A long-time favourite of horror and sci-fi, AI was once consigned to annals of *Tomorrow's World* - along with holographic TV and floating bicycles - but with some fledgling companies now worth in excess of £1bn, AI is fast emerging in the real world. So is now the time for investors to get in on the ground? **Dr Michelle Tempest** and **Dr Sam Winward** of Candesic take a look at why AI is growing in healthcare and who to follow

Believe in unicorns

Artificial intelligence (AI) is an umbrella term for technologies that, rather than being restricted to following precise codified instructions provided by human programmers, can learn to solve problems.

AI systems can build their own assumptions, spot trends, and create insights from massive datasets. It's a fast-moving sector.

In 2010, Google developed driverless cars.

In 2011, IBM's Watson supercomputer beat the human champion at TV quiz show *Jeopardy*. By 2017, a 19-year-old boy called Joshua Browder developed a language AI chatbot from the comfort of his own bedroom and named it 'DoNotPay'. To date it has helped over 375,000 people claim back $9m in unfair parking fines.

As AI races ahead, the question of human superiority in pattern recognition, language, prediction and even judgement is being shaken to the core.

Predicting the future

In terms of healthcare AI, here are some regularly reported quick-fire predictions:

- The AI health market is expected to reach $6.6bn by 2021, growing at 40% CAGR
- AI in medical imaging and diagnosis is projected to exceed $2.5bn market size by 2024
- Health AI is predicted to make $150bn annual savings for the US healthcare economy by 2026.

As AI disrupts the healthcare market, there will be winners and losers, just as there have been in the finance sector.

Figure One highlights a clear trend that healthcare is becoming dominant for AI investments, attracting 15% ($748m) of all funding in 2016.

Of all the 'unicorns' - companies valued over $1bn - 40% are in healthcare and AI 'unicorns' include:

- **Flatiron** (raised $175m, at a $1.16Bn valuation in 2016) a platform that extracts, connects, and structures cancer data using machine learning to fuel the fight against cancer
- **iCarbonX** (raised $154m at around a $1bn valuation in 2016) reached unicorn status within six months. Its pledge is to create a complete health ecosystem for an individual, based upon genomics, proteomics, transcriptomics, immune response and analysis of gut bacteria and lifestyle factors. It leverages machine learning to create actionable, individualised insights
- **BenevolentAI** (raised $100m at a valuation of $1.8bn in 2015) uses AI to combat the mismatch between healthcare information (a new scientific paper comes out every 30 seconds) and humans ability to process it. The firm has had early success through discovering a new compound, which has since been shown to delay the progression of motor neurone disease. It's also had some success with finding a new drug for Amyotrophic Lateral Sclerosis (ALS).

Investment in Healthcare AI is growing faster than AI as a whole, albeit from a low base.

How is AI shaping UK healthcare?

AI is evolving fast and clinical experience tells us that it will change our current healthcare patient journey. For the naysayers out there, the future needs the combination of man and machine to cope with the pincer movement burden of an increasing ageing population with more long term conditions, alongside an acute or chronic staffing shortage. In this article, we focus on how AI is shaping the 'pre-primary care space' as a key way to relieve the strain at the front door of primary and secondary care. We have divided this into three broad classes of solutions:

Internet searches

Be honest, who has not used 'Dr Google' to search a medical query?

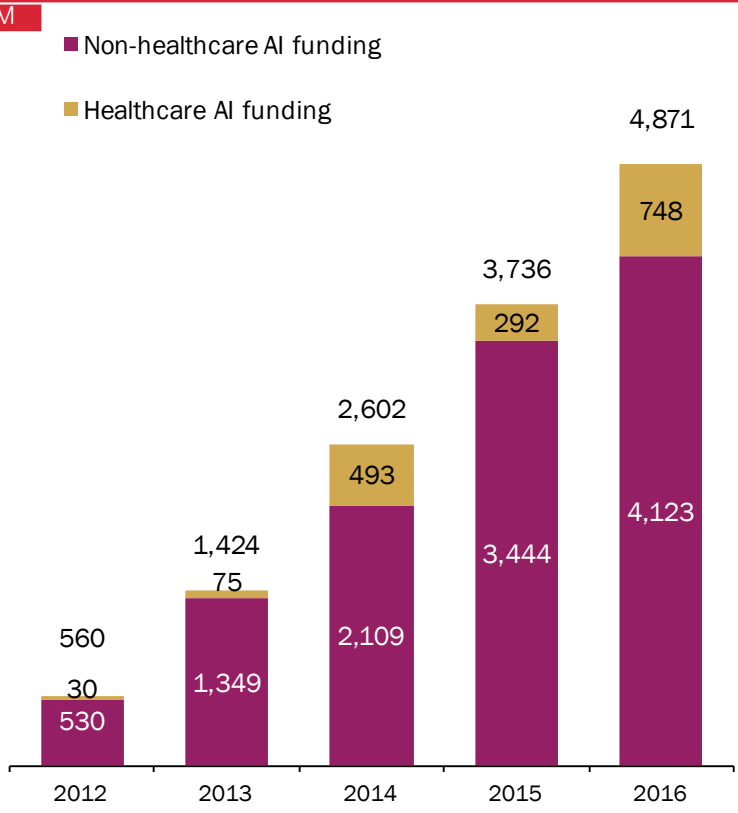
Typing symptoms into Google invariably leads to a momentary cancer scare! In fact, the Internet has been blamed by the media for increasing health anxiety and a new term 'cyber-chondria' has been coined. The limitation of 'Dr Google' is the lack of context; it has no knowledge of your medical background, risk factors, or family history – a clinician looks at the whole picture; Google looks at a string of words. Google has recently announced that if you search words such as 'depression' or 'clinical depression', it will lead users to the clinically validated PHQ-9 (a version of the Patient Health Questionnaire) that can be self-administered to help people figure out whether they should seek help by a mental health professional. Google is doing this in partnership with the National Alliance on Mental Illness (NAMI) and with large data sets and global searches, the AI results of 'Dr Google' will be interesting to track.

Symptom checkers

This is used when patients list their symptoms and the AI algorithm produce a list of possible diagnoses, normally sorted by probability. Some symptom checkers also provide triage information, such as Isabel. Isabel has been running since 2000, started by the founder whose daughter Isabel suffered a near fatal misdiagnosis. Since 2012, Isabel has been programmed with AI advanced natural language processing to cover 6,000 disease symptoms and is focused on helping people double check their diagnosis.

FIGURE ONE - FUNDING FOR AI COMPANIES WORLDWIDE

US$M



SOURCE CB INSIGHTS, CANDESIC ANALYSIS

Personal health assistants

This cohort may be the healthcare care pathway game-changer. The key differentiator is that these platforms ask the users for information to help make better decisions. This allows for clarification, adds a timing dimension, and, critically, permits discovery of information that a patient may not have included into a symptom checker.

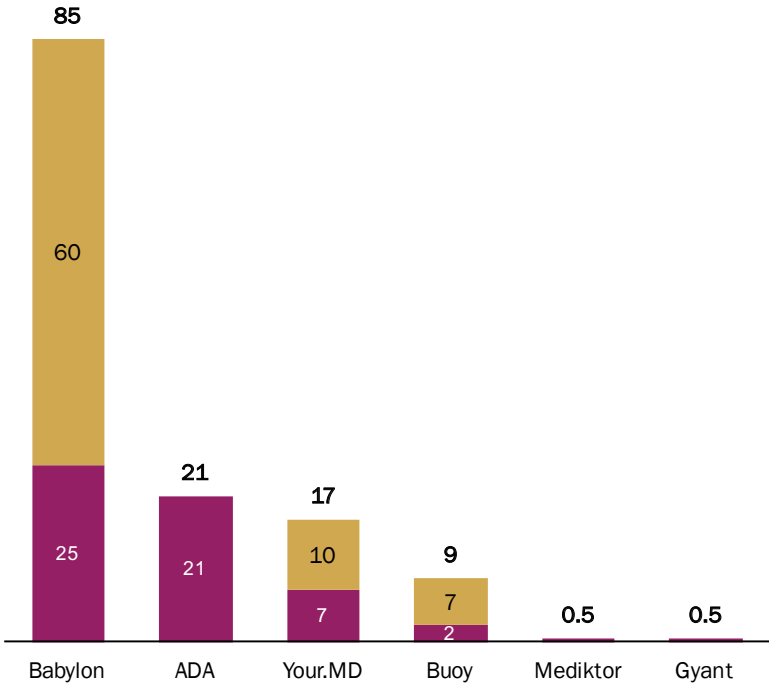
This was also the initial aim of 'NHS 111', a phone line for patients that advises where to go and how urgently. It receives around 15 million calls per year, costing the NHS £180-£240m (£12-£16 per call). The service is not necessarily staffed by medical professionals and relies on pathways of questioning rather than the 'call handlers' clinical knowledge or intuition. Now babylon, the UK-based tele-medicine service, is bringing its AI triage application to this service, aiming to make substantial savings on this model and has recently won a contract in January 2017 to serve 1.2 million patients in north London. Although it's early days, it's easy to imagine how AI could be used in this setting to cut costs and improve efficiency. The current ten to 12 minute NHS 111 call time reduced to a two minute automated questioning via the babylon app, using AI to learn and hence improve over time. babylon has also secured $60m funding to improve its AI capabilities.

In true Candesic style, we were excited to see how sexy new AI technologies are helping patients. So, we set about doing a mini test, for fun, of the readily available personal health assistants. Figure Two highlights six companies that were identified to be offering this service; combined, they have raised around $130m in funding, over half of it in this year alone.

Two virtual patients were created, each with a sexually transmitted disease – a male with gonorrhoea, and a female with chlamydia.

Both patients were symptomatic

FIGURE ONE - FUNDING FOR AI DRIVEN PERSONAL HEALTH ASSISTANTS
US$M



SOURCE CANDESIC ANALYSIS

and were designed to require prompt assessment in a sexual health clinic. Each of the personal health assistants was judged clinically across four dimensions:

- medical history
- diagnostic accuracy/precision
- advice/triage quality
- and ease of use/accessibility

Platforms would score well if they asked key questions that would change the urgency of seeking medical attention, if they offered the correct diagnosis within a small list, if they advised attending a sexual health clinic with advice to avoid sex, and for advising partner testing.

What became clear is that AI healthcare platforms are still learning, which is no surprise. Two platforms lost some user confidence at the first hurdle, amusingly asking for gender directly after typing in the symptom 'discharge from penis'. However, these kind of teething problems or gender inclusivity are generally down to AI still learning human language. Overall, the systems are impressive. Most reached the correct diagnoses and linked to various helpful advice websites. Figures Three and Four summarise our results.

For diagnostic accuracy, the top three performers were Ada, Buoy and Your.MD. babylon, as yet, does not offer a diagnosis but instead focuses on triage and advice, however, it asked a very thorough sexual history and even screened for sexual abuse.

Your.MD scored highly in all four dimensions. It offers a unique solution as it acts as a form of broker for different healthcare services and aims to be the AirBnB for online bookings. Alessandro Traverso, co-founder and COO of Your.MD, describes it as 'a health ecosystem' that helps connect users with a health problem to the best healthcare providers with a solution most relevant to their problem.

Investment thesis: unlock and unleash

Other sectors are ahead in terms of AI, leveraging both data and computing power. Companies such as Netflix and Amazon already harness masses of available consumer data to feedback personalised tempting offers, direct to the end user. If healthcare AI follows the same trajectory, it will create a new wave of opportunity for businesses, investors, and customers. Progress is already happening in the life sciences sector, 360-degree feedback of patient data and predicting risk. Aetna recently contracted with MAP Health Management to pilot an IBM-Watson-based AI tool to predict high-risk substance abuse patients and offer early behavioural intervention.

But while we eagerly await this new brave world, we asked Medopad a medical technology platform valued at several hundred million dollars in a Bloomberg report, which is racing full steam ahead in AI, for some trend insights. Dan Vahdat CEO and co-founder of Medopad noted: 'We have seen increased interest from hospitals and pharmaceutical organisations towards predictive insights for disease treatment. Global governments are requesting 'big data' mining to understand health outcomes for entire populations. And insurers are looking for help to close the gaps between policy holder, healthcare provider and the insurer.'

Finally, hot off the press, Simon Stevens, CEO of NHS England, has nailed his colours to the mast promising to invest even more in AI over the next 12 months. He has also publicly backed the recently published life sciences industrial strategy which recommends greater use of AI. Practically, there will be a roll out of new regional patient data schemes and Stevens highlighted that 'huge swathes' of the NHS could be automated using AI spotlighting radiology, pathology, and dermatology.

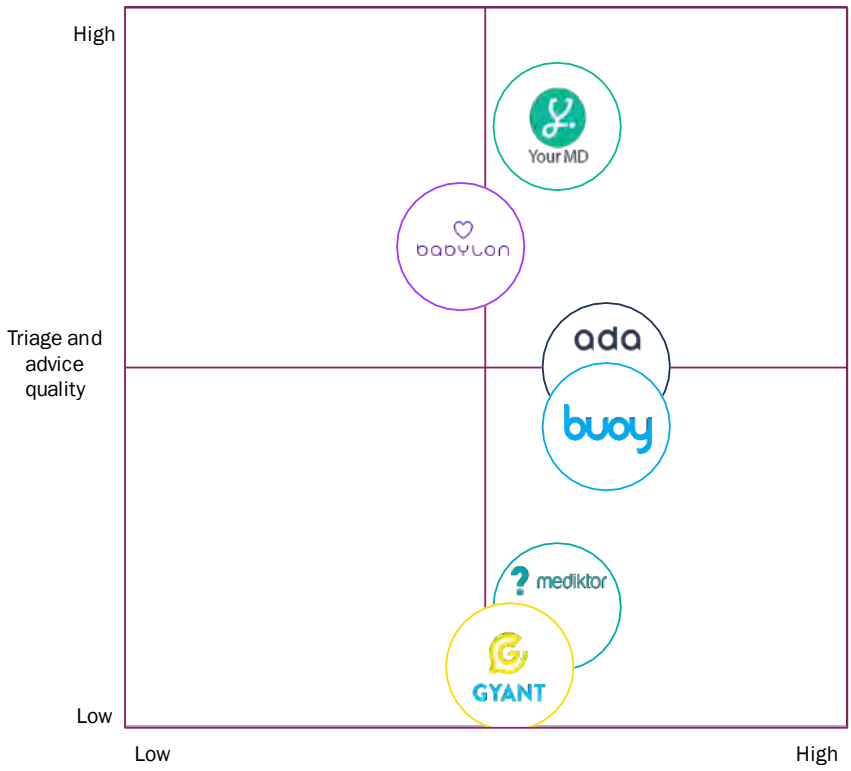
For investors, the time is now to get to know the AI companies, do the due diligence and spot the stars, the unicorns, and the companies that will deliver consistent investment returns. In the short-term, efficiency

savings and data optimisation will predominate, increasing profits, and creating new revenue streams. In the longer-term, truly personalised healthcare could become a reality.

One thing is for sure: AI is here to stay.

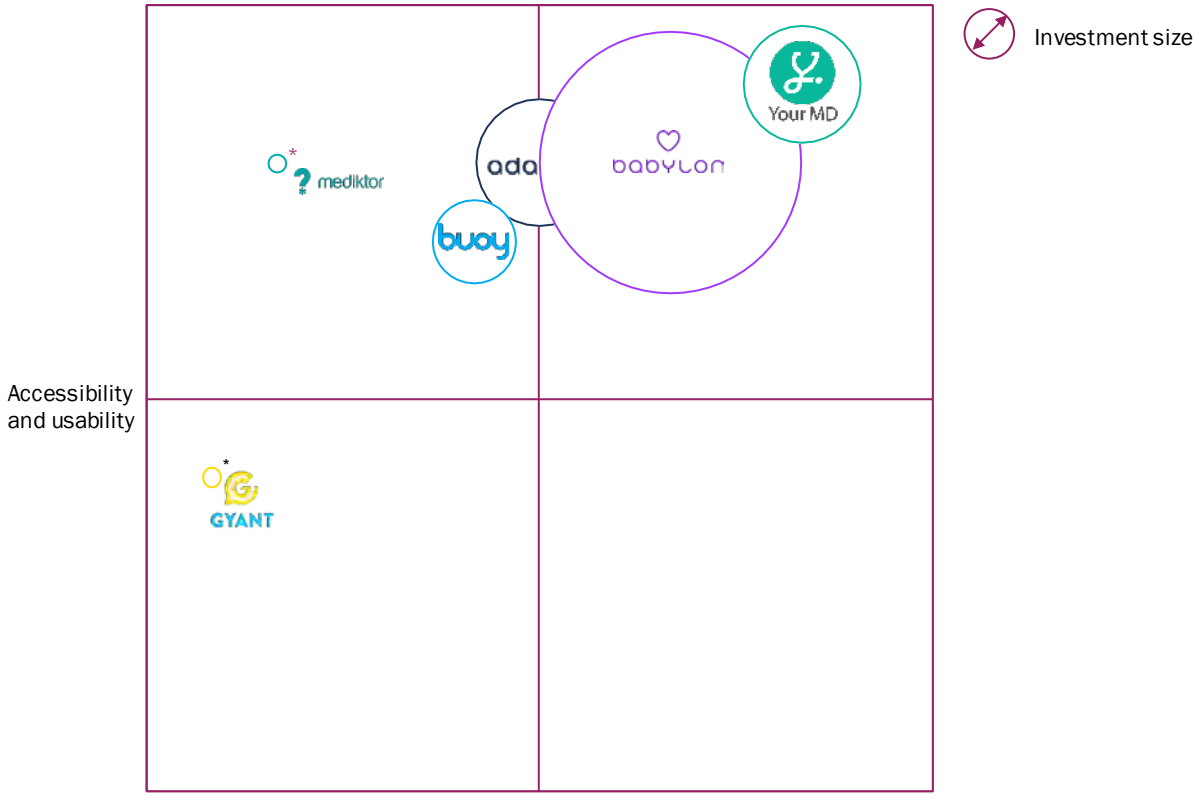
Dr Michelle Tempest, partner, Candesic

FIGURE THREE - CLINICAL ASSESSMENT OF AI PERSONAL MEDICAL ASSISTANTS



SOURCE CANDESIC ANALYSIS

FIGURE FOUR - CONSUMER BENEFIT FROM AI PERSONAL MEDICAL ASSISTANTS



SOURCE CANDESIC ANALYSIS