

HEALTHCARE 4.0

by Michele Buono

in collaboration with Andrea De Marco – Simona Peluso – Sara Piazza

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SIGFRIDO RANUCCI IN THE STUDIO

We followed the anti-fraud inspectors from the Ministry of Agriculture to see if the oil that arrives on our tables really is extra virgin olive oil, as is written on the label, or whether it is better suited to use in an oil lamp. But we'll look at this after tonight's extraordinary investigation, which also serves as a proposal to the Minister of Economic Development, Luigi Di Maio, to Giulia Grillo, the Minister of Health, and to all the governors of the various regions: save 15 billion euros a every year, with healthcare version 4.0. Imagine if our frail older generations could simply swallow a pill containing a number of sensors, which could constantly track their health, and alert relatives or doctors if they found something wrong. Imagine a future where there are no longer files on the shelves of your family doctor's consulting room, because all consultations could be done via telemedicine, and prescriptions could be sent via the cloud, and be read in any pharmacy in Italy. Imagine a future where there are no files in A&E or in the waiting rooms of state-run specialists clinics, because diseases like heart disease, allergies, hypertension or diabetes could be monitored from a distance. Or that the progression of various degenerative neurological conditions or the outcomes of a surgical operation could be checked. Imagine, too, that cancer patients feeling a little lost could consult a database and find another patient who has had the same disease as them, and who has made it through to the other side. Imaging being able to choose the best treatments. Being able to choose, perhaps, to be operated on by a robot that uses a laser instead of a scalpel, guided by the hand of a surgeon - the best there is - from the other side of the continent. It might sound like a utopian fantasy, but the good news is that all of this exists already. We simply need to break down the barriers that currently exist within healthcare, and create a network. We have the skills, we have the technology. The magic word, or rather the magic words, are: predictive medicine, intelligent hospital. Healthcare 4.0, as explored by our Michele Buono.

PAUL YOCK - DIRECTOR OF THE BYERS CENTER FOR BIODESIGN, UNIVERSITY OF STANFORD

Almost twenty years ago, we only made implantable technologies, such as pacemakers, valves, catheters. Now, we create devices that are connected to the internet, which can also perform data analysis.

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Being able to access and download data from these devices every day, instead of visiting patients just a few times a year, is a great opportunity, on the same level as antibiotics.

ANDREW THOMPSON - CO-FOUNDER AND MANAGING DIRECTOR OF PROTEUS

A digital drug is a medicine that, once ingested, can communicate with a smartphone and transfer information.

TODD RICHMOND - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

This is where artificial intelligence comes into play, to put millions of pieces of information in order.

ROBERTO CINGOLANI - SCIENTIFIC DIRECTOR, ITALIAN INSTITUTE OF TECHNOLOGY

Often, doctors discover that two completely different patients with completely different stories may have similar diseases or mutations. At this point, all this information goes back to the doctor, who finds correlations with results that would never be found simply by looking or through experience, because it just would have taken too long.

MICHELE BUONO OFF SCREEN

A hospital isn't so different to an advanced industry: an efficient production system is necessary for a good final product. In this instance, the product is our lives.

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

The first tool you need is a digital folder, into which the information concerning patients from outside the hospital arrives.

MICHELE BUONO OFF SCREEN

This is our electronic health record, our clinical history; but such a system doesn't exist, because the Italian healthcare system is not digitised as a whole, and the various elements do not communicate with one another.

Coronary intensive care unit. The beeps in the background are generated by devices connected to patients 24 hours a day, and provide a huge amount of data.

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

This is life-saving technology; the problem is that it's not connected to a wider network. This information would help treat and care for these patients and future patients; but from the moment they leave the hospital, this data can no longer be used.

MICHELE BUONO OFF SCREEN

Professor Pillon coordinates the government commission for the development of telemedicine in Italy, and also works with NASA, looking at how to stay healthy even on Mars. But for now, let's come back down to earth:

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

Here you are: what we see here are the flows of information, in the sense that the printed paper travels on the trolley and is then taken to the patient.

MICHELE BUONO

But what sense does that make?

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

Well, we are still in a phase where digital technologies aren't being used to their full potential: they are used, but then we print out the data.

MICHELE BUONO OFF SCREEN

It is as if, within an organisation with a high production capacity, emails were written but instead being sent with a simple click of a button, they were printed out and sent in envelopes with a stamp.

SANDRO PETROLATI - CARDIOLOGIST, SAN CAMILLO FORLANINI HOSPITAL, ROME

If we think of an average patient who comes into A&E, he or she normally arrives without any documentation; at that moment, having the medical history of the patient with all the various reports and data is fundamental to providing fast, effective care. If I have this information, I have already gained two, three hours, which, for a patient who presents with a suspected acute heart condition, is the difference between life and death.

MICHELE BUONO OFF SCREEN

The doctors and nurses are excellent, and the San Camillo Forlanini hospital is one of the many leading lights in Italy. But there is a degree of collective intelligence missing.

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

Today, a patient who goes to A&E may then be sent home, having undergone a CT scan and a whole host of tests. Three days later, he goes to another A&E, and that CT scan and everything done before, none of it is available to the second A&E, and so everything must be repeated.

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

Using state-of-the art digital technologies would enable us to save something like 6.8 billion euros every year for the national healthcare system, as well as around 7.6 billion euros for citizens, as a result of better use of time. So basically, we're talking about something that represents 15 billion euros a year, which we are essentially wasting.

MICHELE BUONO OFF SCREEN

The Ministry of Health has a plan for digitisation, and invests more than a billion euros a year in a health system that is fragmented across 21 different regional organisations. Is there a body that can act as director, and put all these pieces together?

SERGIO PILLON - COORDINATOR, ITALIAN TELEMEDICINE COMMISSION

With regard to this issue, no, there is absolutely not.

MICHELE BUONO

Then are there intermediate structures that can transfer knowledge and technology to the healthcare bodies that are spread across the Italian territory?

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

Theoretically speaking, these structures should be present in the various regions, and in the in-house companies that answer to the regions.

MICHELE BUONO

Do these exist?

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

They do not operate - or at least not sufficiently - as a network.

MICHELE BUONO OFF SCREEN

It is as if the air transport industry, where there are millions of fragments of data criss-crossing each other, did not operate within a network structure in order to manage flights, flows of passengers and freight and destinations all over the planet. What would happen to the aircraft in flight? They would crash often. And at the airline desks? They would say to us: "The earliest we can get you to this destination is six months from now." Or to the luckier ones: "Please take a seat in the waiting room, we will get back to you in a few days." Baggage placed on the wrong belts or making its way around the world, on the trail of its owners. We'd say it was madness. Israel. Hospitals, doctors' surgeries, people and machines work within a network structure which spans the entire country. The health system is fully digitised, and revolves around the patient.

YEHzKEL WAISMAN - PAEDIATRIC TELEMEDICINE, SCHNEIDER MEDICAL CENTER IN TEL AVIV

We have created a virtual doctors' surgery: the patient can stay at home, and we, the doctors, can view his or her electronic medical record, and perform a "distance" consultation.

MICHELE BUONO OFF SCREEN

No more paper, and data shared between all parties within the system.

EYAL BAUM - DIRECTOR, TYTOCARE

This is Tytocare: it is a device that enables us to carry out remote medical consultations, thanks to a video camera and a series of integrated medical devices.

MICHELE BUONO OFF SCREEN

The device connects to a secure cloud, and the doctor, wherever he or she may be, can download the file and view it in real time.

YEHzKEL WAISMAN - PAEDIATRIC TELEMEDICINE, SCHNEIDER MEDICAL CENTER IN TEL AVIV

Show me your throat. OK! And now your ear. Thank you.

MICHELE BUONO OFF SCREEN

In this case, meanwhile, a mother has noticed big red spots appearing on her little daughter's skin, but she hasn't taken her to paediatric A&E. With an app on her smartphone, she takes photographs of the spots and sends the files to the public dermatology service online.

GUY SHALOM - DERMATOLOGIST, CLALIT ONLINE

Good evening, I'm Guy, a dermatologist from the Clalit online services. How can I help you?

Yes, of course, I can see that. She's a little girl of three years old, is that right? They are just insect bites. I'll prescribe you a cream to be applied for five days, and everything will be fine, don't worry.

GUY SHALOM - DERMATOLOGIST, CLALIT ONLINE

I can even work from home, and it takes me ten seconds to get from the kitchen to my computer, and the patient doesn't have to take time off work just for a doctor's appointment.

MICHELE BUONO

How do you prescribe drugs?

GUY SHALOM - DERMATOLOGIST, CLALIT ONLINE

The tool recognises my digital fingerprint and the prescription is immediately available in any pharmacy in Israel.

MICHELE BUONO OFF SCREEN

The patient simply needs to hand over his or her medical card to the pharmacist.

PHARMACY CUSTOMER

Everything can be seen via my card: Even medicines prescribed five or ten years ago; tests, operations and even my allergies.

MICHELE BUONO OFF SCREEN

A network of 500 pharmacies, 14 hospitals, 1400 clinics and private medical practices, where all data is shared in real time. This is the Clalit network, the main public provider of healthcare services in Israel.

YEZHKELEL WAISMAN - PAEDIATRIC TELEMEDICINE, SCHNEIDER MEDICAL CENTER IN TEL AVIV

Since 2009, we have conducted more than a million consultations remotely. And I can tell you with certainty that this enables us to send just 12% of patients into hospital.

MICHELE BUONO

What effect have the new technologies had on healthcare?

ELDAD ADAR - DIRECTOR OF INTERNATIONAL RELATIONS, CLALIT

They contribute to optimising the work of staff, and help to save time and money.

MICHELE BUONO OFF SCREEN

Rabin Medical Center. The hospital uses the Alma IT system, which stands for real-time advanced management analysis.

HAGIT HENDEL - MANAGING DIRECTOR, RABIN MEDICAL CENTER, TEL AVIV

It's a platform that links clinical, economic, administrative, personnel and logistics activities.

MICHAEL DRESCHER - EMERGENCY MEDICINE HEAD PHYSICIAN, RABIN MEDICAL CENTER, TEL AVIV

I can see that there are six patients waiting for radiology. We are at a good point here. Here, meanwhile, I can check the number of patients that each doctor is dealing with: Doctor Gilbert has eight, so does Doctor Iyad, and Zuchingko has nine.

MICHELE BUONO OFF SCREEN

It is therefore possible to efficiently coordinate the work of hospitals, whilst ensuring that patients receive the best care.

MIKHAL STEINMAN - HEAD NURSE, RABIN MEDICAL CENTER, TEL AVIV

With a single glance, I can check how many patients haven't yet received treatment, and who is showing signs of pain. I can call a nurse from here, who might be in another department, and say to him or her: "Two patients, him and him, have not yet received treatment. Please take care of them straight away."

MICHELE BUONO OFF SCREEN

The Alma system, in turn, is integrated with the patient's electronic health record.

GALI PERL – ONCOLOGIST, DAVIDOFF HOSPITAL, TEL AVIV

It reduces the risk of making mistakes. For example, the dosages of a drug: if they aren't right, the computer warns me. The same applies if the haemoglobin is too low.

MICHELE BUONO

Does it provide an advantage in terms of diagnosis and treatment?

GALI PERL – ONCOLOGIST, DAVIDOFF HOSPITAL, TEL AVIV

The correlation between the data that we can gather thanks to artificial intelligence allows us to deliver more targeted treatment, and helps a lot with research.

MICHELE BUONO OFF SCREEN

If a large amount of data allows artificial intelligence - which is nothing but augmented statistics - to see more, the entire concept of care changes.

RAN BALICER - HEAD OF RESEARCH AND INNOVATION, CLALIT

I'll give you an example. A few years ago, we found that the number of patients on dialysis, with kidney failure, was growing significantly. We said to ourselves: "Instead of buying more dialysis machines, we should intervene earlier."

MICHELE BUONO

What did you do?

RAN BALICER - HEAD OF RESEARCH AND INNOVATION, CLALIT

We used artificial intelligence to analyse the data and work out how many people would suffer from kidney failure over the next five years, and then we started working on prevention.

MICHELE BUONO

What was the result?

RAN BALICER - HEAD OF RESEARCH AND INNOVATION, CLALIT

The number of patients affected by kidney failure has dropped, thanks to this predictive medicine.

MICHELE BUONO OFF SCREEN

In Israel, developments are being made thanks to a favourable combination of factors: the digitisation of health data, which began more than twenty years ago, and a close connection between hospitals, research, industry and start-ups.

MICHELE BUONO

What impact has digital innovation had on the cost of healthcare?

ELDAD ADAR - DIRECTOR OF INTERNATIONAL RELATIONS, CLALIT

With less hospital admissions, we can build less healthcare structures, and can channel these resources into new services.

MICHELE BUONO OFF SCREEN

Meanwhile, hospitals can focus exclusively on the acute phases of disease and, when necessary, it is the hospital that goes to the patients' home. Germany. The population is getting older, and telemedicine helps to keep neurodegenerative diseases under control.

ERHARD AUST

At this precise moment, I am in the virtual waiting room of Professor Nelles. The Professor is still offline.

MICHELE BUONO

How does it work?

ERHARD AUST

The Professor sends me a code, and then I log in.

GEREON NELLES - NEUROMED NEUROLOGIST, COLOGNE CAMPUS

How are you, Mr. Aust?

ERHARD AUST

I feel that I am getting better.

GEREON NELLES - NEUROMED NEUROLOGIST, COLOGNE CAMPUS

Last time, we increased the dose of Pramipexol a bit, has it helped with your tremors?

ERHARD AUST

Yes, I've been taking it for two days, and it's much better.

GEREON NELLES - NEUROMED NEUROLOGIST, COLOGNE CAMPUS

Now, please raise your hands like this, and bring your thumb and index finger together like this. First just with the left hand. Yep. A bit faster. Great! Thank you. And now all of the fingers. OK .

MICHELE BUONO OFF SCREEN

Just a text message advising the patient to be ready for the consultation; assessments and prescribing are carried out online. Mr. Aust has his checks three times a week.

ERHARD AUST

From Remscheid to Cologne on public transport would take me three hours; now, all I need is a computer or a tablet, and the doctor from the hospital can check up on me even on holiday.

MICHELE BUONO OFF SCREEN

Cologne. NeuroMed Campus.

GEREON NELLES - NEUROMED NEUROLOGIST, COLOGNE CAMPUS

To monitor a course and adjust the drug therapy a patient is receiving, three to five minutes is more than enough time, and we doctors can carry out many, many more consultations.

MICHELE BUONO OFF SCREEN

It increases the well-being of the population and doesn't increase social costs, or costs for healthcare.

Kiel, Baltic sea.

MRS. RADMANN

We have been married for 59 years; I'm a dressmaker, and I still work. We don't have children...once upon a time, we'd go dancing in our free time, or go on a boat or to a holiday villa.

MR. RADMANN

I am a lucky man. It was down to my wife - who really encouraged me - that I went on the training course and became a railway inspector.

MICHELE BUONO

Where did you meet your husband?

MRS. RADMANN

In a bar...on New Year's eve...

MICHELE BUONO

Who made the first move?

MRS. RADMANN

There were two men: I didn't like one of them, but he was a good dancer, and I did like the other, but he didn't know how to dance.

MICHELE BUONO

And what did you do?

MR. RADMANN

At midnight, I said to her: Either you dance with me, or I'll say goodbye!

MICHELE BUONO

And did she agree to dance?

MR. RADMANN

Yes, in the end she chose me, and she let me accompany her home...

MRS. RADMANN

And I got a slap round the face...but not from him. From my mother.

MICHELE BUONO OFF SCREEN

Mr. and Mrs. Radmann are taking part in a clinical trial on distance control and prevention. They wear sensors that continuously measure their vital functions, producing data.

WALTER MAETZLER – CLINICAL NEUROLOGIST, KIEL CAMPUS

We can assess, for example, whether there is any dysfunction with regard to movement, and we can understand ahead of time whether the patient is at risk of falling. Measuring these things in the home environment is important, because this is where the patient lives most of the time, and it's where you can pick up on any signs of anomalies.

MICHELE BUONO

What type of diseases is this system useful for?

WALTER MAETZLER – CLINICAL NEUROLOGIST, KIEL CAMPUS

We work mainly with neurodegenerative diseases, but also with diabetes and heart failure.

MICHELE BUONO OFF SCREEN

In the hospital laboratory, the devices are tested.

CLINT HANSEN – CLINICAL RESEARCHER, KIEL CAMPUS

We record the patient's movements with a series of sensors applied to various parts of the body, and we validate these with a 3D analysis system.

MR. RADMANN

Well, wouldn't it be great if you could see the signs in time, before disaster strikes.

SIGFRIDO RANUCCI IN THE STUDIO

The "disaster" will occur if the current logic, the equation, continues: efficiency equals cuts. This only happens if you navigate by eye, and always work under emergency conditions. Because what are you doing? Cutting beds, cutting A&E departments, both small ones and the bigger ones in major cities, increasing fees for consultations and also increasing waiting times. So, what this means is penalising quality and the right to treatment. And inefficiency feeds that shadowy area which breeds corruption - and in these pockets, life could be made more difficult by digitising everything, if we create a network which connects pharmacies, doctors' surgeries, laboratories, patients and hospitals, dedicating the latter exclusively to those suffering from acute illnesses, those who are truly in need, thus preventing others from being exposed to unnecessary infections, and enabling professionals to spend more time with people who need urgent care. If clinics, or if we have the opportunity to enable our digital medical record to travel with us, containing our medical history, the drugs we use and the doses, we limit the risk of error and help doctors make a faster diagnosis, which could even save lives - we are sometimes talking about a matter of minutes. If doctors had the option of monitoring patients in their home environment, viewing their heartbeat, their blood pressure, and being able to see if there's something wrong and to prevent an emergency before it occurs - well, then it's all taken care of. These systems could even help us to be aware ahead of time if we are faced with an emergency, if there's an epidemic about to break out, or allow us to monitor what's going on in the surrounding environment, in the region, if there are poisons that are causing diseases. In just a few words, we can adapt the old adage to a 4.0 version: prevention is better than cure. And this can be achieved if we digitise everything. Today, meanwhile, there are regions that don't even have a cancer registry, and which simply cannot monitor the evolution of some diseases. If we connect everything to a network, we can do it; we have the skills and the technology, we just need to create software that is capable of collecting and analysing the data. Our know-how has flown to California, where the creators of *Star Wars* have put themselves at the disposal of medicine, and are developing an avatar version of the family doctor, who will be available 24 hours a day.

MICHELE BUONO OFF SCREEN

California. Luca Foschini and Alessio Signorini, graduates of the Sant'Anna School of Advanced Studies in Pisa, are among the co-founders of "Evidation Health". The organisation has two locations, in Santa Barbara and San Mateo, and a hundred partners to interpret the data produced by people and to understand how this information interacts with health.

LUCA FOSCHINI - CO-FOUNDER, EVIDATION HEALTH

For example, the watch that I'm wearing, or these two rings on my fingers, are continuously measuring my activity levels, my heart rate.

MICHELE BUONO OFF SCREEN

A helmet can measure brain waves, a pedometer can measure movement, a digital scale can also detect blood pressure; this device is capable of measuring eye movement. The point is how we give meaning to all this information.

ALESSIO SIGNORINI - CO-FOUNDER, EVIDATION HEALTH

Artificial intelligence allows us to analyse large amounts of data, with so many variables that it would be extremely difficult to do manually.

MICHELE BUONO OFF SCREEN

It involves integrating this information with the rest of a person's clinical data, and recording trends and anomalies.

ALESSIO SIGNORINI - CO-FOUNDER, EVIDATION HEALTH

Giving 500 million data points to a doctor does not help him to do his job better; this data must be synthesised using validated systems to enable the doctor to use the information in the clinical field.

MICHELE BUONO OFF SCREEN

A graphic representation of vital parameters, measured continuously, for a long period outside of the hospital. This is the monitoring data for a patient who has had a knee replacement.

LUCA FOSCHINI - CO-FOUNDER, EVIDATION HEALTH

And so we can see that physical activity is increasing again, very gradually. This is a much clearer overview of the post-operative clinical course, but it is the result of half a million data points.

MICHELE BUONO OFF SCREEN

In this way, it becomes clear whether the patient is recovering or not.

ALESSIO SIGNORINI - CO-FOUNDER, EVIDATION HEALTH

These days, the patient is sent home with instructions on what to do, and they are told that they will be seen again in three months, and to come back if they have any issues. A system of this type enables the doctor to understand where the patient is in terms of recovery, and to intervene if necessary.

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

If we don't insist on confining healthcare to physical spaces, everything becomes possible.

MICHELE BUONO OFF SCREEN

Los Angeles. University of Southern California. Department of Medicine.

ARI SHAPIRO - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

I used to work in the film industry for major companies like Industrial Light and Magic. I was in charge of special effects for *Star Wars*, while for *Life of Pi* and other films, I designed the creatures.

MICHELE BUONO

And what's that got to do with the Department of Medicine?

ARI SHAPIRO - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

My long-term plan is to create a digital individual who can think, react and behave like a real person.

MICHELE BUONO

So for you, medicine is the new frontier of sci-fi?

ARI SHAPIRO - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Absolutely.

MICHELE BUONO OFF SCREEN

Professor Saxon is a cardiologist, and within the department of Medicine, she has created the "Center for body computing" to design a personalised approach to healthcare using digital technologies. However, she wanted to go one step further..

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Most doctors don't have a computer scientist on hand who is capable of creating virtual humans. I wanted to involve him.

MICHELE BUONO OFF SCREEN

Ari Shapiro was working with the university to solve a problem experienced by the army. Veterans of the conflict in Afghanistan and Iraq with stress disorders were not telling the doctors everything, for fear of revealing confidential information, and so the therapies didn't work. I created a virtual doctor for them, so they could open up without fear, and it worked.

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

So I asked myself whether it would be possible to create a team of virtual doctors, using real doctors as a starting point, who could be available all over the world, 24/7.

TODD RICHMOND - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Leslie had the doctors and their skills at her disposal, while we had the technology experts and Hollywood writers to create credible characters.

ARI SHAPIRO - INSTITUTE FOR CREATIVE TECHNOLOGIES, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Once we had created the digital image of Professor Saxon, we loaded her skills and knowledge into her avatar.

AVATAR OF LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Hi. I'm Dr. Saxon, your personal cardiac electro-physiologist.

MICHELE BUONO

How do these skills transform into answers?

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

We catalogued around 2,600 typical questions from patients, working with the Hollywood screenwriters to study the most effective way to respond.

PATIENT

I'm worried about doing exercise, can I work out?

AVATAR OF LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

Physical activity is good for the heart, and I encourage it. If you want, we can monitor your atrial fibrillation so that you aren't running any risks.

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

My virtual self learns as she answers the questions, becoming more and more intelligent.

AVATAR OF LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

If you want, I can work with you to create a personal management plan that is suited to your symptoms and lifestyle.

PATIENT

Thank you Dr. Saxon, it's just what I needed today.

MICHELE BUONO

Has your work changed?

LESLIE A. SAXON - CARDIOLOGIST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

It started to change when I wondered what healthcare would be like if digital technologies ensured that we were no longer limited to occasional medical appointments. It changes the entire model: The patient is at the centre, and takes control.

MICHELE BUONO OFF SCREEN

The roads of California. Los Altos. Silicon Valley.

MARTY TENENBAUM - FOUNDER, CANCER COMMONS

Everything started twenty years ago, when I was diagnosed with melanoma with liver metastases. At the time, it was a death sentence, there were no precision drugs. I spoke to dozens of doctors, and soon came to understand that I was up to my neck in trouble, but I swore that if I could defeat my illness, I would spend the rest of my life trying to do something meaningful for those who found themselves in my situation.

MICHELE BUONO OFF SCREEN

Marty Tenenbaum tried many approaches, and eventually managed to get himself accepted on a experimental clinical trial.

MARTY TENENBAUM - FOUNDER, CANCER COMMONS

It worked for a limited number of patients, and luckily, I was one of them.

MICHELE BUONO OFF SCREEN

As an artificial intelligence researcher at Stanford and an expert in robotics, from that moment on, he wanted to use his skills in another direction, to uphold the promise he made to himself..

MARTY TENENBAUM - FOUNDER, CANCER COMMONS

I wanted to ensure that other patients didn't have to experience what I went through.

MICHELE BUONO OFF SCREEN

He founded "Cancer Commons", a non-profit organisation that connects patients, hospitals and research institutes around the world.

ERIKA VIAL MONTEVERDI - EXECUTIVE DIRECTOR, CANCER COMMONS

We provide an answer to the question: "What can I do, what is the next step?", because in the field of advanced cancer, everything is an experiment.

MICHELE BUONO OFF SCREEN

The service is completely free, and is available online.

LISANDRA WEST - HEAD OF PATIENT SERVICES, CANCER COMMONS

These are often patients who have tried different approaches, and the question they ask us is: "Now what do I do?".

MICHELE BUONO

And what do you do?

LISANDRA WEST - HEAD OF PATIENT SERVICES, CANCER COMMONS

First of all, we use an analysis tool that processes the data relating to the various cases, which enables us to create connections with other patients around the world.

JEFF SHRAGER - HEAD OF ARTIFICIAL INTELLIGENCE, CANCER COMMONS

Experts and algorithms allow us to efficiently coordinate data, variables and thousands of treatments. We can identify which solutions work, and establish a framework of all possible treatments.

MICHELE BUONO OFF SCREEN

A multidisciplinary group of radiologists, surgeons, oncologists and pathologists analyses the cases, and links the genomic data.

MARTY TENENBAUM - FOUNDER, CANCER COMMONS

It is essential that the doctor who is treating the patient is involved, because we only try approaches that he or she also accepts.

ERIKA VIAL MONTEVERDI - EXECUTIVE DIRECTOR, CANCER COMMONS

The patient receives opinions from all the other, let's say, all the other hospitals, structures, universities and academics. You have a recommendation regarding the best approach for you, the patient, within 48 hours.

MARTY TENENBAUM - FOUNDER, CANCER COMMONS

The more information we accumulate, the more artificial intelligence can help us make informed decisions. In this system, everyone is continuously learning from one another.

MICHELE BUONO OFF SCREEN

University of Stanford. Paul Yock, cardiologist and cardiac surgeon, who is known for developing rapid angioplasty for the placement of stents, knows that medicine is no longer just something for doctors, and that innovation can be taught. We should start setting up the scheme from university level onwards.

PAUL YOCK - DIRECTOR OF THE BYERS CENTER FOR BIODESIGN, UNIVERSITY OF STANFORD

The first thing that we ask our students is to go into hospital, to observe the situation for a couple of months and to provide us with a list of at least two hundred needs: not solutions, just the needs of patients that could be met using technology.

BRONWYN HARRIS - TUEO HEALTH

During the course, we realised that there was a lack of adequate measurements in asthma control. Patients tend to underestimate their symptoms and get used to living with a chronic cough.

MICHELE BUONO OFF SCREEN

So the group, consisting of two doctors, two engineers and a computer scientist, developed a device to detect asthma during sleep, using sensors applied to the mattress.

BRONWYN HARRIS - TUEO HEALTH

It is important to record nocturnal wakings caused by asthma. In addition, the device also detects changes in heart rate and respiratory rate.

MICHELE BUONO OFF SCREEN

If a problem occurs, warnings are sent from the app to the patient, his or her family members and the doctor. The working groups are interdisciplinary: Entrepreneurs, investors, doctors and lawyers specialising in patents are also involved.

AYO ROBERTS - BYERS CENTER FOR BIODESIGN, STANFORD UNIVERSITY

We are working on the early diagnosis of acute stroke: we are looking for a way to diagnose this automatically.

ORESTIS VARDOULIS - BYERS CENTER FOR BIODESIGN, STANFORD UNIVERSITY

We learn from one another, and everyone brings something different to the group. I am a mechanical engineer, and I work with the industrial sector.

MICHELE BUONO OFF SCREEN

A few kilometres from Stanford, we are not simply seeing another perspective on health technologies: the existing model is turned on its head.

ANDREW THOMPSON - CO-FOUNDER AND MANAGING DIRECTOR OF PROTEUS

A digital drug is a medicine that, once ingested, can communicate with a smartphone through the body, and transfer information.

MICHELE BUONO OFF SCREEN

Here they design and produce devices and sensors which, when incorporated into a pill, are capable of making it talk: we are no longer the ones who have to chase after doctors and hospitals; now, they are eager to be attentive to us.

ANDREW THOMPSON – CO-FOUNDER AND MANAGING DIRECTOR OF PROTEUS

It works like this: once ingested, this tablet is activated. There's no battery, and no radio frequency. The electrical signal is produced by the body itself. A patch equipped with an electronic plate captures the signals emitted by the pill, and transmits these to a mobile phone via a Bluetooth connection.

MICHELE BUONO OFF SCREEN

The patient can share pharmacological, cardiac and respiratory information with a family member, or with a doctor or nurse.

ANDREW THOMPSON – CO-FOUNDER AND MANAGING DIRECTOR OF PROTEUS

The application allows doctors and healthcare professionals to check whether a patient is following their treatment plan correctly.

KELSEY LEAMAN - PROTEUS DISCOVER

I can click on the patient that I will see tomorrow: I can immediately see that his level of adherence to the treatment plan is 93%, which is very high. The average is 50 percent.

MICHELE BUONO OFF SCREEN

Doctors are often not sure whether a drug is not effective, or whether in fact the issue is that the patient is not taking it correctly. This is a dilemma that costs people their health, raises doubts about research, and drains money from healthcare systems.

ANDREW THOMPSON – CO-FOUNDER AND MANAGING DIRECTOR OF PROTEUS

We have everything we need for this to become a shared reality: a good number of drugs have already been approved, technologies have been authorised by the competent bodies, and we have a powerful network of mobile devices that covers the entire world.

SIGFRIDO RANUCCI IN THE STUDIO

Imagine a healthcare system that functions like the international aviation network. A system that optimises care and prevents waste. And what could be more reassuring than knowing that our loved ones are being monitored daily, perhaps even when they go on holiday? But instead, the data released by the Tribunale del Malato, the non-profit association for patient rights, painted a less than rosy picture of our national healthcare system. The data refer to 2017 and, according to the results, one in three citizens has experienced difficulty in accessing national health services, a figure that is unfortunately on the rise compared to the numbers for 2016. This is due to the high fees for medical consultations, the cost of drugs, and for 56% of the citizens, to the long waiting lists. We are talking about 15 months for a simple cataract operation, 13 for a mammogram, 12 for an MRI, and 10 for a CT scan. 15% of citizens also reported

that they found it difficult to access care from family doctors, paediatricians and urgent services, also and above all due to the limits imposed by time. In addition, one third of citizens also reported that there is little information available and a lot of red tape when it comes to accessing home care. 14% say that there is no provision for this at all in their region. So to speak of prevention in such a context, if this is the general backdrop...But do you know what the paradox is? Our Ministry of Health has a national plan for digitisation, and invests over a billion euros every year, but the regions do not communicate with one another. There's a lack of common leadership. It's a real shame, because we have excellent skills and facilities at our disposal, but these too are unfortunately fragmented across the territory.

MICHELE BUONO OFF SCREEN

Rovereto, near Trento. This retired lady is called Franca, she used to be a teacher. Now, she's a widow and she has to watch out for her asthma and her diabetes, and keep an eye on her blood pressure. The local healthcare provider is responsible for organising the various services in the area.

PAOLO BORDON – GENERAL MANAGER, TRENTO REGIONAL HEALTHCARE SERVICE

Our job is to imagine the population that we will need to provide services for in the coming years.

MICHELE BUONO OFF SCREEN

So far the goal is a good one, without doubt.

PAOLO BORDON – GENERAL MANAGER, TRENTO REGIONAL HEALTHCARE SERVICE

So we have a precise target - the chronic illness sector. We aim to change our models to get closer to this target, providing a faster and more effective response, with the technology we have today.

MICHELE BUONO OFF SCREEN

"Providing a faster and more effective response," is within the repertoire of a general manager. However, actually achieving this is far from being a given. Once the plan had been made, the service turned to the "Bruno Kessler" Foundation in Trento, a research institute.

MICHELE BUONO

What did you do?

PAOLO TRAVERSO - ICT DIRECTOR, BRUNO KESSLER FOUNDATION, TRENTO

We take our technologies, and build the right system; we build all of the technologies that enable interaction between the patient and the system.

MICHELE BUONO OFF SCREEN

It's called the citizen's medical record: all you need is an app, which can be accessed both by citizens and by medical staff.

ETTORE TURRA - TECHNOLOGY DEPARTMENT DIRECTOR, TRENTO REGIONAL HEALTHCARE SERVICE

Today, this centralised archive of records contains around 90 million pieces of information, medical reports, clinical documents; just think, every day this centralised

archive of records receives 100 thousand enquiries, not only from citizens, obviously, but also from other systems, such as the home care system.

MICHELE BUONO OFF SCREEN

This enables citizens in the Trento region, like Franca, to be cared for and receive treatment without leaving the house.

PAOLA LEONARDELLI - HOME CARE NURSE, TRENTO REGIONAL HEALTHCARE SERVICE

Hello Franca! I'll have a quick look in your file to see if I can find the prescription from the doctor: your saturation levels are good, 96%, and your heart rate is 88.

MICHELE BUONO OFF SCREEN

This is not traditional home care.

PAOLA LEONARDELLI - HOME CARE NURSE, TRENTO REGIONAL HEALTHCARE SERVICE

These data are online, and the district doctor can see them; they remain available with a view to providing continuity of care.

MICHELE BUONO OFF SCREEN

When the data are shared within a digital system, a hospital that spans the entire region, home by home, can take shape. It represents an advantage both for the citizen and for the healthcare system as a whole. Data, people, applications, artificial intelligence, medical treatments: the synthesis of all these elements provides a new model for health and hospitals.

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

We have access to excellent medical skills, including from a nursing perspective. These should be brought up to date and accompanied by skills that relate to the use of new tools.

MICHELE BUONO

Do we have trainers here in Italy?

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

Of course, we've got everything.

MICHELE BUONO

We have computer technicians and scientists; are there companies that are capable of building the necessary software?

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

Certainly.

MICHELE BUONO OFF SCREEN

Architects and engineers, and innovations in healthcare are not in short supply; they are just scattered far and wide. We attempt to bring them together, and to simulate an intelligent 4.0 hospital. First and foremost, this represents a hub which is connected to a global network for the exchange of information.

Four floors in total. Minus 1, with servers for digital management activities, the storage area, the pharmacy and the kitchens; Ground floor, with two points of access: reception and accident and emergency. On one side are shops, a coffee bar, restaurants and an auditorium for conferences and shows; on the other are the clinics, the testing laboratories, radiology and CT scanning. Thanks to telemedicine, the emphasis is more on day cases than long stays.

Then, on the first floor, we have individual inpatient rooms in a single area, with the operating theatres and nurses' stations; this level is not divided into departments, to encourage interoperability. Some theatres are set up for remote operations.

As trialled in Genoa, at the Italian Institute of Technology. Here, a microsurgery operation using lasers and robots is being simulated. The surgeon is at his workstation; the patient, meanwhile, could be on another continent.

LEONARDO DE MATTOS - RESEARCHER, ITALIAN INSTITUTE OF TECHNOLOGY

This little piece here is a simulation of a tumour on the vocal cords; I place it under the microscope. We give the surgeon the OK: he slowly cuts it away with the laser, until it has all gone. We can see the extreme precision of the cut, under a millimetre in this instance.

ROBERTO CINGOLANI - SCIENTIFIC DIRECTOR, ITALIAN INSTITUTE OF TECHNOLOGY

This certainly opens up a whole range of opportunities, because it also democratises the availability and skill of the best surgeons, of the doctor, and creates a range of prospects for everyone.

MICHELE BUONO OFF SCREEN

On the top floor are the health management and IT departments: the doctors' offices along with those for the computer scientists and engineers; telemedicine and logistics management to direct the various flows. Gemelli general hospital, Rome.

ANDREA CAMBIERI - HEALTHCARE DIRECTOR, GEMELLI GENERAL HOSPITAL, ROME

Here, we are in the satellite pharmacy, which is a bit like the hold of the ship represented by Gemelli's centralised operating theatres. This is where we receive and prepare all of the materials required for surgery, and where we prepare the kits for patients. Every item that arrives at the pharmacy is labelled with a radio frequency tag, which enables it to be recognised by all of the systems that make up the logistics chain.

MICHELE BUONO OFF SCREEN

The various items are used to create the kits, in accordance with the type of operation that is scheduled to take place.

ANDREA CAMBIERI - HEALTHCARE DIRECTOR, GEMELLI GENERAL HOSPITAL, ROME

The pharmacy can see the situation in the warehouse in real time, and as such, the material can be rearranged and placed back on the shelves.

MICHELE BUONO OFF SCREEN

No operation can ever be delayed due to a lack of materials.

ANDREA CAMBIERI - HEALTHCARE DIRECTOR, GEMELLI GENERAL HOSPITAL, ROME

Essentially, the system fills in the clinical diary, so the patient knows exactly what was used in the operation; however, it also provides the information that enables us to gain an economic overview of the hospital and its activities, so that we can see if appropriate use is being made of the various devices.

MICHELE BUONO OFF SCREEN

Keeping an eye on expenditure and no waste. All of the devices and beds are connected to the network, and communicate information. Milan, European Institute of Oncology.

ANDREA DUPLICATO - IT SYSTEMS DIRECTOR, EUROPEAN INSTITUTE OF ONCOLOGY, MILAN

Each patient is equipped with a chip that acts as a transmitter; the transmitter interfaces with a series of antennas that are distributed through the block, and this enables us to track the patient's movements in real time: or rather, not just the patient's movements, but also the movements of the main mobile devices.

CRISTINA SIMONE - OPERATING THEATRE COORDINATOR, EUROPEAN INSTITUTE OF ONCOLOGY, MILAN

For example, if we want to look for an Olympus workstation, we can see that it is in this room here, so it is easy to get hold of it.

MICHELE BUONO OFF SCREEN

There is a colour for each phase and position of the patient.

CRISTINA SIMONE - OPERATING THEATRE COORDINATOR, EUROPEAN INSTITUTE OF ONCOLOGY, MILAN

If it is blue, we can see that the patient is in the recovery room, if it is green, the patient is in theatre so the operation is in progress, if it is yellow, the patient is still on the ward, and if it is pink, the operation is coming to an end.

FABRIZIO MASTRILLI - HEALTHCARE DIRECTOR, EUROPEAN INSTITUTE OF ONCOLOGY, MILAN

If we click here, we can see the patient's whole history, with all the indications that the anaesthetist needs to prepare the patient, or to prepare the room; these indications change from disease to disease.

MICHELE BUONO OFF SCREEN

To reduce the risk of error and increase safety, the flows of information must go in every direction, and everything must be connected in real time so that nobody can say: "I didn't know", or "nobody told me." Vimercate Hospital. The requests to the pharmacy for medicines come from the various departments, from any of the devices on the network.

ORIANA BAVIELLO - PHARMACIST, VIMERCATE REGIONAL HOSPITAL (MONZA)

The cabinet administers the doses of drugs into the various drawers automatically and independently. Each drawer is dedicated to a patient.

MICHELE BUONO OFF SCREEN

These drawers are then loaded onto trolleys, and can reach the various departments automatically; before the drugs are administered, the nurses check that the patient and the treatment correspond. So it's not possible to make a mistake?

RAFFAELE MADDALENA - NURSING COORDINATOR, VIMERCATE REGIONAL HOSPITAL (MONZA)

No, because the bar codes on the bracelet and the drug would not match.

MICHELE BUONO OFF SCREEN

Greater safety and transparent spending on drugs; and if unforeseen events and unproductive work are reduced, nurses and doctors can focus fully on patient care.

DANIELE FAGNANI - DIRECTOR OF THE ONCOLOGY DEPARTMENT, VIMERCATE REGIONAL HOSPITAL (MONZA)

The patient comes to us early in the morning, goes and has his or her blood tests on the ward, and then we access the lab test results directly, which arrive on the main computer system after 30/45 minutes.

GIUSEPPE VIGHI - DIRECTOR OF THE INTERNAL MEDICINE DEPARTMENT, VIMERCATE REGIONAL HOSPITAL (MONZA)

It means that we can correct the therapeutic strategy we are pursuing in real time, to assess whether any of the alarm parameters have been reached. I can do all of this in an hour for all of the patients admitted, sitting here at my desk, with my tablet in my hand.

MAURIZIO MAURI - PRESIDENT, NATIONAL CENTRE FOR HOSPITAL CONSTRUCTION AND TECHNOLOGY

Financially speaking, a hospital of this type would see extraordinary results because there is no duplication, there is no waste.

MICHELE BUONO

How much would it cost to create a hospital like this?

MAURIZIO MAURI - PRESIDENT, NATIONAL CENTRE FOR HOSPITAL CONSTRUCTION AND TECHNOLOGY

Let's say that a hospital with average levels of activity could cost around 150 million euros.

MICHELE BUONO

How could this be funded?

MAURIZIO MAURI - PRESIDENT, NATIONAL CENTRE FOR HOSPITAL CONSTRUCTION AND TECHNOLOGY

We have carried out an evaluation. Compared to the costs of a traditional hospital, up to 25/30% of annual costs could be saved. If we can save 30% a year, the costs for the new hospital would be paid off within three years.

MICHELE BUONO

How many hospitals like this would we need across the country?

MAURIZIO MAURI - PRESIDENT, NATIONAL CENTRE FOR HOSPITAL CONSTRUCTION AND TECHNOLOGY

Building around 600 hospitals of this type would be ideal.

MICHELE BUONO OFF SCREEN

When it comes to doctors and computer scientists, there is also room for research projects and start-ups that experiment with ideas and projects. Salerno. Palazzo dell'Innovazione, or the Innovation Building. This is where "Healthware" is based.

ROBERTO ASCIONE – MANAGING DIRECTOR AND FOUNDER OF HEALTHWARE

Start-ups could bring this quotient of innovation; clearly, healthcare services all over the world can and are increasingly drawing on these innovations in order to redesign their processes, and experiment with them.

MICHELE BUONO OFF SCREEN

Exchanging experiences and information to accelerate ideas.

ANTONELLA ARMINANTE - PAGINE MEDICHE

Pagine Mediche, or "medical pages", is a digital health platform that connects doctors, patients and services, and using key data, offers a personalised healthcare experience to users.

ROBERTO ASCIONE – MANAGING DIRECTOR AND FOUNDER OF HEALTHWARE

For example, "Amicomed" is one of the start-ups we have here, or which have passed through here; it is designed to help manage blood pressure, and is now based in San Francisco.

MICHELE BUONO OFF SCREEN

This Italian start-up headed to the States to launch its activities. Amicomed is a device which measures blood pressure, producing data and transmitting this to an app.

GIANGIACOMO ROCCO DI TORREPADULA - CO-FOUNDER AND MANAGING DIRECTOR OF AMICOMED

It doesn't just process a single piece of data, but rather, it places each individual piece of information within the context of the previous data gathered, dividing the information by time and understanding and identifying the trend.

MICHELE BUONO OFF SCREEN

This enables doctors to see how the trend is evolving: it's no longer a case of single snapshots provided by the odd measurement here and there - now, a whole "film" can be created for each patient.

GIANGIACOMO ROCCO DI TORREPADULA - CO-FOUNDER AND MANAGING DIRECTOR OF AMICOMED

At this point, we can gain an overview of any anomalies, and it's all much clearer and easier to understand.

MICHELE BUONO OFF SCREEN

A system based on the digital network to which hospitals are connected would represent a favourable environment, for start-ups too. It would create a national market with a direct view of the world, without necessarily stopping off in San Francisco.

MARIANO CORSO - OBSERVATORY FOR DIGITAL HEALTH INNOVATION, POLITECNICO DI MILANO UNIVERSITY

Scientific applications in the world of big data and artificial intelligence would make it possible to create a driver for research. This is the basis for industrial politics and for increasing the appeal of the country.

SIGFRIDO RANUCCI IN THE STUDIO

So why don't we put this plan into practice immediately? We can ensure that we are bulletproof when it comes to the protection of data concerning a given patient; it is the patient himself who ultimately decides whether or not to make his data available on the digital network. So let's get on with building these 4.0 hospitals of the future. We have some modest examples of these types of institution in Italy, in Trento, Milan, Vimercate, and in Rome too, but the only thing is that they don't talk to each other. As we have heard, we need to build 600 new smart hospitals, and the money is there, because we would save 30% on waste, so the costs would be paid off in three years, because it would also lead to reductions in unproductive costs, connected to waiting lists, and needless absences in the workplace. And in turn, that would enable us to access 15 billion euros, a nice nest egg, which could then be reinvested - these estimates come from the Politecnico di Milano university. With this, we could boost construction, we could boost university research, we could provide a boost to start-ups focusing on digitisation, or to training centres - after all, we need digitised nurses. An approach like this would mean not only revolutionising healthcare, but also the quality of health itself. Of course, today's older generation don't know much about the web, they don't even know how to get online, and there may even be areas that aren't covered. But tomorrow's generation will be in their element. But we must start thinking about it today. So, to the Government and the governors of the various regions: start talking. If you do not understand the potential we have, and the riches that exist in our country, we need a psychoanalyst rather than a politician. We've got a doctor who works for NASA, and yet he has been thwarted by an almost total absence of digital communication. What is more important than dealing with the development of a country, than taking care of public health, for those who truly love politics?