FRONTIER TECH INVESTOR

ISSUE NO. 27 JULY 2018

In this issue:

The NHS reborn:

This tech revolution will make the NHS the envy of the world – here's how to be a part of it

Eoin Treacy, Investment Director

On Christmas Eve 2011 the parents of Lucas Rothwell were informed by his doctors their baby boy was going to die.

He had been diagnosed with an aggressive form of cancer and the NHS did not have the means available to treat him. He was incredibly weak. But doctors told his parents that he could be treated if they were willing to fly him to the US.

He was already ill with septicemia, meningitis and pneumonia. His immune system had been so badly damaged by the chemotherapy that there were grave fears he would not survive the trip.

Things were so bad they were informed that a priest should be called to perform the last rites.

Miraculously... Lucas was saved.

Today I'm going to explain how. Not only that, I'm going to show you how the technology behind his sudden recovery could be a part of an even bigger transformation for healthcare in the UK... and particularly the NHS.

I'm not just talking about "saving" the NHS. I'm not talking about a quick fix. I mean a genuine transformation that makes UK healthcare the envy of the world. That changes the medical outlook for millions of British people – and millions more that will flock to the UK to benefit from this.

We're at the start of a revolution – a sudden, dramatic shift that will change the lives of millions.

In short, there is something going on in the UK right now that has the capacity to revolutionise the treatment of cancer.

I don't expect you to have heard of it.

No this is not about immuno-oncology. It's not about gene therapy, genetic sequencing or CRISPR, at least not in the way you might expect. But it is something you need to be aware of because there is a truly impressive commercial opportunity about to open up.

And one small UK company holds the key to it.

We'll come to the potential returns in a second. First, let me explain what's happening.

A $6.5 trillion "mega-sector"

Everyone is concerned with energy.

We spend money on fuelling the car, cooking our food and heating our homes every day. It's a part of all our lives, all of the time. The global energy sector represents an annual spend of about $6 trillion so it is also one of the biggest areas of investigation research and innovation.

But what a lot of people do not appreciate is that the global healthcare sector is by some measures even bigger at about $6.5 trillion of expenditures every year.

Cancer is a huge part of that at about $1 trillion a year.

Cancer is the world's second biggest killer after heart disease but it is the number one most costly disease to treat.

Of course, the difference between the energy sector and the healthcare sector is that in the UK we don't see what we are spending on healthcare coming out of our pockets every week so we don't tend to pay as much attention to the true cost of healthcare.

That's going to change though. The subject is going to move front and centre as the population ages and demand for healthcare rises.

Simply put, the NHS is broke. Radical change is required to fix it.

Will the NHS survive in its current form?

When asked what makes us proud to be British, the #1 answer was the National Health Service (NHS).

It is the one sector that people do not want to give up under any circumstances regardless of the outlook for exiting the EU, taxation or trade. It's a national treasure and it's in serious trouble.

Over the weekend thousands took advantage of the good weather to mark the 70th anniversary of the NHS by demanding that more money be set aside for it.

The 2015/16 audit highlighted the fact that the combined deficit for all trusts was £1.85 billion. That was more than three times greater than the £574 million deficit reported in the 2014/15 report. Not only is the total deficit rising but 65% of trusts are now in deficit compared with 44% previously. That means more money will have to come from the Department of Health and government coffers to cover the shortfall.

The Department of Health has already transferred £950 million of the £4.6 billion that had supposedly been reserved for capital expenditure to fund day-to-day expenses. That represents a significant threat to the sustainability of the whole enterprise since care will undoubtedly suffer if physical infrastructure cannot be sustained.

It was estimated in the 2015/16 report that one of the few ways that could be found to reduce costs was to cap public sector pay and to reduce demand for services. On 21 March 2018 Theresa May announced a pay hike for NHS workers of 6.5% after what had been a seven-year pay freeze. That pretty much ensures the financial stability of the NHS is unachievable over the coming years.

Simply put, as things stand the NHS is effectively bust. It's living on borrowed time.

I don't know a person who had a bad word to say about the staff in the NHS. The quality of care and attention to patient needs given by

nursing staff is beyond reproach.

But we are kidding ourselves if we think that the NHS is not in trouble.

The UK has an ageing population that is living longer and a nationwide free healthcare service is going to require increasingly large flows from government to sustain year after year for the foreseeable future.

This isn't a secret. Everyone knows. However, no one is talking about the inevitable prospect of the NHS being dismantled due to rising costs.

Little wonder then that one of the most effective campaign promises from the Brexit campaign was written on the side of a red bus and driven around the country. "We send the EU £350 million a week, let's fund our NHS instead."

The secret to making the NHS great again

Forget about trying to keep a lid on wages. There is absolutely no way that is going to work.

Living standards have been falling for too long for people to have any further patience with the idea of austerity. If anything, we are only at the beginning of wage demand growth.

The only way we are ever going to get to a position where the NHS is sustainable is if costs are kept under control. That's why I keep banging on about cancer. Not only is it a big expensive problem but it is a fixable one and that really is a cause for optimism.

Cancer Research UK estimates that there were 359,960 new cases of cancer and 163,444 deaths. There is a 50% survival rate after ten years. The US' National Cancer Institute' s figures are 1,735,350 new cases, 609,640 deaths and a survival rate after five years of 66.9%.

The National Cancer Institute estimates that up to 38.4% of people will get some form of cancer in their lifetime. That means every one of us knows someone who is going to get cancer, has cancer, died of cancer, or all three.

The incidence of cancer is rising for any number of reasons ranging from the fact that we are living longer, our life styles, environmental factors, genetics and bad luck. There is absolutely no doubt that survival rates are improving but the cost of care is spiralling to levels that are getting out of control.

The truth is that the NHS really is a national treasure and with some astute management, imagination and with a little luck it could be the undisputed idol of the whole world.

Radiation therapy meets exponential technology growth

Broadly speaking there are three kinds of cancer therapy. These are radiation therapy, which is based on shooting particles at the cancer, chemotherapy, which is drug based, and immunotherapy, which I've written about before and is about re-educating the immune system to kill cancer.

This month I'm going to talk about radiotherapy. To explain how it works, let's first do a little physics 101.

Einstein told us that light travels as both a particle and an electromagnetic

No one is under any illusion that the NHS is perfect, but universal access is pretty hard to bear.

It's really a testimony to how divisive this issue is that there is now a bus going around with this notice on the side: "Brexit bill: £50 billion and counting let's fund our NHS instead." No one is under any illusion that the NHS is perfect, but universal access is pretty hard to bear.

wave. These kinds of waves exceed the visible spectrum so we have radio waves, microwaves, infrared, ultraviolet and X-rays.

When X-rays are used to treat cancer, it is their properties as photons that are used to target cancer cells by irradiating the tumour. As chargeless particles, they heat the nucleus causing damage that emits free radicals which can in turn kill the tumour. This is known as selective cell destruction.

However, the primary issue with using X-rays is that because we are dealing with a photon it tends to pass straight through the body. It might hit the tumour but it also hits healthy cells and irradiates those too. That means less than optimal doses can be administered because irradiated healthy cells with damaged nuclei can develop cancer so the treatment can be self-defeating.

Our story today focuses on a superior form of radiation therapy known as proton therapy.

Discovered inside the Large Hadron Collider

Proton therapy evolved as an idea soon after the first particle accelerators were put into action. Strange as it sounds, the technology behind these incredible machines can be harnessed to fight cancer.

We've known this for a while. But it's taken decades for the technology to catch up with the idea.

And even then the machines cost hundreds of millions of dollars to put into action. With such a specialised piece of kit you need dedicated facilities.

Then there is the amount of radiation that is thrown off by proton therapy machines which creates even greater costs in terms of shielding and even greater costs again when they have to be decommissioned.

What that means is that despite the technology having been in existence for more than fifty years, there are only 79 of these machines in the whole world.

That's where the exponential pace of technological innovation comes in. A group of scientists at the Large Hadron Collider at the European Organisation for Nuclear Research (CERN) in Switzerland came up with a way to do it cheaper, better and with less radiation.

They set up a company to raise capital to commercialise the idea and their first commercial prototype is almost complete in Harley Street. It's an exciting development because it holds out the real prospect that the UK can grab a jump start on becoming the leading destination for what is one of the fastest growing areas of cancer treatment.

Surgical precision vs brute force

As I said, proton therapy is a type of radiation therapy. But it's much more advanced. Why?

Protons are particles with a positive charge so when directed at the nucleus of the cancer molecule it draws away an electron, pulling it out of orbit. That is called ionisation and it changes the characteristics of the atom.

By damaging the molecule, especially its DNA or genetic material, the treatment kills the cancer.

Proton therapy is far superior because it is far more targeted and it does not pass through the body. The delivery of the proton is exact because they are individually energised to specific velocities, which means they can be directed in

It's an exciting development because it holds out the real prospect that the UK can grab a jump start on becoming the leading destination for what is one of the fastest growing areas of cancer treatment.

a very specific 3-dimensional manner and most of their energy is deposited at the site of the cancer.

X-rays on the other hand tend to deposit most of their energy on the skin, some at the tumour site and the remainder on cells behind the tumour. Because proton therapy is so targeted the dose that can be delivered is much higher than would be possible with X-ray therapy.

In short, it's surgical precision compared to traditional radiation's brute force.

Best of all the experience is painless and the patient can be back on their feet a couple of days after the procedure.

So why isn't their one of these machines in every city? Simple. Cost and radiation.

Proton delivery machines are effectively small versions of the Large Hadron Collider, and because we are talking about accelerating subatomic particles to about fractions of the speed of light, a great deal of radiation is thrown off.

Historically, proton machines have been housed in bunkers a couple of stories underneath a hospital in order to shield the rest of the building from the radiation risk. That increases both the building costs, running costs and eventually the decommissioning costs.

It is not unheard of for hospitals to be built around where the proton machine is going to be housed, such is the difficulty of retrofitting existing buildings to host one. That means the cost of installing a proton machine has been beyond the means of many healthcare providers for decades.

What's changed?

Two things have happened of late to make the decision to install proton machines more compelling.

The first is that they are effective. The primary use for proton therapy today is when nothing else works. It is primarily used for inoperable tumours, cancers of the eye and paediatric cancers.

Increasingly, it is being used for advanced forms of prostate cancer. With an 89% effectiveness rate for this latter form of cancer, you can understand why it is so appealing for both clinicians and patients. Remember that in the UK you currently have a 50% chance of surviving cancer so raising that to almost 90% is a massive undertaking.

The technology is finally at a price the NHS can afford. Though it's still not cheap – it's an investment that could really change things.

Today there is only one proton machine in the UK. It's at the Clatterbridge Centre for Oncology. However, this machine has been used almost exclusively for ocular tumours.

A study conducted at Liverpool Ocular Oncology Centre on 346 patients with ocular tumours so large they were unsuitable for other treatment found that 79.1% of those who could count fingers before the treatment could still do so five years after the treatment.

The second big change is the technology is finally at a price the NHS can afford. Though it's still not cheap – it's an investment that could really change things.

The NHS is about to open its first dedicated proton therapy unit at the Christie Hospital in Manchester later this year.

This brings the first dedicated proton therapy unit to the NHS which will focus on tumours beyond those of the eye, which has been a massive undertaking and cost upwards of £250 million. The NHS is planning another facility which is due to open in London in 2020.

There are another four proton

centres under construction by the Rutherford Group that will offer high energy proton beam therapy which is somewhat more advanced than what the NHS is funding.

All of these machines are being built on what can be considered a conventional design which is an approximation of the ring that particle accelerators use to speed up the protons. One of the reasons they cost so much money is because this type of technology requires a huge amount of shielding to protect everyone from the radiation unleashed by the machine.

As I explained earlier, the NHS is essential to the wellbeing of the UK but also to our national sense of identity. It's not enough to simply eek out an existence and if we are going to have the healthiest nation in the world, then we need to have the kinds of treatments that will allow people to live long and productive lives.

So how can we afford it? That's where the share I am recommending for you this month comes in.

Buy this stock: it could save the NHS

Our company has a new design for a proton machine that is linear instead of circular, uses much less radiation, costs less and is equally effective.

It's what is currently being built in Harley Street and it has the potential to change the face of the global proton therapy sector beyond recognition.

The primary reason there are not more proton machines available is because they cost so much and it took time to build up the clinical data to support the expense. With this new technology the size of the addressable market will increase because costs will be lower and many more people will be able to avail of this kind of treatment.

The company that has developed this new technology is Advanced Oncotherapy Plc and it's listed on the AIM Index. When its first system goes into full commercial operation in 2020 it will be the first compact proton therapy provider in the world.

The company was founded by a group of physicists from CERN who first tested a linear design for a proton accelerator in a cyclotron at 73MeV. They have been working on the project for more than 25 years and it is now in the final stage of testing before full commercial rollout.

That is the primary reason why I am writing to you about this company now.

In another year, the UK media will be full of stories about proton therapy in the NHS, and there will be at least three more machines operational using the same legacy technology at private facilities.

When its first system goes into full commercial operation in 2020 it will be the first compact proton therapy provider in the world.

It is the perfect time to bring a new smaller, cheaper, more powerful model to market which will allow many more people to avail of what is a very promising treatment alternative.

The Application of Detectors and Accelerators to Medicine (ADAM) was spun off from CERN in 2007 with the express purpose of commercialising the linac-booster for proton therapy (LIBO).

That led to the development of what is now referred to as the LIGHT project. It's an acronym for "Linac Image Guided Hadron Technology". That word "hadron" gives us a clear idea of exactly what is going in its design. It has created a particle accelerator that no longer relies on a loop to speed up the protons.

LIGHT at last

As I see there are three primary advantages of the LIGHT system. It is modular, can reach high energy intensities and it's small.

The modular design means that the system can be mass produced. Once its first machine is up and running in central London, the company expects to be able to manufacture four per annum.

That alone will accelerate the pace with which this kind of therapy is available all over the world.

The modular design also means it's easier to transport so that it does not have to be manufactured on site but can be produced in a factory setting, which will create an additional cost efficiency. The company will not be manufacturing the units itself and has contracted the French multinational Thales Group to produce the key components which removes manufacturing risk from the equation.

The modular design also helps with increasing the power output of the machine because by adding additional modules the power can be increased. That higher energy intensity is one of the most central components of the LIGHT system.

Today proton therapy machines are housed in bunkers and require massive and expensive shielding because the energy they are functioning at, around 70 MeV, results in 1% efficiency.

That means upwards of 99% of the particles escape the chamber or are lost due to degradation and people need to be shielded from them. As the energy emitted by the system increases efficiency improves at an exponential rate.

However, at 250MeV a future machine will be 100% efficient. Right now, Advanced Oncotherapy is aiming for a machine capable of variable intensities ranging from 70 to 230MeV which will require radiation shielding but much less than is required with a conventional machine.

Due to the fact that much less shielding is required, the machine is now being constructed in central London 141/143 Harley Street, just around the corner from Marylebone Road where space is at a premium.

By creating a linear particle accelerator, the team have essentially created a proton particle gun which is capable of shooting protons at 60% the speed of light. That's a lot slower than the Large Hadron Collider but it is doesn't need to be as fast and at 24 metres long, it is a lot shorter than the 27km loop at the CERN facility.

Competition risk

There are other companies building proton therapy machines.

IBA for example is close to completing three for the Rutherford Cancer Centres around the UK. Varian, Hitachi and Mevion are all also building proton therapy suites around the world.

With such a promising therapy that is increasingly well understood and which is benefiting from the exponential pace of technological innovation, it is understandable that there is competition in the market.

However, it is worth remembering that all of these companies are building machines whose design was first conceived around 30 years ago. The Advanced Oncotherapy LIGHT system has key advantages in speed, accuracy, cost, build time, decommissioning costs and transportation.

For a company of Advanced Oncotherapy's size (it currently has a market cap of £73.9 million) the biggest question is always going to be about funding R&D and daily operations until it starts to generate income, which could be 18 months from now.

The good news is that it has partners who are willing to fund the company until it gets its project to market. For example, on 11 May it announced that it had received $6.5 million from Yantai Cipu which is the first portfolio of the £30 million the

Chinese group is investing in the company.

Yantai Cipu is a privately held, well-connected company that is looking at introducing next generation proton therapy to the greater Chinese market. It now owns 29.9% of Advanced Oncotherapy.

The cash Yantai Cipu has brought to the business has put it in a much better financial position.

This first instalment has allowed the company to come to better terms with its landlord at Harley Street, Blackfinch Investment Ltd. Repaying the loan has ensured that security deposits and liens on the company have been removed so that all its assets are now held free of any security arrangement. That's an important milestone since it removes a threat of dispossession in the event of a liquidity problem at some point in future.

2018 is a big year for the company because in 2017 it announced that it had successfully passed a stream of protons through the first three parts of the machine. It expects to be able to link the fourth and final portion, the accelerator, up this year and that will allow the company to move into treating superficial cancers, and therefore generate income for the first time later this year.

The risk is that the Harley Street facility takes longer to finish. That's not inconceivable since it is being built in a listed building. However, considering it takes between three and four years to build a conventional proton therapy suite in a greenfield site, the lead time of 2.5 years for the central London location is already impressive.

Advanced Oncotherapy is simultaneously building two additional facilities, one near CERN in Switzerland and the other in Syracuse, New York, which are expected to take between 12 and 18 months to build.

An additional risk is that the throughput of the pieces of technology might take longer than first thought and personnel are an additional risk. Advanced Oncotherapy has less than 100 employees so it needs to hold on to as many of its engineers and scientists as it can.

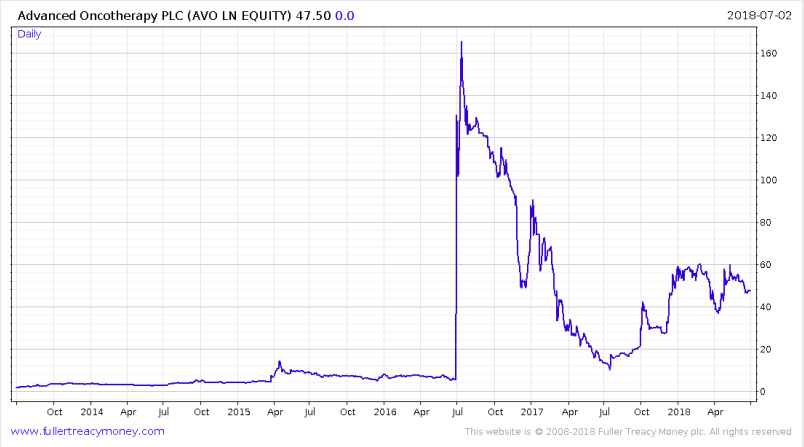
Nevertheless, I am personally very excited about this AIM-listed company and its runway to profitability over the coming couple of years. The closing of the Chinese funding round was a pivotal turning point for the company last year and I believe the anticipated of first revenue some time later this year will be a catalytic event for the share. I recommend buying Advanced Oncotherapy up to 70p. My 12-month target is 100p. BUY.

If everything goes according to plan, my five-year target is at least 400p.

Action to take:	**buy Advanced Oncotherapy PLC**
Ticker:	**AVO**
Price as of 2 July:	**48p**
Buy up to:	**70p**
52-week high/low:	**63.50/9.75**
Market cap:	**£73.6 million**

Figures accurate as of last market close: 02.07.2018

Past performance:



Data as of 03/07/2018

Energy

Company	Ticker	Rec Date	Price Then	Price Now	Gain/ loss %
Orocobre Ltd	ORE. AX	07/04/16	A$ 2.92	A$ 5.43	85.96
Ormat Technologies	ORA on NYSE	06/06/17	$58.79	$53.18	-8.71
Smart Metering Systems	SMS LN	03/10/17	735.5p	753p	3.09
Sherritt International Corp	S CN	06/02/18	C$1.18	C$1.11	-5.93

Technology

Company	Ticker	Rec Date	Price Then	Price Now	Gain/ loss %
Cyberdyne	7779	30/05/16	JPY 2,353	JPY 1,295	-44.96
IBM	IBM LN	07/06/16	$153.33	$139.86	-1.11
SAIC	SAIC US	05/07/16	$58.20	$81.57	44.42
Garmin	GRMN US	02/08/16	$55.75	$61.69	17.06
2U INC	TWOU: US	06/02/17	$33.25	$84.91	155.37
Cisco Systems Inc.	CSCO: US	03/04/17	$33.80	$42.81	31.07
Advanced Micro Devices	AMD US	26/07/17	$14.76	$11.59	-21.48
Microsoft	MSFT	31/07/17	$73.04	$100.01	39.18
Northrup Grumman	NOC US	06/07/17	$301.66	$308.87	3.42
Intel Corp	INTC	06/06/18	$56.60	$50.20	-11.98

Medical

Company	Ticker	Rec Date	Price Then	Price Now	Gain/ loss %
Autodesk	ADSK	19/07/17	$108.83	$131.90	21.20
Abcam	ABC	07/03/17	907.5p	1337p	48.83
Illumina	ILMN	04/09/17	$207.15	$279.10	34.69
PureTech Health	PRTC-L	09/01/18	155.75p	153p	-1.77
Agios	AGIO	06/03/18	$84.23	$85.52	2.97
Becton Dickinson and Co	BDX	03/05/18	$221.35	$238.90	8.27
Canopy Growth Corp	WEED :CN	21/03/18	C$33.11	C$38.42	16.04
Advanced Oncotherapy	AVO	03/07/18	48p	48p	0

Moonshot

Company	Ticker	Rec Date	Price Then	Price Now	Gain/ loss %
SolarWindow	WNDW	07/04/16	$3.96	$3.82	3.54
Alkane Resources Ltd	ALK: AU	05/09/16	AU$ 0.31	AU$ 0.24	-22.95
Editas	EDIT: US	07/03/17	$21.02	$36.99	73.83
Haydale Graphene Industries	HAYD	02/5/17	178.5p	70.00p	-60.78
Superconductor Tech Inc	SCON	28/03/17	$0.95	$0.92	-4.17

For the full portfolio including live prices, please visit the *Frontier Tech Investor* subscriber area. **You can view that by following this link.**