Healthcare Israel

IDB

The Implementation of a National Health Information Exchange Platform in Israel

DIGITAL HEALTH CASE STUDIES

EDITION 03

Acknowledgments: We want to thank everyone who invested their time and effort and shared knowledge to make this document more professional and detailed.

The author wishes to thank the following people for their contributions and remarks:

- **Hagai Dror – Managing Director, Healthcare Israel**
- **Dr. Izhak Zaidise – Chief Medical Officer, Healthcare Israel**
- **Mrs. Mali Shapira – HIE Division Manager, IT Department, Israeli MOH**
- **Tziel Ohayon – Sr. Sales Engineer, PH Solutions Architects, DB Motion - All Scripts**

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ABBREVIATIONS

ATD	administrative information systems
C4I	command, control, communication, computers, and intelligence
CT tests	computerized tomography tests
EHR	electronic health records
EMR	electronic medical records
FHIR	Fast Healthcare Interoperability Resources
G2G	government to government
GDPR	General Data Protection Regulation
HCI	Healthcare Israel
HIE	Health Information Exchange
HIPAA	Health Insurance Portability and Accountability Act
HMO	health maintenance organization
ICD	International Classification of Diseases
INCD	Israeli National Cyber Directorate
IOC	indicators of compromise
IR team	incident response team
ISO	International Standards Organization
MI	myocardial infarction
MOH	Ministry of Health
NGO	nongovernmental organization
OECD	Organization for Economic Co-operation and Development
PACS	picture archiving and communications system

PREFACE

Healthcare Israel as part of The Israeli Healthcare System

Healthcare Israel (HCI) is a government agency created by Israel's Ministry of Health (MOH) in 2016 to deliver lifesaving and cost-saving healthcare innovations, technology, and expertise to the world—government to government (G2G). Its mission is to promote broad and long-standing cooperation between the MOH and partner governments and increase health system exports through tri-sectoral collaborations between governments, health systems, and the healthcare industry to make the world a healthier place.

HCI is a public agency with a start-up's soul. It brings life-saving Israeli healthcare technology and innovation together with the policies and regulations required to move them forward; the training, systems, and expertise needed to implement them; and the foreign governments that have the desire and resources to acquire them. HCI also brings Israeli private sector healthcare leaders and public health organizations under the government's umbrella to shorten the tendering process, facilitate multilayered partnerships, and deliver unique G2G solutions.

Given Israel's small size, many of the international governments and countries that HCI works with are much larger geographically, with much bigger populations and far bigger national budgets.

Israel has created a world-class healthcare system: it has a 90 percent patient satisfaction rate at home, top-tier rankings by international health measures, one of the world's lowest costs per patient, and a world-class community and primary care system.

The country has also become a leading developer and exporter of life-saving healthcare technology, training, systems, policies, medical equipment, and expertise.

Hagai Dror
Managing Director at Healthcare Israel

EXECUTIVE SUMMARY

The Health Information Exchange (HIE) is one of the main national digital health infrastructures of Israel's digital health strategy, which is led by the MOH. From the early stages of the HIE's planning, the MOH emphasized the importance of not only technology but also the health system's structure and budget constraints to generate higher HIE usage rates and, therefore, better results for patients.

When the HIE was conceptualized, most Israeli health organizations used electronic medical records (EMRs). This situation had three main limitations: (1) a patient's complete medical history was not available to all caregivers and providers, as EMRs contained only an individual organization's data, (2) the absence of patients' complete medical histories led to providers requesting unnecessary tests and procedures, and (3) the absence of complete medical histories also meant that medical teams providing emergency care did not have access to life-saving information about the correct course of treatment for patients needing specialized care.

Moreover, the incorporation of EMRs into an HIE involves technical, terminology- and security-related challenges. For example, different organizations may use different names for the same diagnosis or procedure, but it is important that all organizations using the HIE speak the same "language" if an HIE is going to function. Also, privacy and security issues must be considered to be sure that medical information is shared in only the most secure way that prevents private patient data from reaching the wrong hands.

Israel's first implemented an HIE, called Ofek, in the hospitals of Clalit Health Systems, which is Israel's largest health maintenance organization (HMO), and then expanded it to community care providers and, ultimately, national use. Ofek contained a minimal dataset that was decided on by Clalit's physicians and medical teams in its hospitals and community clinics in an effort to make the HIE more accurate and efficient. Using the lessons learned from Ofek's structure and implementation, which revealed gaps and missing data, Israel's second HIE version—Eitan—was developed with expanded capabilities and data.

The Eitan implementation was challenging and included very close collaboration with all stakeholders. But stakeholders' understanding of the HIE's importance has been the main reason that all health organizations in Israel now use it as part of their day-to-day work. To help organizations meet the costs of implementing the HIE, the MOH offered a financing incentives program. Since the implementation, clear improvements in the measurements that affect health organizations and each patient in Israel are visible.

The HIE's architecture accounts for organizational concerns about data ownership, privacy and security, and, of course, the Israeli healthcare system's structure. Furthermore, Israel has invested in addressing problems with differing terminologies within partnering systems to ensure fluent, smooth operations at each point of care.

Following the success of the nationwide HIE design, build, and implementation, work continues on monitoring and improving the platform, including adding new capabilities. The MOH's plan for the future of the HIE contains new developments and features, and that plan is revised each time the MOH updates the national digital health strategy, that is updated from time to time according to the developments in the field.

1. BACKGROUND

1. BACKGROUND

The Israeli HIE model is deeply rooted in the country's healthcare system. To understand the importance and success of the HIE, it is necessary to understand its evolution into its current structure. This knowledge will help countries adopting the HIE understand the steps involved in bringing the HIE to a national scale.

1.1. The Israeli Healthcare System

Israel has created a world-class healthcare system. All healthcare services are provided by HMOs (officially called "health funds"), which have about a 90 percent patient satisfaction rate (Myers-JDC-Brookdale, 2020), top-tier rankings according to international health indicators, and impressive treatment statistics—Israel's life expectancy is among the highest worldwide. The highly developed primary care system has also been praised by the Organization for Economic Co-operation and Development (OECD) as "excellent" (OECD, 2012). Israel also led the world in introducing open access to COVID-19 vaccines for every citizen.

The following Israeli health indicators are from OECD Data (2021):[1]

- **Life expectancy:** 82.8 years (Men 80.7, Women 84.8) (2020)
- **Infant mortality:** 3.1/1,000 live births (2019)
- **Years of potential life lost:** 3,175/100,000 inhabitants (2018)
- **% of daily smokers:** 16.4 percent (2019)
- **Overweight or obese:** 56 percent (2020)

1.1.1. Organization

The National Health Insurance Law ensures each resident access to universal healthcare that includes a comprehensive basket of health services regardless of a patient's gender, religion, age, location, ethnic background, income, or current state of health. The MOH is responsible for the health system's policy setting, regulation, budgeting, planning, and control, and it runs the public health services.

The provision of health services is delegated to four not-for-profit HMO-like organizations (Ministry of Health, n.d.a.). Each Israeli resident is registered in one of the four and can readily move between them, regardless of the individual's medical conditions or income level. The HMOs provide two types of medical services—primary care services and community services—that are determined by the National Health Insurance Law and are updated yearly. Primary care services and ambulatory specialist care are provided and financed by the HMOs in a community. Primary care is usually delivered by family medicine specialists, primary internists, and gynecologists, and according to Rosen (2011), the services are readily accessible. Community services include primary care physicians, specialists, other community-based services, and emergency centers that operate 24/7, which relieves the burden on hospitals' emergency rooms.

Most general hospitals are non-private and owned by the MOH, HMOs, or other NGOs. The clinical quality of the general hospitals in Israel and their facilities are very good. One Israeli hospital has been selected by the magazine *Newsweek* as one of the world's 10 best hospitals of 2021 (*Newsweek*, 2021). There are a few private general hospitals that, as of 2021, make up about 3 percent of Israel's total number of hospital beds (Ministry of Health, 2021). The rehabilitation, geriatric, and psychiatric hospitals are owned by public or private organizations and accept mostly public patients.

[1] Data retrieved from the OECD, https://data.oecd.org/searchresults/?q=

1.1.2. Financing

The healthcare system is financed primarily through a combination of general taxes and health-specific payroll taxes. The taxes are collected by the government, which then pools the resources and allocates them to the HMOs according to a capitation formula. The formula considers the number of patients in each HMO and the patients' age mix, gender, and place of residence to distribute health resources adequately, fairly, and efficiently. The health payroll tax is usually 5 percent of the individual's income, with a discount for low-income families. Citizens pay small co-payments for ambulatory services and prescription drugs, and there is a cap on co-payments for heavy users of services and medications (Commonwealth Fund 2020).

Hospitals are financed through the services they supply to the public, which are paid for by the HMOs and some government subsidies. Some NGO-owned hospitals (which are not part of HMOs) are allowed to accept private patients.

1.1.3. Quality Measurement

Israel measures how well its healthcare system serves patients and publicly publishes quality measurements, (Ministry of Health, 2019) service indicators (such as waiting times), and patient satisfaction rates (Ministry of Health, 2019). Patient satisfaction across all HMOs is regularly monitored and averages around 90 percent. (Myers-JDC-Brookdale, 2020)

Primary care is periodically assessed through national quality indicators, and the results are transparent to the public. The OECD observed that "Israel's primary care services focus on preventive care and patient follow-ups based on extensive quality monitoring indicators, providing an exemplary model to other countries" (OECD, 2016).

The government-designed quality indicators that hospitals use are determined yearly (Table 1), and patients and health professionals can access the quality results online to review a hospital's ranking in relation to other organizations. This process gives patients a voice and a choice in the quality of their healthcare and gives providers the incentive to improve.

In summary, the combination of universal care through the National Health Insurance Law, the wide package of services, strong community care, and excellent hospitals led by the MOH and the four HMOs makes the Israeli healthcare model unique in quality, cost-effectiveness, efficiency, patient outcomes, patient satisfaction, and world rankings.

TABLE 1:
A Sample of Hospital Quality Indicators Program Data, 2013–2019

	2013	2014	2015	2016	2017	2018	2018
Acute Myocardial Infarction (AMI)							
PCI within 90 minutes for patients presenting with STEMI	68%	79%	86%	90%	91%	91%	92%
Percent of patients with ACS given a recommendation for aspiring at discharge	95%	96%	97%	98%	Disc.	Disc.	Disc.
Providing hospital with ECG results of patient with suspected STEMI before arrival to hospital					90%	92%	94%
Percent of patients with chest pain suspected as cardiac event who received aspirin (pre-hospital)				95%	96%	90%	94%
Percent of patients with ACS receiving recommendation for intensive statin treatment upon discharge from hospital					90%	93%	95%
Cerebral Vascular Accident (CVA)							
Median time to Head CT/MRI after arrival at hospital for patients with acute ischemic stroke			55 min.	38 min.	33 min.	29 min.	28 min.
Intravenous thrombolytic treatment (IV rt-PA) and/or mechanical embolectomy for acute ischemic stroke (gross volume)			857	1180	1393	1638	1735
Duplex carotid ultrasound performed within 72 hours of admission to ED for patients with suspected TIA			50%	73%	79%	83%	84%
Performing a Functional Assessment upon admission and discharge to rehabilitation departments after Acute Ischemic Stroke			75%	91%	95%	96%	95%
Patients with suspected CVA who received stard CVA evaluation in the ambulance during the transfer to hospital				82%	96%	96%	97%
Hospital preliminary notification of patients with suspected CVA by ambulance crew					93%	93%	93%

Source: The National Program for Quality Indicators (MOH 2020).
Note: **Teal shading** = did not reach the compliance target (for that year); **grey shading** = reached the compliance target (for that year); **no shading** = compliance target was not set. **PCI:** Percutaneous coronary intervention, **STEMI:** ST-elevation myocardial infarction, **ACS:** Acute coronary syndrome, **ECG:** Electrocardiogram, **CT:** Computerized tomography, **MRI:** Magnetic Resonance Imaging.

2. INTRODUCTION

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2.1. The Israeli Digital Health Strategy

To achieve Israel's digital health transformation, the MOH built a national strategy for digital health, which was approved in 2018 through a government resolution (Ministry of Health, 2018b). The strategy's implementation included building a core infrastructure, as designed by the ministry, to support the strategy.

2.1.1. The Core Infrastructure of the Digital Health Transformation

The national strategy for digital health centers on the digital health transformation. The main goal is to achieve **participatory, patient-centered health** that establishes patient health as a partnership between healthcare providers and patients. Patient-centered health includes exploring data and communication-based methods and options to empower patients to make more informed choices regarding behavior and treatment options that are suited to their condition and play a more active and participatory role in their healthcare. This means providing patients and the public access to information that until recently was available only to health professionals.

The core transformations consist of the following four major healthcare service principles (Figure 1):

- Personalized Medicine
- Health Promotion (Preventive, Proactive, Predictive Health)
- Sustainable Health
- Online Health

Personalized Medicine is the ability to provide medical care that is tailored to the needs of individual patients. **This type of medical care presupposes two complementary components:**

- Research based on Big Data that allows retrospective identification of correlation patterns between successful treatment protocols using large data aggregations
- Accessibility of the data concerning a specific patient and his/her medical history

The two components combine to make it possible to compare a single patient's data with patterns identified across a data set or an entire population. Access to this data prevents inappropriate diagnoses and treatments, reduces unnecessary patient suffering and negative outcomes, and enhances the effectiveness of treatment—while reducing costs (Ministry of Health, n.d.b).

Health Promotion (Preventive, Proactive, and Predictive) reflects the idea that healthcare is moving away from the artificial, binary distinction of health or sickness toward a broader concept of a spectrum of health. At each point along this spectrum, it is possible to promote patient health, reduce the risks of specific illnesses, or delay the onset of medical crises as long as possible to improve quality of life. The key is to use data to predict, prevent, and provide proactive medicine before patients suffer unnecessary or preventable medical crises.

Sustainable Health is a healthcare transformation that maximizes the benefits of existing resources within a healthcare system in sustainable ways. Examples include using telemedicine or changing work procedures in emergency rooms based on a quantitative assessment of processes and an understanding of blockages and bottlenecks.

Online Health empowers health professionals, health providers, and patients by making digital health information available online. As an example, the country's insurance organizations have online sites[2] for people to access their medical records. Figure 1 shows the infrastructure that supports the four cores of digital health transformations.

[2] For example, see https://mac.maccabi4u.co.il/, https://e-services.clalit.co.il/onlineweb/general/login.aspx, https://login.meuhedet.co.il/account/login/strong, and https://online2.leumit.co.il/online/login/Login.aspx.

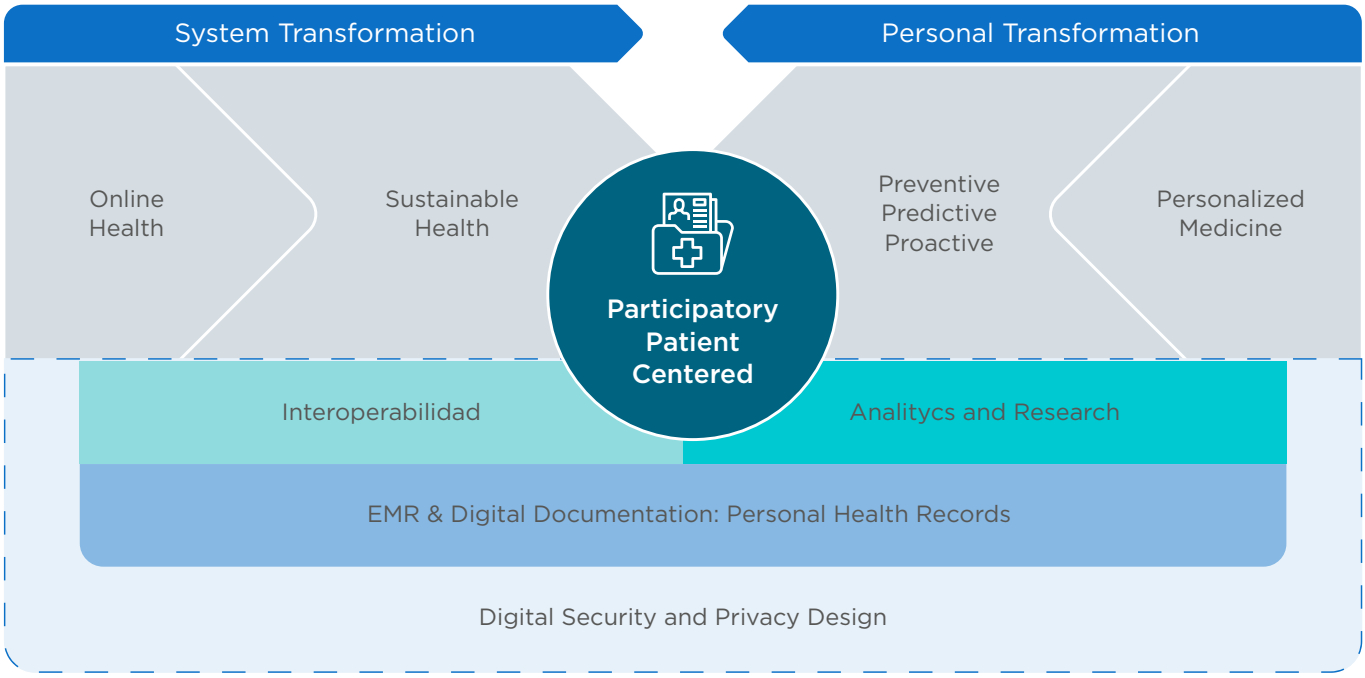
2.1.2. Digital Security and Privacy by Design

The digital security and privacy layer of the national digital health strategy includes cybersecurity and privacy considerations that are taken into account as each of the above transformations is implemented. This layer has two goals. The **security goal** is to ensure that the system is working as expected at all times so that core intellectual property is not infringed upon. The privacy goal is to ensure that patient data and intellectual property are kept according to relevant standards (HIPAA [Health Insurance Portability and Accountability Act], GDPR [General Data Protection Regulation], etc.). Therefore, we incorporate privacy and security standards at all phases of system design, from the planning stage through to implementation.

While cybersecurity is an integral part of every project, some cybersecurity elements need to be addressed independently. **These elements, which mainly exist on the national level under the responsibility of the INCD and the MOH as part of the national health cyber infrastructure, include:**

- Formulating and issuing guidelines and policies for managing privacy and security risks
- Implementing general IT security standards focused on cloud security, endpoint protection, DOS (denial-of-service) threats, and ransomware mitigation.
- Setting up designated sectoral C4I (command, control, communication, computers, and intelligence) capacities such as having a security operation center, gathering cyber-intelligence, monitoring organizational networks (including specialized protocols and IoT devices), distributing IOC (indicators of compromise) and sharing sectoral information, and ensuring interoperability with peer and national cyber agencies.
- Establishing situational digital awareness by having a playbook of cyber situations to be ready for.
- Offering awareness training for the general workforce and designated capacity building for cybersecurity teams on topics such as phishing attacks, secured passwords, social networks, and more.
- Using incident response (IR) teams and building their capabilities, with each organization responsible for its IR team.

FIGURE 1:
Core Digital Health Transformations



Source: Internal Ministry of Health presentation.

2.1.3. Building the Digital Health Transformation's Infrastructure

It is widely accepted that digital health transformations offer dramatic changes and great benefits to citizens, health care ecosystems, and the governments that invest billions of dollars in them.

At the core of the digital health strategy are three gradual, information-based transformations:

1. Collecting medical information in EMRs and digital documentation.
2. Ensuring the medical systems' interoperability.
3. Analyzing and researching health data.

The foundation for all subsequent digital health transformations is the **collection of medical information in EMRs and digital documentation** for every point of a patient's care. The clinical information is collected by EMRs and administrative information systems (ATD\ADT) at hospitals, community clinics, primary care physicians, specialist clinics, and other settings. There is a wide spectrum of EMR and ATD systems in Israel and other countries, from small open-source solutions for doctors or specialist clinics to huge commercial solutions for hospitals networks and HMOs, so specifying the requirements and choosing the right solution is very important for a successful transformation. Privacy and security considerations should also be put into place regarding collecting, saving, and using the data.

The second transformation is **ensuring the medical information systems' interoperability**. Interoperability has a lot to do with all relevant stakeholders in the healthcare system being able to share clinical information, but it also has to do with allowing the stakeholders to operate in seamless, continuous integration from the patient's point of view. This ability is crucial if medical systems are to achieve continuity of care and give doctors a full picture when treating a patient. Health systems' interoperability requires the use of solutions like the HIE platform. The HIE implementation can be at the city, region, state, or country level.

The third transformation—**analyzing and researching health data**—involves analyzing relevant information for data-driven decision-making while making long-term decisions based on trends or ad hoc decisions based on online data and when researching the data to develop new treatments, protocols, medications, and the like based on Big Data tools. Those analytics and research platforms can support doctors in decision-making and support policy design through the vast array of available information-based tools (artificial intelligence, decision support systems).

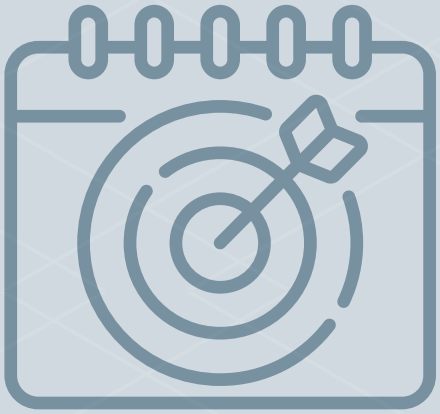
In Israel, the MOH published widespread regulations regarding the use of medical data, with emphasis on the secondary use of data (Ministry of Health, 2018a). Any clinical research involving personal data is subjected to prior approval by a Helsinki Committee that guarantees patient consent and understanding of the nature and risks of the study. Israel's HIE does not allow interorganizational clinical research across its platform.

2.2. The Role of the HIE in National Digital Health Architecture

The interoperability of medical information systems is what makes Israel's digital health strategy work. As mentioned above, the foundation of medical information systems is the proper digital collection of medical information. The foundation for interoperability is the national HIE, which is why it is a fundamental part of the nation's healthcare architecture. The HIE enables all stakeholders in the Israeli health system to access necessary medical information when and where it is needed to serve patients.

Just as public transportation and roads allow people to travel throughout a country, a modern healthcare system should provide digital infrastructure for patients' medical information to travel along with them. On the roads, all drivers are tested and licensed, and in the digital realm, all HIE operators must meet strict regulatory requirements.

The Israeli digital health strategy sees the HIE as the first step toward a properly functioning digital health system. Once the HIE platform is in place, advanced services can be added, including data collection for researchers and smart algorithms to support decision-makers. Even without adding advanced services, the Israeli experience shows the value that comes from sharing medical information through the HIE.



3. THE NEED FOR THE HIE, AND THE CHALLENGES IT ADDRESSES

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3.1. Health Services Challenges

Israel's hospitals and HMOs have used EMRs for the past three decades. All medical information for each Israeli citizen is stored by one of Israel's HMOs. From this digital starting point, Israel took the next step to leverage the power of this data.

When building the national HIE, Israel recognized three major challenges it wanted medical information sharing to tackle:

- **Challenge one: Accessing a patient's full medical history –** Each Israeli patient has a family physician who sees the patient from time to time and stays up to date on the patient's history, illnesses, medications, and medical procedures. When the patient requires hospitalization, care performed in the hospital is not under the family physician's purview. But upon patient discharge, care is ideally transferred from the hospital back to the family physician. However, it is common for care to be disrupted or ceased upon discharge. Hospital physicians commonly ask the patient to update his or her family physician upon discharge so that there is a seamless transfer of care from the hospital to the community clinic. But in many cases, patients have either not visited their family physician to continue their treatment after hospital discharge or have not brought the family physician all their discharge documents. As a result, in these scenarios, family physicians could not continue optimal treatments and patients continued to suffer and were sometimes even rehospitalized.

  An early attempted solution to this problem was for hospitals to send discharge letters to family physicians by fax. But there are clear problems inherent in this interim solution: the need for the hospital to identify the correct family physicians, the need to appropriately time the transmissions and accuracy of transmissions, and the need to have patient data readily available.

- **Challenge two: Preventing unnecessary procedures and tests –** Unnecessary procedures and tests can have negative consequences for patients' health and the financial and operational health of hospitals. Over the years, hospitals and physicians have brought up this issue, but systematic data collection has never been done. The requirement that patients bring all of their medical documents or test materials to the hospital is not realistic or practical, especially in emergencies. On the healthcare provider side, without a clear picture of a patient's medical history, unnecessary procedures and tests are often ordered at great expense to the hospital and healthcare system and at the expense of being able to move as fast as possible when doing so is critical to saving a patient's life.

  The implementation of the HIE between separate organizations addresses both the need to access all relevant data from different organizations as well as the need to prevent unnecessary procedures and save resources.

- **Challenge three: Providing life-saving patient data in emergencies –** During medical emergencies, doctors and emergency medical professionals may be unaware of a patient's medical history, allergies, or current medications (to avoid drug interactions)—which can lead to unnecessary life-threatening crises. For decades, attempts have been made to solve this age-old problem, including the Medic-Alert bracelet, created in the 1950s by Dr. Marion Collins and his family after his 14-year-old daughter suffered a near-fatal allergic reaction during a visit to an emergency room (Medic-Alert, n.d.). While a system of stamping medical information onto a metal bracelet (which patients must remember to wear) did save

lives for years, today Israel has a nationwide HIE solution that delivers critical, life-saving data when and where it is needed by patients and medical professionals, be they primary care providers, ambulatory specialists, or staff at ambulatory or hospital-based emergency centers and hospitals.

The national HIE means that patients do not have to carry around their medical files, medical professionals can obtain the critical patient data needed to save lives and money and prevent unnecessary procedures and tests, and real-time access to patient data informs and empowers medical teams to provide the right medications and treatments at the right time.

3.2. Terminology Challenges

Once information-sharing is in place, the challenge of different organizations using different terminologies must be addressed and overcome. While connecting two or more health organizations, and transferring medical data among various EMRs, it is important that everyone can understand the data. Over the years, health organizations in Israel have used different coding standards, such as ICD, Snomed, RxNorm, Loinc, and others. In addition, many organizations added custom codes and subcodes to fit their specific needs. This created challenges when integrating the systems, as it was necessary to ensure that all health organizations spoke the same "language." For example, myocardial infarction can be called "MI" in some places, "heart attack" in other places, and "myocardial infarction" in others. Accordingly, care and careful management are applied to effectively transfer data between the organizations without disrupting individual systems and standards—a balance that comes from experience over multiple integrations.

3.3. Security Challenges

When implementing an HIE, a key consideration for system architects and managers is the secure and proper use of sensitive data, such as medical information and patient data. **The architects of Israel's HIE applied the following security principles to provide protection for and careful use of sensitive medical data:**

- **No use of a central database –** Israel made the strategic decision not to save its important medical data in one central database. Central databases are ripe targets for hackers who seek to inflict maximum damage and hack the maximum data with minimal effort, so decentralized databases help protect important medical data. The decentralized architecture also addresses stakeholders' psychological barriers to adopting HIEs, as each organization (hospital and HMO) holds its own information.

- **Provision of data at the time of care only –** Israel further secures patients' medical data by ensuring availability only to specific healthcare professionals at the time of care. For instance, a patient's primary physician can have access to most of a patient's medical data, such as for better holistic diagnoses and treatments. But, when specific treatments or tests are needed, other specialists or medical team members can access only a specific patient's data, for a specific purpose, during a specific period.

- **Ensured security standards –** All data transfers and connection points between organizations must meet relevant security standards and regulatory requirements, including Israeli security and privacy regulations and international standards such as HIPAA, GDPR, ISO, and others.

4. THE ISRAELI NATIONAL HIE SOLUTION

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4.1. History

Clalit, Israel's largest HMO took the first step toward HIE use in Israel. **Clalit serves 4 million Israeli citizens, and has two main divisions:** the community division, in charge of primary care and specialist services in the community, and the hospitals division, in charge of managing the 14 Clalit-owned hospitals. **This combination of community clinics and hospitals gave Clalit a clear perspective and deep understanding of the needs of hospitals, communities, and the patients they serve.**

Prior to adopting its HIE, Clalit's community and hospital divisions used different EMRs, which served each division well but provided integration challenges. In early 2000, Clalit launched the Ofek Project, a product of the company DB-Motion to deliver the minimum necessary patient data to every healthcare provider within the HMO at every patient encounter.

Ofek defined six core principles to achieve its primary goal:

- Retrieving data from any kind of EMR through a specific interface
- Defining a minimal clinical data set
- Using patient-centric solutions
- Keeping data where it was created
- Requiring less than a 10-second response time
- Ensuring data security and privacy

The solution for the Ofek implementation was a distributed system that acted as a virtual data repository, which eliminated the need to build a central data repository. In the Ofek project, all the data was stored, owned, and maintained where it was created. Information was retrieved only when required and in read-only mode, so external users were unable to make changes in the source systems. Users needed only to build interfaces to the Ofek network. The information remained stable and secure and available for access only when and where it was needed, based on predetermined levels of access for each end-user.

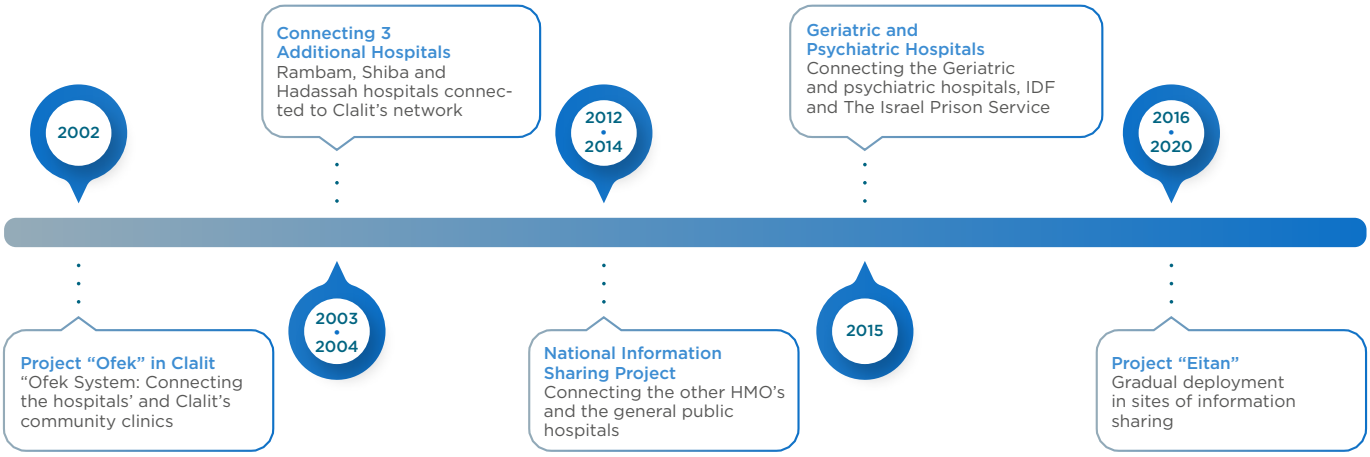
After Clalit adapted the Ofek system to its needs, it began implementing the system in 14 hospitals from 2000 to 2002, following a successful pilot project in Soroka Hospital. The next step of the implementation was to expand the HIE to Clalit's 1,300 community clinics, which was a success because of the large scale of the implementation, and then to organizations outside of Clalit.

In 2003–2004, DB-Motion expanded the Ofek network to three large non-Clalit hospitals. Over the next few years, Ofek received positive feedback from stakeholders in the health system and physicians, which brought it to the attention of the MOH. By 2010, the MOH adopted the Ofek solution, turning it into Israel's national HIE. The process of securing all of the necessary government approvals and funding took several years, but between 2012 and 2014, all HMOs and public hospitals were officially connected to the Ofek network (Figure 2).

The last phase in the Ofek project was to implement it in geriatric and psychiatric hospitals as well as in the IDF (Israeli Defense Forces) and the IPS (Israeli Prison Services). By the end of 2015, all of these organizations were connected to Ofek. For further details on the implementation and expansion process of Ofek (figures 2 and 3), see sections 5 and 6.

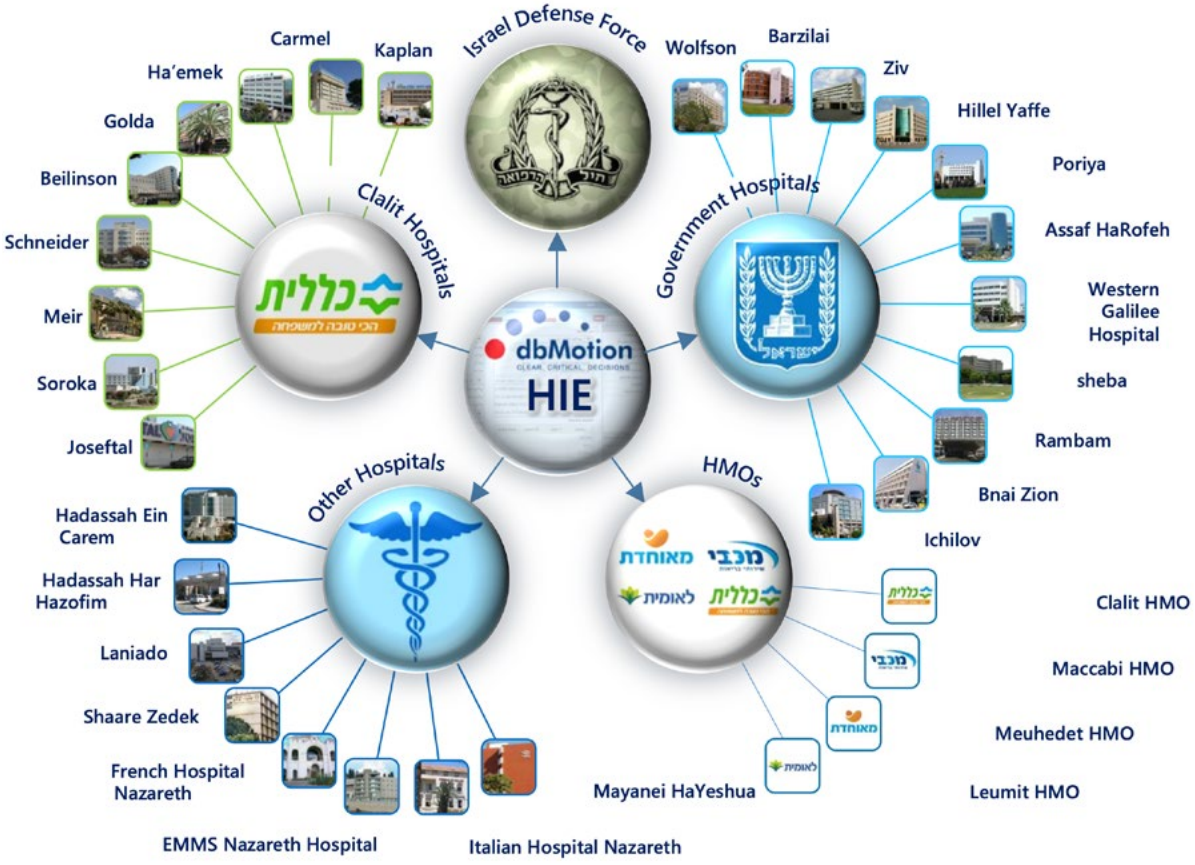
While implementing Ofek nationwide, DB-Motion and the MOH started developing the second version of the HIE, Eitan. The Eitan version expanded on Ofek's capabilities, solved some technical problems, and provided a better experience and better functionalities for users (for example, see section 4.2.2). Between 2016 and 2020, most of Israel's health organizations upgraded from Ofek to Eitan. As of 2022, the MOH has continued transitioning organizations to Eitan while improving functionality and user benefits for both healthcare providers and patients. The ministry is developing the next version of the HIE, Eitan 2.0.

FIGURE 2:
Development of Information Sharing in Israel



Source: Internal Ministry of Health presentation.

FIGURE 3:
Israel's HIE National Network



Source: Internal Ministry of Health presentation.

4.2. Architecture

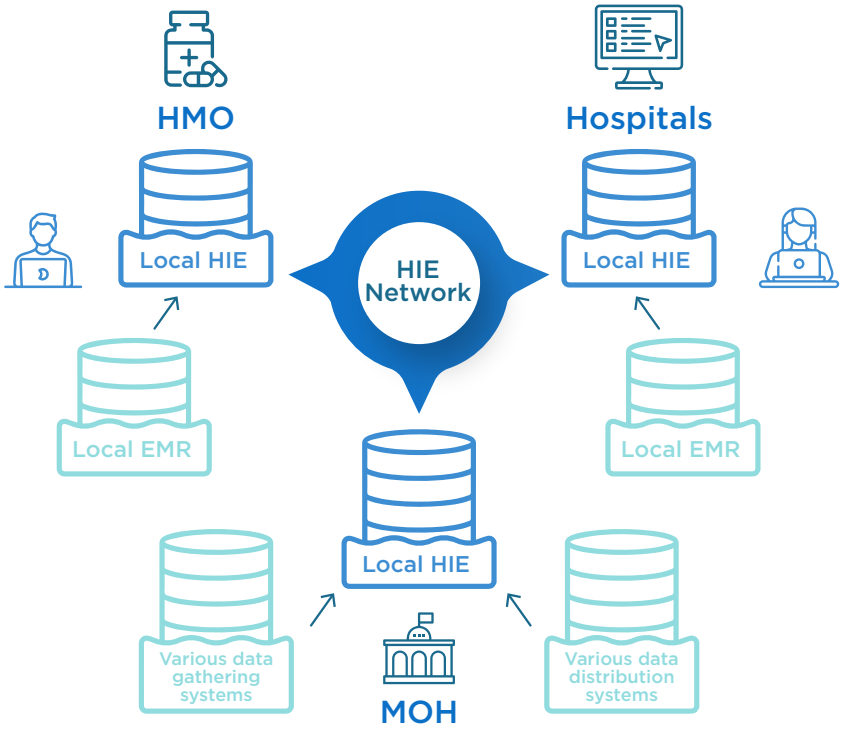
The Israeli HIE network architecture was designed to meet the security and functionality needs of patients, healthcare professionals, and the government. To avoid interruptions in clinical work and provide security, the system designers decided to collect data from a local EMR and transfer it to a local (not centralized) HIE database. The local HIE database is not an EMR replica. It holds all of the EMR data, but, in the transfer process from the EMR to the HIE, the data structure changes to the national data structure to allow for a national data sharing format.

The data transfer process from the EMR to the HIE database is fully under the control of local health organizations. Each local health organization decides which kinds of data to transfer (according to the national instructions and subject to MOH approval) and can even choose to stop data transfers entirely (opt out). However, the system designers decided that only organizations that are sharing data may receive data, so none of the organizations ever opted out.

Once the data is transferred to the local HIE database, it becomes part of the HIE network. For each public hospital and clinic (regardless of ownership), there is a local HIE database, and all network members are connected to it through an internal VPN. The connection hub is located in the MOH, and all health organizations are connected via this main junction. The MOH administers the hub but cannot gain access to data transferred through the network unless the MOH is one of the parties earmarked on a specific data request.

The data is ordered in the HIE software, and the user can see data types (lab results, background diseases, etc.) arranged by clinical domain. At the point of care, a physician can explore a patient's data from the HIE, and when the physician closes the EMR at the end of a patient visit, the patient's data from other organizations is deleted from the recipient organization. In general, the HIE data cannot be entered into receiving organizations' EMRs, except for discharge letters that by law must be delivered to HMOs.

FIGURE 4: Israel's HIE Architecture



Source: Internal Ministry of Health presentation.

4.2.1. Data Types and Clinical Domains

A major challenge in designing the national HIE was to maintain the delicate balance between using a minimal data set and providing enough clinical data. This challenge was solved by the MOH using dual-step decision-making. The first step was to decide on the clinical domains included in the project and then choose the minimal data types with the maximum value for each clinical domain. The clinical domains and data types are summarized in Table 2.

4.2.2. Eitan's Architecture

Some of the key improvements of Eitan compared with Ofek are as follows:

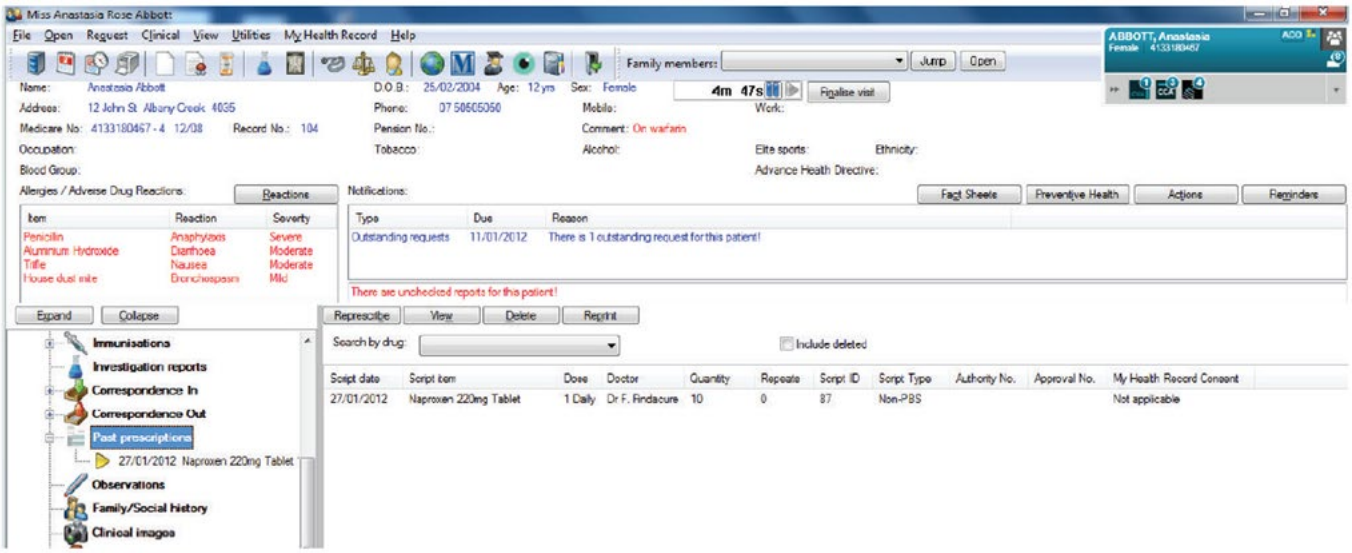
- The end-user software has been replaced with a new agent that is connected to an organization's EMR and appears above the individual EMR as a floating window. A physician can easily open and close it.
- The amount and types of clinical data used in the system have been expanded.
- It is possible to view not only the radiologist summary documents but also the PACS (picture archiving and communications system; X-ray, CT, ultrasound, etc.) files.
- An improved infrastructure supports terminology mapping and conversion as well as analytics for user organizations and the MOH.

TABLE 2: Ofek's Clinical Domains and Data Types

CLINICAL DOMAIN	DATA TYPE AND ADVANTAGES
Demography	The basic demographic details that consistently identify a patient across the network
Encounters	Encounter details are key to understanding patient activities and timelines
Diagnosis	Knowledge of previous diagnoses and existing conditions leads to better decisions for current cases
Medications	Crucial, especially in cases where the patient is not communicative
Allergies	Crucial, for avoiding incorrect medications
Surgeries and procedures	Past procedures could inform and influence current treatments and diagnoses
Laboratories	This helps avoid unnecessary lab tests and empowers healthcare professionals to compare current and previous test results
Imaging	Ability to view the radiologist summary documents and the PACS (X-ray, CT, ultrasound, etc.) avoids unnecessary imaging requests and comparisons between current and previous imaging
Pathology	Summary documents help physicians learn about historical findings relevant to current treatments

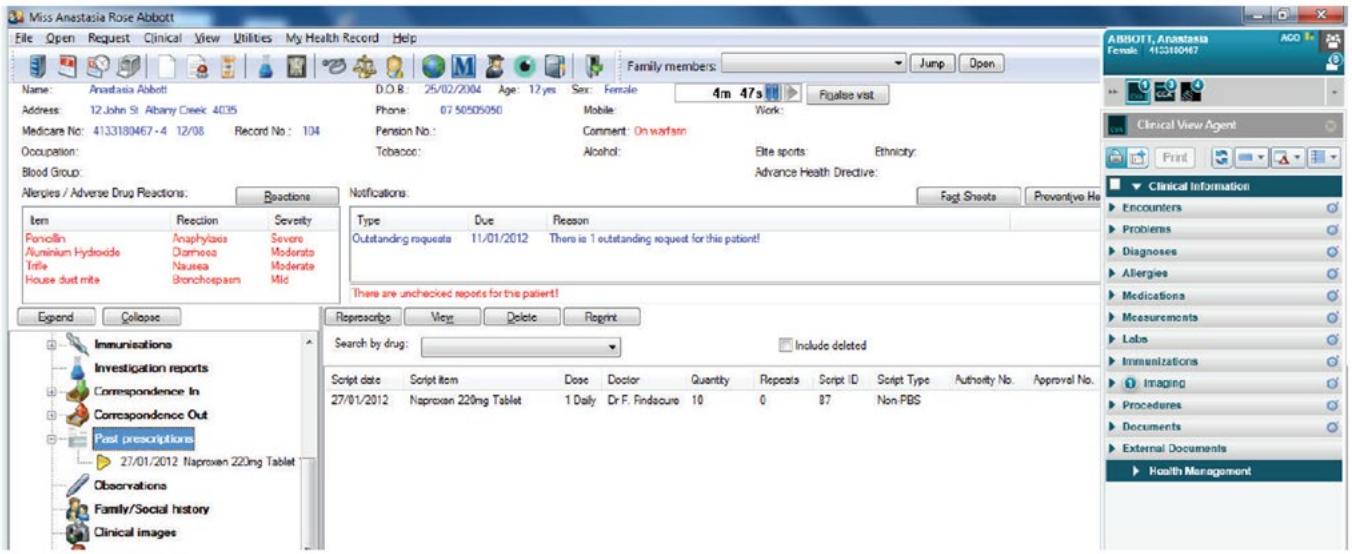
Source: Internal Ministry of Health presentation.
Note: CT = computerized tomography; PACS = picture archiving and communications system.

FIGURE 5:
Eitan's Floating Component Closed



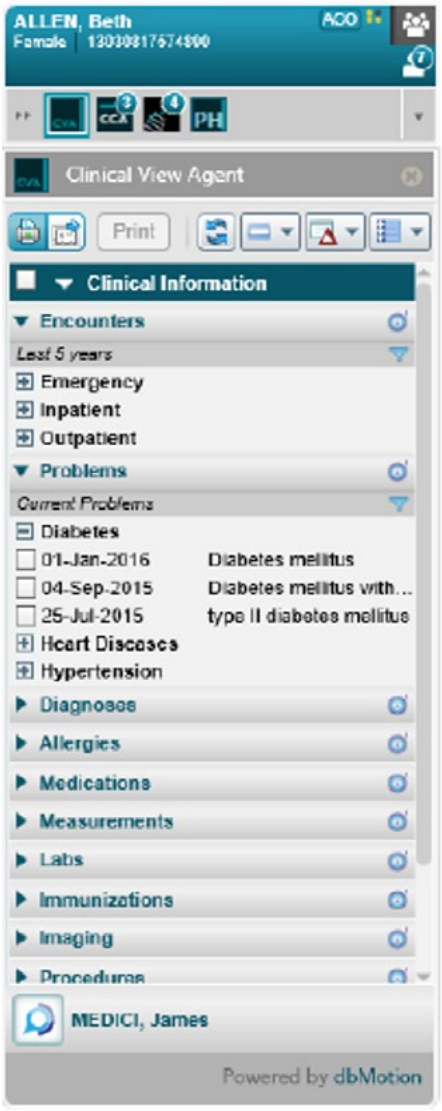
Source: Internal Ministry of Health presentation.

FIGURE 6:
Figure 5. Eitan's Floating Component Open



Source: Internal Ministry of Health presentation.

FIGURE 7: Eitan's Floating Component Internal Sections Open



Source: Internal Ministry of Health presentation.

4.3. Terminology

Once information sharing is in place during an implementation process, **the challenge of different organizations using different terminologies must be addressed and overcome**. One way to overcome it is by using Fast Healthcare Interoperability Resources (FHIR), which is an electronic standard for exchanging healthcare information and terms. FHIR is a new specification based on emerging industry approaches and informed by years of lessons learned about requirements, successes, and challenges of health data use. Given the growing importance of standardization across healthcare organizations around the world, many organizations are adopting the FHIR standard.

When Israel began implementing the HIE platform, though, the FHIR standard had not been created, so there was a need for another solution.

The goals in adopting a solution were:

- Integrate data between organizations and between systems within each organization.
- Transfer data to the EMR.
- Organize and group the data.
- Analyze and gain insights from the data.

The terminology issue was addressed by using technology and forming a professional committee to map and define terms. The technology solution became a central component of the HIE within the MOH, and it is responsible for including each local phrase (diagnosis, procedure, etc.) in a baseline catalogue of terms. When a local organization or healthcare provider seeks medical data, the request is filtered through a central catalogue that converts it into a locally recognized term. This way, local organizations can continue to use localized terms without having to change their EMRs or workflows. The team is working to build a comprehensive terminology solution.

For a central terminology catalogue to work, the converting mechanism must be very accurate. To achieve this level of accuracy, the MOH formed a professional committee divided into three subgroups. The first consists of leaders from the MOH. The second (the Mapping Group) is a subgroup of specialists that includes physicians, a medical registrar, a laboratory worker, a pharmacist, and medical students and is led by a specialist in internal medicine. The third subgroup consists of hospital

and HMO representatives. As the groups worked together, they found that 50 percent of the phrases covered 95 percent of the cases, so they focused on mapping those phrases. Once the mapping was done, data was shared with hospitals and HMOs, feedback was gathered, and the catalogue was clarified and refined. **This work is still in progress, so the final report has not been published. Many sections are still being revised.**

4.4. Security

The security and privacy components in the HIE network were a major part of its design and architecture. The security components were designed to meet the requirements of the MOH's chief information security officer as well as other regulatory agencies including the Israel National Cyber Directorate[3] and the Privacy Protection Authority.

The key security requirements were:

- There is no central repository (clinical database).
- Data from the EMRs or the HIE cannot be used for medical research unless previously approved by the Helsinki Committee.
- Data is accessible to the medical team during the treatment period and for a limited period afterward.
- Central profiles and permissions apply to any user nationwide.
- All actions are monitored (user, data type, timestamp, etc.).
- Classified data are filtered (set a classified encounter or set permissions only for certain users). For example, all psychology encounters and data on abortions are classified.
- The infrastructure is secure (encryption, secure communication).
- There is an opt-out option for patients who do not want to share their data (according to MOH instructions, the default for all patients is in, but there is an option to opt out).
- The HIE solution is developed and implemented in accordance with these security requirements, making sure the provider works closely with the MOH's chief information security officer and the cyber team throughout the process.
- The implemented security measures include other components (role-based approach, data classification with confidential information options, opt-out models, centralized logs, and more).

[3] Government of Israel. "Israel National Cyber Directorate." https://www.gov.il/en/departments/israel_national_cyber_directorate/govil-landing-page.

5. THE ISRAELI NATIONAL HIE IMPLEMENTATION

5. THE ISRAELI NATIONAL HIE IMPLEMENTATION

5.1. Implementation Methodology

The implementation of the Israeli HIE involved health organizations right from the beginning. This increased organizational buy-in, helped overcome objections, and made each organization an important part of the process rather than a recipient of government mandates.

The MOH's first implementation step of the national platform was a kickoff meeting with executive managers in each health organization before the implementation got underway. In this meeting, the MOH's team presented the project, its vision and purpose, and the responsibility of each partner (MOH, health organization, software provider). The MOH started the implementation with the early-adopter organizations while encouraging others to join them. **After the kickoff, while the implementation process was getting underway, the health organizations were responsible for the following functions:**

- **Agreement –** Signing an agreement to formalize the organization's participation containing the commitments made by all parties to the implementation process
- **Infrastructure –** Supporting the technical team with the installation of local servers and paving a line of communications to the MOH datacenter
- **Development –** Developing an interface between the local EMR and the local HIE (together with the local EMR provider)

Throughout the process, the MOH team worked closely with each organization's team to define timelines and provide help with any questions or challenges in the implementation process.

5.2. Key Takeaways of the HIE Implementations

A key takeaway from Israel's Ofek and Eitan implementations is the need for transparency and sharing of all information on the hospital's implementation planning during the implementation process. When all stakeholders felt they were part of the decision-making team, and that they played important roles with real influence, the implementation process moved forward smoothly.

Another takeaway is **the importance of listening to employees to understand their needs**. Doing so helped the employees adapt to the new system and quickly resolve their concerns. For instance, when Ofek was first implemented in most health organizations, the physicians saw it as a critical system like EMRs, even though the MOH's original plan did not classify it as such. The organizations and the ministry had to reconsider their classification upon receiving the many complaints filed by the physicians on the essentiality of the HIE for their daily routines, especially in emergency situations.

A third takeaway, from the Eitan implementation, is **the importance of a friendly user interface** (see figures 5, 6, and 7). The Eitan system is more complex than its predecessor and adds important functionality, which also increases the need to simplify and improve the user interface.

5.3. Incentives

The implementation of a new core system can be a challenge for any organization, but especially for health organizations, which are usually very conservative. The Ofek implementation was remarkably smooth because the organizations clearly understood how its benefits met their needs, so they were eager to move forward with implementation. The Eitan implementation was more complex. Health organizations had to upgrade their infrastructures (servers, interfaces, and more), so several organizations delayed implementing the new version—partly because Ofek was already better than anything that had preceded it and partly because of the costs (time and financial) of upgrading or changing the infrastructure. (The implementation timeline is shown in Figure 2, and the process is detailed in section 4.1.)

To address the financial issue, **the MOH decided to provide a grant to health organizations to cover the cost of infrastructure upgrades and connection to the new HIE.** Grants were given based on the speed of the Eitan implementation: 100 percent funding for organizations that implemented in the first three months after kickoff, 75 percent for organizations that implemented in four to six months, 50 percent for implementation in seven to nine months, 25 percent for implementation in 10 to 12 months, and 0 percent for organizations that delayed implementation past one year.[4]

This incentive model succeeded in motivating several organizations to focus their efforts, build their infrastructures, and implement in a timely manner. Approximately 25 percent of organizations received the full grant amount. **Some organizations have not yet chosen to join the new system, so work continues to help more organizations enjoy the added benefits of the upgraded HIE network.**

[4] From an internal MOH document.

6. EVALUATION OF RESULTS

6. EVALUATION OF RESULTS

To measure and evaluate the results and value of the Ofek HIE, the MOH studied the results between an experimental group of users and a control group. The study shows that the implementation improved clinical as well as administrative results by reducing unnecessary tests and hospitalizations. In the first case it is important to balance the clinical need vs the patient safety and patient satisfaction. While it is necessary to take a blood tests and imaging for a better diagnostic and care, if there are tests and imaging data already available to the physicians, patients do not have to suffer from unnecessary tests or unnecessary exposure to radioactivity. **Also, unnecessary hospitalizations can expose patients to infections and decrease their satisfaction.**

Administrative effects can be measured as cost savings since unnecessary tests or hospitalization days generate unnecessary costs for the payers and the insurers. **The main results of the study are shown in Table 3 (Nirel et al., 2010).**

TABLE 3:
Results of the experimental study of Ofek

SERVICE CATEGORY	**RESULTS** (experimental versus control group outcomes)
Lab tests	6% decrease in the experimental group
	2%–11% overall decrease
CT tests	20% decrease in inpatient CTs
	30% overall decrease in three CT test groups
One-day hospitalizations	Significant decrease in the average number of one-day hospitalizations in the experimental group. (Decrease of 83% in average one-day hospitalizations in the treatment group compared to the control group.
Anecdotal evidence in the treatment group	Improved diagnostic accuracy
	Improved service efficiency
	Easier access to clinical information
	Fewer redundant lab tests
	Shorter waiting times for care
	Improved interdisciplinary hospital communication

Source: Nirel et al., 2010.

7. REFLECTIONS AND RECOMMENDATIONS

7. REFLECTIONS AND RECOMMENDATIONS

7.1. Recommendations

- **Stakeholder management –** Each country and region may have different stakeholders, preconditions, and policy considerations that must be considered when implementing a digital health solution like an HIE. A key lesson from Israel's HIE implementation is that the first step should be to understand the healthcare ecosystem, especially in three main areas:

  - » Health system structure (including the regulation, policy, and billing models)
  - » Existing IT systems in health organizations (including EMRs, terminologies, and interoperability options)
  - » Security and privacy requirements and regulations

  After key information is gathered and the next steps can be planned, it is important to involve stakeholder representatives to increase buy-in, which facilitates the implementation, and provide feedback on ways to improve the system.

- **Main components of the HIE solution –** Another key finding from the Israeli case is that the planning process must consider all the aspects of the HIE solution and be able to divide it into three main components: terminology solutions, regulation and instructions adjustments, and technology and integration solutions.

- **Architecture –** The solution architecture has to serve all or most of the stakeholders' interests. As became clear in Israel, the architecture is what persuaded health organizations to join the national HIE. The decision to avoid a central database, for instance, helped the organizations feel more confident that their data would stay on-site and not be copied or amended by others.

- **Security and privacy –** It is very important to combine the security and privacy components at the design stage of the new HIE. The security and privacy design has to support and secure the data but not disturb the functionality or effectiveness of the solution. For instance, as seen in Israel, the decision to use an opt-out model, even though it is sometimes better to use an opt-in model for privacy protection, made the platform very effective from day one.

- **Terminology –** Terminology issues can be a significant barrier to implementing an HIE. The more EMR systems are in use, the more terminology becomes a major issue. Using a terminology mapping and conversion mechanism from the beginning of the HIE project can help more organizations join HIE initiatives and help simplify and smote the implementation.

- **Implementation partners –** Choosing the right implementation partners can be critical to the success of implementing a national HIE. Once the plan for a national HIE is in place—and stakeholders have been involved from the beginning—the next recommended step is to identify and choose implementation partners who will be the early adopters, meaning those who will begin their implementation quickly and be able to showcase the system's benefits.

- **Incentives for health organizations –** To ensure that health organizations' successes and commitments are sustainable, it is recommended that health organizations taking part in the implementation sign an agreement committing the organization to the implementation process. To further aid organizations and ease the implementation, we recommend using incentive models to attract early adopters and maintain interest throughout the implementation.

In summary, the **end goal of the implementation process is to create a win-win-win situation**—for frontline healthcare providers, healthcare systems and organizations, and—especially—patients. This is happening today in Israel, as demonstrated by the Israeli HIE case that shows **it is possible to implement a national HIE solution while improving services and achieving the support of medical teams.**

7.2. The Future of the HIE in Israel

The HIE implementation in Israel **enables the MOH to use this infrastructure and continue developing more advanced services**. When Israel started to plan the national HIE program, it had a road map of the advanced services and capabilities that used the HIE as a national platform.

The following are some of the features that were planned. Currently, the MOH is considering the right way to implement these features or adjust them:

- **HIE everywhere –** To provide a mobile version of the EMR agent that allows medical staff to access medical information anytime, anywhere
- **Care communication platform –** To allow direct communication between caregivers from different hospitals or community doctors and the hospital, which is vital to continuity of care
- **Personal health records at the palm of your hand –** To allow patients to access their complete medical data anytime, anywhere using the HMO's portal, the HMO's mobile application, or a dedicated flash drive
- **Decision support system interoperability at the point of care –** To allow seamless integration and full interoperability of third-party decision support systems at the point of care
- **IoT repository –** To handle information generated by medical devices and the IoT
- **IoT visualization and analytics –** To allow visualization and analytics of continuous data from medical devices at the point of care.

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