

Complex home healthcare is finally becoming a reality following a wave of entrepreneurial innovation, government funding and investor interest fuelled by the Covid-19 pandemic. There is much to celebrate but some low hanging simple solutions are yet to be implemented, including the use of tech to help solve key clinical issues, such as measuring fluid balance and preventing dehydration. Candestic's **Dr Michelle Tempest**, **Dr Joe Taylor** and consultant urologist **Heidi Tempest** investigate



# Harnessing tech to deliver virtual wards



The buzz around artificial intelligence and chatbots, including chatGPT and MedPaLM, continues to build and could genuinely be used to help improve health and care at a time of acute staffing and financial pressure in the not-too-distant future.

AI solutions can offer meaningful help with self-management and be used to triage serious health issues. Investors, including the likes of Yabeo and Guinness Asset Management, are already encouraging home healthtech companies such as Cera to develop and launch AI platforms that can predict health deteriorations among the elderly population and enable them to stay safely in their own homes for longer.

Another AI platform, Faculty, is being tested in NHS Wales to reduce delayed discharges. The latest data from NHS England shows that almost 14,000 hospital beds per day – around 15% of total bed inpatient capacity – is taken up by patients who are fit to be discharged. NHS bosses blame delayed discharges for clogging up the system, leading to long waits in A&E and an increasing

number of critical incidents as some NHS Trusts run out of beds. Discharge planning is typically done by nursing staff, but it is hoped that AI will be able to link and match discharges with social care availability in the community.

Another British company, C2AI, has mined deep clinical data to help successfully triage patients on elective care waiting lists according to acuity. It can evidence that its AI tools reduce waiting times and that patients are more likely to be treated in the right facility, with the correct staff mix and within a more appropriate timeframe.

Such innovations are both needed and long overdue. The World Health Organisation (WHO) has flagged a global shortfall of over six million human nurses (see Figure One).

'Until Florence Nightingale can be cloned, technology has to be turbo-charged so it can take over some of the more mundane tasks and create capacity,' said Dr Elina Naydenova, CEO and co-founder at Feebris.

'Using our AI-guided technology, carers, healthcare assistants and commu-

nity nurses alike can detect deterioration in less than ten minutes, saving valuable clinical time and preventing avoidable hospitalisations.'

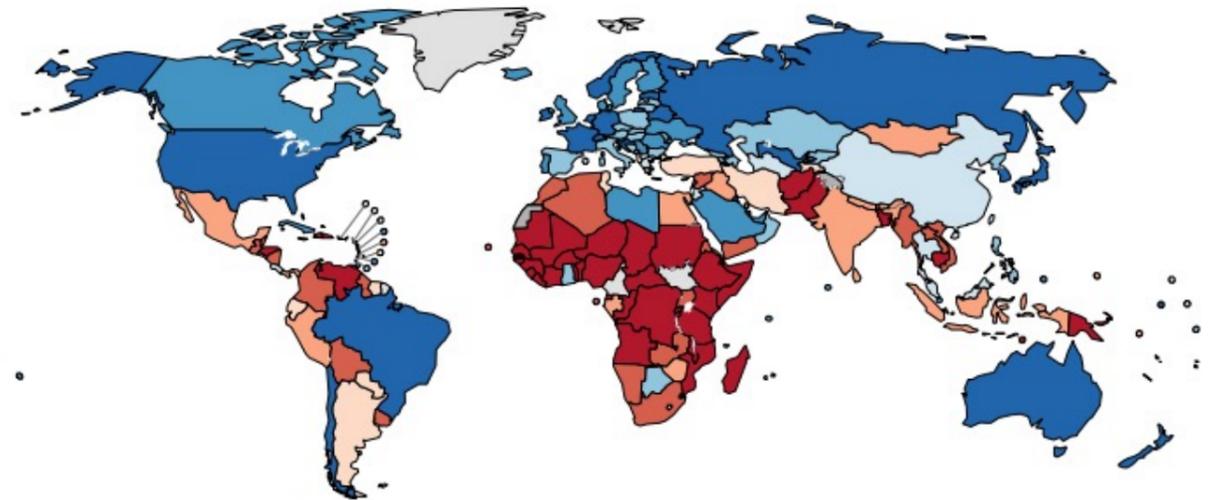
There is plenty to be optimistic about. Already, a full stack of capabilities can help look after people in their own homes. These include:

- **Wearables** fitness trackers and smart watches help track health, wellness and sleep to proactively alert change
- **Smart home technology** smart thermostats, smart water systems can encourage more independent living by reassuring homes are warm and safe
- **Virtual assistants** Amazon's Alexa or Google Assistants are more than just a gimmick, they can help people stay connected and are daily diary reminders of everything from appointments to tablet taking

**FIGURE ONE**  
THE WORLD HEALTH ORGANISATION NOTES A GLOBAL SHORTAGE OF CARERS

PROJECTION OF NURSING PERSONNEL<sup>1</sup> DENSITY IN 2030 (GLOBAL DISTRIBUTION), PER 10,000 POPULATION

■ <10 ■ 10 to 19 ■ 20 to 29 ■ 30 to 39 ■ 40 to 49 ■ 50 to 74 ■ 75 to 99 ■ 100+  
■ n/a ■ Not reported



**NOTE 1** NURSING PERSONNEL INCLUDES NURSING PROFESSIONALS AND NURSING ASSOCIATE PROFESSIONALS  
**SOURCE** WHO; CANDESCIC RESEARCH AND ANALYSIS

- **Telemedicine and virtual wards** health and care platforms exploded during Covid times, and many people prefer to receive medical care and advice from the comfort of their own home. Virtual primary and secondary care appointments are part of the health ecosystem and virtual ward companies are being invested in with new vigour. Prime Minister Rishi Sunak has called for 'bold and radical' action and flagged the need for more virtual wards. Companies such as Huma, Doccla, Dignio, Feebris, current health, Docobo, mymhealth and Spirit health (see Table One) are just some of the operators ready to expand at the request of Integrated Care Boards
- **Robots** physical and digital (physigital), also known as hardware and software, not only provide the power of conversation but can also move and interact. There is emerging evidence that social robots can provide long term companionship, engagement and prevent loneliness

But, for all the whizzy wonders of electronics, gadgets and even FDA approved AI such as Ada (for symptom assessment) or AiDoc (to triage x-rays), this article is going to return to fundamental basics – fluids.

Many fitness TikTok influencers have gone viral with advice on how much to drink before and after work outs. These videos are an important reminder about how fluid balance impacts everyone, even elite athletes. So why is it so often neglected by healthtech entrepreneurs? It may not be sexy, but it is going to be necessary if more people are to be treated outside of hospitals.

## Can fluid balance tracking be improved? Yes

Over 40,000 avoidable hydration-related deaths occur in the UK annually. It is often a predictable and avoidable medical emergency.

ITUs and hospital wards aim to monitor fluid balance fastidiously as they know how critical it is to recovery, but outside of these care environments it is a different picture.

Around 55% of total body weight is

fluid. Total fluid volume should fluctuate by less than 1%, and fluid intake should be balanced by fluid loss (Scales and Pilsforth, 2008; Thomas and Bishop, 2007).

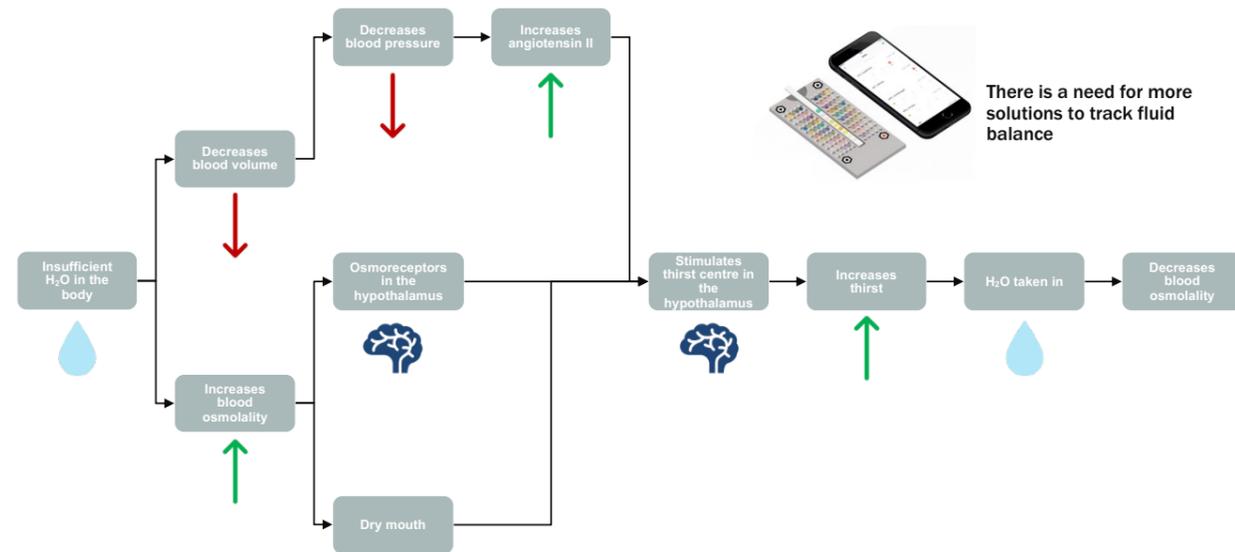
Adequate hydration maintains the optimal concentration of ions in the blood and tissues (sodium, potassium and magnesium) (see Figure Two) and even mild dehydration can cause impaired cognitive function, reduced physical performance, headaches and fatigue as well as dry, less elastic skin, which is prone to lesion (Welch, 2010).

If dehydration persists, the circulating volume of blood can fall, worsening the above symptoms and manifesting in hypotension, a quickening of the heart rate, cold hands and feet and reduced urine output (Large, 2005).

These are common symptoms for a range of ailments and that can make the diagnoses of dehydration difficult to spot, particularly in the elderly. Ensuring a good fluid balance not only avoids the direct problems of dehydration, but also makes the identification of other underlying causes more reliable.

Allowing moderate dehydration to become chronic can cause a general deterioration in health (Mulryan, 2009;

**FIGURE TWO**  
IT IS VITAL TO TRACK FLUID BALANCE ACROSS ALL CARE SETTINGS



SOURCE MULRYAN, 2009; THOMAS ET AL, 2008; BENNETT ET AL, 2004; CANDESIC RESEARCH AND ANALYSIS

**TABLE ONE**  
VIRTUAL WARDS HAVE RAISED FUNDS RANGING IN SIZE FROM £200,000 TO £200M

Competitor	HQ	Largest investor(s)	Capital raised	Staff no.	Speciality	NHS contracted	Services		
							Remote patient monitoring	Clinical monitoring team	In-home services
HUMA	UK	HITACHI AstraZeneca	£200m	251	Cardiac	✓			
current health	USA	BEST BUY	£84m	173	Generalist	✓			
PHL	UK	Aken Capital	U/D	122	Diabetes, COPD, Covid	✓			
spirit health	UK	Innovate UK	U/D	117	Generalist	✓			
dignio	Denmark	Investinor funky.biz	£8.7m	85	Generalist	✓			
Docobo	UK	Graphnet	£227,000	50	Generalist	✓			
HomeLink Healthcare	UK	Foresight	£4.4m	37	Generalist	✓			
my mhealth	UK	eurostars	£2.2m	37	Covid	✓			
doccla	UK	GENERAL CATALYST	£22m	30	Generalist	✓			
inhealthcare	UK	intechnologyplc	N/A	27	Generalist	✓			
care systems	UK	Private	N/A	24	Generalist	✓			

NOTE DOLLARS HAVE BEEN CONVERTED TO POUNDS AT AN EXCHANGE RATE OF \$1.10/£  
SOURCE COMPANY WEBSITES; PITCHBOOK; CANDESIC RESEARCH AND ANALYSIS

**FIGURE THREE**  
WITHINGS' NEWEST PRODUCT, U-SCAN IS THE FIRST HANDS-FREE CONNECTED HOME URINE LAB



About

- Just 90mm in diameter, this health lab sits within any toilet bowl.
- It provides an immediate snapshot of the body's balance by monitoring and detecting a large variety of biomarkers found in urine while also offering actionable advice for health improvements



Data capture made easy

- The data capture is non invasive, effortless, hands-free and automatic
- Each cartridge lasts three months and can easily be changed to meet all your needs



Multiple Biomarker Analyses

- Each cartridge is made of a dozen test pods containing specific types of biomarker tests
- When placed in the reader, this versatile system can support nearly limitless medical and health use cases simply by adapting the test pods

SOURCE COMPANY WEBSITE; CANDESIC RESEARCH AND ANALYSIS

Thomas et al, 2008; Bennett et al, 2004). Missing symptoms of dehydration can also cause hypovolaemic shock which, if not addressed, can lead to organ failure and death.

Despite highlighting the importance of tracking fluid balance, helpful tech is not in abundance. Perhaps because it is a time-consuming longitudinal process to measure how much water is taken in from fluid and food in the diet, and how much is lost through urine but also through faecal matter, sweat, and through the respiratory tract (Waugh 2007).

Accurate recording of fluid input may sound like a basic task, but in the real world it is a challenge. Most people reading this would only be able to arrive at a high-level guesstimate of how many drinks they had consumed today let alone accurately convert that into useful units for a fluid chart measured in 'millilitres of fluid'.

There are a few 'Internet of Things (IOT) smart cups' in existence which digitally measure fluid intake sip by sip and can autofill directly into fluid charts, on the assumption that they are used for all drinking. For example, Aquarete's Hydracup.

Still more difficult is understanding fluid intake from food. Shen et al from Fudan University, Shanghai have developed the I-Self-Care app driven by a database of some 350 foods to help carers and patients understand this important source of fluid intake.

Accurate recording of fluid output remains an emerging market. As of today, a common way to measure if a person is urinating at a normal rate (about 1ml/

kg of body weight per hour) is often down to collecting urine in a catheter bag. Urine colour may also be recorded and should be a pale straw clear colour, with no debris or odour (Smith and Roberts, 2011). In dehydrated patients, the kidneys conserve water, producing urine that is dark, concentrated and reduced in volume. However, the colour of the urine can't always be relied on as a marker of fluid balance as some drugs can alter urine colour and give a false indication of urine concentration.

Studies of the usefulness of bioelectrical impedance analysis (BIA) to determine fluid balance through measurement of total body resistance over time are underway, although currently in the academic research phase. There are a couple of companies out there that are using technology to track 'fluid out', including:

- French company Withings (see Figure Three) which recently debuted a sensor offering a miniaturised urine lab that can be installed in your toilet bowl to measure biomarkers, metabolites and nutrients released in daily urinations – even offering to track female ovulation. Data is returned to a phone app. Described with the catchy title 'Easy as 1, 2, Pee,' the rechargeable, automated device claims to be capable of running dozens of tests. Potentially using low-energy radar sensors to identify an individual's urine stream signature. Although the de-

vice is still awaiting FDA clearance, there is some excitement across European home care providers as the focus on pH, ketone levels and concentration levels could help carers flag signs of dehydration

- For the large number of people who are incontinent (4–8% of the world's adult population) Essity has launched incontinence products with built-in sensors to notify when pads need to be changed

Innovations are welcome (see Table Two). The Care Quality Commission has highlighted the issue of inaccurate measuring of fluids 'in and out' across all care settings from hospital to home. There are reports of inpatients not being given enough water to drink and fluids left out of reach. An audit of fluid balance charts found that staff shortages, lack of training, and lack of time were the major reasons fluid balance charts on hospital wards were not completed appropriately.

In the home setting where care staff shortages are even more prominent, what is out there to help staff measure fluids in and out?

In conclusion, there is much to be excited about as the virtual ward market grows, matures and consolidates. Investors are encouraged to be the disruptors and to help solve practical solutions – such as how to monitor fluid balance, how to reduce paperwork and how to de-burden and de-stress front line community staff.

**TABLE TWO**  
GLOBALLY, THERE IS INCREASING INTEREST IN URINE HOME ANALYSIS

	Head-count	Country	About	Connected to an app	Device needed
<b>WITHINGS</b>	329		U-Scan from Withings is an technologically advanced pebble-shaped urine reader with interchangeable analysis cartridges, designed to assess specific biomarkers without the need for external sample capture of strips		
<b>Healthy.io</b>	279		Healthy.io is a home-based urinalysis kit that turns a smartphone into a clinical-grade diagnostic device. It is the first smartphone-based urine test to secure clearance as a Class 2 device		
<b>vivoo</b>	78		Vivoo is a wellness assistant that provides custom nutrition advice to the users based on their urine sample analysis		
<b>TestCard</b>	46		TestCard creates at home testing that provides immediate results at a low cost. TestCard is a combination of non-invasive, postcard-sized urine test kits, and a mobile phone app that turns your phone's camera into a clinical grade scanner		
<b>bisu</b>	15		Bisu is a home health lab that provides personalised nutrition and lifestyle advice, through easy, accurate urinae and saliva tests		
<b>Scanwell</b>	13		Scanwell Health is an FDA-cleared urine testing application that has instant results at home		
<b>SYMAX</b>	N/A		Symax analyses urine by attaching it inside a toilet for analysing health conditions. It enables early detection of lifestyle with 99% accuracy for leveraging the original algorithm		

**NOTE** DOLLARS HAVE BEEN CONVERTED TO POUNDS AT AN EXCHANGE RATE OF \$1.10/£  
**SOURCE** COMPANY WEBSITES; PITCHBOOK; CANDESCI RESEARCH AND ANALYSIS

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## Will government funding materialise to meet the high demand of diagnostics?

LaingBuisson has published the second edition of its *Diagnostics UK market report*. While imaging and pathology (defined here as all clinical lab services including cellular pathology) are very different disciplines, both are key to diagnostics, with doctors often relying on a combination of the two.

Written after the peak of the Coronavirus pandemic, the report offers a comprehensive view on a high value, growing market that has returned to a normal steady state. While diagnostics was impacted less heavily than other markets, the market awaits the results of proposed government funding.

Among the varying data collated in this latest report is expert commentary, which poses pertinent questions of why, for example, is the NHS's purchasing power not more co-ordinated? Historically, each NHS trust has managed its own imaging and pathology services. Efforts for consolidation began in 2017 but progress towards this has been slow.

The report also offers international comparison, as we highlight that the UK has around half the level of radiologists per capita than the US, Germany and France, with little sign that this will be reversed in the next decade, given the time taken to train these professionals. The UK also has very high utilisation of MRI and CT scanners, which on average are older and nearer to the end of their useful operational lives.

In order to match the high demand of the sector, government investment in the NHS diagnostic infrastructure must be accompanied by investment in training. This will help address the shortage of professionals working in fields such as radiology and histopathology.

This report is key reading for anyone in a decision-making role relating to the UK diagnostics market.

### Who is the report for

- Hospital and clinic c-suite professionals
- Specialist diagnostics providers
- Suppliers of imaging and pathology equipment
- Private Medical Insurance groups
- Clinical Commissioning Groups
- NHS Foundation Trusts
- Professional and trade associations
- Investors
- Banks and private equity
- Central and local government
- Think-tanks
- Lawyers
- Management consultants

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