INTRODUCING PRECISION MEDICINE
In the Victorian era a surgeon’s blood-stained uniform was a source of great pride because it showed medical expertise – the dirtier the coat, the more experienced the doctor. Now we shudder at the thought of a clinician examining patient after patient in dirty clothes, transferring infection and disease from one to the other. It was archaic, and extremely dangerous.

After 23 years of creating information health systems for hospitals and primary care clinics around the world, I now consider the way we treat patient information to be as potentially harmful as those blood-stained surgeon’s aprons from 150 years ago. That’s because clinicians don’t have access to all the information required about a patient to create a treatment plan that directly addresses their unique personal circumstances and genetic make-up.

There is a growing body of research that is highlighting just how ineffective a ‘one size fits all’ approach to treatment can be. Research cited in the international weekly journal of science, Nature, shows that the ten most popular drugs prescribed in the US only help a limited number of people - some as low as one in 25 patients.

A patient’s healthcare plan is being created based on insufficient information, because healthcare professionals aren’t able to take into account the multiple factors that influence a person’s healthcare, such as their medical record, genetic profile, environmental and social background.

Gathering all this personalised information together and making it accessible to a doctor in real time is called ‘precision medicine’ – the new revolution in healthcare.
A key aspect of precision medicine is that patient information is stored in a database with strict privacy protocols. The data can only be accessed by the individual, their healthcare professionals, and potentially those people in their trusted circle of care, such as a close family member.

Governments around the world are investing heavily in precision medicine. US President Barack Obama’s administration has launched the Precision Medicine Initiative². It’s a US$215 million investment to pioneer a new model of patient-powered research that will accelerate biomedical discoveries and provide clinicians with new and advanced tools, knowledge, and therapies. The goal is for one million genomes to be mapped by 2020.

As aging populations drive up the overall cost of healthcare, precision medicine makes economic sense. In December 2015 researchers at the University of Utah published a study³ into the care of patients aged over 65 years. In one group treated with using precision medicine techniques over four months, less than 4.5% required emergency attention, compared to 15.4% of patients in the other group.

In New Zealand, the government has plans for every citizen to have an Electronic Health Record. It’s a great start, but medical history is considered to be only 10% of a person’s health profile. We need to go further and embark on a programme to create a personalised healthcare system.

At Orion Health we are working with other health IT providers to advance precision medicine, and are investing millions of dollars in a global data platform for precision medicine called Amadeus. It will become the cradle of innovation, not only for New Zealand companies, but for companies interested in creating precision medicine applications around the world.

We are also a founding participant in the Precise Driven Health research programme with Waitemata District Health Board and the University of Auckland.

I hope you enjoy this overview of precision medicine. It is an emerging, but exciting field. We are indeed on the cusp of a medical revolution.

Ian McCrae
Orion Health | Founder and CEO

In New Zealand, the government has plans for every citizen to have an Electronic Health Record. It’s a great start, but medical history is considered to be only 10% of a person’s health profile. We need to go further and embark on a programme to create a personalised healthcare system.
Whitehouse forum on precision medicine - February 2016

“All these insights promise the possibility of us being able to cure diseases that, up until now, we couldn’t figure out. We could oftentimes, with real blunt instruments, treat, but it was very ineffective or, in some cases at least, inefficient. And what we’re now seeing is the possibility of us identifying diseases, targeting them, individualizing treatments for a particular patient, and operating with the kind of precision that promises to reduce costs, provide much better care, make our entire health care system much more effective.

And the key to all this is for us to be able to build up databases. And because all of us potentially could have electronic medical records that voluntarily – with strong privacy protections – we pool together so that researchers, practitioners, scientists can share, we may be able to accelerate the process of discovering cures in ways that we’ve never seen before.”

US President | Barack Obama
Much of the data required for the practice of precision medicine exists outside of current medical systems. According to Steven Schroeder, a distinguished professor at Health and Health Care at the University of California, 60% of a person’s health outcome is determined by exogenous sources such as their environment, nutrition and social circumstances, while 30% is genetic, and 10% is from their historical health record.

In this report we look at four types of information – two that relate to genetic makeup, and two that relate to the effect of exogenous sources and what consumers can do positively to alter their health outcomes. They are:

- Human Genome mapping
- The Microbiome – the bugs inside our bodies
- Environmental insights from Epigenetics
- Data captured by consumer technology
Impacts on Health Outcomes

60% from exogenous sources

30% from genetic sequencing

10% from health systems
There are plenty of excuses for cheating on your partner, but until now your genetic profile was not one of them. New research has found people with a particular genetic make-up may be more prone to infidelity. In Sweden, scientists studying a group of men found those with the genetic variant allele 334 are twice as likely to have had a marital crisis\(^6\).

Finding an excuse for bad behaviour is not a great reason to get your genome mapped – but learning more about your genetic makeup so you can improve your health and wellbeing certainly is.

It’s estimated 30% of our health is determined by our genome (the complete set of genetic material present in a cell or organism). Capturing and applying this information is part of a global health revolution called precision medicine. It is designed to create the perfect healthcare plan for every individual.

Getting your genome mapped is a simple and painless procedure. You take a swab from the inside of your mouth and send it away for testing.

Knowing you have a higher chance of developing a chronic illness is useful information if it means you can take steps to prevent, or reduce its harmful affects, for example by changing your diet and exercising more frequently. It can also help your doctor in making a more accurate diagnosis and creating a tailored treatment plan.

As the cost of healthcare spirals upwards, governments around the world are investing in genome projects with the goal of implementing precision medicine initiatives. The UK has the 10,000 Genomes Project\(^7\), in Qatar they have begun the Biobank\(^8\) and in the US the Personal Genome Project\(^9\).

Sequencing the first genome took 15 years and cost $3 billion; today it costs around US$1000 per person (plus interpretation) and its estimated that by 2020 it could be as little as US$10 per person. But price and availability are one thing, deciding if you want to find out about your genetic make-up is quite another. You might not like what you discover and it could present you with more than one or two moral dilemmas.

What if you found you had that cheating gene? Would you use it as an excuse for bad behaviour, or would it provide motivation to overcome your genetic shortcomings?
Overlooked and undervalued. That’s one way to describe the bugs inside our bodies. Which is surprising when you consider that these bugs outnumber human cells by at least 3 to 1 and can play a vital role in our health and wellbeing.

The American Academy of Microbiology estimates that in every body there are 100 trillion\(^{10}\) microscopic bugs living inside each of us. The collective name for these bugs is the Human Microbiome.

Scientists are now discovering that these bugs can be extremely beneficial. Lita Proctor, program director for the Human Microbiome Project\(^{11}\) at the National Human Genome Institute, says these bacteria might actually keep us from getting sick.

That’s because the microbiome plays a role in developing our immune systems when we are born and, once established, it provides us with energy sources and vitamins that our body can’t make on its own.

The more we learn about the microbiome, especially the bugs residing in our stomach, the more we realise just how necessary it is to let the microbiome to get on with its good work. Too many antibiotics and too much processed food can disrupt the bugs and lead to chronic diseases such as obesity and asthma.

The modern desire to wipe out all bacteria could actually be harmful. So while a sparkling clean home is generally admired, letting the dirt and dust settle for a while is apparently better for kids growing up.

One study showed that the dust in homes that have a pet dog can actually protect children from developing allergies and asthma.

It follows then, that understanding more about the microbiome could be just as important as understanding our ‘human cells’. Indeed, scientists now talk about microbiome as ‘the other genome’.

Learning more about the microbiome inside our stomach and mapping our genome sequence will provide us with the vital information that is required in order to practice precision medicine.
The consequences of the Canterbury earthquakes on the people and the landscape has been well documented. But what about the effect on the generations that come after? Will the trauma experienced by those who lived through these awful events have an effect on their children, grandchildren and even great grandchildren?

The answer is very likely to be 'yes', especially when you consider the new scientific field of Epigenetics, which looks at the ways your external environment can affect your genome. It doesn't change your genetic makeup – rather it enables some aspects to become more prominent than others. And the changes can be passed down through the generations.

A Swedish study of historical records showed that men whose grandfathers had experienced famine before they reached puberty were less likely to develop heart disease or diabetes. In Britain another study showed that men whose fathers smoked before the age of 11 were more likely to be above average weight.

At Emory University in Atlanta in the US, they've been conducting experiments on male mice, whereby they exposed them to the smell of almonds (which contains the chemical acetophenone) and then gave them a mild shock in the foot. The poor creatures were given this treatment five times a day for three days, over which time they became fearful whenever they were exposed to the smell of almonds. Ten days later they were bred with female mice (who weren't exposed to the almond smell) and when their offspring grew up many were found to be sensitive to the almond smell, and later the grandchildren of the exposed male mice were also found to be unusually sensitive.

Epigenetics is a developing field and there are new studies emerging in this area from around the world. Knowing more about how our genetic makeup might be influenced by what our parents, grandparents and great-grandparents experienced, and how they behaved, will provide the additional information we need for better and more targeted healthcare.

Capturing this information and making it available to trusted healthcare professionals will greatly improve the accuracy of the diagnosis doctors are able to make and will therefore lead to better health outcomes. The insights gained through this emerging area of medical science will play a vital role in development of precision medicine.
Given the choice, most of us would rather leave our wallet at home than our smartphone. Your phone keeps track of your email, calendar and social media apps, and is probably your primary source of news throughout the day.

Increasingly, mobile devices are turning into a significant tool in disease prevention. The apps on smartphones, as well as new wearable tech such as the Apple Watch and Fitbit, collect data on our exercise and sleep patterns and present it back to us in a digestible form.

It can be a extremely helpful way to stay healthy. Being shown a line graph depicting how fast and how far you are running each day, or how many steps you have taken, is extremely motivating – most of us hate to see a dip in that line of progress!

Until the advent of smartphones and wearable tech it wasn’t possible to easily capture and analyse information about a person’s exercise and sleep patterns.

With knowledge comes empowerment, as a recent article from global consultancy McKinsey\textsuperscript{14} notes. In one survey 85% of patients said they were confident to take responsibility for their healthcare and to find out more about how to stay healthy through online resources.

The vast amount of data gathered from a person’s smartphone will also have an enormous impact on the way doctors treat their patients. They will be able to quickly determine if a course of treatment is having a positive effect, and if they are required to make changes straight away – they won’t even need to see the patient face-to-face because the data can be sent directly to that patient’s electronic file.

In addition, clinicians will be able to push messages out to the patient via their smartphone, reminding them to follow their healthcare plan – whether that is to take medication, go for a walk, or simply ensure they get a good night’s sleep.

At Orion Health we are developing applications that will enhance the partnership between healthcare professionals and consumers. We’ve built an open data platform that will serve as the cradle of innovation for precision medicine. This is the revolution in healthcare that will enable personalised healthcare.

Applications that improve the health outcomes for tens of millions of people will be able to integrate with our platform, following a rigorous vetting process.

The intersection of healthcare and technology is powerful. It enables everyone to live longer, healthier lives.

One of the greatest tools for the practice of precision medicine is your smartphone - and it fits in the palm of your hand.
Timeline
Medical advances in the past 25 years

1992
First vaccine for Hepatitis A

1996
Dolly the Sheep becomes the first mammal to be cloned

1998
First vaccine for Lyme disease

2000
First draft of the human genome announced

2005
First partial face transplant done in France

2007
Scientists discover how to use human skin cells to create embryonic stem cells

2015
US President Barack Obama announces the Precision Medicine Initiative

Precision medicine is a revolution in global healthcare that takes its place alongside the big milestones in medical science in the past 25 years.
End-Notes

7. http://www.genomicsengland.co.uk
Orion Health is a New Zealand technology company that has built a global data platform for precision medicine. The company is committed to providing solutions that enable healthcare to over 90 million patients in more than 25 countries. Orion Health employs over 1250 people globally and is dedicated to continual innovation, investing over 30% of total operating revenue year to date in research and development, to cement its position at the forefront of precision medicine.

www.orionhealth.com