC Chief Data Scientist

## Key stakeholders

Sheba's collaborative approach to data and analytics means that a variety of technical and nontechnical, internal and external partners are involved. Key stakeholders include the following:

- ▶ **The innovation program staff:** the team of computer experts, software engineers, data analysts and statisticians that work at Sheba, either with physicians or external partners, develop new solutions using Sheba's data.
- ▶ **Sheba's management team:** this team - particularly the vice president, the deputy director for patients and the CEO - has been actively involved in the creation of the innovation program and involved in some of its outputs.
- ▶ **Physicians:** physicians at Sheba are actively involved in pursuing, and encouraged to pursue, new ideas to develop. They may even be provided with grants by Sheba for their projects.
- ▶ **Industry:** Sheba has partnered with both start-up organizations and larger tech companies to maximize the use of its data, cover the hub's costs and improve patient care.
- ▶ **Hospital IT department:** Sheba's IT department is involved in providing the infrastructure that the hub needs to use its data lake and connect its applications to the hospital system.
- ▶ **Tech transfer office:** this group focuses on providing insights on how to manage Sheba's Intellectual Property, and how to commercialize and manage the tools developed by the Hub.





## 02

# Evidence of impact

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Sheba's goal is to ultimately improve the quality of care it delivers. The innovation program has allowed the organization to do this through the use of many analytics solutions, including predictive models. Nisim Rahman described one of the recent innovations in response to the COVID-19 pandemic. He mentioned how, at the beginning of the pandemic, Sheba did not have a system in place to manage its COVID-19 patients and track their progress. It was able to combine multiple data sources from its data lake and provide the managers of the hospital with a dashboard that allowed it to see information for each patient and their condition, and track the number of tests performed, the number of deaths and other metrics. It was also able to create an AI model that allowed it to predict the status of its patients in the next six hours. This enabled it to manage its resources and plan the demand for different departments. Thanks to this, it was also able to prioritize patients it thought would deteriorate quicker and send home those who were safe to go.



## 03

# Key challenges

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Sheba has faced many challenges in its journey to harness the power of data and analytics to improve care. Key among these are technology limitations, change management, balancing hospital needs with technology needs, and intellectual property.

- ▶ **Regulation:** this increases the cost of developing some projects and can restrict ability to leverage more resources. "If I could bring all my data to the cloud and work only there without needing the permission from one project to the other, the budget wouldn't interfere with the cost of using the cloud in that regard, things would be easier.", shared Nathalie Bloch.

These concerns were echoed by Nisim Rahman, who described the difficulties in using the cloud: "Only in the last year did they allow us to work with the cloud. And, as you know, when you build something in the cloud it is very good, because you can change the resources. If you want a bigger, better machine with more CPU and more disk capacity, you can do that in seconds in the cloud. This is something that on prem [on premises], you cannot do, and the regulation did not allow us to put the data on the cloud, so it was very problematic. Many, many companies work hybrid, part of the data on the cloud and part of the data on prem. We worked only on prem, and it was very difficult, because we didn't have the right machine."

- ▶ **Staff buy-in:** staff on the ground can often suffer burnout from multiple innovations and technological solutions being implemented that require them to create new habits and learn to navigate a new technology. Busy hospital physicians are having to manage their limited time and resources alongside their commitment to the innovation program. Robert Klempfner described these competing needs in his own working life: "Time is a major issue; [we need to invest] time and effort and focus, and I need to see heart failure patients and can't only play with machine learning models, and a lot of clinicians are trying to do all of these, and it's not simple." Furthermore, Sheba would like to be able to share what it learns globally. Avi Tsur discussed the global aims of Sheba and the ambitions for its interventions: "The problem is not to persuade my colleagues in the hospital to use the AI model. The challenge is to persuade the world."

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**Avi Tsur**

OBGYN expert and Director of the Women's Health Innovation Center

- ▶ **Long-term sustainability:** “We know that one day health care will use AI, but now it’s such a hassle and it takes so much time and so many working hours and people and experts the hospitals don’t have. Hospitals don’t know how to hire a data scientists and data engineers. Hospitals know how to hire physicians, nurses, cleaners, social workers, and suddenly we bring the high-tech industry into a very old-tech medical institution and try to create a small start-up within this dinosaur organization with 9,000 employee and 70 years of working time between us,” explained Nathalie Bloch. The speed and agility that the innovation program require to make the desired changes and improvements are often hampered by the competing demands on Sheba’s IT system. The short-term needs of the IT system and the innovation program often appear to be at odds, even though their long-term goals are more aligned. Nathalie described this situation: “We’re a 2,000-bed hospital. We just upgraded our EMR system and for weeks the entire IT department is working on the bugs of the EMR deployment and update, so there is this inconsistency between the goals and the needs and even the funding of the IT department. This is something that’s discussed quite a lot in a lot of books: the innovation 101 wanting to run very fast and the regular, big mammoth of a company having its processes and working in a very, very certain way, and we can’t disconnect it.” Further, she suggested the solution may be to establish clear communication around needs, and the reasons behind the needs, so that they can create common goals and appreciate the other department’s limitations: “I think that one of the challenges is really to see how we can work together with the IT department in a way that they understand the importance of what they’re doing and how quickly actually we need to react, because if we deal with start-up companies, they cannot wait six months in order to be implemented in a hospital.”
- ▶ **Biased data and analytics:** one of the key risks identified by Robert Klempfner has been around patient safety and the dangers of inaccuracies in the new technology: “You can misinterpret data, you can use inappropriate data, there are all these biases that you are prone to because you’ve used data that you learn from and this data does not represent optimally the population, and you are dealing with some models that are black box and you don’t really understand the prediction, and the interpretability of AI is sometimes very complex for the non-PhD in ML scientists. All these elements of transparency, of fairness, of AI for good - how do we know that it’s safe enough, robust enough to actually deploy an AI system?” To mitigate these risks, Klempfner and the team at the innovation program have established committees and written positional papers on organizational protocols for utilizing AI. However, as an organization, Sheba recognizes the complexities of creating models and making predictions with the multifactorial context of a person’s health and well-being. It is therefore cautious and careful in its application of these models.
- ▶ **Data and information governance:** due to the symbiotic development of innovations through clinician ideas, the innovation program design, and start-up or data company support, there is occasionally confusion around who owns the data, the product or the IP. Sheba has realized it has to be very clear with all stakeholders on what the outcomes will be and who will be able to utilize and own the tools they produce, as well as where the money it makes from marketing the tools goes. Robert Klempfner described these issues: “You have to really understand how to manage the intra-hospital politics, and I think that is always crucial. The politics are always important, so that can be a problem where you don’t manage it correctly. In the worst occasions, we had some difficulties with certain departments regarding this.”
- ▶ **Interoperability:** it has been challenging for Sheba to get all of a patient’s data in once place so that a clinician can access it through a single interface. “Doctors want everything that we can tell them about the patient in the same screen. They don’t want a pop-up, they don’t want to open another application, they want everything integrated,” said Sigal Sina. This, together with the need to integrate data for research and innovation purposes, has led to the creation of the innovation hub’s data lake, to which datasets are still being added.



## 04

## Key enablers

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Along the journey, Sheba has taken a number of steps that have secured the innovation program's success.

- ▶ **Driving regulation change:** as discussed above, one of the challenges that Sheba faced was around regulation. It has worked extensively to demonstrate the value of change and is making progress. "Regulation needs to change with time. We are working with the Ministry of Health and the justice department on domains such as patient confidentiality, on secondary use of medical data, and every couple of months or so, these regulations inch very slowly ahead. A couple of months ago, it wasn't legal in health care to use cloud computing. Now, we have a cloud computing committee that can approve, in certain conditions, the use of public clouds, such as Azure, Google or Amazon Web Services and stuff like that, so things can change," Robert Klempfner explained.
- ▶ **Innovative funding models:** Sheba has creative and adaptive mechanisms for engaging clinicians, researchers and data scientists in their work. Through commercial partnerships, it has found a way to pair its data and clinical knowledge with digital expertise in industry. This has allowed it to develop cutting-edge digital innovations without the backing of million-dollar budgets. Nathalie Bloch described this funding strategy as a challenge, as it involved a great deal of

management and negotiation but said that it also shows how Sheba overcomes restrictions of funding limitations: "The next barrier or problem is definitely budgets. If I had all the budget that I wanted, then it would be much easier, but with a lot of collaboration involved and collaborative work and creating negotiations where both sides win the situation then we are able to create very nice projects without a high budget."

- ▶ **Continuous data improvement:** Sigal Sina described how each project is an opportunity to continue to build out Sheba's capabilities: "Even though we have a lot of data, not all of the data can be used." Each project that it completes helps build its capabilities in this area: "Each project is a POC [proof of concept] and it's done in two directions: one is about doing the best we can for this project, and the other is to learn from it for the future and build on our infrastructure."
- ▶ **Entrepreneurial culture:** Sheba has been creative and strategic in providing clinicians with incentives, such as small business grants. In the last year, Sheba handed out 10 grants, up to US\$50,000 each, to staff innovations in big data and AI. As a leading global hospital, Sheba embraces a proactive attitude of change and innovation, and Robert Klempfner described how attitude is embodied by the hospital staff's "curiosity and entrepreneurship, innovation, state of mind of

the teams that think 'you can't just complain, you need to try and do something about it.'"

During the interviews with the team, its close relationship with clinicians was abundantly apparent, and it impacts the whole process of design innovation. Robert Klempfner described his mechanism for finding the right people to lead the innovation within Sheba's clinician community, and how he nurtures their development and ambition: "You have to look, actively, to find these innovation champions; these people who are willing to give so much of their, theoretically, spare time, because ... some of this work or most of this work is not done during regular office hours. You have to really help these people shine."

To bring these ideas to fruition, the hub engages with data companies in the design, development and deployment of the project, creating a culture within the hospital that fosters the development of new ideas. "The ecosystem is crucial; the fact that you can so easily have this collaboration with the big IT companies, with the Microsoft and Googles of the world, or the Apples, where you have a lot of data scientists," stated Robert Klempfner.

- ▶ **User-centered design:** if Nisim Rahman could give one piece of advice to organizations across the world looking to develop data-driven solutions, it would be to listen to the customers. In his view, “to build a system that will help the doctors, you need to listen to the doctors, to understand exactly what they want.” This was echoed by Sigal Sina: “Each client wants something different from the model. Some want decision assistance, some want capacity prediction, or prediction of medical outcomes. In each case, we need to decide with the clinician what will be the research question and how the solution will be used. In this process, we are developing a common language across data scientists and doctors. We need to make sure that everyone understands one another.”

This clinician involvement in design and development of innovations also helps to create buy-in from staff and facilitates the adoption of the innovation in practice.

Nathalie Bloch acknowledged that “it doesn’t matter how good my data is and how intelligent my data scientist is. Data scientists need champions, clinical champions.”

She credited this close relationship with the clinicians and the hub as providing her and the innovation team with excellent insight into the resources needed on the ground: “I really know what they need and what they want, and I’m always very open to their criticism or their input.”

- ▶ **Global collaboration:** Robert Klempfner described how global partnerships, including partnering with academic institutions worldwide can help validate and harness digital innovations: “It’s important to have partners across the world, where you can collaborate, you can cross-validate your projects.

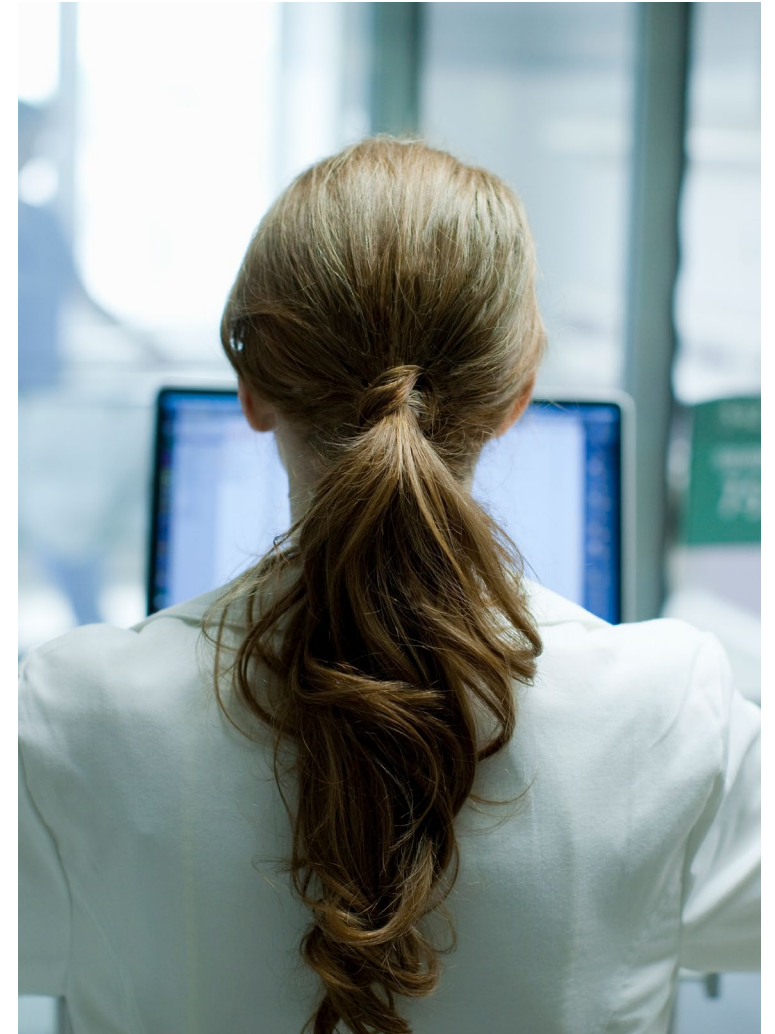
We have this network of innovation and some important partners that we can collaborate with, including collaboration with academia.”

- ▶ **Cross-sector communication:** Sheba continually involves staff from multidisciplinary backgrounds and works hard to ensure that the technical language barriers between data scientists and clinicians are addressed and overcome. This interdisciplinary working and focus on clear communication is key to the success of the hub. Nathalie Bloch stated: “I can bring dozens of the best data scientists from the industry because everybody wants to do health care these days, fortunately, but I cannot educate them how to talk clinical and data languages. You need to be able to really talk both languages and try to understand what’s needed. The data scientists in our team always ask, they need the clinician, they always talk to the clinician, always.”

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To build a system that will help the doctors, you need to listen to the doctors.

**Nisim Rahman**  
Data Architect and Team Lead



## 05

# Future plans

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The innovation program would like to build a more robust infrastructure that could enable it to test new ideas more accurately and efficiently. This would allow it to test the proof of concept models of new projects quicker. Robert Klempfner talked about the importance of a thoughtful and strategic approach toward sequencing the innovations that are taken forward: "I think we will witness a growing number of tools that are integrated into the EMR. I think we'll do it in a stage process, so we'll start with the less dangerous, so to speak, tools. Initially, we're not planning to have an autopilot medical doctor currently. We'll probably see more success initially when you have digital signals, imaging, retina, ECG, CT, MRI, EEG, stuff like that. That's probably where we're going to see more and more success stories, and the way to integrate them and the use cases will probably evolve, and the appetite will gradually increase, and we have to be very careful not to take on projects that are very, very risky, cutting-edge, most likely to fail and create this real disappointment for this whole domain or this branch of science."

For Nisim Rahman, the future of improved care encompasses integrating datasets beyond the hospital: "The vision is that all the digital processing related to the hospital will work together. I can give you an example - maybe in the next year or end of next year, I'd like to offer the patient a better service. For example, if I know at what time he leaves his house, I can tell him which bus to take and where to get off, or if he comes with his car, I can let him know where he can park the car. And then I can say to the doctor in the department, 'your patient is going to be at your desk in 10 minutes,' and when the patient comes to him, the doctor will have all the data that he needs for that patient."





# Acknowledgement

This case study was produced by the Institute of Global Health Innovation (IGHI) at Imperial College London. It has benefited from the support and financial sponsorship of EY. IGHI would like to thank all interviewees who made this case study possible:

- ▶ Dr. Nathalie Bloch, Former Head of the Big Data and AI Innovation Hub, interviewed on 21 October 2020
- ▶ Dr. Jeanette Tuval, Chief Operating Officer of the Hub, interviewed on 14 October 2020
- ▶ Professor Robert Klempfner, Clinical and Scientific Director of the Hub, interviewed on 19 October 2020
- ▶ Dr. Sigal Sina, ARC Chief Data Scientist, interviewed on 19 October 2020
- ▶ Nisim Rahman, Data Architect and Team Lead, interviewed on 20 October 2020
- ▶ Dr. Avi (Abraham) Tsur, OBGYN expert and Director of the Women's Health Innovation Center, interviewed on 22 October 2020

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EYG no. 002882-21Gbl

BMC Agency  
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