Kent Surrey Sussex Academic Health Science Network

NHSX

HUMA REMOTE CARE APPLICATION

Evaluation report

October 2020

1. Executive summary

Purpose of the report

This rapid evaluation was conducted to assess the impact of Medopad, a digital remote care platform for patients with a suspected or confirmed COVID-19 diagnosis. The aim of the evaluation is to inform further roll-out of the solution by analysing the outcomes of a digitally enabled remote care model. Medopad enables remote monitoring of patients' symptoms and physiological parameters such as heart rate, level of oxygen and temperature. It was initially deployed in three sites across primary and secondary care services on April 24th, 2020. The sites included were Central London CCG, Hillingdon CCG, and West Hertfordshire Hospitals NHS Trust (WHHT). In June, the deployment was extended to four additional sites (Brent CCG, Harrow CCG, West London CCG and Ealing CCG).

The evaluation covers the first three months of deployment, between April 24th, 2020 and July 31st, 2020, and focuses on the initial three sites of deployment. The evaluation report outlines the methodology used and the findings of this analysis. The primary aim will be addressed by evaluating two key questions:

1) What is the solution's impact and is it going to benefit the healthcare system?

2) Does the evidence support the wider scaling of this solution?

Key findings

What is the solution's impact and is it going to benefit the healthcare system?

Positive indications of the usability of the solution for patients and clinicians, the high level of patient satisfaction and compliance and no record of adverse events were observed during the deployment.

Whilst some encouraging findings indicate that the use of Medopad saved timed for clinicians, allowing them to manage more patients with the same capacity, and reduced the number of patient contacts, these early indicators would need to be validated with a larger patient population across multiple sites. No conclusion can currently be reached on the impact of Medopad on patient outcomes, such as

mortality and hospital admissions, due to the small sample size and in some sites the lack of comparative measures.

The following bullets summarise key evidence gathered for this evaluation to demonstrate the impact of the solution:

- **Usage and patient engagement**; uptake of the Medopad application within the Virtual Ward population ranged from 16% in the secondary care setting, to 36% across both primary care settings. Patient engagement data was only available for the primary care settings, where positive engagement and usage were shown across the board

- **Usability, acceptability, patient experience and clinician feedback**; of all the patients surveyed, 95% found the application easy to use and 93% were pleased with the remote care service. Overall, patients showed more confidence in the solution as demonstrated by a Net Promoter Score of 71 for the patient group and of -25 for the staff group

- **Impact on workload capacity**; through the ongoing collection of data, clinicians were able to review patients' data in a more efficient manner, saving approximately 3 mins per patient per day in primary care settings, equivalent to £92 saved per patient on average or £6.2k for the total Central London CCG patient population during the study period. Based on the KPI metrics collected, an average of 0.23 GP COVID-19 related appointments per patient were triggered through Medopad, in comparison to 0.37 for non-Medopad patients. The mean number of calls required dropped significantly for Medopad patients (0.69 per patient, compared with 13.19); this is likely balanced in part by an increase in SMS usage (6.92 per patient, compared with 1.0). On the other hand, non-Medopad patients required 7.33 clinical follow-ups, while Medopad patients required 8.68, on average

- **Impact on hospital admissions and readmissions**; in WHHT, out of the 75 Medopad patients, 5% were readmitted to hospital within the 28 days following discharge. In comparison, baseline data showed an 8% rate of readmission for non-Medopad patients

- **Impact on COVID-19 patient outcomes**; a lower proportion of patients using Medopad were sent to hospital due to oxygen saturation levels, according to data reported by Central London CCG. In total 10 Medopad patients (15%) were sent to hospital due to oxygen saturation levels compared to 16 non-Medopad patients (26%). In terms of patient safety, the application appeared

to support patients' recovery, 100% of patients using the platform in a primary care setting recovered compared to 87% of non-Medopad patients from the Central London CCG deployment

Does the evidence support the wider scaling of this solution?

To assess if the evidence available supports the wider scaling of the Medopad solution, the factors described in **Table 1** were considered.

Table 1: Factors considered in the readiness for scaling-up

Factors considered	Ready for scaling	Rationale and relevant evidence
Evidence of use, engagement, and credibility	Yes	Supporting evidence above in the section 'Key Findings' (usage and patient engagement, usability, acceptability, patient experience and clinician feedback)
Evidence of value and effectiveness	Yes (requires further validation)	Supporting evidence above in the section 'Key Findings': • Improved workload capacity (time savings, reduction in patient contacts and appointments) • No significant increases were seen in mortality rates and hospital admissions, although small sample sizes limit the conclusions that can currently be reached as to Medopad having a significant impact on these outcomes. • Impact on patient outcomes (higher recovery rates in the

Factors considered	Ready for scaling	Rationale and relevant evidence
		primary care setting over the study period)
Is this implementable (reach of spread, integration, and cost)?	Unknown	Medopad was deployed in 7 sites but this study has very limited information on the outcomes of the extended deployment. Engagement with the later implementation sites is recommended to understand the costs required to undertake further scale up.
Magnitude of health gain and benefit to system	No (inconclusive results)	The impact of Medopad on patient outcomes was inconclusive and the time savings reported require further validation. Collecting patient and clinical outcomes for multiple sites and with a larger population would be the basis for a further health economic modelling.
Resourcing and measurability requirements	No (improvements required)	The deployment strategy, which would include a resourcing estimation and the continuous collection of metrics and outcomes, is a prerequisite for larger scale implementation. Should further deployment take place, the resourcing and measurability requirements should be designed carefully.

Overall, there is positive evidence in terms of usability, usage, engagement, and acceptability with Medopad, across sites which have provided data for this

evaluation. Nonetheless, there remain several unknown factors which prevent KSS AHSN from drawing strong conclusions regarding whether the application is currently suitable for widespread deployment. Most significantly, there is insufficient evidence regarding clinical and patient outcomes, which necessitates further evaluation before widespread adoption as it relates to matters of patient safety.

Further detail can be found in ‘Section 11: “Discussion’

Limitations

It should be noted that the unprecedented circumstances of the COVID-19 pandemic have naturally played their part in the challenges that have been faced by the evaluation and wider team. Constraints on availability of healthcare professionals and support staff in parallel with stretching timelines have been amplified in these challenging times. Limitations encountered, as part of this evaluation, have been noted below:

- Limited and unavailable data
- Governance challenges
- Pilot study population
- Variation in COVID-19 daily cases and mortality rates
- Sustainability of implementation beyond pilot sites
- Usage of Medopad for patients with lasting COVID-19 symptoms
- Inclusive access to the intervention (digital literacy)
- Usage of Medopad for other conditions (long term conditions for instance)

Further detail can be found in ‘Section 11: Limitations’.

Recommendations

Based on the gathered evidence the following recommendations have been highlighted in detail in ‘Section 11’ of this report.

- Building robust evidence for value and effectiveness

- Monitoring and reviewing data from new pilot sites
- Potential areas for Medopad improvement (UX and supporting processes)
- Steps to take should Medopad deployment persist (integration of clinicians' feedback, measurement strategy and evaluation design)
- Building sustainability

2. Table of contents

3. Table of Figures and Tables

4. Note to the reader

Throughout the report, the authors aim to be clear and refrain from the use of jargon to accommodate a wide range of stakeholders. To this effect, please note the following considerations with regards to vocabulary:

- **Medopad or Huma?** As much as possible, the report uses Medopad when referring to the remote care solution and Huma when referring to the company who developed the product Medopad
- **Application or dashboard?** The Medopad solution is composed of a patient-facing mobile application and a clinician-facing online dashboard. Therefore, the authors refer in some cases to the Medopad application and in other to the Medopad Dashboard depending on the features under discussion

5. Purpose and context of report

Kent Surrey Sussex Academic Health Science Network (KSS AHSN) was commissioned by NHSX to conduct a rapid evaluation of the remote care solution Medopad, developed by the company Huma.

The evaluation focused on assessing the impact of the solution on the clinical outcomes, on the patient outcomes and on the ability of the system to provide remote care relative to the existing pathway. The existing pathway for the pilot sites was the provision of remote care services, referred to as a Virtual Ward (VW), e.g. to call patients regularly to monitor their symptoms and collect their vitals over the phone. The clinical pathway is explained in more detail in 'Section 6: Healthcare pathways during COVID-19'

The aim of this rapid evaluation was to:

- Assess the potential impact of a Medopad-enabled VW compared to a telephone VW, using data provided by the pilot sites and NHSX in addition to existing data sources
- Highlight recommendations for improvement, limitations in the process and scalability of the application relative to the quantitative and qualitative analysis

The results and findings of the quantitative and qualitative analysis were utilised to answer the following key questions:

- What is the solution's impact and is it going to benefit the healthcare system?
- Does the evidence generated from this evaluation support the wider scaling of this solution?

Whilst monetising specific outcomes, this review sought to develop the value proposition by gathering information and feedback from clinicians across the pilot centres to produce a full reflection of benefits, including qualitative outcomes which may not be monetised as part of a health economic evaluation.

6. Care delivery during COVID-19

Introduction

Coronavirus disease 2019 (COVID-19) is a novel severe acute respiratory infection. The first cases were reported in November 2019 in China (Zhu N, 2019). Since then, the numbers of confirmed COVID-19 cases and deaths have been spreading across the world. By March 11th 2020, over 110,000 cases and 4,000 deaths across 110 countries were reported and WHO declared a COVID-19 pandemic (World Health Organization (WHO), 2020; Vannabouathong, 2020).

The United Kingdom (UK) documented its first confirmed case on January 31st, 2020, with a rapid increase in confirmed cases throughout March. Indeed, the cumulative number of deaths involving COVID-19 in England increased exponentially, with 21 reported deaths on March 12th and 1,568 on March 27th, 2020 (ONS, 2020). In early May, 2020, the UK reported the highest number of deaths in Europe with over 30,000 deaths following a positive COVID-19 test (Verhagen M. B., 2020). On September 27th, 2020, the UK had recorded 41,988 deaths within 28 days of a positive test (GOV.UK, 2020).

Current studies suggest that around 80% of patients have mild symptoms and recover, with approximately 14% of infected people experiencing a severe disease including pneumonia, and around 5% becoming critically unwell, e.g. experiencing a septic shock and/or multi-organ and respiratory failure and requiring urgent hospital care (World Health Organization (WHO), 2020). Around 20% of people who become infected remain asymptomatic (Buitrago-Garcia et al., 2020), although further evidence on asymptomatic cases is still emerging. Some patients with confirmed or suspected COVID-19 can deteriorate fast and become high risk, requiring immediate care and hospitalisation. Regular monitoring and early detection of changes in symptoms can enable timely care and appropriate actions when patients are deteriorating.

Remote care

The NHS Long Term Plan outlined, amongst other strategies, the facilitation of digital remote care (NHS England, 2019). Whilst publications identified a slow digital

transformation prior to the pandemic outbreak, COVID-19 has accelerated the implementation of remote clinical care and helped to move services online (Centre for Disease Control and Prevention (CDC), 2020; Taylor, 2020; Collins, 2018).

Regular monitoring of COVID-19 symptoms can be carried out remotely by using video, text message or web-based tools (McLean S, 2009). Monitoring outside of a hospital setting consists of three main elements: patients providing data about their health; the data being transferred to the healthcare systems; and healthcare professionals reviewing the data and providing personalised care to the patients (Sood et al., 2007; McLean, Protti, & Sheikh, 2011). On April 10th, 2020, NHS.UK launched the 'Health at home' campaign to support remote care and promote digitally enhanced ways of accessing GP surgeries and hospitals (NHS.UK, 2020).

The recording of COVID-19 symptoms at home could potentially yield additional benefits, such as a reduction in the risk of infection by minimising face-to-face (F2F) contacts, which poses a risk for both patients and healthcare professionals. Furthermore, digitally enabled primary and outpatient care could give patients more control over their care by allowing them to choose a time and a location convenient to them. Studies have shown that the use of remote monitoring and telemedicine improves patients' quality of life (QoL) and self-care (Atreja, 2017; George & Cross, 2020). A study reviewing remote care have suggested a reduction in the number of hospital admissions without an increase in mortality for patients with severe long term conditions such as asthma and diabetes (McLean, Protti, & Sheikh, 2011). While these findings are encouraging, there is currently no evidence that similar benefits can be obtained with COVID-19 management.

National context

The prevalence of COVID-19 cases varies across England. At the start of the pandemic, London reported the highest number of coronavirus cases in the UK (Batchelor, 2020). Notably, the pattern of spread has changed and the centre of the virus has moved (New York Times, 2020). By September 27th, 2020, the North West of England had the highest number of confirmed and registered cases per 100,000 population, followed the North East, Yorkshire, and the Humber (**Figure 1**: Number of COVID-19 cases per 100,000 in the UK on the 27th of September 2020 (Office for National Statistics (ONS), 2020).).

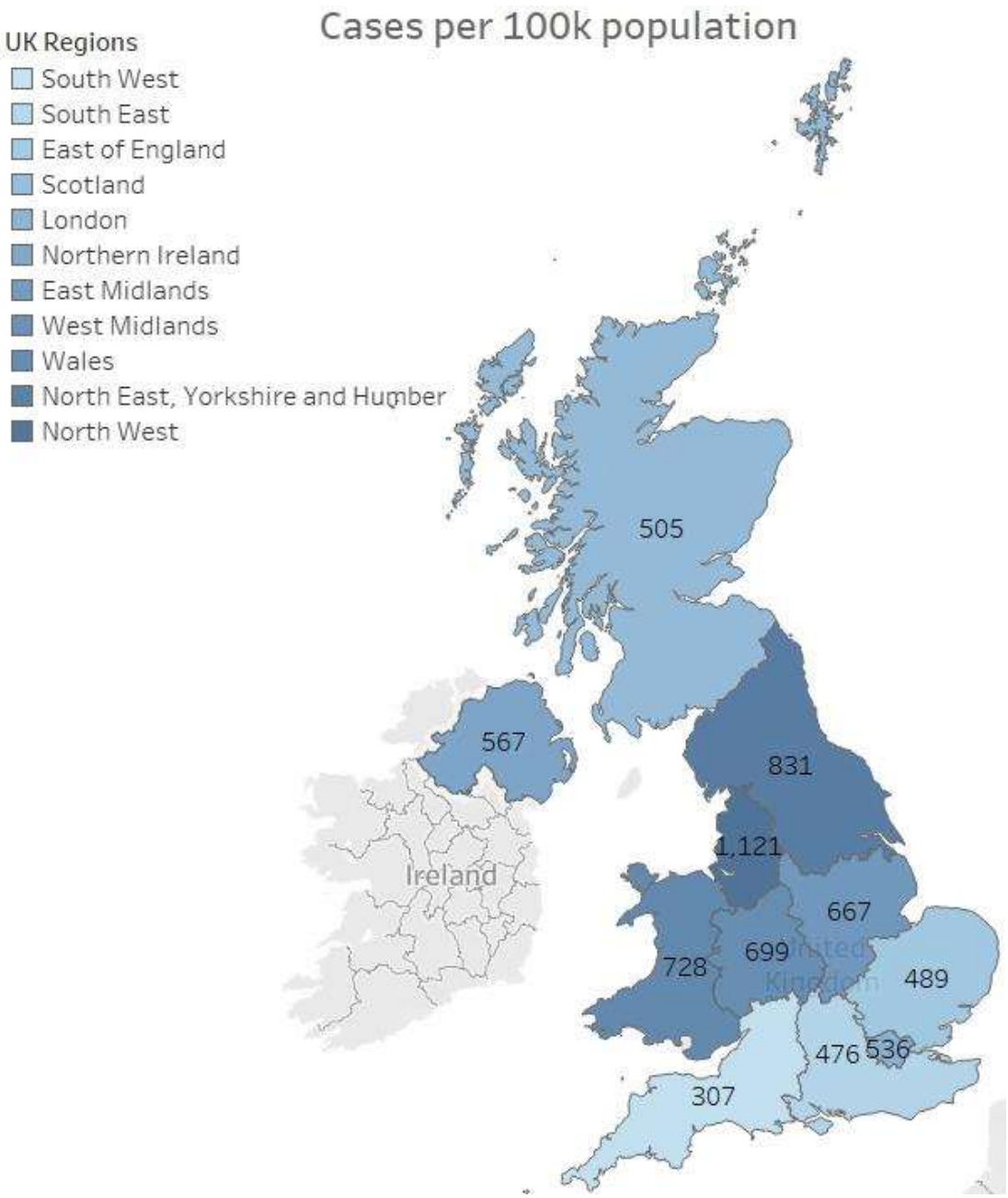


Figure 1: Number of COVID-19 cases per 100,000 in the UK on the 27th of September 2020 (Office for National Statistics (ONS), 2020).

The variance in the number of cases across the UK directly impacts the demand and the pressure on healthcare services in these areas. The ability of primary and secondary care services to manage demand will depend on many factors. The provision of remote care is a measure that could alleviate the strain on services.

Healthcare pathways during COVID-19

Due to the COVID-19 pandemic, agencies such as Public Health England (PHE) and NHS England (NHSE) reviewed and published COVID-19 guidelines and standard operational procedures (SOP) for healthcare providers (GOV.UK, 2020; NICE, 2020). The rapid rise in COVID-19 cases and the ongoing efforts to reduce transmission, whilst maintaining healthcare services for non-COVID-19 patients, have put a strain on health systems not only in the UK but around the world. The aim of the new guidelines was to adapt safe working approaches and control the spread of infection, whilst providing high quality healthcare (NICE, 2020).

Published guidance reflected changes in clinical management of suspected or confirmed COVID-19 cases to avoid the viral spread in primary care, secondary care and emergency departments (NHS England, 2020). COVID-19 cases generally presented in primary care or were reported via NHS 111. Revised guidelines included managing F2F visits in designated facilities, utilisation of NHS 111 online, prioritising high-risk patients and adopting remote triage. It should be noted that case definition of COVID-19 patients and advice associated with care may change, as COVID-19 is a novel infectious disease, and more information is being collected as research continues.

Primary care

Primary care is often the first reference point for patients showing symptoms and is care provided by GPs and other healthcare professionals. In response to the COVID-19 pandemic, rapid and widely adopted changes have been made to primary care, including:

- Utilising digital tools to support consultations, along with other strategies allowing clinicians to see patients F2F at dedicated local practices known as ‘Hot Hubs’ (PULSE, 2020)
- CCG practices supported the increase in the number of assessments, and changes were made regarding remote care triage pathways, coordination with NHS 111 and assessment approach (PULSE, 2020)
- NHSE highlighted the importance of managing demand and of establishing joined up systems and alternative models of care (Willett, 2020)

Patients with symptoms are advised to stay at home, self-isolate and use remote telephone triage NHS services such as 111 and 999 Emergency Ambulatory Service (NHS England, 2020). Patients who contact NHS 111 with potential COVID-19 symptoms, or those who came into contact with a suspected COVID-19 patient, are checked, identified for symptoms and referred to the COVID-19 coordination service if further action is required (**Appendix A**).

Patients who visit primary care services for a F2F appointment are checked for symptoms and referred to secondary care if unable to cope at home or referred to a dedicated COVID-19 Hot Hub. GP-led Hot Hubs are intended to diagnose and advise patients F2F. Patients in Hot Hubs that need further observation but can be monitored at home are referred to remote consultations via the Virtual Ward (VW).

The Royal College of General Practice (RCGP) reported that by April, 2020, the majority of consultations were taking place remotely, via phone or video call (RCGP, 2020). Prior to the outbreak, 90% of GP consultations were face to face, and in the space of two months since lockdown, 90% are now done remotely (Oxtoby, 2020), although NHS Digital data reports a 30% drop in the overall number of GP appointments in March, 2020 (NHS Digital, 2020). It has been suggested that the decline in appointments is not just due to lower demand, but a result of a rise in the use of NHS 111, online signposting services and other telephone triage systems (The Health Foundation, 2020).

Secondary care and A&E settings

Secondary care and A&E provide support and urgent care to high risk patients who either present at the emergency department or are referred from their GP practitioner and ambulatory services.

Patients admitted to hospital can be categorised as high or low risk patients. Patients who develop difficulty in breathing require continued monitoring and, potentially, hospitalisation, and some severely unwell patients are likely to be admitted to the Intensive Care Unit (ICU). In a UK study that observed approximately 17,000 COVID-19 hospitalised patients, 17% of hospital patients required admission to high dependency or intensive care units. Furthermore, out of all admitted patients, 49% were discharged alive, 33% died and 17% continued to receive care in hospital at the date of reporting (Docherty et al., 2020). The UK study showed death in hospital was strongly associated with male gender, older age, BAME (Black, Asian and

minority ethnic), deprivation, uncontrolled diabetes and severe asthma (Public Health England, 2020).

Patients at low risk who do not require continued urgent hospital care and are clinically fit are discharged. These patients are referred to the VW for continued monitoring care as illustrated in **Figure 2**: Hospital reference pathway of COVID-19 patients in Watford's virtual hospital (Knight et al., 2020).

. The VW offers an alternative pathway to inpatient care as it enables existing patients to be discharged from hospital earlier than would have been traditionally possible. Furthermore, some inpatients who are ready to be discharged, following a 48-hour symptom-free observation period, may need continuous monitoring to avoid unplanned readmissions. Remote follow-up (FU) and continuous remote monitoring would offer a further safety net to patients and clinical staff whilst helping with stretched hospital capacity (Colligan, 2015).

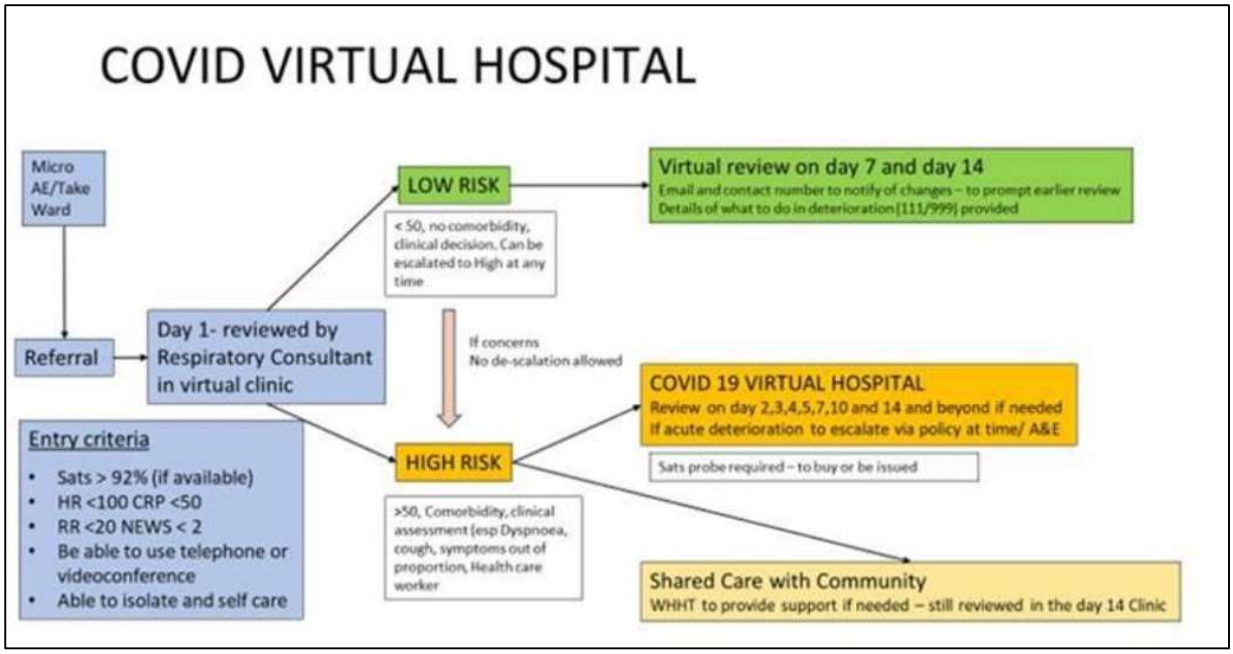


Figure 2: Hospital reference pathway of COVID-19 patients in Watford's virtual hospital (Knight et al., 2020).

7. Huma remote patient monitoring solution

Overview and benefit proposition

Huma (previously Medopad Ltd.) is a British healthcare technology company based in London, UK. It produces applications that integrate health data from existing health databases, patient wearables and other mobile devices, securely transmitting it for clinical analysis.

NICE have developed an evidence standards framework for digital health technologies (DHT), outlining the minimum required evidence that should be available to demonstrate the value of the DHT in the UK depending on the risk categorisation of the digital solution. This includes 'evidence of effectiveness relevant to the intended use' (NICE, 2019). Tier 3b, which applies to "DHTs with measurable user benefits, including tools used for treatment and diagnosis, as well as those influencing clinical management through active monitoring or calculation" has relevance (NICE, 2019, pp. 8-10), as Medopad enables the collection of patient metrics which are used by clinicians to monitor the patients' state and inform clinical actions. However, a tier 3b DHT is stated to "automatically record information and transmit the data to a professional, carer or third-party organisation, without any input from the user, to inform clinical management decisions" (NICE, 2019, pp. 8-10). As Medopad does not record the patient's vitals and symptoms automatically, it does not comply with the definition of a Tier 3b. On the other hand, Medopad does not completely match the definition of a tier 2 simple monitoring DHT, with a key feature of simple monitoring that "information is not shared with or sent to others". From discussions between NHSX and MHRA, the authors understand that the consensus was to consider Medopad as a Tier 2 DHT. After consulting NICE, they also agreed with Medopad being classified as Tier 2 on the basis of Medopad allowing the user to choose if and when to send the recorded data. The functional classification determines the minimum evidence standard and the best evidence standard expected from the DHT to demonstrate effectiveness.

In the UK, Medopad has been selected as one of the remote care tools to support the healthcare system's response to the COVID-19 pandemic. Medopad's COVID-19 remote patient monitoring (RPM) platform has been developed with leading

international clinicians and academics. Huma has worked with NHSX and local NHS organisations to configure and trial the platform in different sites to provide remote monitoring for COVID-19 patients who are at-home, in quarantine or self-isolating.

The Medopad platform is a remote patient monitoring (RPM) and telemedicine solution. It allows healthcare workers to manage patients remotely by tracking symptoms and other clinical indicators as well as monitoring disease progression, identifying patients who are at risk of deterioration in a timely manner, and intervening and acting early. The aim of the Medopad remote care solution is to keep more patients out of hospital whilst reducing the need for F2F care where appropriate, and better managing system capacity. Furthermore, patients are able to stay at home under continued remote care from the clinical team, reducing unnecessary travel, minimising virus transmission and exposure to others (Huma, 2020).

Medopad enables the accurate exchange of health data and information between patients and their NHS care team. Healthcare teams can closely monitor patients' symptoms to advise on appropriate care and promote an early intervention, if required. Staying informed of symptoms and being alerted about the disease progression could avoid further complication, prompt a diagnostic procedure, and a visit either to a hospital or from a clinician.

Medopad operational features

The Medopad remote care solution comprises of a mobile application and the interactive dashboard.

The Medopad application is designed to record and monitor patients' symptoms using a smartphone. Medopad remote care offers patients the ability to record metrics from the safety of their home and at time convenient to them.

The Medopad dashboard is a web-based healthcare portal to be used by professionals to review patients' recorded measurements. Medopad metrics can be viewed alongside EPR (Electronic Patient Records), offering clinicians the flexibility to review more patients and take appropriate action at the right time. In addition, the application allows the operators to set thresholds for vital signs, enabling healthcare professionals to assess out of range metrics effectively.

Medopad and COVID-19 remote care

Primary and Acute Pilot centres

During the initial COVID-19 pandemic period, Medopad remote care was introduced for public use in two separate geographical locations within the UK, providing an opportunity to test the application and facilitate the service transformation more rapidly. The endorsed pilot sites include:

- Watford General Hospital, part of West Hertfordshire Hospitals NHS Trust (WHHT), which is using the COVID-19 RPM solution for patients with mild-to-moderate COVID-19 symptoms who have been discharged from the hospital but need continued remote management to avoid re-admission. Watford General Hospital is a district general hospital covering a mix of rural and town-based population, with a diverse socioeconomic population and age group (Oxford Consultants for Social Inclusion (OCSI), 2020)
- North West London Collaboration of CCGs (NWL CCGs), including Hillingdon CCG and Central London CCG. The two CCGs have Hot Hubs to provide at-scale triage from general practice and NHS 111 for patients who are deemed to require ongoing monitoring of COVID-19 symptoms. NWL CCGs covers 8 distinct CCGs and has an urban and diverse population (NEL - Commissioning Support Units, 2016)

The Medopad solution was initially introduced in three sites (WHHT, Hillingdon CCG and Central London CCG) at the end of April 2020. The deployment was extended to an additional four sites throughout June 2020, as presented in **Table 2**.

Table 2: Sites and timeline of the Medopad deployment.

Care setting	Site	Deployment start date
Secondary care: West Hertfordshire Hospitals NHS Trust (WHHT)	Watford General Hospital	24/04/2020
Primary care: North West London Collaboration of CCGs (NWL CCGs)	Hillingdon CCG	24/04/2020
	Central London CCG	24/04/2020
	Brent CCG	05/06/2020
	Harrow CCG	05/06/2020
	West London CCG	05/06/2020
	Ealing CCG	19/06/2020

The evaluation covers the three sites deployed first and focuses on the first 3 months of deployment, e.g. between April 24th, 2020 and July 31st, 2020.

Users and Target Population

The population used for the purposes of this evaluation include healthcare staff and patients.

The healthcare staff population is comprised of doctors, nurses, and administrative staff trained in using the Medopad application.

The patient population is comprised of suspected or confirmed COVID-19 patients within pilot centres who contacted 111 or 999, were referred to the COVID-19 Hot Hubs for a virtual F2F consultation and referred to the VW for remote monitoring. Patients with suspected or confirmed COVID-19 symptoms who are deemed appropriate for remote care are offered remote monitoring via telephone calls or the Medopad application, depending on the patient's choice and clinical suitability. Patients who were monitored via telephone calls served as a control group and were compared to patients monitored remotely using the Medopad application.

For the purposes of this evaluation, two regions provided the focus; West Hertfordshire and North West London, with a population of around 500,000 in West Hertfordshire Hospital NHS Trust's catchment area (NHS England, 2018), and approximately 1,450,000 across North West London (NHS England, 2015). **Table 3** provides a summary of reported COVID-19 cases and related deaths for the surrounding area.

Table 3: Reported cases and deaths per pilot centres in the UK on 13th of September (GOV.UK, 2020).

Region	Total Cases	Case rate per 100,000 population	Daily Cases (Average)	Deaths	Death Rate per 100,000 population
East of England*	28,243	452.9	135	4,136	66.3
London**	43,189	481.9	311	6,178	68.9

*East of England includes Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk, and Suffolk.

** London includes 32 boroughs in North, West, East and South London.

Key Indicators

COVID-19 is a highly transmittable respiratory disease, with high infection rates and fatalities and widely varying clinical severity. In adults, common COVID-19 symptoms include cough, fever, fatigue, headache, vomiting, diarrhoea (Docherty et al., 2020; Centre for Disease Control and Prevention (CDC), 2020), and anosmia which is a loss of sense of smell or taste (Alshami et al., 2020; Vaira, Salzano, Deiana, & Riu, 2020; The Centre for Evidence Based Medicine, 2020). Patients with mild disease typically recover at home (Gandhi & Lynch, 2020). Mild and moderate cases were usually defined as those that did not have pneumonia, acute respiratory distress syndrome (ARDS) or Intensive Care Unit (ICU) admission (Gandhi & Lynch, 2020).

To better assess COVID-19 related symptoms and identify a patient's health remotely, 5 indicators are collected from remotely monitored patients. These include symptoms, breathlessness, or respiratory rate (RR), temperature, oxygen saturation, and heart rate (HR).

The RR is measured as the number of breaths a person takes per minute. HR, or pulse and oxygen saturation can be measured using an oximeter. An oximeter is a simple device to measure oxygen levels in the blood quickly and easily, an indicator that helps to assess COVID-19 related symptoms and the potential for hospital admission (NHS England, 2020; Greenhalgh, Javid, Knight, & Inada-Kim, 2020; Shah et al., 2020). Oximeters can detect oxygen desaturation as well as silent hypoxia, a low oxygen level in the absence of shortness of breath that usually requires hospital treatment. Oximeters have been commonly used in communities and general practice (Salaried & Munro, 2005). NICE COVID-19 guidelines include oximetry assessment of breathlessness during the pandemic to help assess COVID-19 symptoms (NICE, 2020). Patients who are remotely monitored via telephone calls are contacted daily and required to take readings before the call. Patients monitored via the Medopad application are required to download the application. Upon a first download, patients provide baseline and demographic data. They continue to provide data 3 times a day on the key indicators, except for symptoms, which are provided once a day. To ensure continuous data collection, patients are sent regular text message reminders (SMS).

Patients are provided with a leaflet with instructions for remote care, carried out either by telephone or the Medopad solution. Patients are observed for a period of 14 days, monitored at least every 24 hours by the healthcare professional, and discharged from remote care once free from clinical symptoms for at least 48 hours.

COVID-19 symptoms can change over time. Depending on patient reported symptoms and measures, three categories of patients at risk have been outlined:

- Low risk: (if available) sats (oxygen saturation) >95%, HR <90, RR<20, no other significant red flags
- Medium risk: (if available) sats =94-96%, HR=90-100, RR=21-22, speaking full sentences and deteriorating symptoms
- High risk: (if available) sats <93%, HR>110, unable to speak full sentences. signs of sepsis, other emergency signs

Using a RAG system, Medopad remote care enables the dashboard users to colour code reported symptoms or highlight any changes observed throughout the course of the monitoring period based on predefined criteria outlined in the APACHE II (Acute Physiology Assessment and Chronic Health Evaluation II) Scoring System (**Appendix B**).

8. Methodology and evaluation framework

General approach

This evaluation study utilises the following steps to assess the Medopad remote care application:

- Conducting research and literature review around remote care and the health service pathway in the UK along with usage data and other case studies
- Conducting a quantitative in-depth analysis of KPI Framework data provided by Medopad and the implementation team to analyse key performance indicators of the Medopad remote care solution
- Conducting a qualitative review of data collected from staff and patient surveys and interviews to provide insight on feasibility and patient engagement. KSS AHSN conducted interviews to support the collection of anecdotal evidence, with the analysis integrated into the results within this report
- Building and interpreting an economic model on existing and available data provided to produce a cost-benefit analysis (CBA) that includes highlighting gaps in data, limitations, and the collection of further information as required. The CBA presents the outcome of any projected costs and the benefits of implementing the remote care solution
- The drafting of a final report to provide a narrative on the Medopad remote care application with COVID-19 patients in the UK. The final report includes outcomes and key findings
- Answering the two key questions within the report to help understand the potential benefit to the system of the solution, and whether wider scaling is supported by sufficient evidence
- Identifying areas for further improvement and testing, along with the identification of any limitations and recommendations for improvement

To evaluate this digital solution, the following dimensions were reviewed and analysed:

- Usage and patient engagement
- Usability and acceptability
- Patient and clinician experience
- Impact on workload capacity
- Impact on hospital admissions
- Impact on COVID-19 patient outcomes
- Impact on decision making

Sources

This study produced a to-date current appraisal of the impact of the Medopad remote care solution, estimated using the best available evidence from a range of sources including:

- Quantitative data: KPI (Key Performance Indicator) Framework and extracts from the Medopad dashboard electronic patient records (EPR) provided by the Huma team and collected from the three Medopad pilot study centres
- Qualitative data: collected from surveys for staff members and patients and from 3 interviews with staff and patients conducted by KSS AHSN
- Emerging information and statistics from the public sector bodies such as Office for National Statistics, and World Health Organisation (WHO)
- Emerging academic research and other literature

The scoping plan outlined that NHSX would provide the quantitative metrics and surveys collected from the pilot centres. KSS AHSN ensured that all data received were DPIA compliant prior to any analysis.

KPI Framework Methodology

To better understand the outcomes of the remote care application, three strategic areas were identified to guide the data collection:

- Breadth and frequency of data - to monitor a variety of clinical indicators more frequently
- Service efficiency - to monitor a greater number of patients with increased efficiency
- Clinical action - to identify cases and take appropriate actions to increase patients' recovery and survival rates

The final KPI Framework consisted of 36 questions addressing key indicators to understand how the remote care application reflects the outcome relative to the Framework (**Appendix C**). The key indicators are grouped into five key areas addressing usage and patient engagement, workload capacity, hospital admissions, impact on COVID-19 patient outcomes, and impact on decision making.

The Framework was shared with healthcare staff involved in remote care delivery who were supporting the VW and Medopad patients. Each pilot site provided a self-assessment process to collect data during the implementation process and the ongoing COVID-19 pandemic. Throughout the course of the data collection, discussions were carried out with the NHSX team, clinicians and other support staff providing the data, to ensure greater understanding of the metrics, their clinical relevance and interpretation.

It was agreed that the data be collected for the period between April 24th, 2020 and July 31st, 2020. In addition to the KPI Framework, extracts from the Medopad dashboard and other documentation were shared by NHSX such as a 'Huma Metrics' spreadsheet capturing the spread of the Medopad application (weekly reporting of the number of active users per site). These documents were also reviewed to assess the potential impact of the Medopad solution on the remote care services.

Surveys

KSS AHSN did not design the initial surveys but provided feedback on the drafted surveys to support NHSX. The clinical team was also consulted to give input on the questionnaires. NHSX shared the surveys with the clinical team from the primary and secondary care sites for dissemination. The WHHT did not have the means or capacity to easily share the surveys with staff or patients, therefore the results only reflect the experience of the NWL Hot Hubs' patients and staff members. Patients and staff who actively participated in the remote care, e.g. those who downloaded the Medopad application or managed Medopad dashboard, were asked to complete the survey.

The aim of this survey was to assess and understand the effectiveness and use of the Medopad remote care solution. A total number of 30 surveys were received, predominantly from clinicians. The results of the survey can be viewed in 'Section 9: Results: Qualitative findings from KPI Framework'.

At the end of both surveys, an option to participate in an interview conducted by KSS AHSN was available.

Interviews

KSS AHSN supported with 3 interviews of approximately 30-45 minutes each. Originally, the aim was to interview 2 members of staff and one patient. However, approximately 4 weeks after sharing the surveys, and despite NHSX sending a reminder to the clinical team who had disseminated the surveys, only 1 member of staff registered their interest. It was therefore decided that the interviews would include one staff member and two patients.

It was conducted with participants who agreed to take part in their survey response. The participants were selected on a first come, first served basis meaning that KSS AHSN interviewed the respondents who had first signalled their interest.

Interview questions were designed by KSS AHSN to better understand the use, effectiveness, uptake, and limitations in the Medopad application. The results from the qualitative data collection can be viewed in 'Section 9: Results'.

9. Results

Quantitative findings from KPI framework

The data for the quantitative analysis was collected between April 24th, 2020 and the July 31st, 2020 from the three pilot sites. Due to the limited capacity of the implementation team and the pressure their services were under, the KPI Framework was received on August 25th, with some metrics missing from the dataset.

A series of descriptive statistical analyses were performed to aggregate findings from the metrics collected in the KPI Framework document for primary care in North West London (NWL), including Hillingdon CCG and Central London CCG, and the secondary care service of West Hertfordshire Hospitals NHS Trust (WHHT) as outlined in 'Section 8: Methodology and evaluation framework'.

The key metrics have been split into four sections: usage and patient engagement, impact on workload capacity, hospital admissions, impact on COVID-19 patient outcomes, and impact on decision making.

Usage and Patient Engagement

Understanding of usage and patient engagement was gathered through a total of 9 questions in the KPI Framework (**Appendix C**) which were collected for the primary as well as secondary care services.

NWL CCGS

Between April 24th, 2020 and July 31st, 2020, a total of 1,567 patients with moderate COVID-19 symptoms across the two pilot sites in NWL were referred into the Hot Hub clinics. Of these, 1,196 (76%) were admitted to the Hillingdon CCG Hot Hub site and 371 (24%) to the Central London CCG Hot Hub site (**Figure 3**). The reason for the disparity in volume between the two is not known. The cumulative number of COVID-19 cases by London Borough, between April 24th, 2020 and July 31st, 2020, show that 1,155 cases were recorded in the Hillingdon borough and 726 cases in the Soho Camden borough, these figures include mild to severe cases (London Datastore, 2020). It is important to again note that only patients with moderate COVID-19 symptoms were put onto a VW.

Of the total patients who were referred into the Hot Hub (n=1,567) in NWL CCG, 318 (20%) were put onto a VW, with 60% (190) of VW patients referred from Hillingdon CCG and 40% (128) from Central London CCG (**Table 4**).

Table 4: Summary of total number of moderate COVID-19 patients referred to Hot Hubs and Virtual Ward (VW) in NWL CCG.

Usage and capacity	Hillingdon CCG	Central London CCG	Total
Total number of patients referred to Hot Hub	1,196 (76.3%)	371 (23.7%)	1,567 (100%)
Total number of patients on VW	190 (59.7%)	128 (40.3%)	318 (100%)

Of the 318 patients admitted to the VW across both CCGs, 116 (36%) were using the Medopad application and 202 (64%) were non-Medopad patients monitored via Telephone calls. Interestingly, 141 (74%) patients on a VW in the Hillingdon CCG and 54 (42%) patients on a VW in Central London CCG opted out from using the Medopad application and therefore did not download the application at all. In addition, Central London CCG refers to an additional 7 (5%) VW patients who opted out of Medopad after a first download. No data on subsequent opt out was available for Hillingdon CCG. The questions in the KPI Framework did not provide a reason for not downloading the application, leaving the reasons for the variance between CCGs unknown.

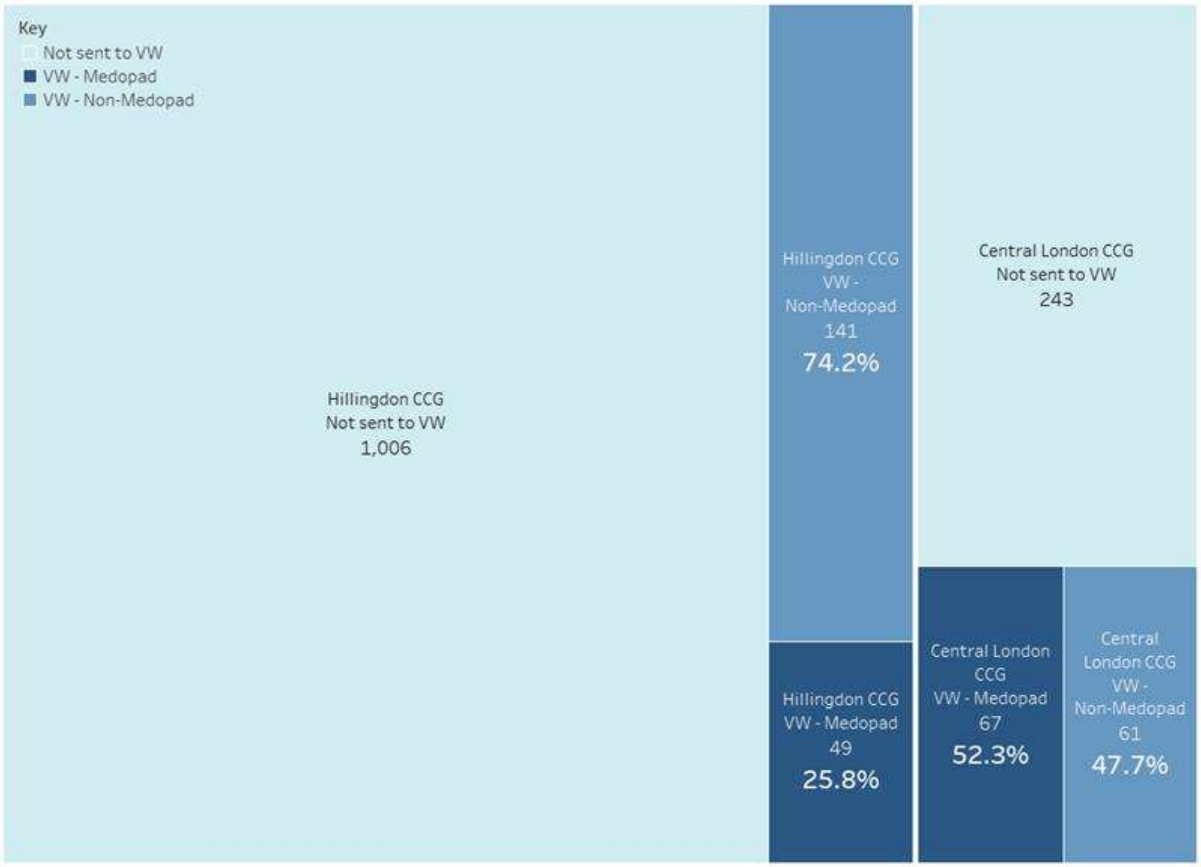


Figure 3: Tree map of the patient population in Hillingdon CCG and Central London CCG, with the total number of moderate COVID-19 patients referred to Hot Hubs, to the Virtual Ward (VW) and to Medopad.

When comparing the uptake and usage of the Medopad application, both Hillingdon and Central London patients showed positive engagement and usage statistics. Hillingdon CCG results showed that 100% (n=49) of patients who downloaded the Medopad application inputted data once to three times a day over the prescribed data collection period. Similarly, Central London CCG results showed that 90% (n=67) of patients continued using the application over the prescribed period, with an overall average of 94% continued usage across the two CCGs.

Additionally, Central London CCG also recorded the volume of patients put on VW who had their oxygen saturation measured, with 100% of both Medopad (n=67) and non-Medopad (n=34) patients having this measurement taken. Hillingdon CCG also showed that 100% (n=34) of patients on VW using Medopad had their oxygen saturation measured, although data was only provided to June 14th, 2020.

WEST HERTFORDSHIRE HOSPITALS TRUST (WHHT)

Between April 24th, 2020 and July 1st, 2020, a total of 462 patients with moderate COVID-19 symptoms in the Watford General Hospital from the WHHT were admitted to the VW and cared for remotely. Unlike in the above primary care settings, the total number initially referred into the VW was not shared. Of the total VW remote care referrals, 75 (16%) were using the Medopad application and 387 (84%) were non-Medopad patients monitored via Telephone calls (**Figure 4**).

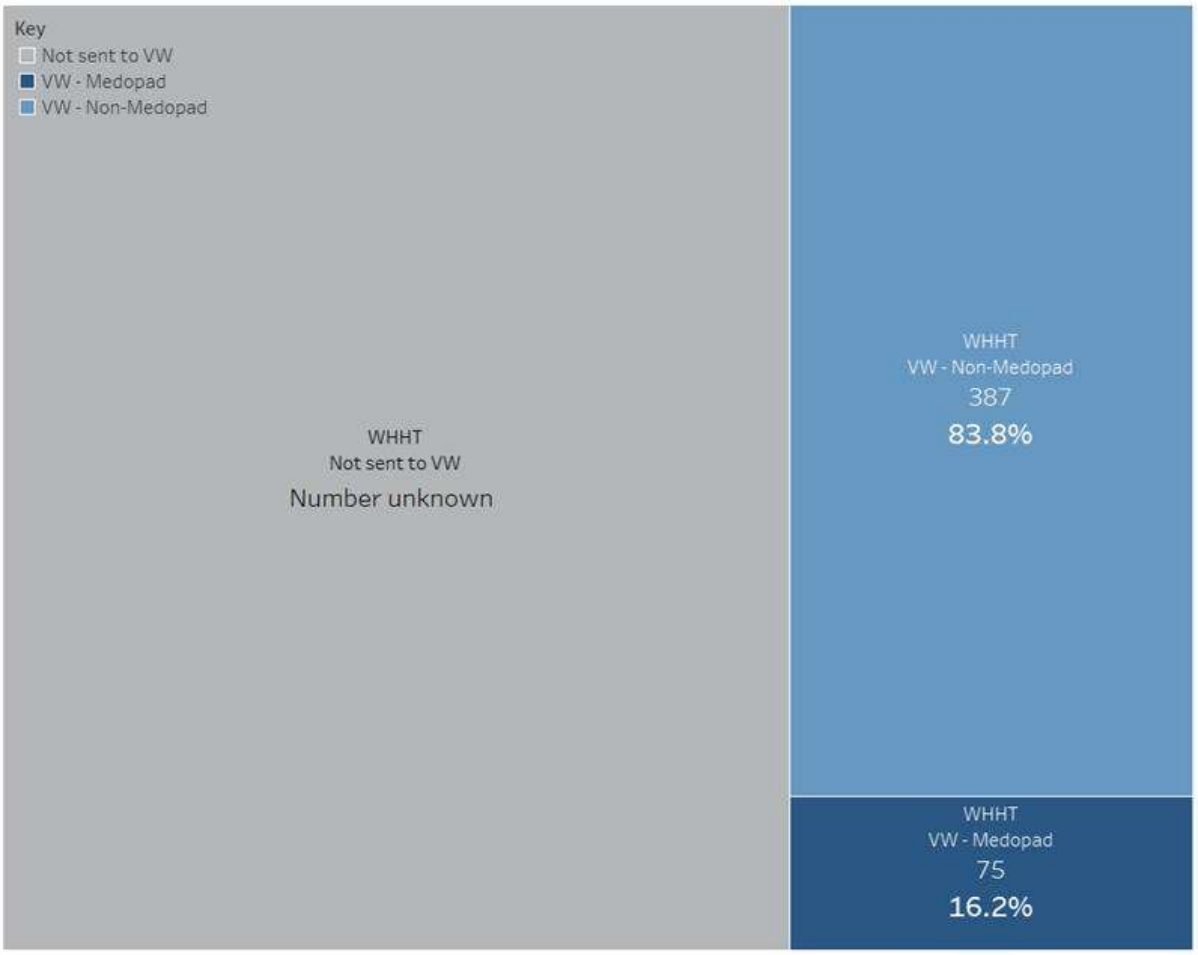


Figure 4: Tree map of the patient population in WHHT, with the number of COVID-19 patients referred to the VW and to Medopad.

In addition, data was provided on 900 referrals into the VW between March 13th, 2020 and May 13th, 2020, primarily before data collection for this study began, which has been used as baseline data when looking at readmissions later in this section.

When comparing primary and secondary care, the proportion of moderate COVID-19 patients using Medopad was lower in the WHHT secondary care setting (16%) than that seen across both NWL primary care Hot Hubs (36%). With secondary care sites serving as an immediate healthcare service providing urgent medical care for those patients with more severe symptoms, this is perhaps to be expected.

Salient points: Uptake of the Medopad application within the VW population ranged from 16% in the secondary care setting, to 36% across both primary care settings. Patient engagement data was only available for the primary care settings, where positive engagement and usage were shown across the board. Across both NWL CCGs, 94% of patients continued to use the application at least daily over the prescribed period. To our knowledge there is no national average figure reporting uptake for healthcare apps, but as a proxy for comparison, the report 'Realising digital-first primary care' reveals that use of online services is low, with only 15% of patients booking appointments online or 16% of patients ordering repeat prescriptions online (Deloitte, 2020).

Impact on workload capacity

Through the KPI framework, and additional data collection, several potential efficiency savings have been identified, focused on monitoring times, GP appointments, and patient contacts. Whilst it has not been possible to collect this data uniformly across the three sites, it can still provide useful insight into the opportunities for releasing staff capacity through efficiency savings that can be gained when considering further rollout.

CENTRAL LONDON CCG

Central London CCG provided the most information regarding efficiency savings. Data collection was carried out to estimate the time taken to adequately monitor VW patients, provided by Central London CCG only, and data regarding GP appointments and patient contacts was taken from the KPI framework.

VW monitoring time

The time taken to adequately monitor the Medopad patients in comparison to the non-Medopad patients suggested a time saving of approximately 3 minutes per day for Medopad patients, with 12 minutes spent per Medopad patient compared with 15 minutes per non-Medopad patient. The structure of the question and the information provided did not explicitly refer to the type of healthcare professional affected by the time saving, therefore an assumption was made that it referred to the Hot Hub GPs.

Similarly, the average number of patients supported by one staff member per hour was higher for Medopad in comparison to non-Medopad patients, with 20 patients per staff member supported when using Medopad, compared with 12 patients per staff member when not using Medopad. This results in an additional 8 patients able to be supported per staff member.

These figures imply efficiency savings for patients who are monitored used Medopad, although are taken from a relatively small sample size in a single site. An extended data collection, ideally across more sites and with a larger sample size, would be needed to confirm these results. Furthermore, this estimate may vary among practices or practitioners and would require further validation.

GP appointments

Based on the KPI metrics collected, provided by Central London CCG on August 11th, 2020, the number of GP COVID-19 related appointments per patient triggered by Medopad in comparison to non-Medopad patients who were monitored on VW via a telephone call, was lower in total with 0.23 to 0.37 respectively (**Figure 5**). The variance is especially stark when focusing on doorstep and home visits, which are likely to involve a degree of travel for the GP.

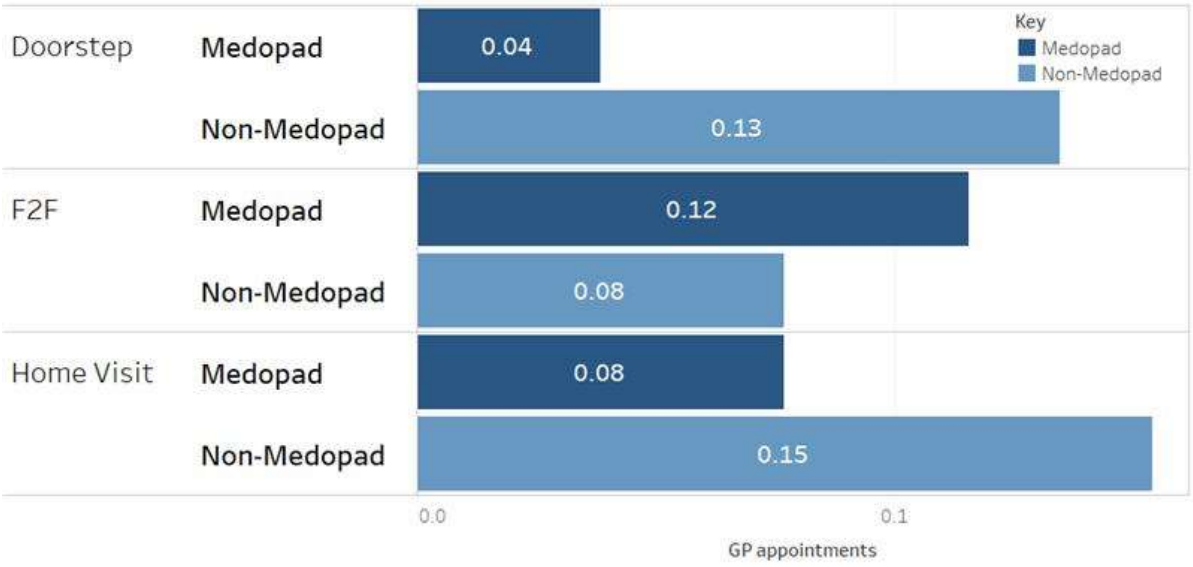


Figure 5: Average number of appointments per patient triggered a Medopad reading or a VW call (Non-Medopad) for Central London primary care CCG.

It is important to note that more appointments could have been triggered per patient that have not been captured through the KPI metrics.

Patient contacts

Additionally, data was supplied on patient contacts via SMS (including reminders and "other" messages), admin phone calls (including successful and failed phone calls), and clinical follow-ups (including video calls, and successful and failed phone calls).

On average, across these additional contacts, Medopad patients required fewer contacts with 16.3 per patient in comparison to non-Medopad patients, who required 21.5 per patient. The breakdown of the data in **Figure 6** shows that, for Medopad patients, the highest number of contacts were due to SMS reminders and clinical follow-up calls (6.9 and 8.7 per patient respectively), whilst for the non-Medopad patients it was admin calls and clinical follow-ups (13.2 and 7.3 per patient respectively) which were the primary point of contact. Additional metrics on the time that it takes to send a SMS and to make an admin call would need to be collected to estimate the effects. Nonetheless, if the time taken to send a SMS is less than that required to make a phone call, this data could suggest some freed capacity due to the use of Medopad.

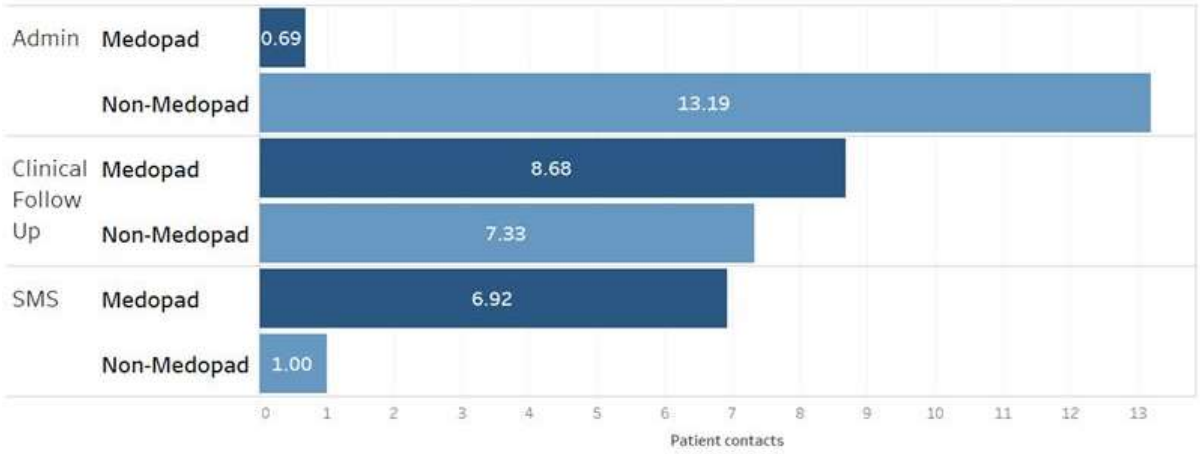


Figure 6: Number of patient contacts (excluding appointments triggered) related to Medopad or non-Medopad patients in the Central London primary care CCG.

As previously stated, Central London CCG has provided the richest insights into potential efficiency savings, with positive findings for Medopad patients regarding monitoring time, GP appointments, and additional patient contacts, whilst noting the small sample size.

HILLINGDON CCG

Available data from Hillingdon CCG focuses on GP appointments and patient contacts for Medopad patients only. Unfortunately, no data was available to use as a comparator for non-Medopad patients, which limits the conclusions that can be drawn.

GP appointments

At the end of data collection period, 49 GP related appointments triggered by Medopad readings were recorded, with no further information provided on patient contacts. Midway through the data collection, 33 GP COVID-19 related F2F or Hot Hub appointments triggered by Medopad readings from a patient population of 34. This data would suggest that every one of the Medopad patients on 31st July and 97% on 14th June had a GP related F2F or other appointments triggered by the Medopad readings. This runs counter to both the expected outcomes, as the Medopad application aims to reduce the number of F2F contacts, and those seen in Central London CCG. Extended data collection on the process or population would be needed to confirm these findings.

Patient contacts

From the data collected at the midway point, 357 patient contacts related to Medopad when excluding follow-up calls or visits, and 394 patient contacts related to Medopad when including follow-up calls or visits were recorded. On average, 12 contacts per Medopad patient were made including follow-ups, which is slightly lower than the average of 16 seen in Central London CCG. No breakdown of the type of contact made is available to allow further investigation into these differences.

Overall, the data provided for Hillingdon CCG has limited value for drawing conclusions into efficiency savings using Medopad, due to the lack of a comparator, and some potential inconsistencies in the recording of data.

WEST HERTFORDSHIRE HOSPITALS TRUST (WHHT)

Questions from the KPI framework were used to estimate Medopad's impact on capacity within the VW, with the available data focusing on patient contacts.

Patient contacts

Telephone calls made to Medopad patients were scheduled on days 1, 2, 7 and 14, and to non-Medopad patients on days 1, 2, 3, 5, 7, 9, 11 and 14. The data collected on the number of calls made to patients per day indicated a reduced number of patient contacts in line with these schedules, with 4 planned calls to Medopad patients in comparison to 8 planned calls to non-Medopad patients, at an average call length of 8 minutes. This suggests a reduction in patient contacts by 50%. Notably, the data presented in **Table 5** suggests that at an average of 32 minutes call time per patient, a total of 40 hours of medical professional time has been saved for the 75 Medopad patients. It was unclear in the data collected if the time saving related to consultants only or if it was a mix between consultants' and admin staff's time. Based on conversations with the clinical team, it has been assumed that it related to consultant time only.

Table 5: Time spent on moderate COVID-19 patients being reviewed on Medopad and VW in WHHT secondary care service.

Number of GP COVID-19 related appointments	Medopad patients on VW	Non-Medopad patients on VW

Total no. of patients	75	387
Calls per patient	4	8
Total call time per patient	32 min	64 min
Total call time	2,400 min	24,768 min

In summary, the data collected from the WHHT suggests that fewer check-up telephone calls are required for Medopad patients when compared to non-Medopad patients.

Salient points: Increased efficiency using Medopad can be seen in the data collected across both primary and secondary care settings. Central London CCG shows potential time savings in monitoring patients on the VW (3 minutes saved per patient per day), reductions in GP appointments (a reduction of 0.14 appointments per patient), and reduced patient contacts (5.2 fewer per patient). These time savings are mirrored, albeit through a more limited data set, in the secondary care setting of WHHT where a 32-minute total reduction in call time per patient can be seen for those using Medopad.

Impact on hospital admissions

Hospital admission data was made available by both NWL CCGs, and readmission data by WHHT.

NWL CCGS

The number of patients who have been admitted to hospital after having been monitored on VW was recorded by Central London CCG (**Table 6**). Due to the lack of data from Hillingdon CCG regarding Non-Medopad patients, and the small sample size, further data collection would be required to draw any conclusions. As mentioned previously, any variance may also be related to the severity of patient's clinical symptoms rather than the remote monitoring method.

It should also be noted that there are inconsistencies with the data collected when compared to patients sent to hospital in relation to oxygen saturation. Patients admitted to hospital after having been monitored on the VW were reported to be lower in both CCGs than the number of patients sent to hospital in relation to oxygen saturation. The expectation would have been to see higher or equal numbers admitted overall, so further investigation would be needed to clarify this data collection further.

Table 6: Number of patients who have been admitted to hospital after having been monitored on the VW.

Site	Medopad patients on VW		Non-Medopad patients on VW	
	Total patients	Admitted to hospital	Total patients	Admitted to hospital
Central London CCG	67	2 *(3%)*	61	2 *(3%)*
Hillingdon CCG	49	7 *(14%)*	141	N/A

WEST HERTFORDSHIRE HOSPITALS TRUST (WHHT)

The number of Medopad patients who were readmitted back into hospital within 28 days was 5% (4 out of 75 patients) as can be seen in **Figure 7**. Out of 75 Medopad patients, 14 (19%) required extra calls, e.g. in addition to the 4 calls each Medopad patient had. In comparison, baseline WHHT data collected for the period between March 13th and May 13th, 2020 indicated that out of 900 patients at baseline, 76 (8.4%) patients were readmitted (either during the follow-up or after the discharge).

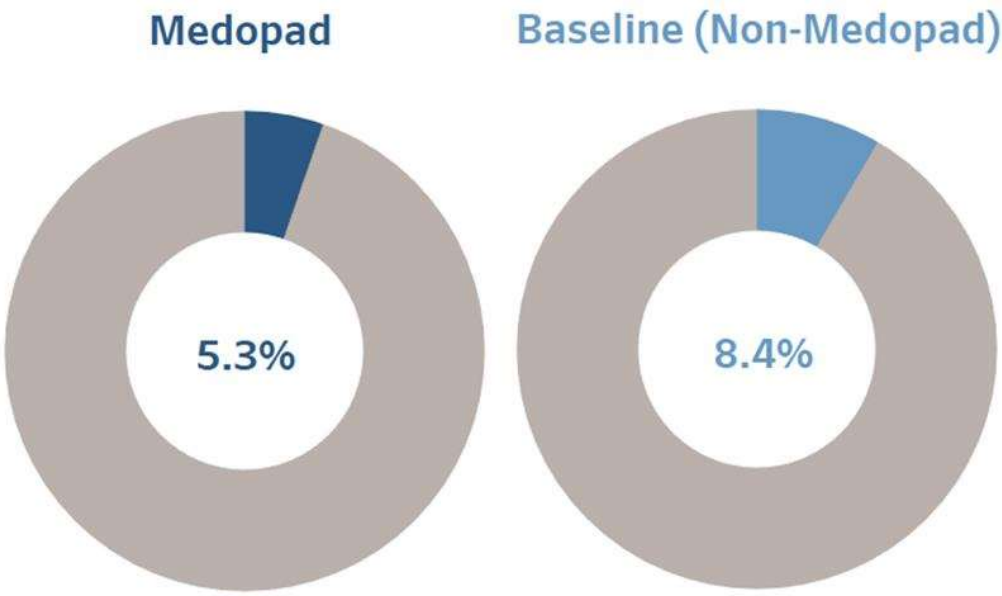


Figure 7: Hospital readmission % from patients on the Medopad solution from April 24th, 2020 to July 31st, 2020 vs. baseline (non-Medopad) patients from March 13th, 2020 to May 13th, 2020 in WHHT.

Although the data suggests a higher rate of readmission amongst baseline patients in comparison to patients who were remotely monitored using Medopad, it is important to note that the baseline data was collected during the peak of the first wave of COVID-19 when more daily cases were reported. No additional information on the patient demographics or comorbidities was provided, so further data collection would be recommended to confirm these findings.

Salient points: Where comparison has been possible, hospital admission and readmission data show equal or lower rates for Medopad patients than those seen for patients in the existing pathway. Due to inconsistencies in the timing and completeness of data collection, further studies are recommended to confirm these initial findings.

Impact on COVID-19 patient outcomes

Reporting the impact on outcomes for COVID-19 patients included analysing data collected on themes relating to the:

- number of patients sent to hospital in relation to oxygen saturation and silent oxygen desaturation

- number of patients with disproportionate oxygen desaturation
- number of patients who recovered
- number of patients who died

Patient outcomes (oxygen saturation and desaturation)

Data on Medopad were obtained from both CCGs and data on the non-Medopad patients from Central London CCG (**Table 7**). Since the data on the two patients' groups has not been obtained from both CCGs, the comparison between the Medopad and non-Medopad oxygen saturation findings is made on data from Central London CCG. No data on oxygen saturation or desaturation was collected in the secondary care setting.

In Central London CCG, 10 Medopad patients (15%) were sent to hospital due to oxygen saturation levels compared to 16 non-Medopad patients (26%). Although there was a lower proportion of hospital referrals due to oxygen saturation levels for Medopad patients compared to non-Medopad patients, these findings are likely incidental; there is no proof of correlation or causality between the method of care and the number of hospital referrals. This can more likely be explained by the patients' symptoms and severity of disease rather than by the method of remote monitoring used.

Table 7: Number of patients sent to hospital in relation to oxygen saturation levels.

Site	Medopad patients on VW		Non-Medopad patients on VW	
	Total patients	Sent to hospital	Total patients	Sent to hospital
Central London CCG	67	10 *(15%)*	61	16 *(26%)*
Hillingdon CCG	49	8 *(16%)*	141	N/A

The number of patients with silent oxygen desaturation were higher in Hillingdon CCG (n=19) than Central London CCG (n=6), with both being captured as of July 31st, 2020. Similarly, the number of patients with disproportionate oxygen desaturation were higher in Hillingdon CCG (n=7) than Central London CCG (n=6), despite the Hillingdon data on disproportionate oxygen desaturation being captured midway through the project, approximately a month before the end of data collection. Hillingdon CCG reported one patient for whom the disproportionate oxygen desaturation did not change. It was not specified in the data provided whether these were Medopad or non-Medopad patients.

Recovery and mortality rates

NWL CCGS

All Medopad patients (100%) recovered and were discharged from the VW across both primary care settings, and 87% (n=61), of non-Medopad patients who were discharged from the VW in Central London CCG recovered. No data on non-Medopad patients was available from Hillingdon CCG.

Furthermore, of those who had been on the VW and not on Medopad, no patients with COVID-19 symptoms in Hillingdon CCG and only one patient in Central London CCG later died. No deaths were recorded amongst patients who were monitored on Medopad. Due to the small number of patients, no conclusions should be drawn.

WEST HERTFORDSHIRE HOSPITALS TRUST (WHHT)

Data provided from the baseline non-Medopad period of March 13th, 2020 to May 13th, 2020 shows a crude mortality rate of 2.0%, with 18 deaths from 900 patients. Data provided to July 31st, 2020 shows no additional deaths within either the Medopad (n=75) or non-Medopad (n=387) populations. No additional data was provided by WHHT on recovery rates.

Salient points: Oxygen saturation and desaturation levels, whilst potentially providing context to the severity of patients' symptoms, are less useful when evaluating the effectiveness of the Medopad solution. Admission and readmission levels are consistent or slightly better for Medopad patients, but with small sample sizes and at different stages of the pandemic. Positive recovery rates were seen in Medopad patients in Central London CCG in particular, and there is no data to suggest that mortality rates were adversely affected for Medopad patients, with no deaths recorded, albeit from very small sample sizes.

Impact on decision making

The impact on decision making was gathered through two questions identified in the KPI Framework. One question addressed 'How often elevated observations are acted upon by the Hot Hub GP for patients on the VW using Medopad' and 'average time elapsed from elevated observations or symptoms to triage on VW or to clinical action'.

NWL CCGS

Central London CCG indicated that approximately 50% of elevated observations are acted upon, on average, within 10 minutes from patients on the VW using Medopad. The same information was not made available for non-Medopad patients. Hillingdon CCG indicated that the answers for both questions could be obtained from the staff survey. Further detail can be found in the qualitative findings section below, under the heading 'Workload capacity and decision-making improvements', with the findings largely inconclusive.

As data on the impact on the decision making was estimated using self-reported measures, it is recommended that further testing would need to be carried out to confirm the impact of the Medopad solution on the timely delivery of care.

Salient points: There is no conclusive evidence to suggest either way whether Medopad had an impact on improved decision making. A larger scale exercise including recording comparator metrics for non-Medopad patients within the quantitative data collection would be recommended.

Additional metrics within the KPI framework

There were a number of additional metrics within the KPI framework that had been intended for analysis, but they could not be obtained due to the double challenge of limited clinical capacity and the lack of existing processes to collect them:

- Increased use of hot hubs for COVID (Increase in the number of patients referred to Hot Hubs from local GP practices)
- Improved COVID patient risk identification (better identification of symptoms and response)
- Increased safety of healthcare professionals (sick leave / agency costs for health econ model)

- Improved hospital outcomes (reduction in length of stay, reduction in admission to ICU, length of stay for ICU admitted patients)
- Societal/social benefits from improved hospital outcomes (reduction in the incidence of long term COVID-19 symptoms, recovering patients able to return to work faster)
- Improved capacity for ambulance usage (reduction in the number of ambulance call outs for patients on VW)
- Improved health outcomes for the clinical team (improved physical and mental health through reduced stress levels)

Qualitative findings

Survey and interview participation

KSS AHSN provided support and feedback on the survey questions for staff and patients, with consultation from the clinical team, whilst NHSX disseminated surveys with the clinical leads. The two surveys used can be seen in **Appendix D**. The first gathered feedback from 30 patients who had used Medopad: the second gathered feedback from 12 healthcare staff users. Interviews were carried out by KSS AHSN with patients or staff members who agreed to participate in an interview (**Appendix D** presents the interview questions).

As the authors do not know how widely the patient survey was shared, the response rate cannot be determined. The patient survey was not disseminated by WHHT, so it would have been sent to a maximum of 116 Medopad patients, hence the survey captured the views of just under a third of the Medopad patients in Hillingdon and Central London CCGs. There is no information available about the dissemination of the staff survey, so the response rate there cannot be estimated. Similarly, because the number of clinicians involved in the running of the Hot Hubs was not communicated to the evaluation team, the authors are unable to assess how representative the answers are.

A series of How-To Webinars coordinated by NHSX on the theme of “the tech enabled Virtual Ward experience” is also referenced in this section as it provides information on the clinicians’ experience, especially for the WHHT site which did not take part in the surveys.

Usability

Usability feedback was gathered through several questions in the surveys. Of the ten applicable responses to the staff survey question ‘What do you like about the Medopad dashboard?’, 33% of respondents felt it was easy to get started on the dashboard, and only one person picked the option ‘it was easy to understand how the dashboard works’. Moreover, 56% of staff members surveyed thought that the Medopad dashboard was easy to review patient data. During the interview, the staff member was more positive, stating that it was ‘very easy to use’ and scoring the usability 9/10.

Patients felt that the app was easy to use with 95% of recorded answers being ‘easy’ or ‘very easy’ when questioned. When asked what they liked about the app’, 71% of respondents picked the option ‘it was easy to record my data’, 57% agreed with the statement ‘it was easy to get started with the app’ and 52% chose the answer ‘it was easy to understand how to use the app’.

Salient points: The usability of the Medopad solution was rated positively both by patients and staff members. Many clinicians felt that it made it easy to review patient data and two third of patients liked how easy it made recording their data.

Acceptability

Several perspectives were explored to assess the acceptability of the Medopad solution. When asked to rate their confidence in the data made available through the Medopad platform to support the delivering of care, the average score of the respondents was 6.9 out of 10. This suggests the clinical team has confidence in Medopad to assist patients’ care.

Patients’ acceptability of remote care was positive, 76% of patients surveyed stating that they would be happy to use this form of care again (after removing blank entries). The 2 interviewees also agreed that they would now prefer to receive remote care with Medopad rather than over the phone, one stated they would still use other methods of care in situations when it was more applicable. Additionally, 11 respondents selected the word ‘reassuring’ to describe Medopad (out of 8 proposed options), this was the most selected word, followed by ‘useful’ and ‘invaluable’ with 3 mentions each.

Both staff members and patients were asked how likely they were to recommend Medopad to someone else. The answers to these questions were used to compute the Net Promoter Score (NPS). A NPS is a standard user experience metric for new

products or technologies. Respondents are asked to grade, on a scale of 0-10, how likely they are to recommend the technology to a colleague, friend, or family member. Respondents are then classified, based on score, into “promoters” (a score of 9-10), “passives” (a score of 7-8) or “detractors” (a score of 0-6). The definition of a good NPS will depend on the type of technology and the country of the users surveyed. But according to Bain & Co, the source of the NPS system, any NPS score above 0 is good, anything above 20 is considered "favourable", above 50 is excellent, and above 80 is world class (Perceptive, 2020). Whilst both groups were likely to recommend the solution, the patients were more willing to endorse the product than clinicians, with an average score of 71 compared to -25. This suggests that the focus for user acceptability could be more tailored towards the healthcare professional users.

Salient points: The user acceptability varied between the clinician users and the patient users. Patients showed more confidence in the solution as demonstrated by a Net Promoter Score of 71 for the patient group and of -25 for the staff group. Organising some interviews or focus groups could help understand why some staff members showed more reservation towards Medopad.

Patient experience

As illustrated by **Figure 8**, 90% of the patients surveyed rated their experience of the remote care services good or very good.

Both staff members and patients were asked how likely they were to recommend Medopad to someone else. The answers to these questions were used to compute the Net Promoter Score –NPS). Whilst both groups were likely to recommend the solution, the patients were more willing to endorse the product than clinicians, with an average score of 71 compared to -25. This suggests that the focus for user acceptability could be more tailored towards the healthcare professional users.

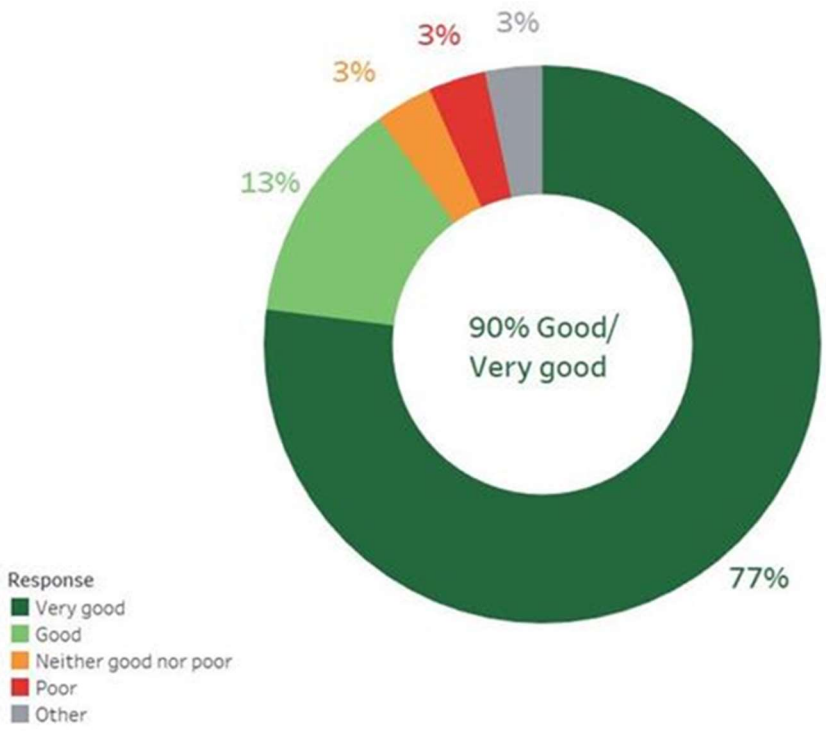


Figure 8: Patients' answers to the question 'Thinking about your recent COVID-19 experience, overall, how was your experience of our service?'

When asked to justify their score of how likely they were to recommend Medopad, 20 of the respondents left a comment (out of 33). The supporting statements were overwhelmingly positive, with patients feeling both reassured and empowered by the regular monitoring.

> *"It was an easy app to use, which allowed me to maintain daily contact with the nurses and doctors. I always got a call back when unwell to review my condition which I found very containing during an anxiety provoking time."*

> *"I could see, for myself, symptoms worsening or improving, which stopped me worrying and I felt in control […]"*

> *"It gave me a peace of mind to see that I was monitoring especially when the oxygen level was dropping and reporting they called quickly to check on me."*

Similarly, most of the respondents spoke glowingly about the care they received from the clinical team. The patients reported finding the team helpful, indeed, the adjective mentioned in 3 comments. The timeliness of the care was also highlighted, with 8

counts of the words “prompt/promptly”, “quick”, “fast” and “as soon as”. Moreover, numerous words belonging to the lexical field of care could be found in the patients’ comments. They underlined that they felt supported words such as “to be cared for or “supported” (8 mentions); the words “considerate”, “kindly”, “friendly”, “empathetic”, “dedicated” showed the emotional bond created through the remote monitoring (8 mentions); the quality of the care received can be perceived through the use of the words “attentive”, “conscientious” and “efficient/effective” (5 mentions).

> *“Super quick and efficient with their responses. Felt they dedicated a lot of time and attention to me and I was not left hanging. Couldn’t praise them higher. Doctors were lovely and frequently called to check on me.”*
>
> *“I received excellent treatment and care with doctors/nurses/staff treated my situation with sincere care and I have the utmost respect for the entire team, giving their all especially with covid-19 being at it's worst. I am in awe of such handling of patients.”*
>
> *“The doctors and nurses were fantastic! […] I felt very well looked after and treated. A very high level of attention and care, which I will never forget”*

Salient points: The patient experience of the Medopad application was overwhelmingly positive as demonstrated by the testimonies in this section, and the surveys showing 90% rated their experience as good or very good. They also spoke highly of the care they received on the Virtual Ward and of the attitudes of the clinical team.

Clinician feedback

The respondents indicated that they were mostly from the Hillingdon or Westminster boroughs with 50% and 42% respectively and 8% from Kensington and Chelsea; and doctors constituted 67% of the respondents (nurse, manager, administrator and hut coordinator were the other professional categories represented).

When asked about how they thought Medopad had impacted patient outcomes, the respondents’ comments presented a variety of opinions. The positive remarks included the role of Medopad to improve clinical decision making:

> *“Escalating to secondary care earlier.”*
>
> *“Quicker decision”*

"More proactive care and able to educate patients about monitoring and escalating care as needed"

Others were worried about the Medopad application creating more anxiety for the patients and felt that Medopad was taking more clinician time as irrelevant observations were being flagged for review by other healthcare professionals.

"Some patients also were recording worrying symptoms but when you spoke to them on the phone they were fine. [Medopad] created more calls and work"

To improve the Medopad dashboard, the respondents recommended the development of functionalities and features for the users, such as patients being able to edit entries and staff members to add additional symptoms. **Table 8** summarises the suggestions of improvement collected through the survey and the interviews.

Table 8: Suggestions of potential improvements for Medopad.

Area of improvement	Description of the improvement
Transfer of data from the dashboard to patient records	To have a clear flagging system for new symptoms. This would reduce the risk of human error when transferring the data to SystmOne, e.g. accidentally logging some data from the previous submissions.
Management of discharged patients	To be able to archive the discharged patients, via a click-and-drag feature which would apply to the patient list. It would make viewing the dashboard easier.
Visualisation	To improve the range for the axis of the graphs: for the temperature graph, they wanted the axis to focus on the values between 30 and 45 degree Celsius (rather than starting from 0). For the saturation, rather than an axis ranging from 0-100, to have 80-100. This would make the plot more meaning and avoid the graphs displaying a flat horizontal line.
Auto refresh feature	To add an auto refresh feature on the dashboard. It would enable administrative staff to fulfil some other

Area of improvement	Description of the improvement
	tasks more efficiently as they would not have to manually refresh the page.
Heart Rate display	To have more granularity on the values for the Heart Rate, currently it is given as an average (or a minimum and maximum values) which does help when updating data into SystmOne. Having the nominal value for the last reading rather than the average for the previous would be useful.

Salient points: Feedback from clinicians regarding the impact of Medopad varied. Whilst some thought that it improved the clinical decision making and enabled more timely care, others felt that it risked increasing their workload by generating more calls. The respondents provided recommendations for future improvements of the dashboard, which should be considered with attention before further implementation of the solution.

Workload capacity and decision-making improvements

The key benefits that were unveiled through the qualitative data analysis include the staff perceptions that they could monitor patients faster and needed less time to escalate after patient deterioration. Indeed, 58% of staff members felt that on average it was more time effective to monitor patients remotely using the solution.

When asked how long it takes to adequately monitor a patient, 92% of respondents picked the options ‘up to 10 minutes’ and ‘between 10 and 20 minutes’ for Medopad patients, against 75% for non-Medopad patients (**Figure 9**). When using the midpoint of each time range and excluding blank values, the average time taken to adequately monitor a Medopad patient was 11 minutes 22 seconds compared to 15 minutes for non-Medopad patients, hence, a time saving of 3 minutes 38 seconds per Medopad patient.

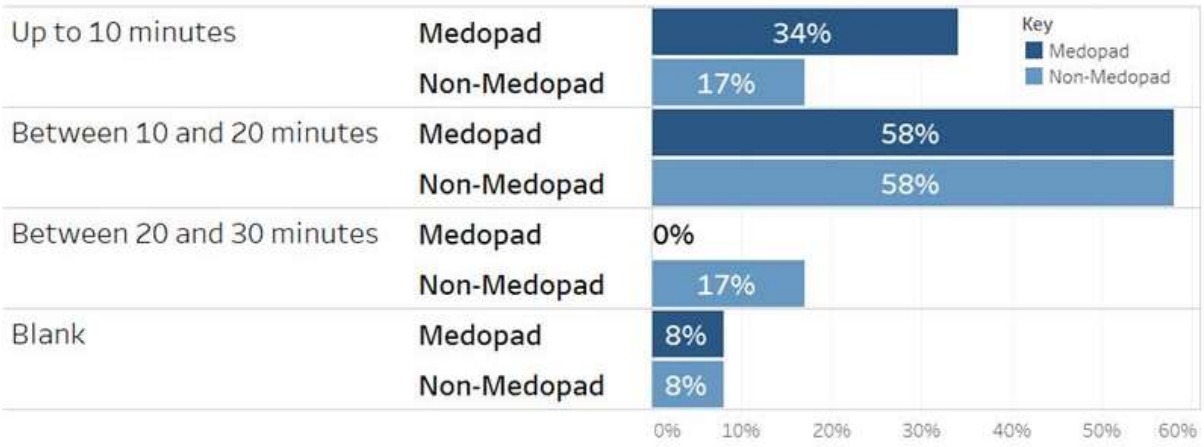


Figure 9: Time taken to monitor a patient on the VW.

The potential reduction in time taken until a patient is escalated remains unclear due to the small number of samples collected, although a good proportion of staff indicate that clinical action has been taken faster for Medopad patients, than those not using Medopad. Indeed, out of the applicable replies, 33% of respondents stated they took between 0-10 minutes when using Medopad compared with only 17% when not using Medopad. The longest time until escalation whilst using Medopad was 50-60 minutes (1 response) whereas the longest without using Medopad was only 30-40 minutes. This could suggest that Medopad overall is quicker on average per patient but in some cases, there is a delay until escalation. When using the midpoint of each category, the average time for Medopad users was 16 minutes 45 seconds, with the average time for non-Medopad users similar at 16 minutes 15 seconds.

As the time-savings are based on self-reported data collected on a small sample size, further research should be conducted to validate the potential improvements in decision making that may be achieved.

In a series of How-To Webinars coordinated by NHSX on the theme of “the tech enabled Virtual Ward experience”, Dr Matthew Knight, a consultant respiratory at WHHT and clinical lead for the deployment of Medopad, reflected on the impact of the app and highlighted the following benefits:

- Reduced frequency of patients calls for triage

- Allowed clinicians to rapidly review patient's oxygen saturation, pulse, temperature and symptoms score in real time (with colour coding for severity) and focus time on those that were most in need
- Allowed clinicians to identify several cases where deteriorating oxygen saturation occurred before patients' symptoms worsened
- Saved time for clinicians, increase in real-time data and good display of data

Salient points: Many staff members surveyed perceived Medopad as more time effective to monitor patients remotely when compared to a telephone VW. Similarly, the amount of time they needed to monitor a patient on the Medopad enabled VW was smaller than for a patient on the telephone VW. More data collection is needed to draw conclusion with regards to the impact of Medopad on the time taken until a patient is escalated.

10. Health economics

As part of the evaluation scope, this study explored how the data collected could be used to evidence the economic impact of the Medopad application as well as advising on the potential benefits that could be evidenced by further evaluation

The aim of an economic modelling analysis is to assess the impact of a solution in terms of savings for the healthcare system as well as broader social benefits, relative to the counterfactual, which in this case is the remote telephone triage COVID-19 pathway.

Methodology and standardised data sources

The aim of a cost-benefit analysis is to determine if the economic value of an intervention can justify its cost by comparing the cost of two or more alternatives and reviewing the return on investment. Savings are estimated from the healthcare system's perspective and the effects of an intervention on all costs should be considered (i.e. direct cost, effect on health expenditures, social and health outcomes to the patient). Costs and benefits ought to be discounted to reflect the lower economic value of an expense, accounting for the time value of money, as well as the higher value of a benefit that is realised earlier (HERC, 2019).

For each outcome, data is needed to determine inputs for the model. The input data required are the:

- Total population in the project area, e.g. patients referred to VW
- Target population, e.g. in this study the patients referred to the VW and using Medopad
- Level of engagement with the target population, e.g. % of patients onboarded onto the Medopad application
- Scale of impact in changing the outcome, e.g. % of success at achieving the outcome

This process, outlined in **Figure 10**, takes a standard approach of working out the number receiving the intervention, multiplied by the net benefit or impact per person,

multiplied by a factor to remove the optimism bias, to give a total net benefit of the benefit stream, over and above the counterfactual.

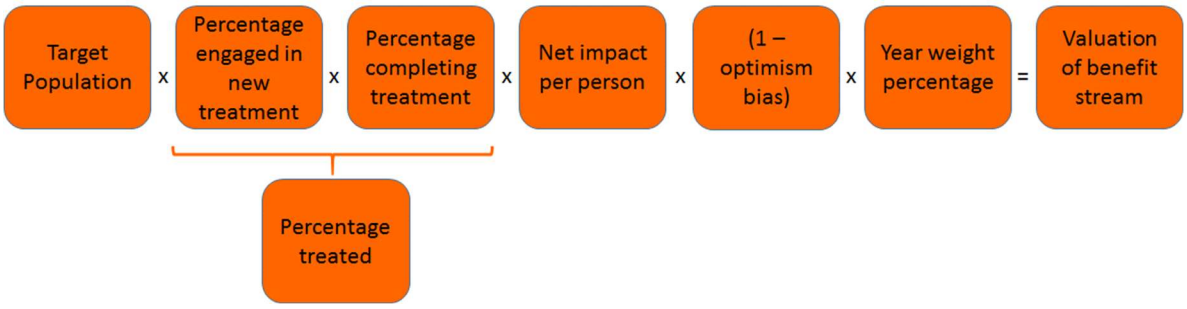


Figure 10: Calculation of total net present benefit.

There are different categories of benefits relevant for the health economics evaluation, they are as follow:

- **NHS related cash releasing benefits**: These benefits produce immediate cashable savings to the provider; an example of this benefit would be the deprescribing of a drug
- **NHS related non-cash releasing benefits**: These benefits are important to reducing demand and strain on services, but a fiscal value cannot be realised without decommissioning of services. Benefits which can be described as non-cash releasing include reduced readmission or generation of time savings for staff that they may allocate to other activities
- **Social benefits**: Social benefits relate to the overall benefit to the public, including, but not limited to, fewer sick days and improved health and wellbeing
- **Other benefits**: Although the health economic model is primarily concerned with the fiscal benefits associated with Medopad, it is important to acknowledge other benefits that might not have an accurate value and may be attributed through qualitative review, e.g. staff experience or patient experience

Standardised data sources

HM Government has looked to enable quicker and more efficient delivery of cost benefit appraisals, particularly by local government, through the funding and development of three sets of standardised unit cost databases, from which we will look to draw data as standard.

- Greater Manchester Combined Authority 'Unit Cost Database' (2019) which divides costs into financial costs and economic costs. These terms broadly equate to 'public sector delivery costs' and 'all other socio-economic costs' (GMCA, 2019)
- PSSRU's 'Unit Costs of Health and Social Care 2019' and (PSSRU, 2020)

These sources present an effective mechanism for identifying values for many costs and outcome benefits.

Optimism bias

It has previously been reported that commissioners and practitioners are often overly optimistic about the outcomes that will be achieved by the project or programme and the amount of money that will be needed to deliver these outcomes (GMCA, 2019). It seems reasonable to assume that the degree of over-optimism will be greater when the data and evidence upon which the cost benefit model is based are uneven, old, or incomplete. Therefore, the model applies optimism bias correction factors in response to the level of uncertainty in the data or assumptions used.

Appendix 5 gives details on the confidence grade system. The confidence grade applied is determined by the lowest assessment in the descriptive columns. The optimism bias correction factor for the data is then determined based on the lowest confidence grade found in relation to each individual outcome and costs are increased by the corresponding percentage factor.

Challenges in evidencing the benefits

As part of the support provided for the project, KSS AHSN worked with the clinical team throughout April and May 2020 to agree on the outcomes which should be collected in the KPI framework (see **Appendix C** for the full list of metrics). As

discussions were progressing with the implementation team on what already collected metrics they could report on and what additional metrics they could obtain, it became evident that most of the metrics available were informing on the process of implementing Medopad rather than its impact. Indeed, only 14 of the 37 metrics were outcome measures. Process measures, whilst important to track the progress of a project, are often somewhat limited to help understand the economic impact.

In the interpretation of the outcome measures, another challenge came from the relatively small number of patients that were using Medopad. With a total of 116 in the NWL Hot Hubs and 75 in WHHT, and the fact that the outcomes monitored would not affect the whole patient population, only a small number of outcomes were measured. This particularly impacted the collection of outcome measures such as the number of deaths and admissions, which could not, therefore, be used for the modelling.

Furthermore, the data collected did not give a longitudinal view of the patient journey, as it did not follow the patient from primary to secondary care, for example, or from the hospital discharge to the patient's condition 28 days after discharge. Therefore, it would not be prudent to assume causality between the use of Medopad and some of the clinically relevant data collected, as there was no way to delineate between the confounding factors (patient demographics, severity of the disease at the start of care, etc.) and the impact of Medopad.

Finally, some measures, such as the number of patients who recover having been monitored on the virtual ward for instance, are encouraging for the solution but do not directly translate into a benefit stream. A variety of assumptions, relying on an extensive review of published evidence, should be applied to turn this outcome into an economic saving. For instance, for the metric described, this could mean having to estimate the healthcare and societal cost of a fast recovery compared to a slow recovery, to rely on international studies to identify adverse effects of a slow recovery or to utilise the data collected during another public health crisis as a comparator. These tasks are outside the scope of this project.

Key inputs and outcomes

To build an economic model such as a cost benefit analysis, a certain number of input data are required for calculation purposes to determine the outcomes of the model.

Population and comparator

The target population was the number of moderate COVID-19 patients who were using the Medopad application to receive remote care (e.g. 49 for the Hillingdon Hot Hub, 67 for the Central London Hot Hub and 75 for the WHHT site). Outcomes for this population was compared to the outcomes for the comparator population (i.e. the number of moderate COVID-19 patients who were on the VW but not on Medopad). In total, this equated to 141 patients for the Hillingdon Hot Hub, 61 for the Central London Hot Hub and 387 for the WHHT site.

Data collection

A first set of data was shared with KSS AHSN on June 25th, 2020, a month before the final data collection deadline. The file, which had data from the NWL Hot Hubs but not from the WHHT site, had missing fields and some measures did not follow the descriptions included in the template. Throughout continued discussions with the NHSX team and their relay of our queries to the clinical colleagues we were able to get more clarity on the data submitted.

The agreed deadline for the data collection of the KPI Framework metrics was July 31st. However, the clinical team needed more time to populate the data collection spreadsheet, therefore an extension was agreed for the reception of the data (the KPI Framework was still to capture the data between April 24th to July 31st). The last update on the metrics was received on August 25th, although with some figures still missing from the KPI Framework, the scope of both the quantitative analysis and the health economic modelling was impacted.

Outcomes

The outcomes explored include the reduction in time needed to care for patients (monetised benefit), the impact on admission rate, mortality rate and on the management of deterioration (non-monetised outcomes).

Benefit and cost streams

Improved workload capacity

As part of the data collected during the implementation, WHHT reported on the:

- Average number of calls needed to monitor patients not on Medopad: 8

- Average number of calls needed to monitor patients on Medopad: 4

A call is on average 8-minute long across both populations; therefore, **32 minutes of consultant time were reported to be saved per patient on average**.

This benefit is a non-cash releasing benefit. This type of benefit is important in reducing demand and strain on services, but a fiscal value cannot be realised without the decommissioning of services. Benefits which can be described as non-cash releasing include reduced readmissions and increased efficiencies that allow staff allocate time to other activities.

Through economic modelling, non-cash releasing benefits can be monetised to illustrate the economic impact of the time made available by the benefit. According to the Unit Cost of Health and Social Care 2019 (Personal Social Services Research Unit, 2019), the cost per hour of a hospital-based medical consultant is £109. Consequently, the increased capacity would equate to **£58 saved per patient on average, or £4.4k for the total WHHT patient population**.

In the KPI framework, Central London Hot Hub reported on:

- The time taken to adequately monitor a Virtual Ward patient not using Medopad (per day): 15min
- The time taken to adequately monitor a Virtual Ward patient using Medopad (per day): 12min

Thus, according to these self-reported measures, 3 minutes of clinician time are reported to be saved per patient per day using Medopad. If we consider that the average patient is monitored on the Virtual Ward for 14 days, a total of 42 minutes of clinician time are saved on average per patient.

Similarly, this benefit is also a non-cash releasing benefit. According to the Unit Cost of Health and Social Care 2019 (Personal Social Services Research Unit, 2019), the cost per hour of a GP (unit cost – including direct care) is £132. Consequently, the increased capacity would equate to **£92 saved per patient on average or £6.2k for the total Central London CCG patient population during the study period.**

Other potential benefits

In addition to the economic benefits described above, other benefits relating to the use of Medopad may be seen to accrue over time. Due to either a lack of evidence regarding the scale of these benefits, or the absence of a mechanism to reliably

monetise their impact, the inclusion of these benefit streams is not currently practical.

- **Number of hospital admissions and readmissions:** A firmly evidenced reduction in hospital admissions and readmissions where patients have been monitored through Medopad, as opposed to a telephone-based VW, could be monetised, and be included in future economic modelling. As well as collecting these outcomes on a larger patient population, the analysis should be adjusted for confounding factors such as patient demographics and severity of the patient's condition when they initially join the VW.
- **Number of GP appointments:** The impact of Medopad on the number of appointments needed to adequately monitor patients on the VW could be estimated and used to build a benefit stream. A reduction in GP appointments would also create capacity for the clinical team to monitor more patients, as well as reduce the overall cost of care. A decrease in the number of GP appointments is not always a desirable outcome (e.g. optimal care may mean receiving more appointments for some patients). Therefore, judgement should be exercised when assessing the use of such resources. In principle, the NHS seeks to provide services that represent good value for money, rather than inexpensive services that may risk creating costly untoward outcomes further along the line.
- **Impact on mortality rate:** This could be estimated by monitoring the number of COVID-19 related deaths for patients using Medopad. A reduction in mortality rate compared to telephone-based monitoring would represent an increase in quality of life (for the patients who would survive as a result of the use of Medopad) and could be monetised using Quality Adjusted Life Years (QALYs) and the theoretical value of a QALY (Willams, 1985) Similarly, comparison between patient groups should be adjusted for demographic factors and co-morbidities, as it would be difficult to attribute a reduction in mortality to Medopad in full.
- **Delivery of more timely care**: By exploring whether Medopad can enable better clinical response to patient deterioration would be interesting for future evaluations. It would entail modelling different scenarios of the impact of deterioration on patient outcomes and cost implications (based on longitudinal patient-level data for instance) and measuring the impact of remote care on the patient's timely management (by analysing the clinical actions and patient outcomes for a group of deteriorating patients for instance). Comparison

between patient groups should be adjusted for demographic factors and co-morbidities.

- **Release of clinical capacity:** Through the automatic colour coding of symptom severity and vital signs (based on agreed clinical thresholds) displayed in the Medopad dashboard, clinicians can immediately visualise the patients that are stable and need no further action other than continued monitoring. As a result, they can dedicate more time to making appropriate clinical decisions for patients with unstable readings. Should this benefit be evidenced in a future evaluation, it would be crucial to estimate how long clinicians spend on "routine review" in a non-digitally enabled virtual ward and on Medopad. Performing a spot check over several days for each patient, for example, would likely provide the evaluation team with enough data points to calculate an average time for Medopad and the comparator.

Cost streams

When implementing a new technology across primary and secondary care services, it is also important to consider the cost implications to the healthcare system. In regard to Medopad, such considerations include the licencing fee for the solution, the cost of staff time in setting up the solution and the cost of other devices needed to use the solution, such as pulse oximeters.

Cost of service fee: pilot sites have benefitted from use of the Huma solution for free, it is a pro bono offer from Huma until December 31st, 2020. Huma's pricing strategy for NHS services is presented in **Appendix F**. Should further sites wish to adopt the solution, consideration should be given to this cost.

Cost of other devices: the pulse oximeters were provided to the sites by NHSX free of charge. As with the service fee, this cost can be waived for this project but should be accounted for when considering future implementations. To provide some context on potential costs, NHSX has a budget of £300,000 to distribute 15,000 devices, suggesting a unit cost of approximately £20 per pulse oximeter.

Cost of staff time: the solution was introduced remotely via a series of conference calls. According to the clinical team, these calls covered a variety of aspects, from selecting the features they wanted for the clinicians' dashboard to working through the logistics of the implementation, in addition to providing training to the staff members on the solution. Huma also provided training videos for the wider team

involved in the project. Estimates of staff volumes and time requirements were not provided, but it is recommended that these potential costs are also considered for any further roll-out of the Medopad product.

11. Discussion

Insights

Overview on Medopad's impact and benefits

The Medopad remote care application offers regular monitoring and management of suspected or confirmed COVID-19 cases. The application was used in three different healthcare services, which provided a real-world validation of the solution in both Primary and Secondary care settings. This evaluation has offered an insight into how Medopad can support a more agile healthcare service to meet the needs of a dispersed patient population at a time when the demands and risks faced may vary greatly from week-to-week.

The objective of this report was to evaluate the impact of using the Medopad remote care application, the benefits it provides to the system and to understand the solution's suitability for further scaling. The application has been compared to telephone-based processes of triage and remote monitoring to assess its repercussions on delivery of care, service efficiency and patient outcomes.

The section below highlights key findings, derived from the qualitative and quantitative analysis ('Section 9. Results'), outlining the impact of the solution and the benefits generated to the system:

- **Usage and patient engagement**; uptake of the Medopad application ranged from 16% in the secondary care setting to 36% across both primary care settings (out of the total VW population). Patient engagement data was only available for the primary care settings, where positive engagement and usage were shown across the board
- **Usability, acceptability, patient experience and clinician feedback**; of all the patients surveyed 95% found the application easy to use and 93% were pleased with the remote care service. Overall, patients showed more confidence in the solution as demonstrated by a Net Promoter Score of 71 for the patient group and of -25 for the staff group
- **Impact on workload capacity**; through the ongoing collection of data, clinicians were able to review patients' data in a more efficient manner, saving

approximately 3 mins per patient per day in primary care settings, equivalent to £92 saved per patient on average or £6.2k for the total Central London CCG patient population during the study period. Based on the KPI metrics collected, an average of 0.23 GP COVID-19 related appointments per patient were triggered through Medopad in comparison to 0.37 for non-Medopad patients. On average, non-Medopad patients required 7.33 clinical follow-ups, while Medopad patients required 8.68. The average number of calls required dropped significantly for Medopad patients (0.69 per patient, compared with 13.19); this is likely balanced in part by an increase in SMS usage (6.92 per patient, compared with 1.0). On the other hand, non-Medopad patients required 7.33 clinical follow-ups, while Medopad patients required 8.68, on average

- **Impact on hospital admissions and readmissions**; in WHHT, out of the 75 Medopad patients, 5% were readmitted to hospital within the 28 days following discharge. In comparison, baseline data showed an 8% rate of readmission for non-Medopad patients

- **Impact on COVID-19 patient outcomes**; a lower proportion of patients using Medopad were sent to hospital due to oxygen saturation levels, according to data reported by Central London CCG. In total, 10 Medopad patients (15%) were sent to hospital due to oxygen saturation levels compared to 16 non-Medopad patients (26%). In terms of patient safety, the application appeared to support patients' recovery where 100% of patients using the platform in a primary care setting recovered compared to 87% of non-Medopad patients from the Central London CCG deployment

Strong engagement and uptake, while showing that the application can be used in a clinical setting without negatively impacting health outcomes, are positive indicators that Medopad could be a good candidate for further deployment. Feedback regarding the platform suggests that, once established, it can integrate with processes, saving time in terms of patient reviews, and providing reassurance to staff and patients during a very challenging period. There is, however, evidence that Medopad patients receive more clinical follow-ups, which might mitigate efficiency savings, despite the overall reduction in the average number of contacts for Medopad patients. There are limitations in the data collection and sample size which raise the need for further evaluation and validation before deployment at scale.

Suitability for deployment

The following section will seek to determine whether the evidence generated as part of this rapid evaluation is sufficient to support further scale. To do so, the following factors were reviewed:

- Evidence base of uptake, engagement, and credibility
- Evidence base of value and effectiveness
- Suitability for deployment (reach of spread, integration, and cost)
- Magnitude of health gain and benefit to the system
- Resourcing and measurability requirements

EVIDENCE BASE OF UPTAKE, ENGAGEMENT, AND CREDIBILITY

Ensuring the solution is well-received by the users (both patients and clinicians), with strong adherence levels, is a key test regarding sustainability. This will be vital in ensuring the solution is deployable at a larger scale, should the service of care persist at the current standard.

Patient uptake and experience

Hillingdon CCG results showed that 100% (n=49) of patients who downloaded the Medopad application inputted data one to three times a day over the prescribed data collection period. Similarly, Central London CCG results showed that 90% (n=67) of patients continued using the application over the prescribed period. Additionally, in Central London CCG 100% of Medopad (n=67) and non-Medopad (n=34) patients had their oxygen saturation measured. Hillingdon CCG showed that 100% (n=34) of patients on VW using Medopad had their oxygen saturation measured, although, the data was dated to the 14th June 2020. Results on the uptake and usage of Medopad are positive and suggest a good patient compliance rate. No data was obtained from WHHT to assess enable comparison. Collecting patients' perspective from the secondary care services is recommended to evaluate differences in uptake and compliance.

The patient survey revealed that respondents felt the app was easy to use with 95% of recorded answers being 'easy' or 'very easy' when questioned. Overall, the patients surveyed were satisfied with the remote care service received with 93% of

the respondents describing it as “very good” or “good”. Moreover, when asked to describe Medopad in one word, the most selected word by respondents (45%) was “reassuring”. Similarly, 62% of the respondents stated that they “liked having the visible reassurance that the GP had reviewed [their] data”. It appears that the patients surveyed found the interface intuitive, were satisfied with the care received and gained a sense of reassurance from Medopad. The latter point is interesting as there is emerging evidence of COVID-19’s impact on mental health (The Health Foundation, 2020).

Clinician feedback

The Medopad application was developed to track patients’ symptoms remotely and to monitor disease progression and flag deterioration in a timely manner.

Collecting clinical symptoms using Medopad has enabled healthcare staff to monitor patients remotely and continuously from their homes. The findings of this evaluation showed that remote monitoring using Medopad not only allowed staff to capture clinical data usually collected in-house or via telephone triage, but also enabled data to be collected more frequently since patients uploaded their data three times a day.

In the staff survey, 56% of the respondents stated that the Medopad dashboard made it easy to review patient data. Similarly, when asked about confidence in the platform to support care, the respondents’ average score was 6.9 out of 10. These results suggest that most of the staff members find Medopad useful to enable remote care but with almost a third of the respondents not sharing such a positive view of the solution.

Further questionnaires or interviews would be needed to understand what motivated the less positive feedback to help inform further spread of the technology. These contrasted opinions can also be seen in the answers to the Net Promoter Score (NPS) question “How likely is it that you would recommend the Medopad COVID-19 Dashboard to a colleague”. The average score was -25 but 2 of the 13 respondents picked a score of 0 and 2 other respondents picked a score of 10.the average score was -25 but 2 of the 13 respondents picked a score of 0 and 2 other respondents picked a score of 10.

Conclusions regarding uptake, engagement, and credibility

Evidence collected through the evaluation provide positive feedback regarding the patient experience and uptake of the Medopad application. The level of engagement shown and confidence found in the solution suggest that it may be a favourable

option for wider deployment for remote monitoring of COVID-19 patients, assuming the quality of support and level of service can be maintained across new pilot sites. Whilst the patient experience was positive, clinician's experience was more varied, which highlights the need for possible further improvements to the clinician's interface before implementation on a wider basis. Improvement suggestions should be addressed before pursuing with further deployment.

EVIDENCE BASE OF VALUE AND EFFECTIVENESS

The second key test before deciding on further scale is to understand whether the solution generates operational, clinical, or patient benefits.

Impact on workload capacity

Outcomes, in terms of the data collected relating to the downstream impact on capacity, were broadly positive across the three sites. Results in primary care showed that the Medopad application released capacity for healthcare staff, providing timesaving evidence of 3 minutes per day per patient, and allowing staff to monitor 8 more patients per hour when using Medopad. As suggested in 'Section 9: Results', these estimated figures would need to be confirmed through further data collection to assess whether findings are replicated in other settings.

Data relating to the number of GP appointments following remote monitoring was incomplete across all three evaluation sites, with Central London CCG providing the only source of information. Based on the KPI metrics collected, an average of 0.23 GP COVID-19 related appointments per patient were triggered through Medopad; in comparison to 0.37 for non-Medopad patients. The variance is especially stark when focusing on doorstep and home visits, which are likely to involve a degree of travel for the GP and may include a greater burden in terms of costs and time taken. This finding reflects potentially promising evidence to support a reduction in GP appointments thanks to Medopad; however, we would encourage further data collection across existing sites to validate this preliminary insight.

While there were time savings in terms of reviewing patients' data and potentially decreasing the number of GP appointments, there was a slight increase in the number of clinical follow-ups required across Central London CCG. On average, non-Medopad patients required 7.33 clinical follow-ups, while Medopad patients required 8.68. While the average number of calls required dropped significantly for Medopad patients (0.69 per patient, compared with 13.19), this is likely balanced in part by an increase in SMS usage (6.92 per patient, compared with 1.0). Overall it may be fair to say that Medopad has supported clinical efficiency in primary care, but

it may be worth considering whether any additional appointments were the result of Medopad providing effective early warning of deterioration, or a result of clinical questions not being reliably answered by the data provided.

For WHHT, it was reported that the usage of Medopad enabled the services to save on average 4 calls per patient (32 minutes of consultant time were reported to be saved per patient on average). These results are encouraging but will need to be confirmed by a more in-depth evaluation to check whether they are replicated in other acute sites.

Hospital readmissions

Moreover, in WHHT, out of the 75 Medopad patients, 5% were readmitted to hospital during the 14 days follow up, and 5% readmitted within 28 days after discharge. Comparatively, baseline data showed an 8% rate of readmission for non-Medopad patients. Figures suggest similar readmission rate for Medopad patients and non-Medopad patients. Notably, these data were not collected at the same time during the COVID-19 first wave and no additional information on patient demographics or comorbidities was provided.

Mortality, recovery rate and other patient outcomes

No untoward outcomes were found in terms of patient mortality or recovery rate. Data from Central London CCG indicated no patient deaths associated with Medopad-using patients, while only one patient died from the non-Medopad group. Similarly, 100% of patients using the platform in a primary care setting recovered over the course of the data collection period; compared to 87% of non-Medopad patients from the Central London CCG deployment. Medopad was associated with a lower number of patients referred to hospital due to oxygen saturation levels. While this could suggest that Medopad used a higher threshold for such readings, that was not borne out through patient feedback. Patients cited the quick response to a drop in saturation levels as a reassuring factor of the service.

Overall, results remain inconclusive due to the small sample size, making it difficult to prove causal relationships between these metrics and the use of Medopad. Further assessment and oversight of health outcomes associated with Medopad may be required if the system is used across a wider area. Variation may be due to supporting services as much as the platform itself and any further evaluation may need to take supporting processes into account.

Additional COVID-19 learnings

As part of the onboarding process, patients using Medopad filled in a baseline questionnaire collecting demographic data. Questions included weight, height, smoking status, pre-existing conditions, and regular medications, in addition to some COVID-19 specific questions. Clinical teams valued this baseline questionnaire, as it provided some recent demographic information on the patients monitored. When comparing the questionnaire answers to the Electronic Patient Record (EPR); the clinicians were able to understand which information needed updating and had more accurate data to base their clinical decisions on.

Using the data collected during the first wave of COVID-19, thanks to projects such as the Medopad pilot, it would be valuable to conduct a generalised review of the VW patients exploring demographics factors, co-morbidities, reported symptoms and clinical outcomes. This could capture learnings on how to best manage COVID-19 patients and could be utilised by national programmes such as NHS at Home. It could also drive the update of the clinical guidelines ahead of an anticipated second wave to reflect on elements, such as the length of monitoring or the interpretation of different threshold for oxygen saturation.

Conclusions regarding value and effectiveness

The evidence base regarding the value and effectiveness of the Medopad application, as it currently stands, is not robust enough to justify a recommendation for the broader adoption of the intervention. It is unclear whether trends identified within the scope of this evaluation could be attributed to the use of Medopad, or a product of natural variation or selection bias prioritising a direct, non-Medopad approach for patients with more severe symptoms.

Further investigation would need to be carried out to fully review the economic and social impact of the Medopad remote care solution on a wider scale. Should a further evaluation be carried out, it would be valuable to consider other potential benefits as part of the economic modelling such as hospital admissions, readmission rate but also the impact on number of GP appointments whether they are F2F, home visits or telephone/video consultations. Clearer determination of the value and effectiveness of the solution would be addressed through the gathering of more complete data across a wider sample size, which would in turn support the development of robust economic modelling.

IMPLEMENTATION READINESS (SPREAD, INTEGRATION AND COST)

Beyond a robust evidence base, it is important to consider implementation factors when considering scale-up.

Spread and reach

The Medopad platform was deployed across 7 sites in different waves between April and June 2020, but this evaluation focused only on the first three pilot sites where the deployment took place. For the other 4 pilot sites, no information was shared on the deployment strategy, the outcomes measured or the feedback from patients and staff members. Therefore, it would be important to understand how the subsequent waves occurred to assess whether the solution can be successfully deployed across multiple sites. As further spread of Medopad would depend on the ability of the solution to scale up (e.g. adequate IT infrastructure and technical support for instance) and also on the capacity of the clinical teams to support that level of deployment, the evidence for spread and reach is currently inconclusive.

Integration

Whilst overall feedback was broadly positive regarding the use of the platform, some staff responses suggested issues exist with the current onboarding process. Some individuals reported difficulty getting started with the application, while only one respondent felt it was easy to understand how the dashboard works. Whilst the sample size is small; this may prove to be an important consideration if the solution is deployed to more locations. It would be remiss to overlook the time pressures involved in deploying a new solution to meet the challenge of a global pandemic. Any such issues will likely scale along with the solution if further deployments are pursued; it is important to ensure that the training and onboarding plan is sufficient to support a broader user base.

Cost

As part of this piloting exercise, the Medopad application was offered pro-bono by the company. It is our understanding that beyond December 31st, 2020, this costing model will change to an annual fee per project dependent on the number of users as described in **Appendix F**. The pricing is subject to change and the information presented in the appendix is only accurate at the time of publication. Pricing will likely be a predominant factor in ascertaining whether additional CCGs and Trusts are willing to adopt this solution at scale. Due to limitations in data collection leading

to a limited health economic model, there are no results to demonstrate if the cost of the solution would enable the decision to further scale the intervention. Ensuring a robust economic model is produced, which captures the costs of the platform post-piloting, will be key to understanding whether this solution is cost-effective to the system.

MAGNITUDE OF HEALTH GAIN AND BENEFIT TO THE SYSTEM

As described in 'Evidence for value and effectiveness' the data collected does not provide sufficient evidence of the impact of Medopad on patient and system outcomes, as only relevant to one pilot site in some instances or a small sample size. The magnitude of the health gains cannot be estimated nor inform the suitability of the solution for further spread. Benefit to the system should be explored through a health economic model, which would more clearly define impact on health outcomes and the population benefitting. Getting a better understanding of the latter would be crucial, particularly in terms of understanding which patients are directed to the VW with telephone monitoring, as opposed to Medopad. This detail would help determine how the capacity of clinicians might be impacted, based on potential case mix and the appropriate model of care.

For the pilot, although clinical and patient outcomes such as number of admissions and readmissions, and mortality and recovery rate have been collected, the only benefit stream that could be monetised was the time savings for staff members. In the secondary care pilot, a reduction in the average number of calls required to monitor the average resulted in £58 saved per patient, or £4.4k for the total WHHT patient population. In a primary care setting, the time saved in reviewing patient details resulted in savings of £92 per patient on average or £6.2k for the total Central London CCG patient population during the study period. The other outcomes appeared inconclusive due to the limited data. Potential benefits to be evidenced through additional evaluation could include a decrease in readmission rates, a reduction in the length of stay for admitted patients, no change or improvements in mortality and recovery rate.

RESOURCING AND MEASURABILITY REQUIREMENTS

When thinking about the scalability of a solution, it is key to fully understand what resources are required to enable deployment at such a scale. Estimates of staff volumes and time requirements were not provided and without these values it is difficult to plan for deployment on a larger scale. It is recommended that these requirements are clarified and that any potential costs are also considered for a further roll-out of the Medopad product. Clear measurement strategies are required

when considering further scaling of such a solution. The KSS AHSN has not been privy to such documentation and would, therefore, advise the development of these before proceeding with scale-up. The information provided regarding resourcing and measurability was insufficient to support further scale.

CONCLUSIONS REGARDING DEPLOYMENT SUITABILITY

Based on data available to the evaluation team it is difficult to draw strong conclusions regarding whether Medopad is currently suitable for widespread deployment. While the application is already in use across several pilot sites, four of the seven sites were out of the scope of this evaluation. There is evidence which suggests that, despite some onboarding issues, Medopad can be incorporated into hot-hub processes effectively. At present, cost is not a barrier to deployment, as it is temporarily being provided for free. Importantly, there may be hidden costs in terms of the impact on resources that are not currently apparent. There is insufficient evidence regarding health outcomes, which necessitates further evaluation before widespread adoption as it relates to matters of patient safety.

Table 9 summarises the findings for all themes considered while assessing Medopad in terms of suitability for further deployment.

Table 9: Factors considered in the readiness for scaling up.

Factors considered	Ready for scaling	Rationale and relevant evidence
Evidence of use, engagement, and credibility	Yes	Supporting evidence above in the section 'Key Findings'
Evidence of value and effectiveness	Yes (requires further validation)	Improved clinical outcomes Patients outcomes including mortality and hospital admissions were collected, but, due to the limited number of occurrences of these outcomes no conclusion can currently be reached as to Medopad having a significant impact on these outcomes.

Factors considered	Ready for scaling	Rationale and relevant evidence
Is this implementable (reach of spread, integration, and cost)?	Unknown	Medopad was deployed in 7 sites but this study has very limited information on the outcomes of the extended deployment. Engagement with the later implementation sites is recommended to understand the costs required to undertake further scale up.
Magnitude of health gain and benefit to system	No (inconclusive results)	The impact of Medopad on patient outcomes was inconclusive and the time savings reported require further validation. Collecting patient and clinical outcomes for multiple sites and with a larger population would be the basis for a further health economic modelling.
Resourcing and measurability requirements	No (improvements required)	The deployment strategy, which would include a resourcing estimation and the continuous collection of metrics and outcomes, is a prerequisite for larger scale implementation. Should further deployment take place, the resourcing and measurability requirements should be designed carefully.

Limitations

The following section seeks to address challenges and limitations encountered through the evaluation process.

Limited and unavailable data

One of the key limitations of this evaluation has been the challenges encountered throughout the collection of data. Partly due to rapid delivery to pilot sites, along with

the clinical team's very stretched capacity, the definition of data items, as well as the collection and reporting process was not as thorough as it could have been. This is largely down to the unprecedented circumstances of the COVID-19 pandemic but should serve as a reminder if further evaluation work is undertaken.

The clinical team's capacity made it difficult for them to engage with the evaluation team, despite their willingness to contribute. The lack of direct communication between the evaluation team and the company, Huma, was another hurdle in obtaining the needed information within the agreed timeline. Despite recommendations on the metrics needed for the evaluation, liaising with the clinical colleagues to finalise the KPI framework, proactively raising unclear or incomplete metrics and showing flexibility by extending the data collection deadline, the evaluation team was unable to obtain the complete dataset described in the scope of the project. Due to these limitations with the data, we were unable to demonstrate some of the KPIs and other outcomes, leading to outcomes appearing inconclusive or the evidence unavailable for further decision-making.

Governance challenges

Establishment of a consistent dataset could reduce the risk of potential Information Governance issues, while ensuring that all reported information remains comparable with all other sites and reports. Open and frequent communications with the NHSX team were a real asset to problem solve such issues faced during the evaluation as they arose. Despite the efforts of the NHSX team to address challenges and queries, the lack of global oversight and clear governance structure had an impact on the project. Typically, KSS AHSN would work with the provider themselves and their relevant leads to ensure findings do not overlook any evidence gaps. For example, due to lack of engagement with Huma, KSS AHSN was unaware of the company's plans for further commercial developments, therefore, unable to determine insights regarding the long-term spread, integration, and potential reach of the platform.

Pilot study population

The platform was used to manage patients who showed moderate COVID-19 symptoms and reached out for medical help across part of North West London. Three pilot sites were used with 191 patients using Medopad across all locations. As this group, as well as the staff providing the service, was further segmented it was not always possible to draw certain conclusions from the data provided. For example, data pertaining to secondary care was only received from a single site rendering it impossible to assess whether a reduction in readmissions was replicated

in other settings. Primary data formats varied across the two CCGs meaning that mortality and recovery metrics were also only based on results provided by a single organisation.

Furthermore, the Medopad has been deployed across a wider footprint as the original evaluation was agreed. As other sites did not have the capacity to support additional data collection beyond the initial launch, data were not provided to inform the evaluation. It may be worth sharing the outcomes of this evaluation with representatives from these sites to assess if their experience supports findings.

COVID-19 daily cases and mortality rates

GOV.UK shows a fluctuation in the number of COVID-19 cases and mortality rates daily. The number of reported cases recorded a peak in April followed by the fall in May to early June (GOV.UK, 2020). With regards to mortality rates, all English regions recorded an increase in age-standardised mortality rate between March and April 2020, followed by a decrease from May till July 2020. The rollout of the Medopad remote care started in May 2020 with the data collection on the implementation process from June and July.

This variation in cases and mortality reflects the variable risks and demands the healthcare system is currently facing. While there is little that can be done by way of recommendation, other than continue to encourage behaviours to limit spread, this remains a limitation of any evaluation as outcomes observed at one time for a particular organisation, may not reflect the outcomes experienced elsewhere.

Sustainability of implementation beyond pilot sites

This use of the Medopad solution was free of charge due to piloting. It is important to mention that implementation of an additional cost to the services may be a limitation for an uptake of such service in local communities, trust, and other centres.

Usage of Medopad for patients with lasting COVID-19 symptoms

Approximately 10% of people experience prolonged COVID-19 symptoms occurring even after mild acute illness (Greenhalgh, Knight, A'Court, Buxton, & Husain, 2020), including infection, inflammatory responses and other immune reactions (Zirui Tay, Poh, Rénia, & MacAry, 2020). Continued monitoring of COVID-19 patients who have downloaded, registered, and used the application could offer continued support post-discharge as a form of a safety net to patients. Since patients are advised to have a further community follow-up or chest x-rays if symptoms, such as a persistent cough,

continue (British Thoracic Society, 2020), further monitoring could support long-term COVID-19 recovery.

Furthermore, significant symptoms may be encountered by survivors including anxiety, sleep disorder, fatigue, limited exercise tolerance, and memory loss (Kemp, Corner, & Colvin, 2020; Tsai LK, 2005), which could add additional burden to the healthcare system if not addressed in a timely and effective manner.

Inclusive access to the intervention

Given the digital and cost-free nature of the application to the user, it can be accessed by a substantial proportion of the population. Nonetheless, it is important to note that accessing healthcare remotely can provide a significant challenge to those patients most in need or those less technically advanced, including older people, people with learning and physical disabilities, or people from socio-economically disadvantaged background who may have not the same means to access a smartphone.

Studies have shown that hospitalisation and deaths from COVID-19 may be related to socioeconomic status and ethnicity (Office for National Statistics (ONS), 2020; Verhagen M. B., 2020; Office for National Statistics (ONS), 2020). In England, people living in more deprived areas are twice as likely to die than those living in less deprived areas, although this is a generally trend, COVID-19 increases the effect. In July 2020, the age-standardised mortality rate for deaths in the most deprived areas was 3.1 deaths per 100,000 population in comparison to 1.4 deaths per 100,000 population in the least deprived areas in England (Office for National Statistics (ONS), 2020). Furthermore, for some users, English might not be their first language, or they may have learning disabilities.

This data analysed for this evaluation covers populations that had been offered remote care by primary and secondary care services based on medical need and the presentation of moderate COVID-19 symptoms. The disparity between COVID-19 remote care outcomes across these populations may reflect demographic variation as well as variations in symptoms and severity. Further work will need to be carried out to better understand the outcomes of the remote care solution while exploring the patient population in greater detail to ensure that Medopad offers a broadly accessible and equitable service.

Longer term usage of Medopad

This evaluation only focuses on the impact of the Medopad remote care service within the context of the COVID-19 pandemic. Therefore, should Medopad be implemented for remote care outside of the response for the COVID-19 crisis, the authors would recommend for a full evaluation to be conducted to assess the impact of the product on the pathways and services affected.

Recommendations

This section seeks to provide recommendations in support of future deployments and accompanying evaluation work.

Building robust evidence for value and effectiveness

As further pilot sites adopt the Medopad remote care application, it would be useful to continue to evaluate the application on a wider basis, further validating findings and testing hypotheses based on the data provided to date. To better understand the involvement of healthcare professionals and to assess the impact of the application on their work, we suggest obtaining data for each staff user separately.

There are a variety of outcomes that require further evidence to make a full assessment of Medopad's deployment to date and a strong recommendation regarding its further use. Recommendations mainly amount to obtaining evidence to validate outcomes highlighted within this report, checking whether findings are replicable in new locations, or even at different periods of time (i.e. mid- or post-COVID-19 wave) in the same locations. These outcomes include data collected regarding: hospital admissions and readmissions; GP appointments; impact on mortality and recovery outcomes; action taken due to oxygen desaturation; and efficiency savings, both in terms of time saved in review of patient data and downstream impact on follow-up time.

By gathering further data regarding the usage of Medopad across clinical settings a more thorough health economic model could be developed. The process of monetising the benefits and unseen costs of the product could provide a robust way to drive further adoption, should the findings be positive, and ascertain the impact and value of the solution to the patients, clinicians and overall system. Health economics can be a powerful tool to assess the financial commitments associated with an intervention from a range of perspectives, assuring commissioning parties

while reflecting the supporting efforts required across a system and capturing the utility of an intervention. It is recommended that a health economic assessment of the costs and benefits of Medopad is pursued. Doing so may allow for a scenario to assess the platform with the subscription costs of Medopad included, which would provide a degree of future proofing for when the zero-fee 'pilot' period has elapsed.

Monitoring and review in new pilot sites

Should a further evaluation be conducted, the authors would recommend including the evaluation partners before the start of the project to ensure they can best guide the implementation and form working relationships with the company and the clinical team in the early phases. Moreover, the authors would advise on having transparent conversations at the start of the project with the clinical leads regarding their capacity. If agreements cannot be reached to protect some of their time for the evaluation workstream, the evaluators and the organisation commissioning the evaluation should consider seeking the help of external clinical experts.

Discussions with key individuals and leads from Huma would further support any additional evaluation work, enabling the evaluation team to understand the company's perspective in terms of value proposition and long-term planning. Due to the unforeseen consequences of COVID-19, these conversations were not possible as part of this evaluation, however, the evaluation team would encourage maintaining a dialogue with implementation leads in the future to provide further insight into the findings of the evaluation, and to help close any potential gaps.

Going forward, KSS AHSN would suggest a more thorough governance structure and clear reporting processes to be implemented for each step of the project, with roles and responsibilities more clearly defined. Through this structure, a clear data framework could be established for all participants to follow, ensuring that consistent data is collected across all locations. Clear definition of the data requirements would ensure consistent application of the platform across any new pilot sites, hopefully avoiding concerns regarding selection bias based on outcome measures observed to date.

Potential areas for Medopad improvement (UX & process)

Feedback from patients regarding the application, and supporting services, was largely positive, and some clinicians reflected similar satisfaction, citing that the platform enabled quicker decision making and escalation. Other participants,

however, raised the issue of false positives based on patient readings that required further calls to investigate where there were ultimately no issues.

> *"Some patients also were recording worrying symptoms but when you spoke to them on the phone they were fine. [Medopad] created more calls and work"*

This is an example of the reassuring, proactive behaviour other participants have rated highly. It does raise the question of whether such experiences could highlight where the questions and measures collected by Medopad could satisfy clinical concerns without the need for further contact.

Responses to the clinical survey highlighted the potential need to consider the onboarding process if deploying the solution on a wider basis, as some participants did not find it easy to get started with the platform, while only one claimed to understand how the platform worked.

It may be beneficial to provide guidance to help identify cases where Medopad may not be appropriate to the patient's circumstances. Resources should be allocated to ensure that data is gathered from patients using an alternate approach. This could ensure that the services supported by Medopad remain accessible and flexible to provide the best care for the individual patient regardless of their circumstance and severity of their condition.

Steps to take should Medopad deployment persist

'Section 11: Discussion' described the methodology used across five factors to determine whether the solution should be further deployed. Results were inconclusive based on the information available to the evaluation team, but it is important to note the uptake, engagement and credibility evidence base was strong whilst the value and effectiveness evidence base was promising, pending further validation. Given the current singular times, it is worth noting that tests used in pre-COVID-19 periods, to determine whether technologies should be further deployed, may, at this time, appear stringent. KSS AHSN would recommend that logic and discretion be applied should the deployment of Medopad escalate in response to nationally driven requirements. If the relevant authority determines deployment should proceed, KSS AHSN would advise for the following steps to be taken to better prepare for such a scale-up:

- Medopad improvements as highlighted in 'Section 9: Results: Clinician feedback' and 'Section 11: Discussion: Potential areas for Medopad improvement (UX and supporting processes)' should be addressed

- Understanding the feasibility of the scale-up, in terms of resources, capital and the platform's technical ability to cover a broader userbase should be enhanced
- A measurement strategy to continue collecting data related to the outcomes per the KPI framework across new sites would need to be well defined. Building from the existing data collection will be key to demonstrate robust and conclusive evidence. Where possible, and to address clinician's limited capacity to collect data, Huma should incorporate some of these metrics as part of the analytical component to their Medopad platform
- Once sufficient data is collected, enabling the monetisation of outcomes through a larger sample size, development of a health economic model to determine the cost-effectiveness of the solution will help clearly showcase the impact and benefits of the solution to the system
- The solution's pricing strategy might need to be reviewed to ensure the cost post-implementation is not solely born by the relevant site (CCG, Trust) purchasing the solution

Sustainability

Assessing the sustainability of Medopad presents a particular challenge during a time where the service is being provided for free. Along with its discrete use to address specific challenges that are facing the healthcare sector during the COVID-19 pandemic, the absence of cost is inherently unsustainable over the long-term. It is for this reason that we recommend including a fully costed scenario in any further health economic evaluation.

This evaluation provides feedback that could be used to inform the uptake and user experience of the platform for non-COVID deployments in time, but these would also need evaluating under their own terms and as a separate exercise. Medopad could be positioned as a post-acute monitoring care service which could avoid further referrals and appointments, while offering a better understanding of survivals symptoms and clinical recovery (Landi, 2020). As previously mentioned, the evaluation of such deployments is beyond the scope of this report and would greatly benefit from a closer working relationship with Huma to establish a measurement strategy that reflects their own commercial development and intentions.

12. Concluding Remarks

As stated in the opening sections of this report, the intention of this evaluation was to help answer the following two questions:

1) **What is the solution's impact and is it going to benefit the healthcare system?**

2) **Does the evidence support the wider scaling of this solution?**

Whilst considering the further spread of the Medopad application, it might be easy to overlook the importance of user engagement, however, the positive results observed through this evaluation should not be under-estimated. Along with positive feedback from patients, both in terms of ease-of-use and satisfaction with the service, patients particularly commented on the feedback loop created by the ability to see that readings were being actively reviewed by the clinical team. Supported by this engaging experience, data were consistently provided by patients throughout the evaluation period, a critical step in making it a viable intervention.

Whilst Medopad appears to save the system time by providing a more efficient means to review patient data; in some areas this appears to lead to a rise in appointments and other contacts. This may be a positive outcome (i.e., by allowing for regular, timely reviews, actions were taken to check on potential deterioration at the earliest opportunity) but could highlight regular clinical questions raised that were not covered by the data items collected, creating a need for workarounds. Further analysis of contacts may be needed to understand what prompted the follow-ups and consultations before a clear picture of the benefits the platform can provide emerges. Some clinical feedback suggested that on occasion patients have presented with signs of deterioration but, upon further inspection, these proved to be false positives. It is difficult to speculate as to whether that is the result of the platform, or its utilisation by patients, however, it may warrant exploration.

Further evaluation will be an important step in understanding the full economic implications of Medopad, which is a requirement that should be reviewed again prior to widespread adoption. Due to time pressures and an absence of consistent data, the health economic analysis undertaken by KSS AHSN was inconclusive. As part of any intermediate step-up in the deployment of Medopad, careful planning should be undertaken to collect data to enable a thorough economic review to measure and monetise the potential benefits and costs of the intervention.

Whilst health economic analyses provide an insight into the sustainability and risks associated with an intervention, it is important to bear in mind that utility is generally the priority for patients and clinicians (Ong, Redmayne, & Sarmah, 2009). The feedback received regarding the Medopad application is broadly favourable in this respect, although there remain key considerations for further rollout of the technology, such as the development of a scalable strategy for onboarding new sites that will enable staff to feel empowered by the new platform and processes.

The deployment of Medopad in the current circumstances is exceptional, the time pressures throughout the first wave of the COVID-19 pandemic have largely been sustained for healthcare staff over the summer, making it difficult for all parties to engage in an evaluation as expected. The discrete nature of the current deployment in response to COVID-19, in addition to the constantly changing nature of demands on the system, further complicate the process of drawing clear conclusions. Decisions made regarding the further spread of the technology may need to take a pragmatic approach in terms of the available evidence.

Medopad offers a somewhat useful and engaging platform for remote monitoring, but it is not without scope for improvement and further deployment should take this into account. KSS AHSN are unable to conclusively say whether Medopad is suitable for a widespread deployment at this stage; however, there are no major reasons to prohibiting its further use either. The central recommendation of this report is to ensure clear oversight of any incremental deployments to ensure any potential risks are identified and managed, while conducting further evaluation of the application.

13. References

Alshami, A., Alattas, R., Anan, H., Al Qahtani, H., Al Mulhim, M., Alahilmi, A., & H, A. A. (2020). Silent Disease and Loss of Taste and Smell are Common Manifestations of SARS-COV-2 Infection in a Quarantine Facility: Saudi Arabia. *medRxiv*. doi:doi: https://doi.org/10.1101/2020.05.13.20100222

Atreja, A. e. (2017, February 17). Impact of real world home based remote monitoring on quality of care and quality of life in inflammatory bowel disease patients: one year results of pragmatic randomized trial,. *Journal of Crohn's and Colitis, 11*(Suppl_1), S362–S363. Retrieved from https://doi.org/10.1093/ecco-jcc/jjx002.678

Batchelor, G. (2020, March). *Slowing the spread of infection and taking advantage of regional differences*. Retrieved from edgehealth: https://www.edgehealth.co.uk/post/covid25march2020

British Thoracic Society. (2020, May). *British Thoracic Society Guidance on Respiratory Follow Up of Patients with a Clinico-Radiological Diagnosis of COVID-19 Pneumonia.* Retrieved from brit-thoracic.org.uk: https://www.brit-thoracic.org.uk/document-library/quality-improvement/covid-19/resp-follow-up-guidance-post-covid-pneumonia/

Buitrago-Garcia, D., Egli-Gany, D., Counotte, M. J., Hossmann, S., Imeri, H., Ipekci, A., . . . Low, N. (2020). Occurrence and transmission potential of asymptomatic and presymptomatic SARS-CoV-2 infections: A living systematic review and meta-analysis. *Plos Medicine*. Retrieved from https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003346

Centre for Disease Control and Prevention (CDC). (2020, May). *Symtpoms Coronavirus Disease*. Retrieved from cdc.gov: https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

Centre for Disease Control and Prevention (CDC). (2020, June). *Using Telehealth to Expand Access to Essential Health Services during the COVID-19 Pandemic.* Retrieved from cdc.gov: https://www.cdc.gov/coronavirus/2019-ncov/hcp/telehealth.html

Colligan, J. (2015). *The virtual ward. Managing the care of patients with chronic (long-term) conditions in the community.* Retrieved from Royal College of Nursing: https://www.rcn.org.uk/professional-development/research-and-innovation/innovation-in-nursing/case-studies-demonstrating-the-value-of-nursing/janice-colligan

Collins, B. (2018, January 16). *Adoption and spread of innovation in the NHS*. Retrieved from The Kings Fund: https://www.kingsfund.org.uk/publications/innovation-nhs

Deloitte. (2020). *Realising digital-first primary care .* Deloitte Centre for Health Solution.

Docherty, A., E., H., Green, C. A., H, H., PiusR, L, N., . . . P, O. (2020). Features of 16,749 hospitalised UK patients with COVID-19 using the ISARIC WHO Clinical Characterisation Protocol. *MedRxiv*. Retrieved from https://www.medrxiv.org/content/10.1101/2020.04.23.20076042v1

Gandhi, R. T., & Lynch, J. B. (2020, April). Mild or Moderate Covid-19. (M. M. Caren G. Solomon, Ed.) *The New England Journal of Medicine*. Retrieved from https://www.nejm.org/doi/pdf/10.1056/NEJMcp2009249

George, L., & Cross, R. (2020, February 10). Remote Monitoring and Telemedicine in IBD: Are We There Yet? *Curr Gastroenterol Rep, 12*, 12. Retrieved from https://doi.org/10.1007/s11894-020-0751-0

GMCA. (2019). *Cost Benefit Analysis.* Retrieved from Greater Manchester Combined Authority: https://www.greatermanchester-ca.gov.uk/what-we-do/research/research-cost-benefit-analysis/

GOV.UK. (2020, September 4). *Cases in United Kingdom*. Retrieved from GOV.UK Coronavirus (COVID-19) in the UK: https://coronavirus.data.gov.uk/cases

GOV.UK. (2020, September 3). *Cases in United Kingdom*. Retrieved from GOV.UK: https://coronavirus.data.gov.uk/cases

GOV.UK. (2020, March). *Coronavirus (COVID-19): guidance*. Retrieved from GOV.UK: https://www.gov.uk/government/collections/coronavirus-covid-19-list-of-guidance

GOV.UK. (2020, September 3). *Deaths in United Kingdom*. Retrieved from GOV.UK: https://coronavirus.data.gov.uk/deaths

Greenhalgh, T., Javid, B., Knight, M., & Inada-Kim, M. (2020, April). *What is the efficacy and safety of rapid exercise tests for exertional desaturation in covid-19?* Retrieved from The Centre for Evidence-Based Medicine: https://www.cebm.net/covid-19/what-is-the-efficacy-and-safety-of-rapid-exercise-tests-for-exertional-desaturation-in-covid-19/

Greenhalgh, T., Knight, M., A'Court, C., Buxton, M., & Husain, L. (2020, August). Management of post-acute covid-19 in primary care. *BMJ, 370*. Retrieved from https://www.bmj.com/content/370/bmj.m3026

HERC. (2019). *Cost-Effectiveness Analysis*. Retrieved from herc.research.va.gov: https://www.herc.research.va.gov/include/page.asp?id=cost-effectiveness-analysis

Huma. (2020, August). *Huma*. Retrieved from Huma: https://huma.com/

Kemp, H. I., Corner, E., & Colvin, L. (2020, May). Chronic pain after COVID-19: implications for rehabilitation. *British Journal of Anaesthesia, 125*(4), 436-440. Retrieved from https://bjanaesthesia.org/article/S0007-0912(20)30403-7/fulltext

Knight, M., Evans, D., Vancheeswaran, R., Van der Watt, M., Newland Smith, A., Oliver, C., . . . Barlow, A. (2020). A virtual hospital model can help tackle the covid-19 pandemic. *HSJ*.

Landi, F. G. (2020). Post-COVID-19 global health strategies: the need for an interdisciplinary approach. *Aging Clin Exp Res, 32*, 1613-1620. doi:doi.org/10.1007/s40520-020-01616-x

Llewellyn S, P. R. (2014, July). Facilitating technology adoption in the NHS: negotiating the organisational and policy context – a qualitative study. *Health Services and Delivery Research*.

London Datastore. (2020). *Coronavirus (COVID-19) cases*. Retrieved from data.london.gov.uk: https://data.london.gov.uk/dataset/coronavirus--covid-19--cases

McLean S, S. A. (2009). Does telehealthcare offer a patient-centred way forward for the community-based management of long-term respiratory disease? *Primary Care Respiratory Journal, 18*(3), 125-6. Retrieved from https://doi.org/10.3132/pcrj.2009.00006

McLean, S., Protti, D., & Sheikh, A. (2011). Telehealthcare for long term conditions. *BMJ*, 342:d120. Retrieved from https://doi.org/10.1136/bmj.d120

NEL - Commissioning Support Units. (2016). *Healthy London Partnership Children & Young People's Dashboard - North West London STP area.* Retrieved from Healthy London Partnership : https://www.healthylondon.org/wp-content/uploads/2017/11/NWL-datapack-for-CYP-2016.pdf

New York Times. (2020, September). *United Kingdom Covid Map and Case Count*. Retrieved from The New York Times: https://www.nytimes.com/interactive/2020/world/europe/united-kingdom-coronavirus-cases.html

NHS Digital. (2020, March). *Appointments in General Practice - March 2020: Summary.* Retrieved from digital.nhs.uk (excel sheet): https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/march-2020

NHS England. (2015). *Digital Roadmap Footprints: London.* NHS England. Retrieved from https://www.england.nhs.uk/digitaltechnology/connecteddigitalsystems/digital-roadmaps/footprints/london5/#_North_West_London

NHS England. (2018). *West_Hertfordshire_Hospitals_NHS_Trust_Annual_Report_and_Accounts.* NHS England. Retrieved from https://www.england.nhs.uk/wp-content/uploads/2019/10/West_Hertfordshire_Hospitals_NHS_Trust_Annual_Report_and_Accounts_2018-19.pdf

NHS England. (2019). *The NHS Long Term Plan.* London: NHS England.

NHS England. (2020, September). *Coronavirus guidance for clinicians and NHS managers*. Retrieved from ENGLAND.NHS.UK: https://www.england.nhs.uk/coronavirus/

NHS England. (2020, August). *Remote monitoring in primary care*. Retrieved from England.NHS.UK: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/06/C0445-remote-monitoring-in-primary-care.pdf

NHS England. (2020). *second-phase-of-nhs-response-to-covid-19-letter-to-chief-execs-29-april-2020.* NHS England. Retrieved from https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/04/second-phase-of-nhs-response-to-covid-19-letter-to-chief-execs-29-april-2020.pdf

NHS England. (2020, August 11). *Standard operating procedure (SOP) for general practice in the context of coronavirus (COVID-19).* Retrieved from England.nhs.uk: https://www.england.nhs.uk/coronavirus/publication/managing-coronavirus-covid-19-in-general-practice-sop_19-march/)

NHS.UK. (2020, August). *Health at home*. Retrieved from NHS.UK: https://www.nhs.uk/health-at-home/

NICE. (2019, March). *Evidence Standards Framework for Digital Health Technologies*. Retrieved from NICE: https://www.nice.org.uk/Media/Default/About/what-we-do/our-programmes/evidence-standards-framework/digital-evidence-standards-framework.pdf

NICE. (2020). *Coronavirus (COVID-19)*. Retrieved from NICE.ORG.UK: https://www.nice.org.uk/covid-19

NICE. (2020, April). *COVID-19 rapid guideline: managing suspected or confirmed pneumonia in adults in the community.* London: National Institute for Health and Clincial Excellence. Retrieved from https://www.nice.org.uk/guidance/ng165.

Ofcom. (2018, August 2). *A decade of digital dependency*. Retrieved from Ofcom: https://www.ofcom.org.uk/about-ofcom/latest/features-and-news/decade-of-digital-dependency

Office for National Statistics (ONS). (2020, September 25). *Coronavirus (COVID-19) Infection Survey pilot: England, Wales and Northern Ireland, 25 September 2020*. Retrieved from Office for National Statistics: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/coronaviruscovid19infectionsurveypilot/englandwalesandnorthernireland25september2020

Office for National Statistics (ONS). (2020). *Deaths involving COVID-19 by local area and socioeconomic deprivation: deaths occurring between 1 March and 17*

April 2020. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsinvolvingcovid19bylocalareasanddeprivation/deathsoccurringbetween1marchand17april.

Office for National Statistics (ONS). (2020, August). *Deaths involving COVID-19 by local area and socioeconomic deprivation: deaths occurring between 1 March and 31 July 2020.* Retrieved from ONS.GOV.UK: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsinvolvingcovid19bylocalareasanddeprivation/deathsoccurringbetween1marchand31july2020

Ong, N., Redmayne, G., & Sarmah, R. (2009). *The Development of a Tool for Assessing the Optimal Adoption of Healthcare Technologies in the NHS.* Brighton: Health and Care Infrastructure Research and Innovation Centre;.

ONS. (2020, April 7). *Deaths registered weekly in England and Wales, provisional: week ending 27 March 2020*. Retrieved from ONS: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsregisteredweeklyinenglandandwalesprovisional/weekending27march2020

Oxford Consultants for Social Inclusion (OCSI). (2020). *A needs analysis report for Hertfordshire Community Foundation.* Retrieved from Hertfordshire Community Foundation: https://www.hertscf.org.uk/shares/Hertfordshire-Matters---Full-report-REVISED-6th-Feb-2020-with-additional-date-information-smaller-file.pdf

Oxtoby, K. (2020, July 7). *The rapid rise of digital consultations since Covid-19*. Retrieved from GM Journal: https://www.gmjournal.co.uk/the-rapid-rise-of-digital-consultations-since-covid-19

Perceptive. (2020). Retrieved from https://www.customermonitor.com/blog/what-is-a-good-net-promoter-score

Personal Social Services Research Unit. (2019, December). *Unit Costs of Health and Social Care 2019.* Retrieved from PSSRU: https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2019/

PSSRU. (2020, January 31). *Unit Costs of Health and Social Care 2019*. Retrieved from PSSRU: https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2019/

Public Health England. (2020, August). *Disparities in the risk and outcomes of COVID-19.* Retrieved from assets.publishing.service.gov.uk: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/908434/Disparities_in_the_risk_and_outcomes_of_COVID_August_2020_update.pdf

PULSE. (2020, April 2). *GPs set to diagnose Covid-19 face to face in 'hot hubs'*. Retrieved from PULSE: https://www.pulsetoday.co.uk/news/uncategorised/gps-set-to-diagnose-covid-19-face-to-face-in-hot-hubs/

Raleigh Veena, S. (2020, September 4). UK's record on pandemic deaths. *BMJ*, 370 :m3348. doi:https://doi.org/10.1136/bmj.m3348

RCGP. (2020, April 19). *RCGP calls on Government for 'Remote Care' plan for patients during COVID-19.* Retrieved from rcgp.org.uk: https://www.rcgp.org.uk/about-us/news/2020/april/rcgp-calls-on-government-for-remote-care-plan-for-patients-during-covid19.aspx

Salaried, I. G., & Munro, N. (2005, July). The use (or otherwise) of pulse oximetry in general practice. *Br J Gen Pract, 55*(516), 501-502. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1472779/

Shah, S., Majmudar, K., Stein, A., Gupta, N., Suppes, S., Karamanis, M., . . . Patte, C. (2020, June). Novel Use of Home Pulse Oximetry Monitoring in COVID-19 Patients Discharged From the Emergency Department Identifies Need for Hospitalization. *Academia Emergency Medicine, 27*(8), 681 -692. doi: https://doi.org/10.1111/acem.14053

Shaun, G. (2020, July 31). Covid-19: England had worst excess mortality in Europe in April. *BMJ*, 370:m3058. doi:https://doi.org/10.1136/bmj.m3058

Sood, S., Mbarika, V., Jugoo, S., Dookhy, R., Doarn, R. C., Prakash, N., & and Merrell, R. M. (2007, November). What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings. *Telemedicine and e-Health, 13*(5), 573-90. Retrieved from https://doi.org/10.1089/tmj.2006.0073

Statista. (2020, September 2020). *Cumulative number of coronavirus (COVID-19) deaths in France, Germany, Italy, Spain and the United Kingdom*. Retrieved from Statista.com: https://www.statista.com/statistics/1115043/coronavirus-deaths-timeline-in-the-eu-5/

Szinay, D., Jones, A., Chadborn, T., Brown, J., & Naughton, F. (2020). Influences on the Uptake of and Engagement With Health and Well-Being Smartphone Apps: Systematic Review. *J Med Internet Res*.

Taylor, K. a. (2020, April 3). *COVID-19: Accelerating digital transformation in healthcare.* Retrieved from Deloitte: https://blogs.deloitte.co.uk/health/2020/04/covid-19-accelerating-digital-transformation-in-healthcare.html

The Centre for Evidence Based Medicine. (2020, April). *In patients of COVID-19, what are the symptoms and clinical features of mild and moderate cases?* Retrieved from cebm.net: https://www.cebm.net/covid-19/in-patients-of-covid-19-what-are-the-symptoms-and-clinical-features-of-mild-and-moderate-case/

The Health Foundation. (2020, June 18). *Emerging evidence on COVID-19's impact on mental health and health inequalities*. Retrieved from The Health Foundation: https://www.health.org.uk/news-and-comment/blogs/emerging-evidence-on-covid-19s-impact-on-mental-health-and-health

The Health Foundation. (2020, May). *How might COVID-19 have affected people's ability to see their GP?* Retrieved from health.org.uk: https://www.health.org.uk/news-and-comment/charts-and-infographics/how-might-covid-19-have-affected-peoples-ability-to-see-GP

Tsai LK, H. S. (2005, September). Neurological manifestations in severe acute respiratory syndrome. *Acta Neurol Taiwan*, 113-119.

Vaira, L. A., Salzano, G., Deiana, G., & Riu, G. D. (2020). Anosmia and Ageusia: Common Findings in COVID-19 Patients. *The Laryngoscope*.

Vannabouathong, C. D. (2020). Novel Coronavirus COVID-19: Current Evidence and Evolving Strategies. *The Journal of bone and joint surgery. , 102*(9), 734-744. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7219842/

Verhagen, M. B. (2020, June). Forecasting spatial, socioeconomic and demographic variation in COVID-19 health care demand in England and Wales. *BMC Med, 18*(203). doi:https://doi.org/10.1186/s12916-020-01646-2

Verhagen, M. B. (2020). Forecasting spatial, socioeconomic and demographic variation in COVID-19 health care demand in England and Wales. . *BMC Med* , 18, 203 . Retrieved from https://doi.org/10.1186/s12916-020-01646-2

Willams, A. (1985). *Economics of coronary artery bypass grafting.* Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1416615/

Willett, K. &. (2020, March). *COVID-19 NHS preparedness and response.* Retrieved from england.nhs.uk: https://www.england.nhs.uk/wp-content/uploads/2020/03/20200302-COVID-19-letter-to-the-NHS-Final.pdf

World Health Organization (WHO). (2020, March). *Coronavirus disease 2019 (COVID-19) situation report – 51.* Retrieved from who.int: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200311-sitrep-51-covid-19.pdf?sfvrsn=1ba62e57_10

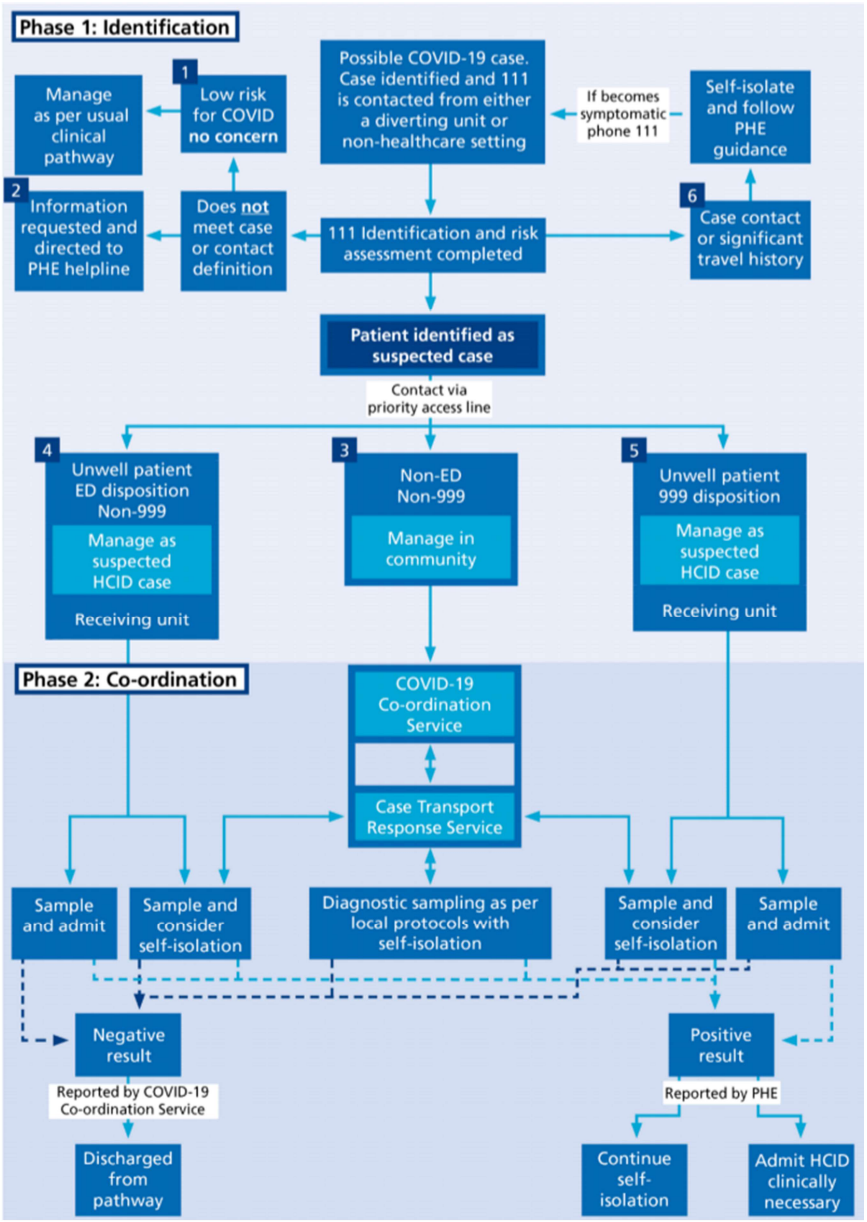
World Health Organization (WHO). (2020). *WHO Director-General's remarks at the media briefing on COVID-2019 outbreak on 17 February 2020.* Retrieved from WHO.INT: https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-covid-2019-outbreak-on-17-february-2020

Zhu N, Z. D. (2019). A novel coronavirus from patients with pneumonia in China. *N Engl J Med.*, 382:727-733.

Zirui Tay, M., Poh, C. M., Rénia, L., & MacAry, P. A. (2020, April). The trinity of COVID-19: immunity, inflammation and intervention. *Nature, 20*, 363-374. Retrieved from https://www.nature.com/articles/s41577-020-0311-8

14. Appendices

Appendix A: Primary Presentation of suspected cases (note: showing two phases in the pathway)



Data source: NHS, Novel Coronavirus (COVID-19) Patient Pathway, v 2.2 20/02/2020

Appendix B: APACHE II (Acute Physiology Assessment and Chronic Health Evaluation II) Scoring System

APACHE II score.pdf

Appendix C: KPI Framework

KPI%20Framework%
20COVID-19%20Med

Appendix D: Staff and Patient Surveys and Interviews

Staff%20Survey.docx

Patient%20Survey.docx

HUMA_Interview_Questions_Patients.docx

HUMA_Interview_Questions_Staff.docx

Appendix E: Optimism bias correlation grading

Type of data source	Confidence grade	Age of data source: <2 years	2-3 years	3 – 4 years	5 – 9 years	=>10 years
		1	2	3	4	5
Formal service delivery contract costs Figures derived from local stats / RCT trials	1	0%	5%	10%	15%	25%
Practitioner monitored costs Figures based on national analysis in similar areas	2	10%	10%	15%	25%	30%
Costs developed from ready reckoners Figures based on generic national analysis	3	15%	15%	20%	30%	40%
Costs from similar interventions elsewhere Figures based on international analysis	4	25%	25%	30%	40%	50%
Cost from uncorroborated expert judgement	5	40%	45%	50%	55%	60%

Appendix F: Huma Service cost

Pricing document_Huma.pdf