E-DRONE

Drone deliveries and the medical use case

Research Summary May 2023

UCL

UNIVERSITY OF LEEDS

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Table of Contents

Introduction

E-Drone is a three-year research project funded by the Engineering and Physical Sciences Research Council (EPSRC). The research used NHS case studies to evaluate the potential for drones to be used to make deliveries.

The project brings together researchers from different disciplines, drawn from four universities:

- Bournemouth University
- University College London
- University of Leeds
- University of Southampton

This report provides a summary of our research findings in relation to the use of drones for medical deliveries.

Through a series of short interviews with NHS practitioners, observational work, and analysis of product movement data, we have explored the role of transport in supporting pathology services in detail and are continuing to evaluate the potential for drone services to support and enhance this work.

Interview participants highlighted the requirement for the transport of urgent medical items on an ad hoc basis and analysis available datasets has enabled some initial evaluation.

Further evaluation has been undertaken of the role of drones in transporting aseptic medicines linking with the drone trials that took place between the Isle of Wight and Portsmouth.

Links to our publications provide more detailed information and further resources can be found on the project website: www.e-drone.org

We welcome comments and questions. Please direct these to:

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Communicating about delivery drones – the significance of medical use cases

Plans for the use of lower airspace to move goods and people are progressing. This is a key point in time to engage with stakeholders...

...but, focusing only on medical use cases supresses public debate.

The UKRI have developed a vision for Urban Air Mobility (1) which envisages the routine use of highly automated aircraft (drones and eVTOL) at lower altitudes within urban and suburban areas to move people and goods.

Within this vision the use of drones for medical logistics represents an initial step towards wider use of delivery drones with increased adoption anticipated over the next few years. This is a key time to engage diverse stakeholder groups in debates around this potential transport future.

Our research shows that the use of drones for deliveries has attracted limited attention from the UK public. This is partly because it has little or no current consequences for people's everyday lives, but also reflects how the subject is being communicated (2).

In the UK, trials of drone delivery services represent the most significant source of recent media coverage. Drone trials have focused on the movement of medical items to more difficult to reach communities. The problems associated with this approach to communication are (3):

- Press releases have over-stated the potential benefits of future services, often providing simplistic comparisons with existing transport use. There is limited acknowledgment that the activities are trials for the purposes of exploring operational issues rather than emerging services.

- The use of socially desirable use-cases has the effect of limiting debate as few feel the need to challenge a service that appears to benefit the NHS.

Drone overflights which support health services are considered to be more acceptable than general delivery uses...

...however, the benefits to UK health services are unclear.

The UKRI's Future Flight Vision and Roadmap (1) states how use cases which demonstrate social value are part of the strategy for achieving public acceptance and Phase 3 of the Future Flight Challenge (4) includes further drone demonstration projects with a medical focus.

As researchers, we are calling for a shift away from seeking public acceptance in favour of a co-developed approach to determining the scope of drone deliveries. Providing greater transparency around drone trials which involve the NHS is an important step towards achieving this.

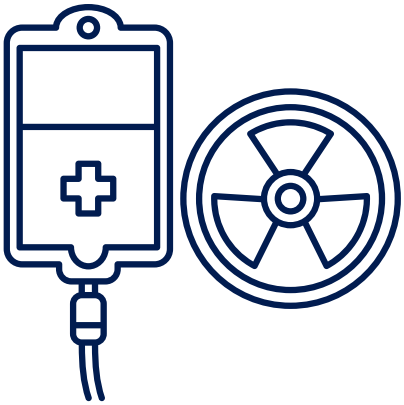
We have developed interactive approaches to introduce the concept of using drones for deliveries to a general audience, including the use of Virtual Reality (VR) to introduce the idea of drone delivery overflights into familiar contexts. This avoids a focus on a medical use case, allowing participants to first think about the introduction of drone deliveries more generally (5).

Findings from the VR work demonstrate how the medical use case positively influences acceptability. This emphasises the need for transparency around the benefits of moving medical items by drone with the following sections demonstrating how potential benefits are still unclear.

Over the summer of 2022 our researchers took VR to Bournemouth and Boscombe town centres and Southampton City Centre. 241 passers by used the headset and completed a survey.

Figure 1. Using the VR headsets in Southampton City Centre

Transporting aseptic medicines by drone



The is no evidence of an existing need to transport chemotherapy by drone in the UK.

The benefits of time savings need to be evaluated in the context of the whole process.

Solent NHS Drone Trials

The movement of chemotherapy drugs by drone was the focus of a trial between Portsmouth and St. Mary's Hospital on the Isle of Wight in 2022. The aseptic pharmacy at St. Mary's hospital closed in 2021 and individualised cancer treatments are now prepared in Portsmouth and transported by taxi and hovercraft.

E-Drone researchers have undertaken a detailed analysis of this use case (6, 7). Key findings include:

- Based on historic weather records, it was estimated that the drone used in the trial (Mugin V-5 Pro drone see Figure 2) would be able to provide a service on 78% of days. When a higher wind tolerance is assumed, this increased to 97% of days representing a 1% improvement in reliability over the hovercraft. The drone would also need to be able to transport both chilled and ambient medicines simultaneously to avoid additional trips and therefore provide time and energy savings.

- Assuming improvements to the drone specification could be achieved, time savings would be gained over the existing mode of transport. However, the preparation of shorter expiry chemotherapy treatments involves multiple stages and is determined by staff and laboratory capacity and the timing of the patient’s blood test. Time saved on the final transport stage was not fundamental to the timely administration of treatments.

- With an improved drone specification and changes in the timing of orders, manufacture and appointment times, some cost benefits and reductions in carbon emissions could be achieved. However, scope also existed to reduce costs and emissions by using alternative products and/or combining with existing scheduled transport services which would continue regardless of whether a drone service was introduced.

Cancer treatments are carefully planned and therefore can exploit existing transport services including those which are coincidental with the treatment (e.g., travel of specialist chemotherapy nurse).

Figure 2. The Mugin V5 Pro hybrid drone being loaded with chemotherapy treatments

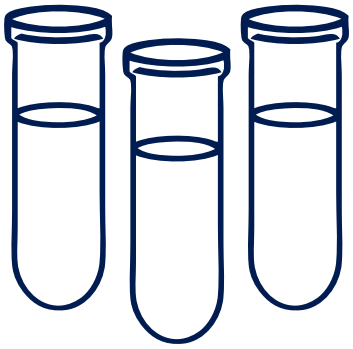
Wider Implications

The Solent Drone trials provided the opportunity to test the effects of vibration on monoclonal antibodies, a cancer treatment which can have a very short expiry following preparation. This provided initial evidence that the quality of the products tested was unaffected by the short test flight. The effects of longer flights (for example, the 30 minute flight between Portsmouth and St Mary's Hospital on the Isle of Wight) and the use of different drone models on the integrity of the product is not yet known (8).

Patients have a routine pre-chemotherapy blood test two to three days before treatment has been scheduled. This test determines whether treatment preparation proceeds, with a second blood test closer to the time of manufacture sometimes being required. Interview participants from NHS trusts indicated that the timing of the patient's blood test was an area of greater priority and capacity limitations within aseptic pharmacies would be likely to limit the potential for more responsive preparation. Therefore, shorter journey times may offer advantages for the transportation of chemotherapy treatments in *some* circumstances, but this needs to be evaluated within the context of the whole process and with consideration of all available transport options. The timing of the patient's blood test is more critical than the speed of delivery and capacity limitations in aseptic pharmacies would be likely to limit scope for more responsive preparation.

A key recommendation of 'Transforming NHS Pharmacy Aseptic Services in England'(9) is for a shift to hubs located away from the hospital site for the preparation of higher volume products to "allow space for the aseptic facilities in hospitals to deliver the more complex, individualised medicines much closer to the patient" (p6). Bespoke treatments, sometimes with shorter expiries, are likely to continue to require administration to patients close to the aseptic pharmacy. Information provided by one NHS Trust showed that three quarters of cancer treatments were administered on the same site as the aseptic pharmacy. The ability to treat cancer patients in the community is dependent on the capacity of the facility and availability of specialist medical staff and further research required to understand demand.

Transporting diagnostic specimens by drone



Pathology samples are transported from community healthcare sites by networks of daily van rounds.

Typically, a maximum transit time of two hours is required.

Pathology collection rounds

In England and Wales around 300,000 pathology tests are performed every working day, helping to prevent, diagnose, treat and monitor diseases (10).

Tests undertaken at GP surgeries are transported to pathology hubs based at larger hospitals through networks of daily van rounds. Some van rounds extend across low density, rural areas, sometimes collecting a very small number of specimens from individual surgeries. These need to be transported within a two hour time window to ensure that they remain viable for analysis.

Analysis of pathology workload data and route schedules, alongside observations and interviews with practitioners across NHS Trusts, has helped identify existing challenges associated with transporting and processing diagnostic samples in a timely and efficient way (7):

- **Afternoon peaks in deliveries of samples to laboratories affect workflow.**
- **Some patient groups compelled to travel to hospital for samples to be taken (e.g., to ensure fast-tracking).**
- **The rigid routes of pathology vans not able to respond to changes in demand, such as late running clinics or when there are no samples to collect.**

Very small volumes of samples picked up from remote surgeries present efficiency limitations. Figure 4 shows an example of a rural van round.

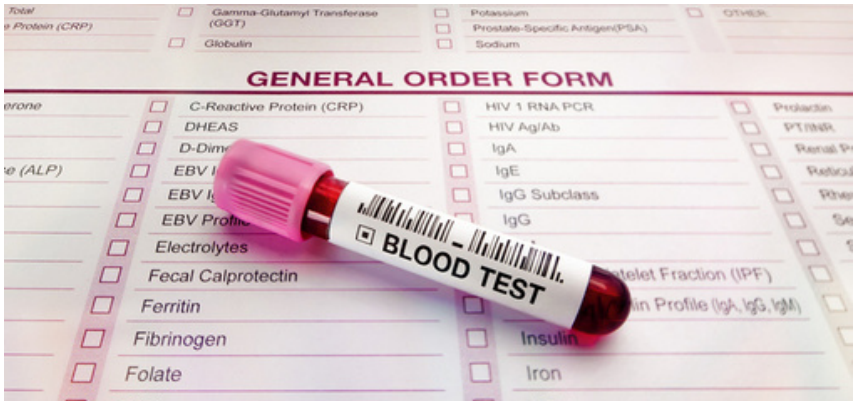


Figure 3. Blood samples typically weigh 30g.

The weather resistance of drones limits the potential for cost and emissions savings.

Pathology van rounds are also used to transport bulkier items. Strategies which integrate drones would need to accommodate these needs.

Could drones support pathology collection services?

The potential for drones to support pathology collection services by providing more frequent and/or on-demand direct services between GP surgeries and laboratories has been explored using GP pathology workload data from the Southampton and New Forest area (11). This assumed that collections from selected outlying GP surgeries are undertaken by a drone with the same specification to that used in the recent Solent drone trials.

The analysis found reductions in van round time and emissions could be achieved but operating costs would be significantly higher than the business-as-usual case, even allowing for lower future drone staffing costs. As with the evaluation of aseptic medicines, the weather resistance of the drone impacts on costs and emissions, with the need for the deployment of taxis on no-fly days.

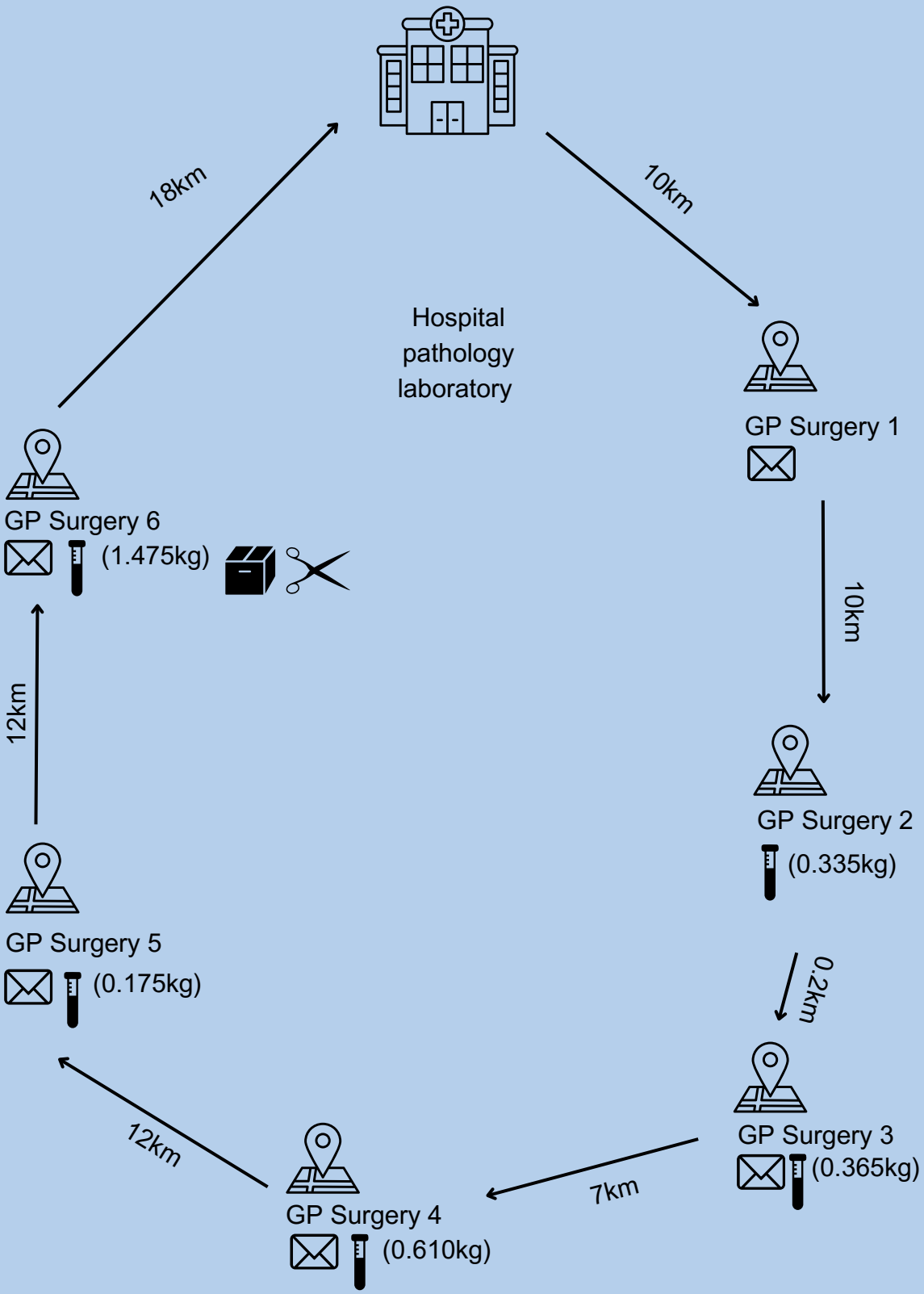
Van rounds also provide additional functions. Our observations showed how the movement of stores, sterile equipment and post represents a further function of the existing pathology van rounds, noting occasions when no specimen collection was needed and only post was delivered or collected. The integration of drones would require alternative approaches to deal with these requirements. The financial and environmental costs of transporting post warrant further analysis.

Further modelling of pathology collection services

Further modelling work is underway using data from Dorset. This will provide a detailed evaluation of the energy saving potential resulting from the integration of drones across different scenarios and practical requirements (drone range and weather tolerance, flight paths and landing requirements).

The E-Drone research team will also be working with NHS Highland to understand the operational implications of the integration of drones within pathology collection services building on their recent and planned drone trials.

Figure 4. Example of a rural pathology van round (7)
Not to scale



Transporting urgent medical items by drone

Specialist couriers and taxis are used to transport urgent medical items between healthcare sites.

The urgency of these items is not fully understood.

Ad-hoc urgent transport needs

Interviews with NHS practitioners highlighted the need to urgently transport individual items between healthcare sites. Specialist couriers and taxis were used in most instances, but some examples of using staff vehicles, and therefore staff time, were also given. The frequency of these ad hoc requirements was very low (7).

For example:

- A large city general hospital pharmacy arranged ad hoc transport for 14 individual items during 2021, most requests were to and from hospitals in the same region within a range of 25-40km, but some requests were made from hospitals over greater distances (up to 120km).

- A blood sciences department within a district general hospital arranged ad hoc transport for 34 individual items over the course of ten months, with the longest distance being 245km.

During interviews, practitioners described how courier and taxi services could be difficult to book, especially out of hours, and delays were sometimes experienced. Within one dataset there was an average time delay of three hours between transport services being ordered and the service arriving.

Community based clinical trials also generated low frequency transport demand. These require stringent monitoring and control, meaning that specialist couriers were preferable or for the item to be escorted by a member of staff to the laboratory.

The scope for drone services to support this demand requires further exploration. Drones could provide a more responsive transport service and would be well matched to the size of the packages. However, the low level of demand and current limitations in accessing airspace would be unlikely to justify drone service provision in isolation.

We are interested in understanding the cumulative demand for ad-hoc transport services, the relative level of urgency and how this is determined and defined.

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