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RESEARCH ARTICLE

Maternal Enhanced and Critical Care and Outcomes Over Three Years: A Descriptive Observational Study

Penelope Anne Beddoes[1] | Helen Francesca Stanworth[1] | Luke William Budworth[2,3] | Vivien Anne Dolby[4,5] | Brian Raymond Wilkinson[1,6] | Thomas Oldroyd Lawton[1,2] | Deborah Louise Horner[1,5]

[1]Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK | [2]NIHR Yorkshire & Humber Patient Safety Research Collaboration, Bradford, UK | [3]Wolfson Centre for Applied Health Research, Bradford, UK | [4]Improvement Academy, Bradford Institute for Health Research, Bradford Royal Infirmary, Bradford, UK | [5]Yorkshire and the Humber MEaCC Steering Group, Bradford, UK | [6]University of Leeds, Leeds, UK

Correspondence: Deborah Louise Horner (deborah.horner@bthft.nhs.uk)

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ABSTRACT

Objective: To describe the characteristics, care needs and outcomes of the enhanced maternal care (EMC) population.

Design: A descriptive observational study.

Setting: 13 acute NHS trusts in the Yorkshire and Humber region from January 2021 to October 2024.

Population: 4321 patient care episodes captured in the Maternal Enhanced and Critical Care (MEaCC) database.

Methods: A retrospective analysis of data from the MEaCC database for all care episodes between January 2021 and October 2024.

Outcome Measures: Outcomes included patient demographics, mode of delivery, leading causes for EMC, physiological support needs, overall outcomes including mortality and requirement for ICU among the EMC population and proportion of EMC care delivered by EMC trained midwives.

Results: 4321 episodes of EMC were recorded during this period. 9% of women required EMC or critical care, with most managed in maternity units: only 4% of EMC patients required critical care admission. 7% had invasive monitoring. The mean BMI was higher among MEaCC patients than regionally. Women of black ethnicity are more likely to require EMC or ICU. Most needing EMC would have been considered 'low risk' pregnancies.

Conclusions: A significant proportion of women require higher levels of support during and after pregnancy. Training of midwives in EMC should be a priority. UK-wide capture of EMC data would allow benchmarking of care, highlight best practice, inform service commissioning and drive further research.

1 | Introduction

Recent MBRRACE-UK reports [1] have described a concerning and statistically significant increase in overall maternal mortality between 2017–2019 and 2020–2022, with maternal mortality rising from 8.79 to 13.56 per 100 000 maternities (2017–2019 to 2020–2022). MBRRACE-UK assessed that improvements in care might have altered outcomes in around half of maternal deaths, reaffirming the need to improve recognition and management of maternal deterioration.

MBRRACE and Maternity and Newborn Safety Investigation (MNSI) reports provide insight into maternal deaths. Those sick enough to require ICU are included in the intensive care national audit and research centre (ICNARC) reporting systems; the subject of a UK sprint National Maternity and Perinatal Audit (NMPA) [2] in 2019 and recently, a large Scottish cohort study [3]. Internationally, most studies of maternal morbidity examine those meeting the World Health Organisation (WHO) definition of severe maternal morbidity and generally review the critical care population [4, 5]. An exception to this is the French EPIMOMS study group, who have prospectively studied and reported rates of maternal morbidity of 13% [6], a much larger cohort than the 2.24 women per 1000 pregnancies who required critical care in the NMPA paper.

The NMPA audit highlighted the lack of data for women managed *outside* of critical care in enhanced maternal care units, echoing recommendations from the 2018 RCOA EMC guideline [7] which called for the establishment of a 'dataset of care given to critically ill women in the obstetric unit' and the 2023 Intensive Care Society (ICS) guidance on the development and implementation of EMC units [8]. These patients receive level 1 care as defined by 'Guidelines for the provision of intensive care services (GPICS)' [9] (Figure 1).

To capture data for these patients, the Yorkshire and Humber maternity clinical network established the Maternal enhanced and critical care (MEaCC) dataset in 2020. All 13 acute NHS trusts in the region have engaged with the MEaCC project, an area that provides care for 53000 births a year—approximately 10% of English births. Between January 2021 and October 2024, data were captured on over 4000 episodes of EMC. This paper examines perinatal morbidity and reviews the outcomes for women who become unwell during and after pregnancy and considers the implications for service delivery across the region.

2 | Methods

Enhanced Maternal Care was defined as:

> An intermediate level of care for pregnant or recently pregnant women where a higher level of observation, monitoring and interventions can be provided than on a ward but not requiring high dependency care/ organ support
>
> [8].

Patients included in the database were those identified by the ICS 2023 guideline as most likely to benefit from EMC, includes the following:

- Women whose medical review has been triggered on a maternity-specific early warning score.
- Women requiring more frequent than 4-hourly observations for reasons other than labour or special monitoring, for example, continuous ECG monitoring or invasive arterial blood pressure monitoring.
- Those recently stepped down from Critical Care (level 2 or 3 care).
- Any woman about whom there is concern regarding clinical condition and risk of deterioration who would benefit from closer observation for acute or chronic pre-existing disease.

Data for EMC episodes were captured using a secure data portal (CaseCaptureTM; Athera Insights) from 18th January 2021. All women who are pregnant or up to 6 weeks postpartum receiving enhanced maternal care on maternity units are included, as well as those requiring higher levels of care within critical care units.

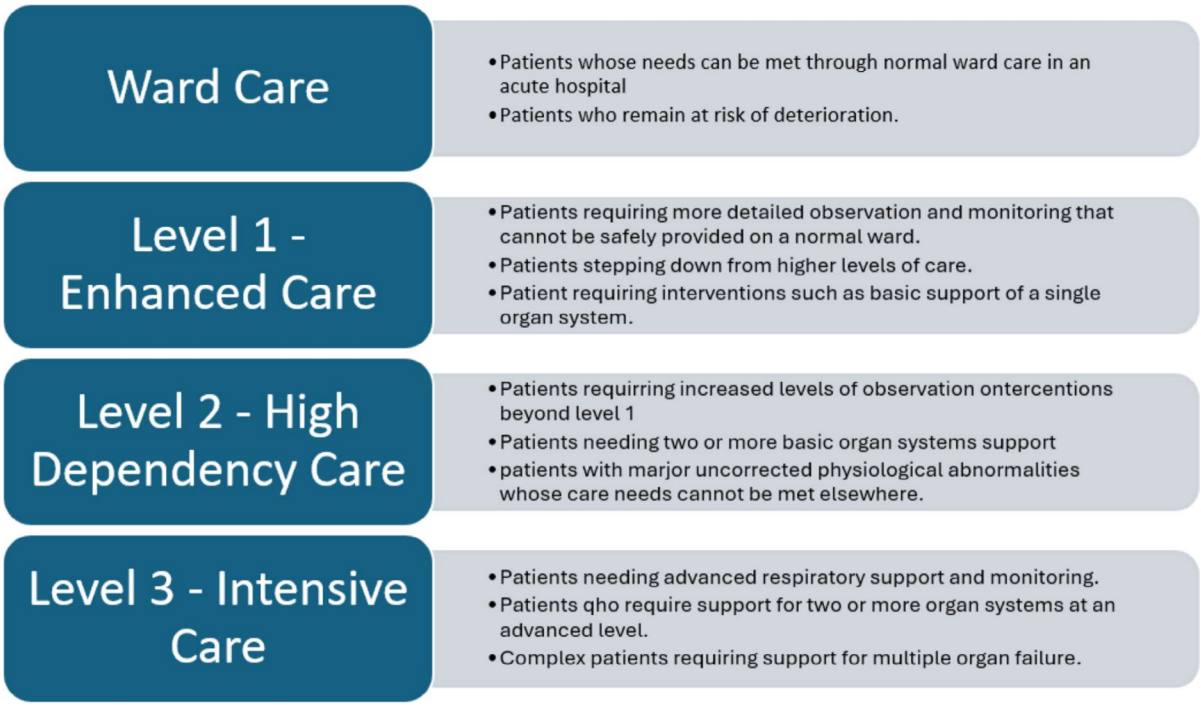

FIGURE 1 | Levels of care as defined by GPICS.

Information is pseudonymised and, as only non-identifiable data is analysed, consent is not required though individuals can withdraw from the database on request.

For each patient, the following categories of information are collected:

- Demographics (age, ethnicity, postcode area, past medical and pregnancy history),
- EMC activity data (date and time EMC commenced, reason for EMC requirement),
- Level of EMC support (use of invasive observation, frequency of observations, requirement for organ support, nature of therapies/treatments used),
- Physiological parameters (observations, blood test results),
- Delivery details, and
- Outcomes (daily multidisciplinary team review completed, discharge destination, need for critical care or other non-maternity inpatient specialty ward transfer, whether mother and baby separated post-delivery).

There have been several iterations of the database since launch, with the addition of new data categories in subsequent versions, altering denominator numbers in some categories. For example, in MEaCC 2, live from 1st October 2022, the sepsis bundle was incorporated for all women with an EMC admission and diagnosis of sepsis and documentation of obstetric debrief was added. Table S1 contains all parameters recorded on the MEaCC database.

Patients were not involved in the development of the dataset. Key primary outcomes for this paper are summarised in Table 1. A core outcome set was not used. Where relevant, we have put results into context by comparing them to other sources of data for this group of patients.

3 | Results

Between January 2021 and October 2024, 4321 patients were entered into the MEaCC database. They were cared for at 17 maternity units across 13 acute trusts in the region. To avoid underestimating EMC requirements because of missing data, we compared EMC episodes with total birth numbers at four units (ranging from small district general hospitals to large tertiary centres) with the most complete data for the financial year 2023–2024. In total, there were 20 049 births across these 4 trusts between April 2023 and April 2024, with 1736 (8.7%) episodes of enhanced maternal care, though in some units the rate of EMC requirement was as high as 12%.

Regionally, 48.2% (1980/4107, 214 missing) of EMC was delivered by fully or partially EMC trained staff, and most care took place in maternity units, with only 4% (167/4136, 185 missing) requiring critical care admission. Critical care outreach teams were involved in care in 7.8% (325/4157, 164 missing) of cases. Whilst the definition of enhanced maternal care remains standardised, the exact location of this care is dependent on multiple factors, including the medical requirements of the woman, agreed level of enhanced competency training of the staff providing EMC in each unit, and the locations of labour ward and critical care in the hospital.

TABLE 1 | Primary outcomes.

Outcome	Description
What proportion of women who enhanced maternal care (EMC) or critical care?	EMC and critical care episodes as a proportion of total birth numbers
What are the demographics of women needing EMC or critical care?	Mean age
	Mean BMI
	Prevalence of common medical comorbidities of women in database
	Representation of women of Black and Asian ethnicity in the database compared to representation of these ethnicities among women booking for pregnancy care in the region
What are the leading reasons to need EMC or critical care?	Reason for EMC as entered in database
What are the physiological support or monitoring needs of women on EMC or critical care?	% needing arterial lines
	% needing critical care transfer
Regionally, is EMC delivered by midwives with EMC training	Proportion of women for whom > 80% of care is delivered by midwives who have achieved regionally defined EMC competencies.
What were the outcomes following EMC?	Mode of delivery among those needing EMC or critical care
	Gestation at delivery for those requiring EMC or critical care antenatally
	Mortality among women in database
	% requiring cardiopulmonary resuscitation (CPR)
	% of stillbirths or early neonatal deaths among women in the database

3.1 | Characteristics of Women Requiring EMC

The mean age of EMC patients was 28.5 (range 15–52), similar to the mean age at booking of 29.4 in the region, and 60.4% (2592/4321) of patients were primiparous. Medical comorbidities are shown in Table 2. Of note, nearly half of patients (44.5%, 1921/4321) who required EMC reported no previous medical problems. The most common co-morbidities, affecting just over 10% of all EMC patients, were mental health disorders, reflecting a high prevalence of anxiety and depression in the population [10]. Other frequently observed comorbidities were gestational diabetes mellitus (GDM) (7.2%, 312/4321) and asthma (8.0%, 232/2907—added in MEaCC V2). The prevalence of GDM is higher than the national population prevalence of 5% [12]. Overall, 10% (445/4321) of women had diabetes, gestational, type 1 or type 2, which is similar to the NMPA sprint audit critical care cohort, where diabetes was found to confer an odds ratio of 2.09 for critical care admission [2]. The mean BMI in the EMC population was 28.5, compared to a mean of 25.5 regionally. 9.8% (384/4264, 57 missing) of EMC patients were current smokers; meanwhile, regionally, MSDS records show that 13.1% of women are recorded as smoking at their booking appointment.

TABLE 2 | Medical comorbidities among EMC patients.

Comorbidity	MEaCC population prevalence	Birthing or general population prevalence
BMI > 30	34.0%	28.2%[a]
Mental health disorders	10.3%	17.0%[b]
Asthma	7.9%	3.4%–12.4%[c]
Gestational diabetes	7.2%	5.0%[d]
Essential hypertension	2.5%	0.6%–2.7%[e]
Type 1 diabetes	1.9%	0.4%[f]
Cardiac disease (structural/ischaemic/congenital)	1.1%	0.2%–4%[g]
Epilepsy	1.1%	0.5%–1%[h]
Type 2 diabetes	1.0%	1.0%[f]
No medical comorbidity	44.5%	—

[a]Mean booking BMI in Yorkshire and the Humber (July 2021–October 2024), provided by NHSE and the maternity services data set.
[b]Mental Health and Wellbeing in England: Adult Psychiatric Morbidity Survey 2014 [10].
[c]Asthma in pregnancy, BMJ 2007 [11].
[d]NHS England. Healthier You: NHS Diabetes Prevention Programme [12].
[e]NICE clinical knowledge summary: Hypertension in pregnancy [13].
[f]A cohort study of trends in the prevalence of pregestational diabetes in pregnancy recorded in UK general practice between 1995 and 2012 [14].
[g]Cardiac disease in pregnancy, published in Clinical Medicine 2012 [15].
[h]RCOG Green top guideline: Epilepsy in pregnancy [16].

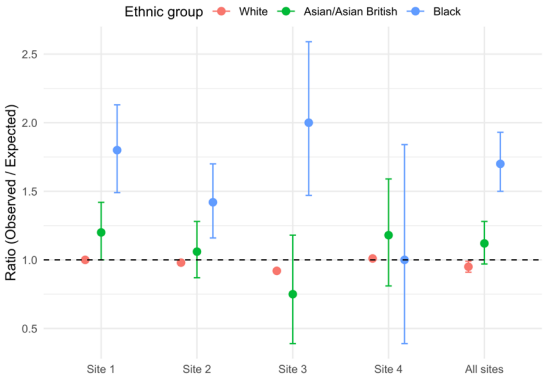

FIGURE 2 | Ratio of EMC episodes against number of EMC episodes expected based on representation of White, Black and Asian ethnicities reported by MSDS at each site (with Bayesian 95% credible intervals).

Using the four trusts with the most complete data for this parameter, we have compared representation of ethnicities in the MEaCC population to the booking population at that trust, to interrogate whether minority ethnic groups are overrepresented in our cohort (Figure 2). This suggests that people from Black minority ethnic groups are more likely to require EMC than those from White and Asian groups. It appears that women of Asian ethnicity are more likely to need EMC but this did not reach statistical significance.

3.2 | Indications for EMC

The most common indications for enhanced maternal care were postpartum haemorrhage (53.8%, 2589/4234, 87 missing), followed by pre-eclampsia/eclampsia (15.1%, 638/4234, 87 missing) and sepsis (13.9%, 600/4321). Commonly, EMC was commenced in the immediate or early post-partum period (1–24 h postpartum). The most frequent mode of delivery among EMC patients was by caesarean birth (55%, 2314/4148, 173 missing), which, as would be expected, is higher than the regional caesarean rate, which is between 35% and 40%. 30.9% (1283/4148) of patients had a successful or attempted instrumental delivery.

13.9% (600/4321) of patients had sepsis as an indication for their EMC episode, with 95% (570/4321) of these having it as a sole indication. It was common for multiple sources of sepsis to be suspected, but urosepsis was the most diagnosed cause of maternal sepsis, followed by chorioamnionitis and genital tract infections. Culture growth results are in keeping with these clinical diagnoses, with the commonest positive cultures being streptococci and gram-negative organisms. This contrasts with previous studies of maternal sepsis in the critical care population where respiratory infections predominated [17]. In the group of 157 patients who required critical care admission for sepsis, chorioamnionitis, genital tract and urosepsis also predominated.

3.3 | Management/Therapies During EMC

Although most women required a short period of intensive monitoring, few had invasive monitoring: 5.7% of women (238/4162, 159 missing) had arterial lines inserted, 0.36% (15/4162) had central lines, and 1.3% of women (55/4162) had both. 15.3% (637/4160, 161 missing) women required supplemental oxygen.

4% of women (174/4204, 117 missing) needed some form of ventilatory support, usually non-invasive ventilation or high flow nasal oxygen; 1.6% (67/4204) required invasive ventilation. 11.3% (474/4204, 117 missing) patients required vasopressor support, usually a peripheral phenylephrine infusion. A small number received noradrenaline (0.59%, 25/4147).

Acute kidney injury (AKI) was relatively uncommon with only 10.4% of patients (414/3960, 361 missing) meeting AKI criteria. Pre-eclampsia was the diagnosis most associated with the development of AKI. Severe AKI was rare: 0.85% of women (34/3960) met criteria for stage 3 AKI.

3.4 | Outcomes Following EMC

Most patients who received EMC recovered; however, 0.32% of patients (14/4321) required cardiopulmonary resuscitation and seven patients died (0.16%). The mean gestation at delivery for all patients who received EMC was 38.2 weeks; however, where patients were admitted during pregnancy and prior to labour (1064/4321), the mean gestation at delivery was 32.8 weeks. Most neonates required routine post-natal care; however, 16.0% (340/2130) received high dependency or intensive care, 5.6% (120/2130) specialist care and 7.2% (155/2130) transitional care. Of those in the database, 1.9% (81/4150, 171 missing) of neonates were classed as stillbirths and there were a further 47 early neonatal deaths, making up 1.4% of live births in the MEaCC database.

Following delivery, where data was complete, 75% (2040/2702, added in MEaCC 2 and 3) of patients had a documented debrief. Most patients who required EMC received follow up, though this was usually routine and midwife led. 19.2% (521/2193) received follow up by a consultant obstetrician and 6.4% (175/2193) were followed up by an obstetric anaesthetist.

4 | Discussion

4.1 | Main Findings

Around 9% of booked pregnancies require enhanced maternal care in acute trusts in our region. Most patients requiring EMC were pre-morbidly well, with few significant pre-existing medical conditions. The prevalence of common comorbidities, such as mental health disorders and asthma, is similar to those found in the maternity population.

Some conditions are associated with a higher likelihood of requiring EMC, for example diabetes mellitus, and are the focus of future work in the region. Women from Black minority ethnic groups were more likely to require EMC than women of White/British and Asian background, though not in proportion with the increased risk of death observed in women from black minority ethnic backgrounds in the most recent MBRRACE report [1].

Most acute deterioration among maternity patients is managed in maternity units, with occasional input from outreach services while admission to critical care is rare.

Most women recovered fully and were discharged home; however, a stillbirth and early neonatal death rate of 1.9% and 1.4% respectively highlights the impact of deranged maternal physiology on neonatal outcomes.

4.2 | Strengths and Limitations

This is the first paper to describe this group of patients and provides compelling insights into a cohort of women who develop enhanced care needs during pregnancy and the peripartum period. Pregnancy is not an illness; however, with increasing maternal age and the burden of complexity rising in the general population, a higher number of pregnancies are complicated by acute illness, which is reflected in the fact that around 9% of all birthing people required EMC during or after their pregnancy. While MBRRACE-UK and MNSI reports have provided invaluable understanding and recommendations based around those experiencing the most severe outcomes, this data tells us about a significant and previously unquantified group of patients who require additional enhanced specialist care.

A limitation to analysis of some parameters was missing data. In most trusts, data is entered by midwives and doctors working on units as part of the clinical team. Staffing and resource limitations will therefore affect their ability to do this contemporaneously. In some units in the region, staff (either clinical or data clerk) have dedicated time to input data, resulting in more complete records. With increasingly sophisticated information technology, the regional data controller plans to address this issue by transitioning to a system whereby data is automatically extracted from electronic health records into the database.

Inconsistency among systems and processes may have affected the way that data was recorded across different units. For example, the maximum early warning score (EWS) among women needing EMC is recorded in the database; however, we were unable to use this to quantify the degree of physiological disturbance among this group because of the variety of scoring systems used in the region. The implementation of the nationally standardised Maternal Early Warning Score (MEWS) aims to provide a robust tool to aid the recognition and appropriate escalation of pregnant women displaying evidence of physiological deterioration. It will also serve to address this limitation for future data analysis.

4.3 | Interpretation

Many patients deemed 'low risk pregnancies' became unwell and required enhanced care during the peripartum period. This discrepancy as well as the relative physiological compensation in this specific cohort, highlights the need for timely recognition of deterioration in all maternity settings, along with responsive systems to detect such deterioration in this group of patients. This underscores the importance of multidisciplinary training through courses such as Maternal AIM (Acute illness management) and PRactical Obstetric Multi-Professional Training (PROMPT) as well as an ongoing need to train midwives in the provision of EMC.

This data has wide-reaching application beyond our immediate understanding of clinical context and management of specific conditions. Participating trusts have used insights from the MEaCC database to inform training needs among their staff: knowing how often their patient population will require EMC, units can forecast the number of midwives requiring EMC training responsively. Using EMC data in combination with the Birthrate Plus tool [18], units in the region can also more accurately predict the staffing levels and skill mix required to manage patient acuity levels. The Ockenden report [19] recommended that maternity units train a core team of senior midwives in the provision of high dependency (enhanced) care, such that one midwife trained with enhanced care skills be available for each shift. It also highlighted the need for effective governance systems to monitor and safeguard staffing levels on individual units. The MEaCC database serves as an important tool utilised across the region to monitor and address these essential actions.

Of those women requiring higher levels of care, the vast majority are managed in a maternity setting, with only a small proportion needing critical care transfer. The individual size and location of each maternity unit will inevitably influence the number and complexity of cases seen. Understanding this individualised case mix through the database dashboard tool can inform unit specific standard operating procedures for EMC, as well as critical care transfer thresholds which reflect the case mix and complexity seen across the varying maternity units.

Expansion of the database to a national level would be feasible and has been recommended by several recent enhanced maternal care and maternal critical care [7, 8] publications. There are no existing best practice tariffs in maternity care. If national data collection for all EMC patients were implemented, the impacts of specific aspects of care on patient outcomes could be more easily measured, and compliance with 'best practice' could be monitored. Currently, trusts may be financially disadvantaged by managing EMC patients in maternity units, rather than in critical care, where specific tariffs for their treatment apply. Receiving EMC on maternity units is often the optimum environment for their care needs, with neonatal and obstetric expertise immediately available, and a best practice tariff would help address the financial burden associated with this.

This data is already serving to inform several research projects in the region, including in the development of risk prediction models in maternity. National data collection with larger patient numbers could inform and underpin a national research agenda with the aim of improving care for women requiring EMC and the outcomes for them and their babies.

5 | Conclusion

In this paper we have highlighted some of the key insights that the MEaCC project and its database can provide and discussed ways that this is currently being used in the region. With around 9% of all women (most of whom initially appear low risk) needing EMC, a large section of the maternal population stands to benefit from improved understanding of the demographics, management and outcomes of those becoming unwell in pregnancy or the postpartum period. As the number of patients included in the database increases and with technological developments improving data capture, more in-depth analysis of specific conditions and patient cohorts will be possible. Our ability to care for these patients will be enhanced through an improved ability to plan training and match staffing to individual unit acuity as well as more widely through informing areas for future research, commissioning of services, safety and quality improvement.

Author Contributions

Penelope Anne Beddoes: data analysis, manuscript writing, content and editing. Helen Francesca Stanworth: manuscript writing and editing. Luke William Budworth: data analysis, manuscript content and editing. Vivien Anne Dolby: database design, maintenance and management, manuscript concept and planning. Brian Raymond Wilkinson: data analysis, manuscript concept, content and editing. Thomas Oldroyd Lawton: data analysis, manuscript concept, content and editing. Deborah Louise Horner: database design, manuscript concept content and editing, data analysis.

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The authors have nothing to report.

Ethics Statement

The MEaCC database is an audit database with information collected for the purpose of service evaluation. All data stored on a secured platform, information is pseudonymised and non-identifiable. Data storage and access is carried out in accordance with formal data sharing agreements between participating trusts and the data controller with approval from all trust Caldicott guardians.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.