MSc Digital Transformation for the Health and Care Professions BMDS7005

An Evaluation of the Electronic Patient Clinical Record (ePCR) implemented by the Welsh Ambulance Services University NHS Trust (WAST), from a Clinical Perspective

Dissertation submitted in partial fulfilment of the award of

Master of Science in Digital Transformation for the Health and Care Professions

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5th May 2025

Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

I confirm that this essay is my own original work and does not include text created by a generative artificial intelligence tool.

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Contents

1 Introduction

1.1 The Welsh Ambulance Services University NHS Trust

Established in 1998 the Welsh Ambulance Services University NHS Trust (WAST) is the emergency arm of the National Health Service (NHS) in Wales (Welsh Ambulance Services NHS Trust, 2022c). The service enables all patients with a perceived life-threatening injury or condition to ring the emergency 999 telephone number. A call taker will then assess the patient's symptoms using a computerised system, and the call is categorised, depending on urgency. The nearest available ambulance is then dispatched to the patient.

Historically, all patients who rang 999 were sent an emergency ambulance, with most patients being transported to hospital. Ambulance crews received only basic training and qualifications, providing emergency life–saving treatment at the incident scene and transporting emergency patients to the hospital as quickly as possible. Due to the number of inhabitants in Wales increasing, with the population aging (ONS, 2021), the demand for the NHS has led to overcrowded social care homes and hospitals. The outdated system of transporting all patients to the hospital had to change, as it had led to a knock-on effect of ambulances waiting for increasing times to hand over patients at the hospital. These delays increased the risk of severe harm to patients by 9% and caused avoidable deaths for those who had waited multiple hours for an ambulance to arrive (Association of Ambulance Chief Executives, 2021). In a survey in 2015, 59% of ambulance service patient deaths were caused by the delay in an ambulance reaching the patient (Yardley and Donaldson, 2016). No patient should die or be severely harmed because of long waiting times for an ambulance.

In April 2007, WAST merged with NHS Direct Wales and was then able to incorporate a telephone advice and triage system within the emergency sector. From this time, it has been possible to triage patients who do not need an emergency ambulance and provide them with the most appropriate course of treatment and advice depending upon the questions answered regarding their symptoms and medical history. This can range from a visit to their doctor, or self-travel to a suitable Accident and Emergency (A & E) Department. Providing patients with the 'right care and advice, in the right place, every time by delivering quality driven, clinically led and value focussed services' (Welsh Ambulance Services NHS Trust, 2024) is the overall goal of WAST. By getting the care right for the patient, unnecessary trips to the A & E department, longer hospital stays, and hence longer patient waiting times can be avoided. For example, studies have shown that the rapid reduction of a patient's pain reduces the length of hospital stays in A & E departments (Sokoloff *et al.*, 2014), and that inappropriate pain management following surgery can delay recovery and increase morbidity and mortality rates (Baratta, Schwenk and Viscusi, 2014). The correct care will enhance the patient's experience, whilst also providing a positive influence on A & E departments, ambulance waiting times, readmission rates etc. (Hayes and Carroll, 1986).

Although the outcomes can depend upon matters outside of the Paramedic's control, e.g. the severity of the patient's illness/symptoms, age, aetiology (reason, or symptoms for the illness) etc (Tohira *et al.*, 2016), the care they provide to the patient is entirely within

the Paramedic's hands. Research has evidenced the best way in which to treat a patient's condition, for example, the treatment of chest pain (Skinner et al., 2010). Therefore, the Paramedic has standards and guidance to adhere to, based on that evidence, which enables them to provide the safest, most appropriate care (Brown, Surendra Kumar and James, 2019).

An electronic patient clinical record (ePCR) was introduced into WAST in March 2022. The ePCR would capture the whole of the patient's care provided. The ePCR could also allow the Paramedic to see the patient's past medical history, then provide details of the patient's care to the hospital on admission, or the relevant general practitioner (G.P.) etc. if the patient was not transported to hospital.

Since its introduction, there has been no evaluation of the ePCR, so it is unknown whether its introduction has led to an improvement in clinical care. This evaluation will be the first of its kind to be conducted in WAST and can show whether there is evidence of any improvement. If patients receive appropriate care at scene, then the problem with unnecessary vehicles queueing outside hospital will be improved.

1.2 What would best practice look like?

Changes set out by the Welsh Government, (Welsh Government, 2018), stressed that health and social care needed to change. One factor was treating more patients in the community, hence, avoiding the need for hospital attendance. In addition, patients need to have the most appropriate care. Evidence has shown that by treating a patient's symptoms without delay, the patient can have a better outcome, and hospital stays can be reduced (Shahriari *et al.*, 2015). This will then help to improve ambulance response times as less ambulances will need to wait outside the A and E department.

Research suggested that ePCRs improved clinical outcomes in chronically ill patients, the quality of received healthcare improved, efficiency was increased and there were less errors made (Zaman and Chauhan, 2021). To enable a more accurate measure of a patient's treatment, highlighting what works well, in addition to any improvements required, WAST would introduce an ePCR which would be able to provide the required evidence of exemplary care provided. 'Designed FOR Paramedics BY Paramedics' (Terrafix Limited, 2019). The TerraPACE ePCR would be completed on an Apple iPad with sections for certain conditions, in addition to recording the patient clinical observations and any treatments. This would provide up-to-date information specific to the patient, their observations, treatment etc. This technology would also help enable the NHS to work as one rather than being fragmented as it could link into the patient's other NHS records, e.g. their G.P. records. The Paramedic would be able to see previous WAST ePCRs to ensure that patient history would be captured to ensure nothing was missed.

From this system, analysts could extract data to demonstrate the level of clinical care provided. This would be the first time that WAST could use almost real-time data for quality measures and improvement, service demand by patient demographics or condition, and forecasting.

1.3 Problem summary

Currently there is a huge risk to patients who can wait several hours for an ambulance due to long queues outside hospital. Sometimes more than ten ambulances are queuing, waiting to pass their patients to hospital staff to gain the appropriate care. This is of great concern as the risk to patients from either deterioration, or delay in care can be life threatening. The caller who dialled 999 has already classed the call as an emergency.

A rich picture was drawn (figure 1), which would help to visually illustrate the issues surrounding the PCR, and the data which could be gathered from it. As can be seen, if patients do not need to attend hospital, highly trained Paramedics now have the knowledge and skills to treat patients, then leave them at home, or signpost them to another service, for example, a referral to a falls agency. This will reduce the number of patients seen and discharged by the hospital staff.

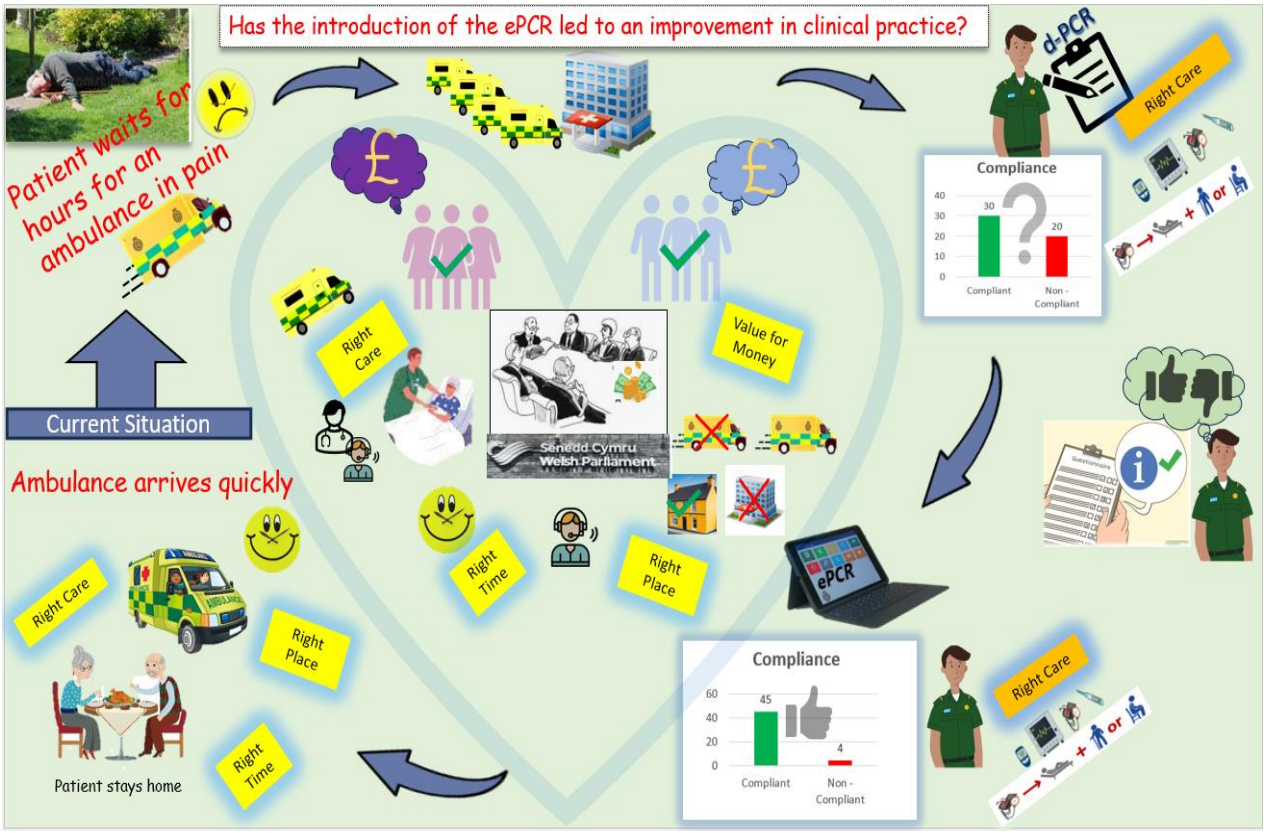

Figure 1: Rich Picture

Due to the technologies within the ePCR, the Paramedics can be supported to care for the patient by seeing their medical history, using appropriate decision software, and receiving reminders to complete specific things based on individual patient needs. This should enhance the patient's care and ease hospital blockages (figure 2). It will also show a better value service to the Welsh Government.

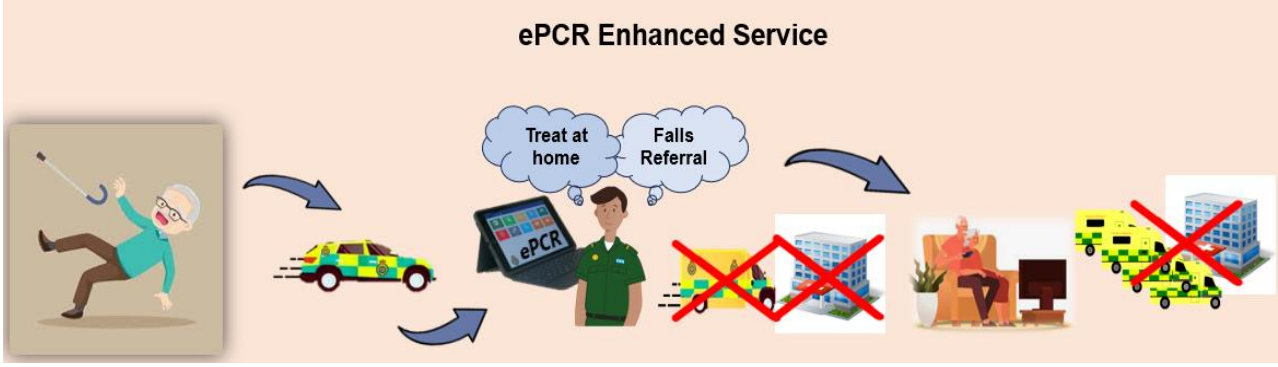

Figure 2: ePCR enhanced service.

The ePCR was intended to provide a larger amount of timely, accurate data to assure clinical performance. However, upon implementation, to ensure data integrity of the ePCR system the Clinical Intelligence and Assurance Team (CIAT) conducted data quality checks on clinical indicators, to ascertain whether the raw data captured was a complete record of the patient observations and treatment. These data quality checks showed that the data was not robust (Muxworthy *et al.*, 2022).

Also, due to the complexity of the ePCR design, the data was difficult to locate, and because of this, there were errors in the Structured Query Language (SQL) queries used to download the data, hence the data was not reliably accurate. An example of this is having several places where a patient can refuse an element of care. There were instances where a section relating to patient refusal of assessment or treatment had been completed by the Paramedic, but this was missed when finding the data. Due to this, patients who had refused treatment were not identified as having a justified exception to not receiving analgesia.

The scripting had to be amended to incorporate the missed (blue) fields:

Table 1: Analgesia refusal scripting.

Analg_Refus	(tinyint (0-255)) Lookup: 0 = “No” 1 = “yes” 2 = “Check”	Patient refused analgesia	PatientInfo_ConsentClinical_consent like ‘Consent Refused’ OR PatientInfo_ConsentTreatments_consent like ‘Consent Refused’ OR PatientRefusal_RefusedOptions like ‘Treatment’ OR Pathways.Patient_Refused_Treatment = 1

1.4 Project Scope

The scope of this dissertation was to evaluate whether the implementation of the ePCR has led to an improvement in clinical practice, and where any required amendments can be made to improve usability and compliance with standards. As the ePCR has been fully implemented, a summative evaluation was carried out.

The evaluation of the ePCR system was a significant piece of work, as it enabled problems to be identified with user error/understanding, ePCR design, or the ability to access the correct data. It also showed what parts of the ePCR work well, and what

impact any previous changes or interventions have had. From the findings of the evaluation, changes can be made to strengthen the ePCR, and its use, for example, user training. The evaluation also helped in finding trends in non– compliance to clinical standards (indicators) which are the gold standard of patient care.

The results of both the evaluation and the questionnaire will be shared within WAST to enhance the quality of the ePCR and its use in addition to sharing it with the other stakeholders (figure 3).

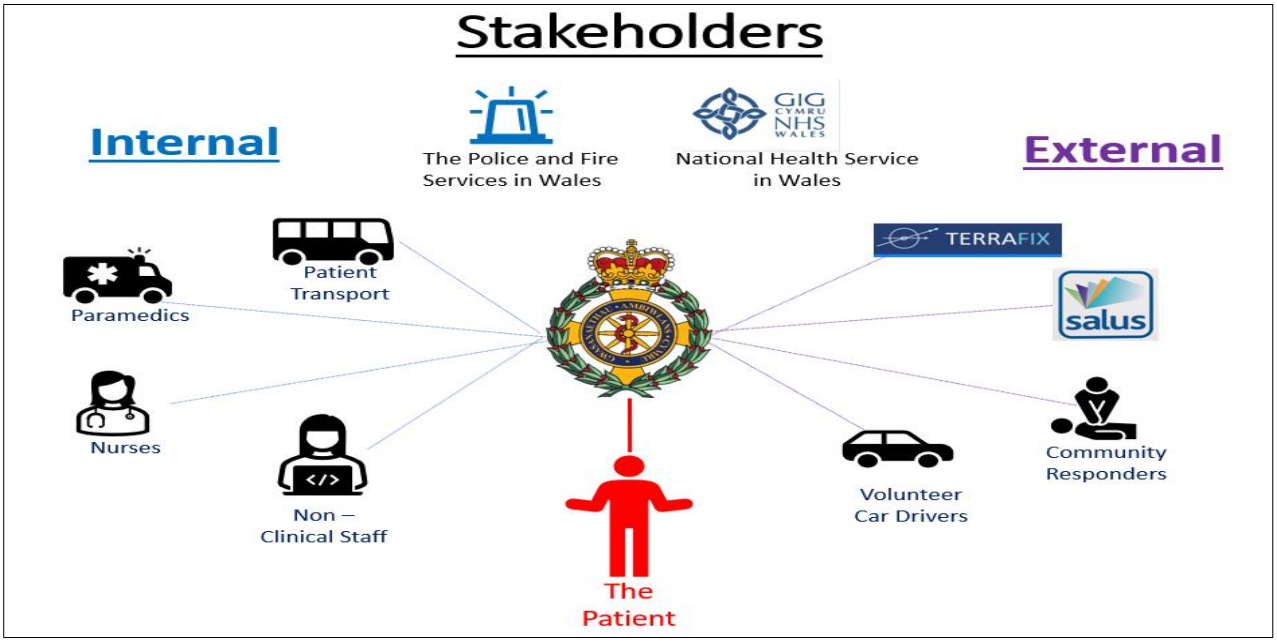

Figure 3: Stakeholders.

1.5 Project Aims

The project aimed to ascertain whether the intended benefits that were outlined in the Project Initiation Document (PID) (Harris, 2021), Full Business Case (FBC) (Harris, 2020), and Delivering Excellence (Welsh Ambulance Services NHS Trust, 2022a) were realised, and whether the introduction of the ePCR has demonstrated an improvement in clinical practice. This was evaluated by the comparison of clinical indicator data obtained for the previously used digital pen patient clinical record and the ePCR.

The project also aimed to show the level of care received by the patient, and whether this was the expected standard. This care was found by looking at the clinical indicators of practice which is defined by the gold standard of research-based care. These were for:

- Patients identified as having a fractured hip or neck of femur (NOF).
- Patient where ST–elevation (STEMI) was shown during a 12 lead Electrocardiogram (ECG) (heart attack).
- Patients who have experienced a hypoglycaemic (low blood sugar) episode.
- Patients who had experienced a cerebrovascular accident (stroke).

The short-term aims were to identify what performance levels were being achieved within the ePCR, and to ascertain any reasons behind the good or poor performance. For example, has performance improved, or worsened compared to the dPCR? What specific elements are these, and what are the reasons for them? For example, Aspirin administration for STEMI patients?

The longer-term aims are to use the information in both the qualitative and quantitative data to propose specific improvements for future iterations of the ePCR. For example, if Paramedics felt that the ePCR was difficult to navigate, then an alteration of the navigation would be needed. The overall outcome should help to inform the aims outlined in the WAST Trust Integrated Medium-Term Plan 2024 - 2027 (Welsh Ambulance Services NHS Trust, 2024) which will help to provide patients with the '*right care and advice, in the right place, every time by delivering quality driven, clinically led and value focussed services*.' This will help to ensure that patient care is clinically appropriate and, it helps to avoid unnecessary hospital care which in turn can lead to higher waiting times for patients who need an emergency ambulance.

1.6 Study Objectives

The evaluation looked at the following which were cross matched against specified aims set out in the PID and the FBC:

- Appropriate use of the ePCR (field completion, e.g. patient condition, examination, observations, diagnostic code, etc.)
- Time at Scene (whether extended or not)
- Availability of data

The evaluation did not specifically look at individual costings of hardware, software, time, etc. However, this may be considered, for example, the time at the scene of the incident.

Reports were examined to identify the usability of the data, for example, prediction of future medicine usage, etc. User questionnaires were distributed and analysed to ascertain the ease of ePCR use, and any recommendations which would enhance the user experience and data collection.

Within WAST, it is important to demonstrate how Paramedics meet expectations around clinical assurance as this is within their gift (response times have external influences).

Feedback from staff made during clinical intelligence training conducted by CIAT regarding ePCR has suggested that it has been being difficult to use. Also, within the first two years, there were 45 requests made to TerraPACE (Terrafix) for changes to the ePCR which are costly and take a long time to implement. An example of this is interface changes requested by CIAT in Change Request CR0019 and CR0023 following approval on 24th November 2022 and 21st March 2023 had still not been actioned on 28th March 2024 (Charters, 2024).

Quantitative data was obtained relating to compliance to both the digital (dPCR) and electronic (ePCR) patient clinical records (PCRs). Shown below is a summary of the initial findings of the quantitative data. The data relates to compliance of 'bundles' of care

for specific conditions. These are fractured neck of femur (NOF), STEMI (heart attacks), stroke, and hypoglycaemic episodes (low blood sugar). The results show that there was a large drop in each clinical indicator bundle compliance (see figure 4 below). The graph shows dPCR data from January 2017 to December 2018, and ePCR data from January 2023 to November 2024. It shows that the level of appropriate patient care had dropped, however, until investigation, it was not known whether this was down to the care provided, or ePCR completion. It would, however, be unlikely that someone would change their practice as soon as ePCR was introduced.

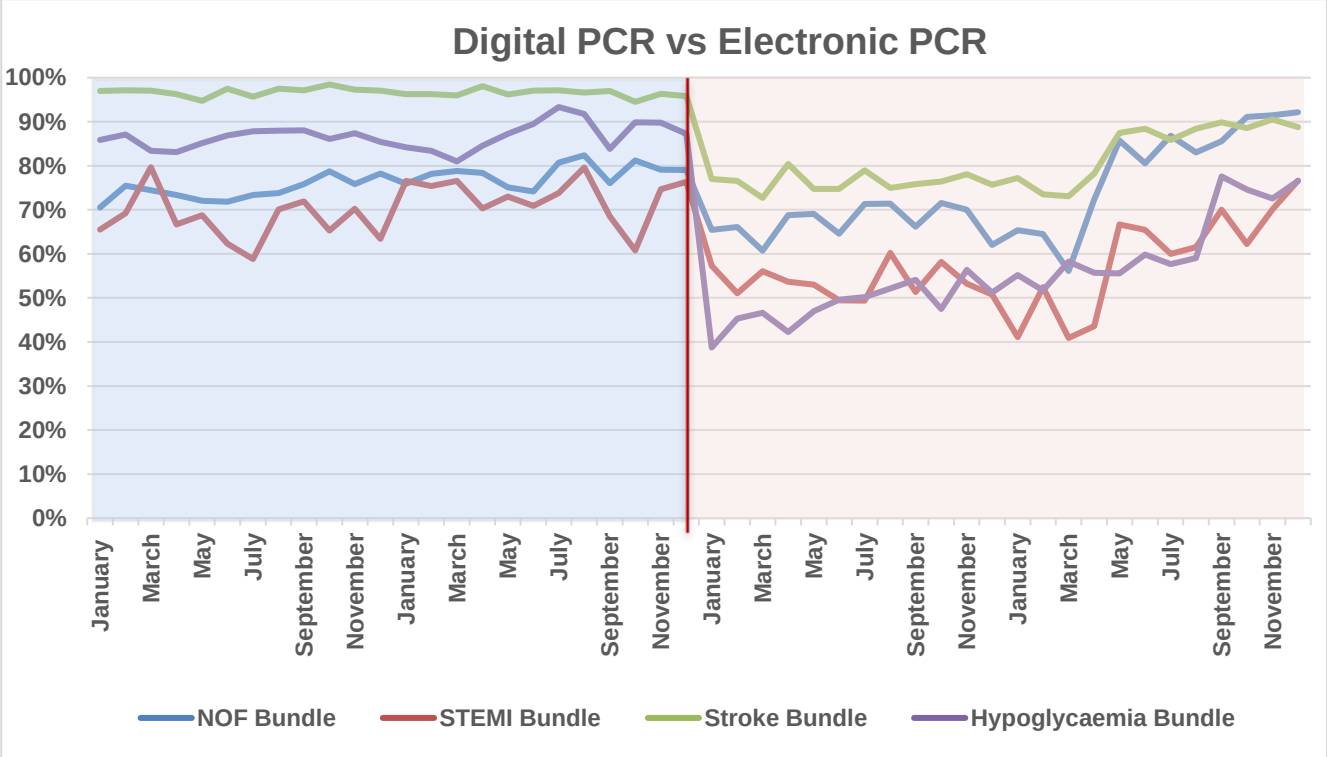

Figure 4: Summary Diagram of dPCR vs ePCR.

1.7 Dependencies

The quantitative data was dependent on the ePCR system working appropriately. The qualitative data depends upon the Paramedic's completion of the Microsoft Form. The author needed to ensure that the appropriate authority was sought, and that the distribution method was successful. Should either of these have not been considered, then actions taken to resolve any issues found, the qualitative data would not be obtained.

1.8 Risk and Mitigation

To mitigate the risk of inability to obtain the qualitative data, the author contacted the WAST Communications Team to seek their advice about gaining the proper approval and methods of communication. Once obtained, the advice was followed to ensure that the correct permission was sought, and the best methods of gaining Paramedic responses were used, for example, the ‘start-up’ screen on WAST iPads etc. Also, by monitoring the number of respondents, the author can send out reminders to prompt the Paramedics to respond if necessary.

The author considered a face-to-face approach, however, that would have caused a risk of bias in participant selection due to Paramedic work areas, shift patterns, contact details, etc. To reduce this, face-to-face contact was replaced with an online form, to give the opportunity for all clinical Paramedics to provide their opinion and experience of using the ePCR.

Also, the author researched the most effective way to design the questionnaire to ensure that the risk of any predicted bias had been decreased, for example, leading questions like “why do you feel the ePCR is bad?” prompting the respondent to agree that the ePCR is bad (Bowling, 2002). There were multiple free-text boxes to provide Paramedics with the opportunity to provide their opinions, in addition, there were no mandatory fields which would force them to complete questions they preferred not to.

1.9 Clinical Assurance and Intelligence

The NHS in Wales is funded by the Welsh Government (WG) (Digital Health and Care Wales, 2024) and needs to ensure efficiency and effectiveness. WAST needs to provide up to date information to prove that the money is being well spent, and that they are providing the best service possible to patients.

Previously, due to the lack of clinical data available, the eight-minute response target has been the focus used to prove a high standard of care through the speed of ambulance arrival at the incident scene (Price, 2006). Since the evolvement of technology, coupled with an increase in the skills of Paramedics, nowadays, in addition to the time of arrival of ambulances, there is also a need to demonstrate the quality of care provided to patients to provide assurance that the clinical standards are adhered to.

As a member of the CIAT within WAST, the author has a part to play in helping ensure that the clinical care data provided to the Welsh Government and other NHS bodies throughout the UK is accurate, and where improvements to clinical care can be made, that appropriate actions are taken, in line with WAST policies.

1.10 Patient Clinical Record History

All Paramedics who practice in Wales must be registered with the Health and Care Professions Council (HCPC, 2018), and are legally required to keep an accurate account of all care provided to every patient (Health and Care Professions Council, 2024). Paramedics must complete a PCR, which must contain the patient details (name, address, date of birth, etc.) in addition to all clinical observations obtained (heart rate, blood pressure obtained, etc), drugs administered, or any treatment provided to the patient. If the patient details are unknown, this must be documented.

Initially, to capture all the required patient information, Paramedics within WAST used a paper version of the PCR, however, this had several limitations. There are approximately 250,000 patients attended to by WAST Paramedics annually (Welsh Ambulance Services NHS Trust, 2022c). There were 422 fields on the PCR required to capture and record all the relevant details from each incident, and on some occasions, there was more than one PCR required per patient. For each paper PCR to be manually sorted, scanned, validated, and saved into an electronic database would take an excessive amount of time. To allow a record to be stored, only an image for each of the PCRs was

uploaded. To enable each record to be found, the data from eight of the fields could be saved. This included the incident date and unique PCR number, the incident number, the call code, the patient's surname, first name, date of birth, and the postcode. Whilst this would provide a search facility should a record be required for investigation or complaints purposes etc.; it did not allow any relevant clinical information to be captured or withdrawn electronically. Whenever any meaningful patient clinical data was required for reporting or auditing purposes, this had to be done manually, for example, if a clinical auditor needed to look at all stroke incidents from January 2023, they would need to conduct a manual search of all the records for that month and extract the ones with a corresponding condition code (which is 172 for a stroke diagnosis). This was a very time-consuming task, for which there was a risk of auditor error.

The paper PCR was replaced by a digital version (dPCR) in October 2015. This new version consisted of a special version of the paper PCR which was completed by the Paramedic with a digital pen. The information was then held on a microchip within the pen, the pen was then docked into a docking station either within the ambulance stations, or hospital A & E departments. Upon docking, the data was then transferred from the digital pen onto a computer database held on a server at WAST headquarters.

The newly introduced dPCR had more fields (628) and could then enable the CIAT to download any required data from it. The data could then be used by the CIAT to conduct clinical audits, of which the results could then be used to inform service improvement requirements or to demonstrate improvements made to patient care. Any data required by the Welsh Government on compliance to care standards could also be supplied.

The digital version of the PCR (dPCR) was intended to be a bridge between the simple paper PCR a new electronic version (ePCR) (Winspear, 2018).

Several issues surrounding the dPCR and its use became apparent once it had been fully embedded. There were time lapses between Paramedics writing out the dPCR and docking their pen. This resulted in the data being either missing or incomplete at the time of reporting. The cameras located within the digital pens were being accidentally covered by the Paramedic's fingers, which meant the data was not appearing on the downloaded dPCR image. As Paramedics often completed the dPCR whilst in a moving vehicle, or on an uneven surface, their handwriting was often difficult to decipher. The longevity of the digital pens was less than expected, so the pens had to be replaced regularly. During the period where a Paramedic was waiting for a new pen, the old paper PCRs had to be used, so no electronic data was recorded. There were faults with the digital pen cameras, which meant that either large portions of information were missing, or appeared to have been scribbled over, rendering them unusable. A great amount of data had to be manually audited due to the large narrative fields which could not be electronically searched.

These issues meant that there was less data than originally anticipated (Welsh Ambulance Services NHS Trust, 2020). Also, the data that was obtained was not always accurate, for example, the patient's respiratory recording was electronically saved as seventy two instead of twelve, due to a slight curve in the number one.

These identified issues with the data, not only posed a risk to the reputation of the organisation but also meant that Paramedics were being provided with inaccurate feedback regarding their clinical practice. This could have led to a reduction in staff morale, and any substandard practices may have remained uncovered due to the inaccuracy of the data.

Following the full implementation of the dPCR, work commenced on obtaining an electronic version of the PCR. This would be an important progression, as WAST was the only UK ambulance trust at that time that had not progressed to the fully electronic version of the PCR (ePCR).

A ‘task and finish’ group was established in February 2018. This group would develop a Full Business Case (FBC) or Business Justification Case (BJC). In addition to the ‘task and finish’ group, a subgroup was also set up. This group consisted of WAST senior employees, who each had an area of responsibility based on their individual expertise.

On 1st November 2024, there were 1,045 fields in the ePCR, and 4,062 Paramedics using the ePCR system (data obtained from the ePCR system via an SQL query).

The ePCR system has far more fields than both the digital and paper PCRs, with different sections to be completed, dependent upon the patient’s presenting condition. For example, a “falls in older adults” section to document information about older fallers, in addition to the standard fields like patient observations (pulse, blood pressure, etc). To ensure proper completion, the user must complete all relevant fields that relate to the patient, their presenting complaint, signs, and symptoms etc.

Due to the layout and the increased number of fields, it is far more complex than the one-page paper and digital versions. However, there is currently only one record per patient, To capture all the relevant data previously, there may have been a need to complete several dPCRs due to the extended length of time for patients to be either handed over to A &E staff, or waiting for an ambulance to transport the patient if a lone Paramedic had been sent to the patient in a rapid response vehicle (RRV).

The following system diagram in figure 5 represents the ePCR’s place within the 999 call process. It shows the requirements for the ePCR to work, along with the other systems that it is connected to, for example, the Welsh Demographic Service where Paramedics can obtain the patient’s NHS number. Once obtained, it can then be used to access the patient’s medical records from their G.P. practice to obtain their past medical history. Once the Paramedic completes the record when they are with the patient, it is then ether passed onto the hospital or saved onto a WAST server.

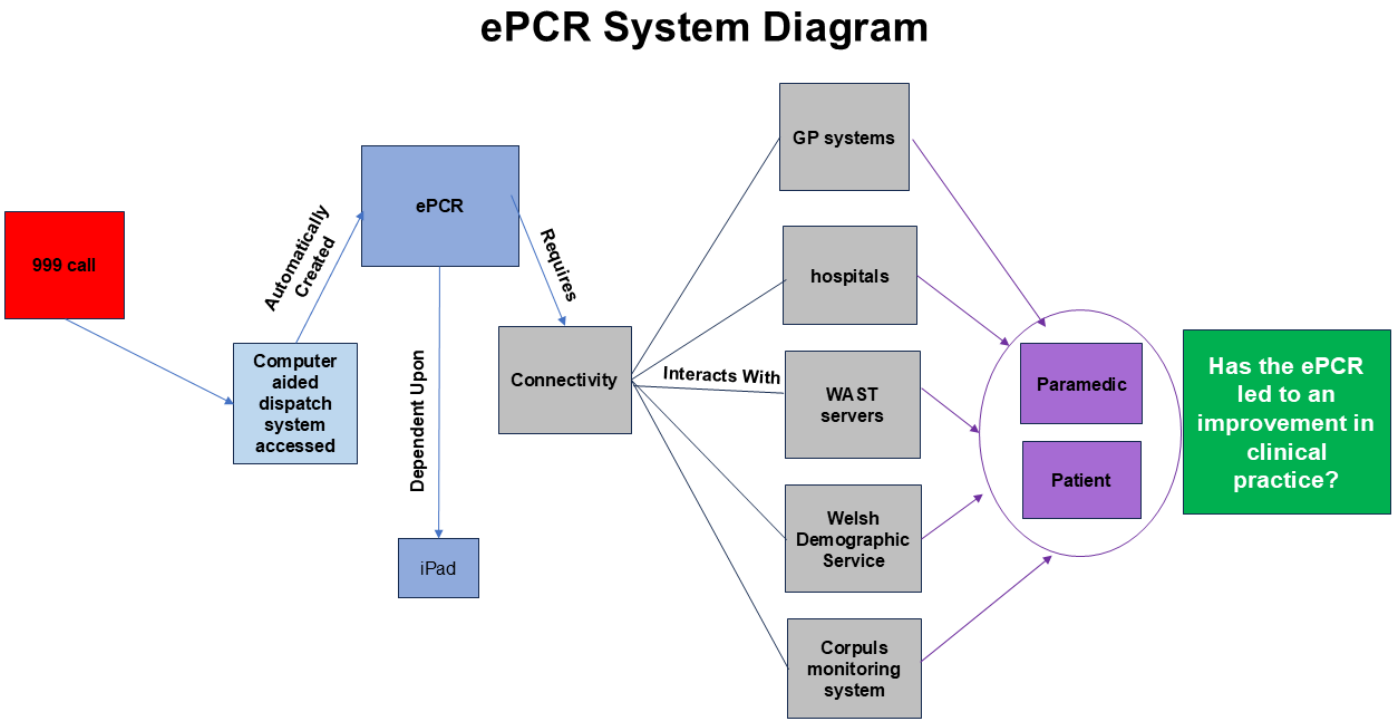

Figure 5: ePCR System Diagram

1.11 Further Findings

The study will also show how the ePCR system compares to other similar initiatives in the healthcare setting. It will help to find problems with data integrity, e.g. are the reports accurately selecting the correct data due to the system complexities and design. Also, there are many records (48,112 in period 01/01/2024 to 31/10/2024) auto closed by the system, possibly due to the system design as records are automatically closed after a certain time (12 hours) and cannot be re-opened for addition or amendment due to being saved onto the server.

There have been problems with wireless connectivity documented in patient records that were discovered during routine clinical audits, often in rural areas. These records were updated by a different individual due to the Paramedic being unable to update the record. There have also been crossed records found which were caused by the Paramedic accidentally opening the incorrect record and updating it. An adverse incident form was created for each record to log the issues.

The ePCR can capture the whole package of care provided by the Paramedic. The data shown in figure 6 below (obtained via an SQL query on 27/06/2024 by the WAST Principal Clinical Information Officer) shows a snapshot of the ePCR sections used by Paramedics, for example, the breathing table was completed in 53.9% of patients.

ePCR Tables (section) Utilisation

Figure 6: ePCR table utilisation graphic.

2 Literature Review

2.1 Literature Selection

A comprehensive literature review was conducted. The literature focused on:

Table 2: Literature Selection

Focus of Literature Review	
a)	Earlier implementation of ePCR within ambulance services or the wider health services, whether the information used for reporting is raw data.
b)	Lessons learned from the implementation /use of ePCR within the ambulance setting.
c)	Earlier implementation of electronic PCRs within other healthcare settings.
d)	Human factors that have influenced the adoption of technology.
e)	Research on human factors e.g. learning styles etc.
f)	Different values and beliefs, how these may affect the use of the ePCR with regards to motivation etc.
g)	Research on human characteristics, to develop an easier-to-use ePCR.
h)	Data sharing, tracing of the whole patient journey as accurate data should be recorded.
i)	End-to-end quality issues, for example, data linkage.
j)	Literature about device interoperability and mobile health, specifically the ability to ensure that the data exchange and usage between one or more pieces of equipment are effective, safe, and secure, e.g. between the ePCR iPad, data terminals, etc
k)	Alterations/improvements to ePCR systems, and their effects on user acceptance.
l)	The number of fields used, as currently, when looking specifically at factors that should be completed for each patient, e.g. ethnicity, there is a percentage of records that have no human input.
m)	Data protection and ethical information about the use of patient and staff information.
n)	Any evidence where machine learning has proved successful in medical data security, data protection, and identifying any security risks through abnormal behaviour patterns.

Focus of Literature Review	
o)	Research relating to the use of artificial intelligence, optical character recognition software, or similar natural language processing products that have been used to enable specific words from the narrative to be used, e.g. DNACPR, etc.
p)	Questionnaire design (ePCR users, best methods, questioning techniques, etc). This may need to be shown on internet channels, e.g. YouTube, LinkedIn, etc.
q)	Research on the adoption of similar ePCR systems in other healthcare settings, specifically looking at ones which proved successful.
r)	Look for data relating to specific challenges in mobile health technology adoption e.g. iPad, as the ePCR is used on mobile devices.

The databases used were Pubmed, e-Library for Health, Google Scholar, and UWTSD database. General searches were carried out, which, due to high numbers were narrowed down. The narrowed down literature review search results were:

Table 3: Narrowed down literature review search results.

Date	**Search terms used.** **All searches were:** **Advanced search, words contained in title,** **date range 2000 - 2024:**	**Number of papers identified**
29/09/2024	Ambulance AND Electronic patient records	6
30/09/2024	electronic patient records	116
24/10/2024	electronic patient clinical records AND clinical performance	3
27/10/2024	electronic patient record and clinical performance	195
28/10/2024	ambulance and electronic patient	122
30/10/2024	Scottish and evaluation of electronic health records	43
30/10/2024	Advanced search, words contained in title, Scottish ambulance and evaluation of electronic health records	2
03/11/2024	electronic health record OR	88

Date	Search terms used. All searches were: Advanced search, words contained in title, date range 2000 - 2024:	Number of papers identified
	electronic patient record, AND any field contains impact on compliance AND any field contains UK OR United Kingdom OR Wales OR Scotland	
03/11/2024	successful implementation AND electronic patient record	14
06/11/2024	Electronic patient report form	9
15/11/2024	electronic patient record AND best practice	10
16/11/2024	Electronic Health Record Evaluation and ambulance	48
16/11/2024	Scottish Ambulance Service AND Evaluation	13
Total		**669**

The literature was scrutinised, and following exclusion, 31 suitable pieces of literature remained. These were categorised into the following:

Table 4: Literature categories

Category of literature	Number
Cohort Study	17
Cross – Sectional Study	2
Interviews	6
Literature Review	6

2.2 Literature findings

As demonstrated in the diagram below; Avedis Donabedian suggested that the best way to evaluate the effect of healthcare IT for health, quality, and safety is to use the following framework which examines three components: structure, process, and outcome (Donabedian, 1986). The literature was cross matched against the framework.

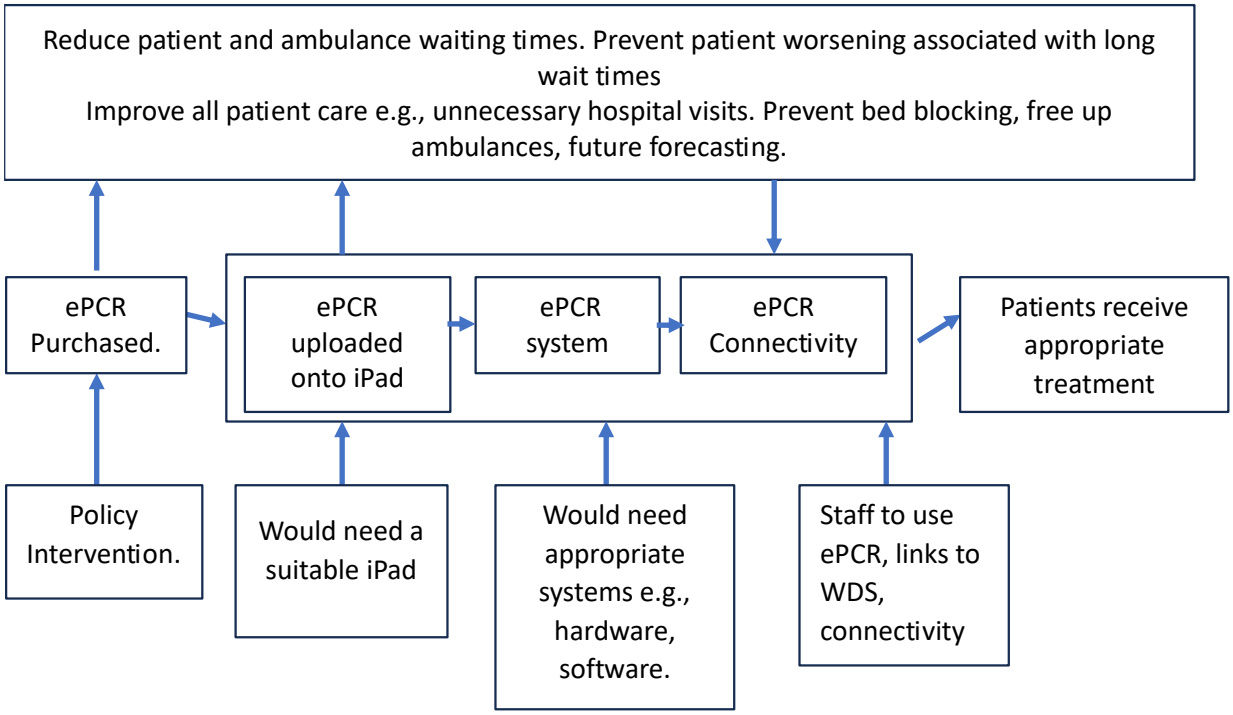

Figure 7: Donabedian Diagram of the ePCR.

2.2.1 Electronic record evaluations

In 2018, a telephone survey was conducted across 13 ambulance trusts within the UK (Porter *et al.*, 2018). The aims were to investigate both the opportunities and the challenges of primary care of ePCRs. The results found that 7 of the 13 were using ePCR. 4 out of 6 had previously used ePCRs but had reverted to paper PCRs. 3 out of 4 were already either contemplating a move or already moving to an improved version of the ePCR. There was no typical hardware or software being used. Observations showed that Paramedics were entering data retrospectively, for example, writing it on a glove, then transcribing it onto the ePCR. There was little sharing of data between other healthcare providers, or information used to aid decision making.

Although this was before WAST had migrated to the ePCR, the initial findings mirror those of WAST, regarding issues experienced with ePCR completion. WAST, to date has already made 50 change requests to TerraPACE, and has plans to introduce a more user – friendly version which is easier to navigate in the future.

In his literature review, Menachemi (Menachemi and Collum, 2011) realised the potential for electronic health records (EHRs) to improve the health care system and provide a better standard of care. With medication errors reduced by 55% (which has not been shown to be the case for WAST), he found that medical errors could also be reduced.

Drugs, and their contraindications like allergies could be highlighted, and nudge tools, similarly to those introduced within WAST could be used. However, from his research, he was also aware that incorrect completion of EHRs could have a negative outcome for patients (Campbell *et al.*, 2006). This could be a fact for WAST to be aware of, especially as Paramedics can see previous patient records, and make decisions based on what has previously been recorded against patients. Thus, although his literature reviews were clear, it cannot be deduced whether the EHR would improve health outcomes.

Koppel's qualitative and quantitative study (Koppel, 2005) found that whilst hospital computerised physician order entry (CPOE) systems were renowned for reducing medication errors by up to 81%, they were also responsible for either causing or exacerbating medication errors. Koppel's study is conflicting as states that CPOE systems both reduces and causes medication errors. The highlighting of potential drug issues could be a positive move for WAST Paramedics as they can often prescribe or administer drugs to patients and currently must consult other sources such as JRCALC for contraindications. If there was an automated flag to warn of potential drug contraindications, this would be of benefit to Paramedics, saving time, and reducing risk to patients. This would, however, need to be trialled to ascertain whether there was the potential to cause harm to WAST patients.

During Barley and Gunson's review of 10% of the total 13,443 adult ePCRs completed during 2019 for one NHS Trust in England (Barley and Gunson, 2021).They discovered that, out of the fields on the 'social history' section of the records, 28.6% had no fields at all completed. The most completed fields were 'mobility' and 'home circumstances' whilst 'sexual orientation' and 'language' were the least completed fields. The average (median) number of fields completed was 7.

During a similar audit looking at the data capture of the dementia section of 314,786 electronic patient records for patient aged 65 and over, 13.5% (aged 65+) and 16.5% (aged 75+) had recorded dementia in the correct place (Fogg and Paramedic, 2018). Dementia was also recorded in 16 free-text fields, and in 38.4% of records, dementia was recorded in more than one place on the record. This audit showed that the way in which dementia was captured varied.

Likewise, during a cross – sectional study on the use of the ePCR in the Brazilian Air Force, (BAF) health services found that most respondents felt it had a positive impact on work dynamics and efficiency (75.6% and 66.7%). Consultations and physical examination were the most used elements (90.1% and 67.1%) The most advantageous aspects were information storage (75.6%), dexterity and the practicability of recording (55.1%). The most highlighted disadvantages were those relating to electronic equipment and system errors (69.7% and 65%) (Vilas Boas *et al.*, 2024).

These findings compared to WAST where during an audit of a newly introduced drug called methoxyflurane, of the 460 patients who received the drug, 30 (6.52%) ePCRs had the drug recorded solely in the narrative (Muxworthy and Teulon, 2024). Following this, data was extracted in October 2024 by the Principal Clinical Information Officer to ascertain the use of fields, and the drugs section was completed in 164,916 occasions

(21.47%) of the overall ePCRs recorded. Following this, an audit of drug documentation is planned.

This shows that the recording of various types of information in the different electronic patient record systems still has common issues regarding the correct practice.

A common issue that has been seen within WAST whilst conducting clinical audits is that Paramedics document patient observations and treatment in the narrative section instead of the correct observations/treatment sections. Whilst conducting a reflective review of electronic medical records Aronson, (Aronson, 2019), realised that most observations made by Lawrence Weed in 1968 about medical records are still valid today (Weed, 1968).

Weed, who had designed an electronic medical record called PROMIS in the 1970s had stated that all the data needed can be ascertained almost immediately. Advanced charts showing improved graphical data can be designed, and due to being electronic, medication errors regarding handwriting occur less. Dr Aronson however also noted that things aimed to make tasks easier like the “copy” and “paste” functions can enable the user to forget to amend the record, thus rendering the record inaccurate.

These observations are like those that have been encountered within WAST. There is a copy and paste functionality within the ePCR, however, it has been noticed that on occasion, two records have identical narrative, thus questioning the accuracy of the narratives. Whilst the information provided by both Weed and Aronson have valid points for reflection, it could be deemed as outdated as today users are more likely to use technology daily and are less likely to use handwriting. Also, technology advances quicker than research can be carried out. Also, as Weed had designed PROMIS, he may have been biased in his opinions.

Jackson also wanted to see if the patient observations were recorded accurately. He looked at EHRs from Oxford hospitals between 1st January 2016 to 30th June 2019. He found that the actual recordings of patient observations were statistically different to expected. An example of this was the recording of a temperature of 36.0°C in patients. There were 15.1% compared to the expected amount of 4.96%. Also, blood pressure readings ended in zero in 2.2% instead of the expected 1%. This raised suspicion as to whether the observations had been accurately entered into the patient observations sections (Jackson *et al.*, 2022). Although the literature appears to be accurate, it only considers statistical probability, and not actual patient readings. Although it is expected that 4.96% of patients may have a temperature of 36.0°C, 100% of patients could have had that temperature, especially if there were external factors, for example, the same room temperature.

Within WAST, there is a large amount of patient observations which are only documented in the narrative section of the ePCR. This now raises the question as to whether it would be more accurate if Paramedics were writing the observations. The temperature section within the WAST ePCR, as shown in figure 8 below has a free–text numerical box, whereby the value entered must be between 0.0 and 44.4, however, the same issues could arise, and Paramedics could accidentally enter the incorrect temperature, such as 36.0°C.

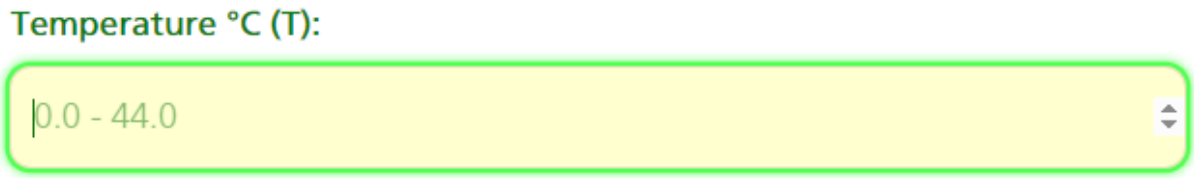

Figure 8: Temperature section of WAST ePCR.

In a recent audit of newborn temperature management, out of 75 records audited, 19 (25.3%) had the temperature correctly recorded within the observations section of the ePCR, however, the 56 (74.7%) remaining babies' temperatures were recorded within the narrative free-text section only. This shows that there is a problem with the recording of observations within WAST (Muxworthy and Jones, 2024). The findings of this audit were comparable to a study carried out by Goodwin (Goodwin *et al.*, 2022) which looked at 1,582 ePCRs which had been created for babies born outside of the hospital setting from 1st February 2017 to 31st January 2020. The survey found that only 86 of the 1,582 ePCRs (5.4%) had the baby's temperature recorded. Due to these low results, 20 Paramedics were interviewed to find reasons for non – compliance. Of the Paramedics questioned, most stated that they could not take the baby's temperature due to a lack of equipment. This was not the case for WAST staff, as all vehicles had been equipped with both warming aids and a temperature probe (Magee, 2023).

Williams looked at the rollout of ePCR across 22 ambulance services across the UK from a data perspective. The results found that ambulance services had experienced challenges with the implementation, and that there had been a wide variation in the way in which the ePCR had been used by the different ambulance services. There had also been a large variance in staff compliance, and the availability of a link between primary and secondary care was not always appreciated. Williams felt that progress had been erratic rather than linear which had been shown by difficulties that the ambulance services had experienced when putting the idea of using the ePCR into practice (Williams *et al.*, 2019).

2.2.2 Paper versus electronic records

When Alhaug (Alhaug *et al.*, 2022) carried out a comparison of the data relating to 474 patients on the C-Spine register in Norway in both electronic and manual versions of the patient record, he found that electronic versions of patient records were more accurate compared to manual records.

In 2018, during Almohtadi's (Almohtadi *et al.*, 2021) comparison of data using a two – tailed z–test following the move from paper records to electronic patient records (EPR) for surgical admissions, he was able to prove that that the EPR is not inferior to the paper records. He specifically looked at venous thromboembolism (VTE) risk assessments, re–assessments, conducted after 24 hours, prophylaxis prescriptions, administration, and patient compliance. He found that the move had not had a negative impact, nor did it interfere with the completion of VTE risk assessments, hence did not negatively affect the ability to reach national targets.

The National Institute for Health and Clinical Excellence (NICE) guidelines state that "both the drug and the description of the reaction must be documented on all forms of prescription and in a patient's medical records" (National Institute for Health and Care Excellence, 2014). Cook conducted an audit to determine whether both the drug used, and their reactions were documented on both paper patient records and electronic patient records (EPR). All 100% documented the allergy status on the paper drug charts, however of those, only 70% had the severity type of allergic reaction documented. This compared to only 62% of patients having their allergy status documented on the EPR. This shows that the paper records had 38% more drugs documented on them. The audit also showed a large variation in compliance rates for the EPR. Out of the four areas, compliance rates ranged from 33% compliance to 100% compliance. Due to the large variance in compliance, improvement work is taking place prior to a second data collection exercise taking place to find if there has been any improvement, and to capture the severity of allergic reaction (Cook *et al.*, 2023).

When looking at patient reported outcome measures (PROMS) manually input versus those input onto EPRs, Husselbee found that although it took two years to embed the PROMS data onto the EPR system, the speed at which the analysis could be done was reduced from 3 months to 2 days. Also, there was a larger amount of data that could be extracted which meant that he could gain more of an understanding of musculoskeletal health (Husselbee and Price, 2021).

When conducting observations of the time efficiency between 192 paper and 160 electronic patient records (EPRs), Berger established that doctors spent more time using EPRs than completing paper records. He found that nurses were more adaptable than physicians and experienced fewer negative things when accepting the new EPR system (Berger *et al.*, 2024).

Cajander surveyed nurses about the use of patient accessible electronic health records (PAEHR) via an email link. Of 8,460 nurses, 35.4% (2,867) responses were received, of which 89.9% were female. She analysed the data using 'exploratory factor analysis'. Results depended upon who they thought owned the PAEHR, and the nurses – patient relationship. More experienced nurses were more positive than their younger counterparts (Cajander *et al.*, 2022). The results of this study could be deemed as slightly biased, as 89.9% were women, and historically most nurses were female until 1997, therefore more experienced nurses may be female, and younger counterparts may be male (Evans, 2004).

To help improve compliance to the sepsis bundle, Warstadt set up a multidisciplinary team to provide training and feedback on the use of EHRs. He carried out a prospective comparison of the compliance for paper versus EHRs used between June and December 2020. He found that EHR use had increased from 23.3% to 87.2%, and compliance had increased from 71.2% to 85%. Thus, proving the use of EHRs to improve sepsis bundle compliance (Warstadt *et al.*, 2022). This was the opposite of that found within WAST for STEMI (Muxworthy *et al.*, 2022) and stroke care bundles (Charters *et al.*, 2022).

The direct comparison of paper to ePCR records within WAST cannot be completed, as no comparable data has been collected within the paper PCR system. The information

recorded on the paper PCR was not captured electronically due to the large quantity of data held within it. However, data recorded on the dPCR manually with the digital pen also compared favourable to recording on the ePCR (Muxworthy et al., 2022).

2.2.3 Training methods

To date, within WAST, there has been no clear evaluation of the training methods used for ePCR. There was no set physical roll out of training for the ePCR. The only method of training was online training. It was interesting to note that during semi structured interviews, Kaplan and Korkmaz (Kaplan and Korkmaz, 2023) found that 91% of nurse educators, and 96.4% of students preferred observational learning. Also, most nurse educators and students felt that learning by gaining familiarity by user experience of the tool prior to its use would have been preferred. If this method of training had been adopted for the ePCR within WAST, there may have been a better rate of compliance to the ePCR individual field completion.

During a literature review carried out to look at the training of the electronic medical record system (EMR) for new healthcare staff in Australia, it was ascertained that it is essential for new healthcare staff, such as nursing students to learn the EMR by having a simulated clinical setting to help them to understand the EMR. The literature also recognised that there is an urgent need for higher education nursing programmes to support undergraduate nursing students and faculty staff, and to guarantee that the EMR can be successfully implemented into the undergraduate nursing syllabus (Mollart *et al.*, 2020). These, however, have not been proved.

From her mixed methods approach of using semi-structured interviews and retrospective data to examine the quality of electronic prehospital patient record data (ePPR), Kjær established that although the quality of data was high, there was still a need for improvement. This was due in part to the training provided, alongside the ambulance professionals' attitudes and the use of the tool in scenes of emergency due to the Paramedic's stress levels being raised. She felt that the end user should always be included in any development of electronic patient record. That way, the use of the tablet and software would be trialled in an emergency setting, giving a more accurate reflection on the use (Kjær *et al.*, 2023).

The training provided by WAST was minimal for such a complex tool. WAST staff were provided with the iPad and had to complete an online training module to learn the main aspects of the tool (Welsh Ambulance Services NHS Trust, 2022b). There are clinical notices published when there is a change to the tool (Robertson, 2024). This style of training may not be the best style of delivery to all Paramedics due to different learning styles. Some may have preferred to have been shown personally, others written instructions etc. (Sinnerton, Leonard and Rogers, 2014).

2.2.4 Patient impacts

During González (Córdova González, 2022) literature review to find out how the EHR effects the patient's relationship with their doctor, he noted that there was little research relating to the quality of care provided from a clinical perspective. It is therefore predominantly unclear whether it has positively affected the quality of care provided. It

was, however, clear that the doctor - patient relationship was affected due to the computer being an unintended third party. From a WAST perspective, it has not been identified whether the patient relationship has been affected by the new ePCR, however, there are now easily accessible research–based tools, for example, Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidelines attached to the ePCR to help the Paramedic provide the correct care to the patient, which means that the Paramedic no longer has to carry a paper version to patient locations.

A study using discussion groups which looked at patient safety in the Maldives found discrepancies in usability relating to the lack of training on the use of (EHRs). A standard training package, alongside protocols for the use of EHRs was required to ensure consistency, appropriate use, and to govern a more positive influence on information sharing (Selna *et al.*, 2022).

Le wanted to see if patients with similar conditions could be linked together via EHRs to help predict future medical concepts. He found that the rate of accuracy was up to 56.1% and the figures for recall up to 69.5%. The number of true positives was 86.9%, which proved accurate, as the treatment had been carried out on the patient. Thus, EHRs can be a successful way of predicting future requirements (Le *et al.*, 2020). Whilst this literature is based on actual figures following assessment, in healthcare, patients are also assessed via the telephone, therefore this literature may not refer to patients who have not had a face to face assessment, therefore linking medical concepts of telephone assessments may not be accurate.

When conducting a literature review to see whether electronic medical records (EMRs) improve quality of care, Manca and Griever believed the answer to be yes (Manca and Griever, 2015). They found that patient care had improved, there were less medication errors which led to less time spent on investigations. There was better communication between caregivers, other healthcare providers, and patients. From a user's perspective the EMR provided efficiencies through the availability of better data, access to more patient information, and the need for less manual tasks. Also, increased use would help to improve the quality of future system use.

To help capture care bundle compliance in Texas, Collinsworth (Collinsworth *et al.*, 2014) worked with experts to modify the EHR system. This would enable them to capture elements of a delirium care bundle on a newly created tab, which, when analysed, the data would provide compliance rates. During this process, he found that changing the EHR was time–consuming and complex, and that it was crucial to have the support of the Senior Leadership Team alongside help from information technology (IT) departments and seek continuous feedback from the users. Also, understanding the different multidisciplinary teams and their needs, and having their guidance throughout would be essential. This has been something that the CIAT within WAST has been trying to do to enable the capture of data on the ePCR to be easier. This, however, as outlined above, has proven to be a very expensive and lengthy process as all changes must be made via Terrafix. One common theme with both Texas and WAST was the introduction of Microsoft Power Business Intelligence (Power BI) dashboards to display the results of the care bundle compliance in a user–friendly way.

Another way in which ePCRs can help improve clinical practice is via the introduction of clinical decision support software (CDSS). During his literature review, Kawamoto (Kawamoto *et al.*, 2005) found that clinical practice and patient care significantly improved in 68% of the seventy trials. Although it is already known that medication errors can be reduced by using CDSS (Nuckols *et al.*, 2014), the literature reviewed also showed how five of the possible fifteen features of the CDSS had led to an improvement. As a result, Kawamoto recommended that these five features should be implemented into CDSS wherever possible. However, they are not aligned to the “five” rights of CDS (Osheroff, 2009). WAST has already implemented CDSS into the ePCR. An example of this is the major trauma tool. Different versions are available, dependent upon the area the Paramedic is working in. No evaluation has been conducted to ascertain whether the electronic CDSS is more effective than the paper version previously used. Therefore, his findings can neither be confirmed, nor denied from a WAST perspective.

In his cross sectional and longitudinal study carried out from 2014 to 2017, Shekelle (Shekelle *et al.*, 2021) concluded that the ambulatory clinics, which were already classified as superusers, performed better than those who became superusers over the three year period. This would suggest that the clinical performance within WAST would increase, the longer the ePCR was used.

Ayaad examined the care provided by hospitals using paper based records against those using EMRs. He concluded that both the expected care and the recognised care were of a higher standard when the EMR was used in that hospital (Ayaad *et al.*, 2019). Again, this would suggest that WAST would see better clinical performance when using the ePCR, however, this is yet to be proved.

Rotenstein also had similar results when she studied the time 291 primary care physicians spent using the EHR. She found that the more time spent using the EHR, the better the ambulatory care quality outcome measures were (Rotenstein *et al.*, 2022). Within WAST, to date, no correlations between time spent utilising the ePCR and improved clinical performance have been measured.

During her survey of 4214 clinicians on their perception of whether EMRs improved patient care, Jones (Jones *et al.*, 2017) found that clinical practice improved the more the EMR was used and developed. Generally, a clinician felt that they would need to use the EMR for at least 2 years before they would show any improvement in patient care. These findings, however, have not been substantiated by WAST. The ePCR was fully introduced into WAST in March 2022, therefore, from this deduction, Paramedics who have been using the tool since its implementation should feel that it their clinical practice has improved, however, this was not evidenced in the survey.

In a cross – sectional study, Kern carried out a comparison of patient care between 204 physicians who were using EHRs and 262 who were using paper. She concluded that for four measures (haemoglobin A1c testing, breast cancer screening, chlamydia screening and colorectal screening) there was a correlation between EHR use and higher rate of care (Kern *et al.*, 2013). Within WAST, this correlation is yet to be proved.

2.3 Literature Summary

There were trends in the way that the ePCR was introduced and it was generally felt that more user involvement in the choosing of both the software and the tool would have been of benefit. In addition, more in-depth training should have been carried out to ensure user familiarity with the software. This is still supported as a recent study also found that exhaustion, sleeplessness, and job dissatisfaction were more predominant among those who used ePCR least (Lohmann-Lafrenz *et al.*, 2025). The testing of the tool in emergency situations would also be recommended to ensure that the tool was user–friendly in real–life use.

The ePCRs were felt to be difficult to use in the first instance, and the more familiar with the tool people became, the better the information entered was, which led to the better the quality of patient care. On several occasions, the tool had been altered at least once to help improve its quality.

The literature reviewed suggests that the introduction of ePCRs has led to an improvement in patient care, for example, through less medication errors. The ePCR can provide better knowledge of patient treatment, however, better recording was needed to contribute to this, for example, the recording of haemoglobin levels.

These findings resonate with WAST. The tool was adapted from one used in the Scottish Ambulance Service (SAS). There was little involvement with operational Paramedics. The tool was believed difficult to use, and the training provided did not meet all individual training needs. There have been multiple changes to the tool to date to make it easier to use. Paramedics can access previous patient records to ascertain their care history, however, this is reliant upon correct record keeping.

The literature that was reviewed is from various healthcare settings, so therefore shows no bias towards the ambulance profession. The information was across various years, and differing countries, so is therefore a large representative of electronic health record systems, not just those in the UK.

The data sources used were mainly large, so were representative of the study area. With any literature however, they may be specific author bias dependent upon the message that the author wishes to portray. Statistical data should be accurate, however can still be interpreted differently dependent upon the author’s views.

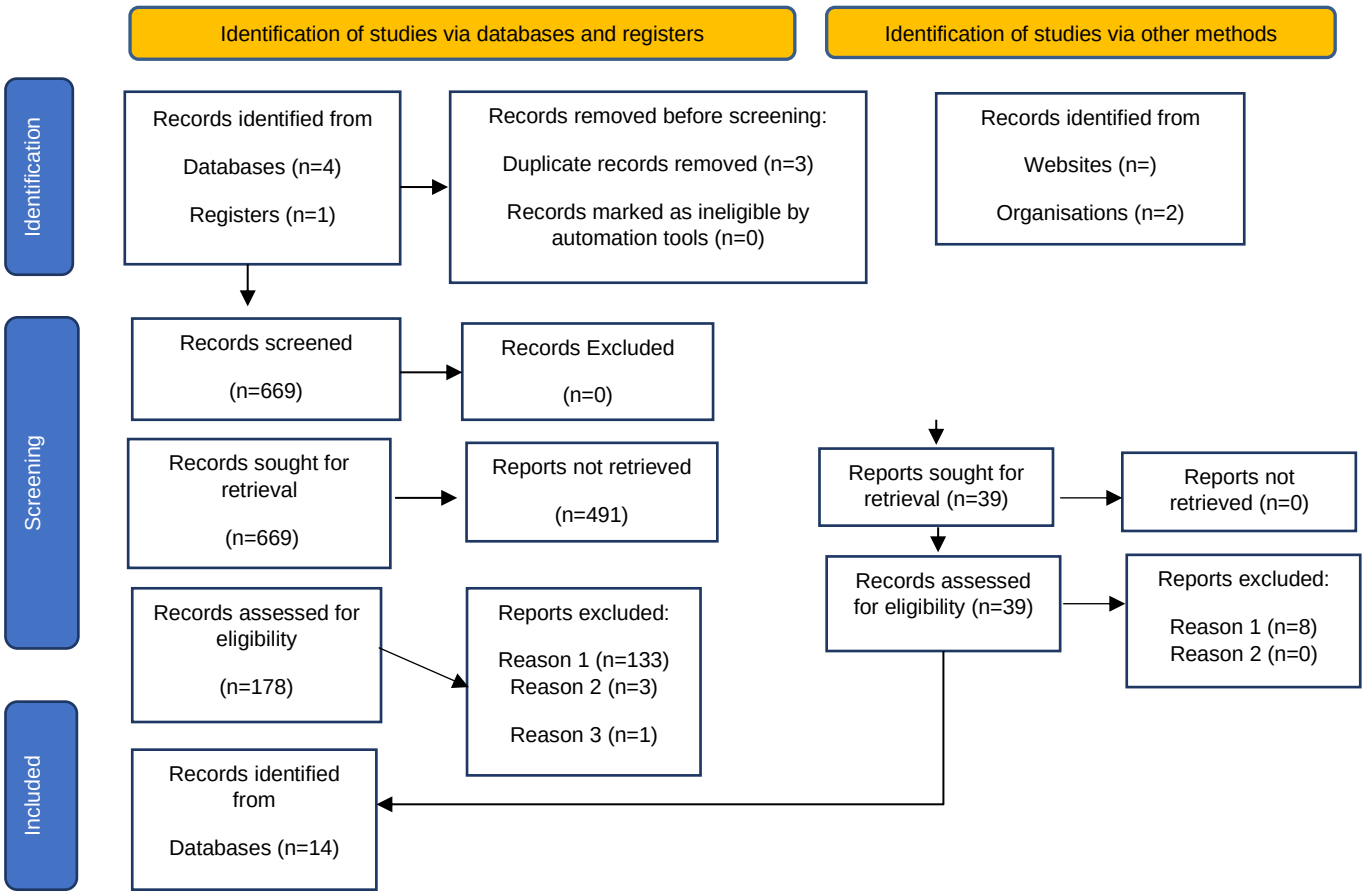

Figure 9: PRISMA Diagram to show literature search.

3 Method

3.1 Mixed Methods

A vital part of Quality improvement is evaluation (The Health Foundation, 2015). If carried out well, it can support problem-solving, develop knowledge, and help make decisions. For this evaluation, a mixed method approach was used which would gain both qualitative and quantitative data on order to answer the following question of “has the introduction of the ePCR led to an improvement in patient clinical care?”

3.2 Qualitative Data

The information required relates to individual user feedback regarding the specific ePCR utilised within WAST and its day to day operational use. Due to this, it was necessary to ask ePCR users for their personal opinions relating to the ease of use of the ePCR, and any positive or negative effects it has had on their personal clinical practice. To enable this, there was a bias, as only staff who fully utilise the complete ePCR system to perform their clinical role have been included.

The chosen method of data collection for the study was via a semi–structured user questionnaire designed and distributed via a Microsoft Form (see appendix 1). This contained both multiple choice answers, and free narrative boxes where the Paramedics could enter their own words to describe their thoughts and experiences. This was felt to be the most practical and cost-effective way to gain honest feedback in a timely manner as:

- Paramedics are based throughout the whole of Wales and have varying rotas that cover 24-hour periods 7 days a week, often with shift overrunning. Trying to obtain a face-to-face session would be costly and very time-consuming, with the possibility of late cancellations.
- The role of a Paramedic is an emergency one, therefore there cannot be a pre-planned convenient time to arrange to contact the Paramedic.
- Paramedics routinely carry an Apple iPad, so access to the Microsoft Form will be easy, and they can complete the form at their convenience.
- Paramedics may not provide honest opinions if they were seen face to face or may not just answer the question being asked but provide opinions on various other factors too.

Research was carried out so the study would contain suitable questions to provide a non–biased view of the ePCR within WAST. The author designed the questionnaire on Microsoft Forms and asked a small number of Paramedics who worked within her Directorate to trial the form and provide feedback to help her to ascertain whether the form was fit for purpose. The settings were altered as one question was set to single choice but needed to be multiple choice. Also, the Paramedics could not initially access the form due to permissions.

The questionnaire was distributed via email to Health Board Clinical Leads to forward onto their respective teams with a two week completion deadline on it. Once the two

week response deadline was reached, the results were analysed by using both Microsoft Forms which had pre–analysed data, and Microsoft Excel to gather trends and themes from the free–text narrative boxes. This enabled her to find any saturation points following the information being tested to ensure that the result was not due to chance.

The framework method for the analysis of the qualitative data (Gale et al., 2013a) obtained was not used as it was felt that a thematic analysis was more suited to the study due to the nature of the questions asked and the responses gained.

The thematic analysis was carried out by downloading all the answers onto an excel spreadsheet, then recognising themes that emerged from the free – text answers to the questions. Due to the small number of respondents, the themes were manually categorised, for example, any answers regarding the sharing of information, ePCR layout etc. Filters were then used to count the relevant responses. Whilst this was effective for this small set of data, the author acknowledges that for larger data, a more effective solution, for example, natural language processing would be considered, similarly to that demonstrated in Microsoft Forms.

3.3 Quantitative Data

To show whether the ePCR had made a positive difference to clinical practice, a comparison of pre and post clinical performance was required. This was done via a quantitative method of looking at clinical indicators of practice, ambulance response times for red calls and call to door times for strokes. The clinical indicators are a UK wide measure of clinical performance used within the ambulance service. Each element of care should be carried out to ensure clinical safety. Also, care which lies outside of the care bundles can result in inappropriate hospital admissions and lengthened stays which can increase response times, thus having a negative effect on patient care.

There was a direct comparison made between the two descriptive data sets of clinical indicators. Although the individual patients in the data are different, for the purposes of the comparison, they will be assumed as the same, e.g. all stroke patients will be considered equal. The reason for this is that there are justified exceptions allowed for each aspect of the care provided in each clinical indicator, e.g. an unconscious patient cannot raise their arms, or speak and, therefore are classed as compliant for FAST (face, arm, speech test).

The clinical indicator reports were examined for comparison. The data from the dPCRs for period January 2017 to December 2018 (inclusive) was obtained. The data from the ePCRs, for period January 2023 to December 2024 (inclusive) was obtained. The care bundle data has been provided monthly to Emergency Ambulance Services Committee (EASC) from WAST. The data is both collected, and quality assured by WAST data analysts. The information is available for any members of the public to view from the Ambulance Service Indicators (ASIs) via the EASC website (Emergency Ambulance Services Committee, 2024). The data regarding the individual elements of the care bundles, the red response times, and the call to door times were obtained and verified via an information request submitted to the WAST Insight and Data Services Team.

A clinical indicator is a tool which can be used to check clinical aspects of care that can have an impact on the outcome of patents. The clinical indicator is developed by comparing the Paramedic's practice with evidence based best practice. The data must be accurate, reliable, measurable, and complete, and regarding the things that matter most to patients and clinicians. The clinical indicator tool can be used to benchmark the Paramedic's practice and enable improvements to be made to enhance patient care.

The dPCR was introduced in October 2015. The ePCR was fully implemented in March 2022. A 2 year period was selected for the comparison following an initial settling in period for each. Although these may seem like a direct comparison, due to less fields within the dPCR, most justified exceptions could only be taken from the narrative section. Due to this, auditors had to manually audit non-compliant dPCR records.

Because of the nature of the incidents, e.g. number of STEMIs in a month, the sample data was for all patients who presented with that condition, consideration must be given regarding statistical significance where the numbers are low. The records consist of four clinical indicators:

Table 5: Clinical Indicator elements of care

Clinical Indicator	Elements
Stroke	**The stroke clinical indicator consists of four elements:** 1. FAST test, which measures facial droop, arm strength and slurred speech. 2. Blood glucose levels to show if there is a low blood sugar level. 3. Blood pressure levels to see if there is raised blood pressure. 4. Glascow coma score (GCS) which assesses levels of consciousness.
STEMI	**The STEMI clinical indicator is for patients who have an ST–elevation myocardial infarction (heart attack) diagnosed following an ECG consists of four elements:** 1. Was Aspirin administered? 2. Was GTN (Glyceryl trinitrate) administered? 3. Were there two pain scores recorded to ascertain whether analgesia was required, and if it was given, was it effective? 4. Was there an analgesia administered? A pain relief given to help ease the patient's chest pain.

Clinical Indicator	Elements
Fractured neck of femur	**This is for patients with a suspected fractured hip and consists of three elements:** 1. Measuring of vital signs (breathing rate, heartbeat, oxygen saturations, blood pressure and GCS). 2. Were there two pain scores recorded to ascertain whether analgesia was required, and if it was given, was it effective? 3. Was there an analgesia administered? A pain relief given to help ease the patient's pain.
Hypoglycaemic episode	**Episode of low blood sugar with associated effects and consists of the three elements:** 1. Was there a pre – treatment blood sugar test carried out? 2. If treatment to reverse the low blood sugar was required, was it given? 3. Was there a post – treatment blood sugar test carried out to see whether the treatment had worked, or whether further treatment was needed?

4 Results

4.1 Results of Paramedic Questionnaire

There were 78 responses (1.9%) to the questionnaire of approximately 4125 Paramedics who used the ePCR system within WAST at the time (this number is approximate due to turnover of staff, sickness etc. but correct at time of SQL query run on 9th January 2025).

Table 6: Job title

Job Title	Number	Percentage of 78 responses
Paramedic	39	50%
Advanced / Trainee Advanced Paramedic	20	25.6%
Emergency Medical Technician	9	11.5%
Senior Paramedic / Duty Operational Paramedic	7	9.0%
Ambulance / Urgent Care Assistant	3	3.8%

The role of Paramedic was the highest stated job title of people completing the questionnaire (table 6).

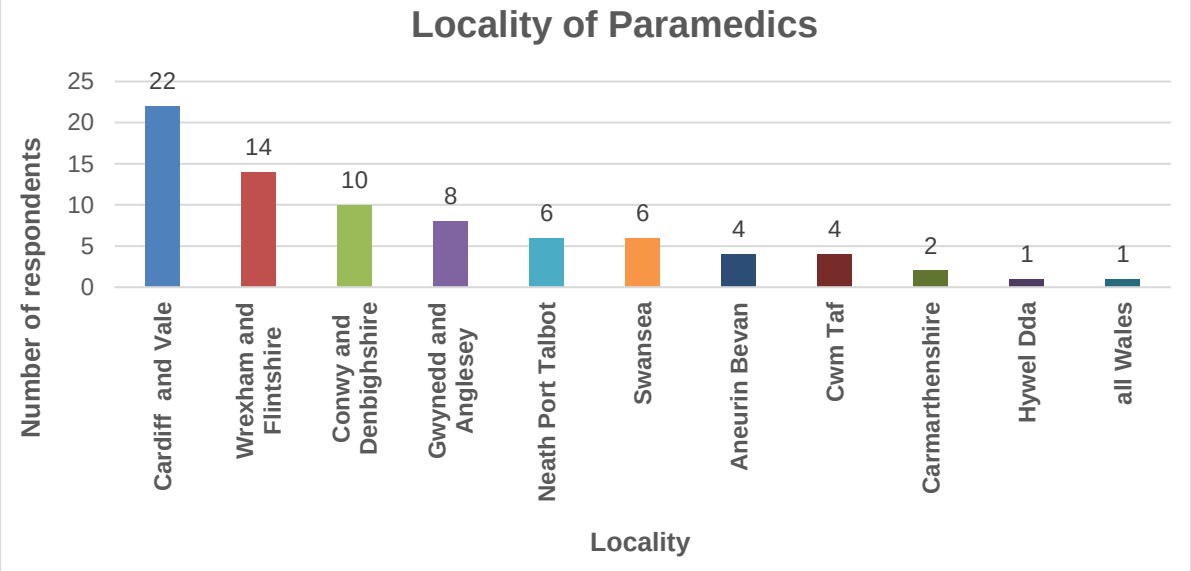

Figure 10: Graph to show Paramedic Locality

Most respondents came from Cardiff and Vale. From the results (figure 10), a drop down box could have prevented differences in answers for the same locality, e.g. Conwy & Denbighshire, Conwy and Denbighshire, Conwy, Denbighshire etc., however, this was not considered suitable at the time, as locality areas could alter, or some be unknown / missed in the questionnaire design, for example, someone who covers all Wales as management, but does shifts as an operational Paramedic across various locations in Wales.

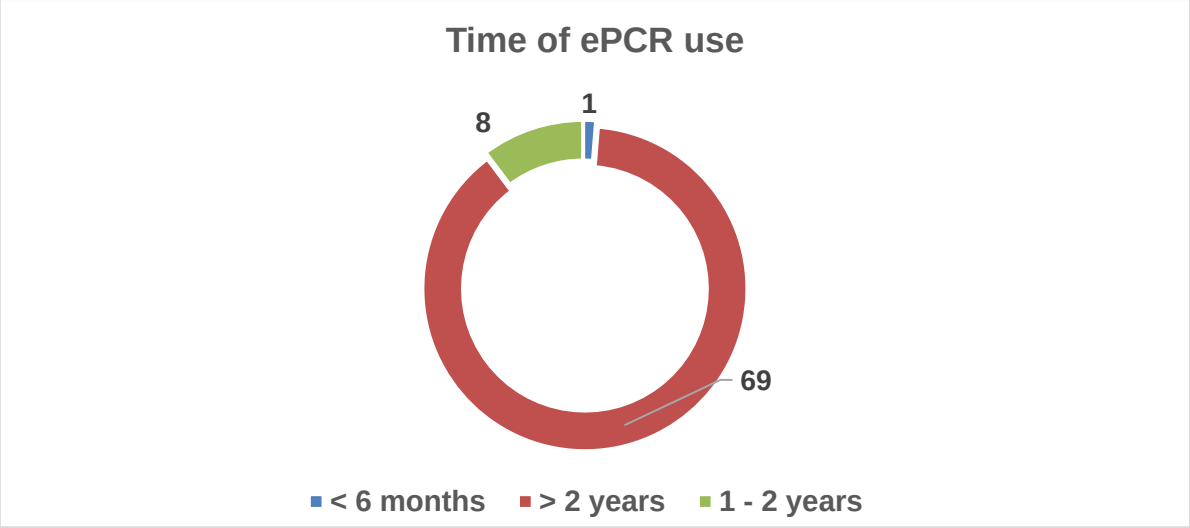

Figure 11: Doughnut graph to show time of ePCR use.

Most Paramedics (69) had used the ePCR for more than two years, and only one person had used it for less than 6 months (figure 11).

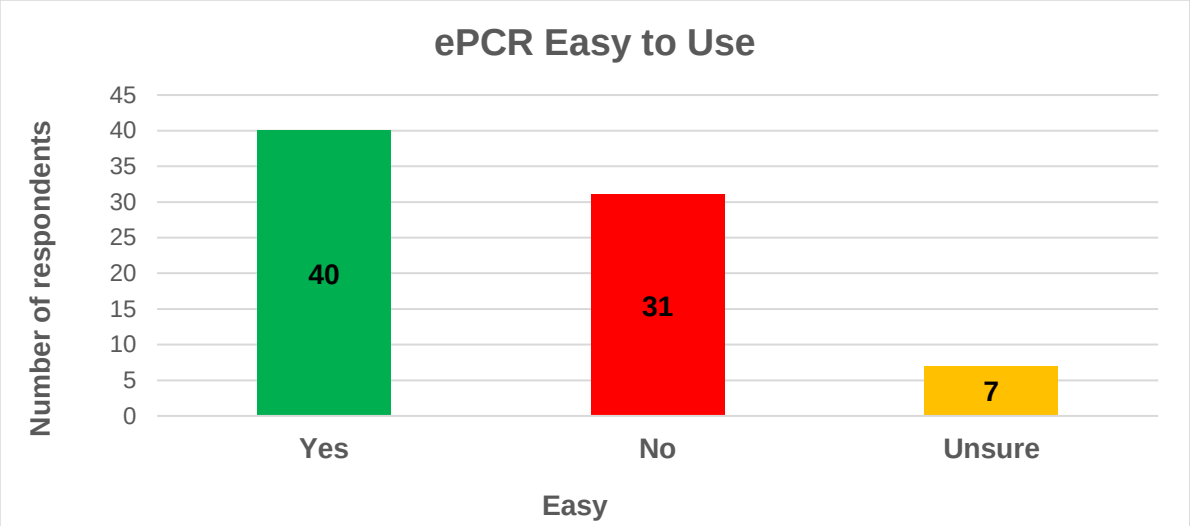

Figure 12: Graph to show if ePCR is easy.

When questioned whether easy to use, 40 Paramedics felt the ePCR was easy to use, however 31 Paramedics said it was not, and 7 were unsure (figure 12). Some Paramedics said the ePCR system was easy to use, however their comment contradicted this. For example, one said they felt it was not easy to use, but then made a positive comment, saying that it is very user friendly, has clear layout, is uncluttered, and flows well.

The main trends in comments on why people felt it was easy to use or not are broken down in table 7 below.

Table 7: Trends in comments regarding ease of use.

Trends identified in Comments	Number	Percentage of 78 responses
Layout is easy to follow	47	60.3%
Poor Flow	15	19.2%
Repetitive	7	9.0%
Connectivity Issues	4	5.1%
Too much information on it	3	3.8%
Copy and Paste removed	1	1.3%
Restrictive word count	1	1.3%

Other comments regarding the ease of use of the ePCR were:

One Paramedic said that some questions appear irrelevant, e.g. asking an 80 year old patient if they take cocaine. Also, there were concerns regarding poor connectivity to other systems, and the ePCR losing connectivity. The need for completion also made people feel as if they were being distracted from the patient. Several Paramedics said it prompts them to ask questions or conduct patient observations that they may otherwise have forgotten. Also, people felt that it became easier with familiarity, despite no formal training. One Paramedic liked the link to the JRCALC Guidelines. One stated they felt it was more like an auditing tool than a patient clinical record.

Several Paramedics felt that it was easier to document everything in the clinical narrative. This is seen to be both a positive and a negative factor from a clinical intelligence and assurance stance. While a clear and concise narrative is needed to log the incident details, it must not replace the appropriate documentation within the correct sections. This is due to being able to both audit patient care by looking at specific patient groups and predict future care needs. An example of this is the recording of falls. If a patient falls frequently due to low blood pressure, they may benefit from a referral to their G.P. If the blood pressure is not recorded in the appropriate section, this could be missed, and the patient's needs not addressed.

Several Paramedics had used other ePCR systems and had found the WAST ePCR system better.

All 78 respondents (100%) said that they had experienced connectivity problems. When asked to expand upon the reasons for this, the responses were:

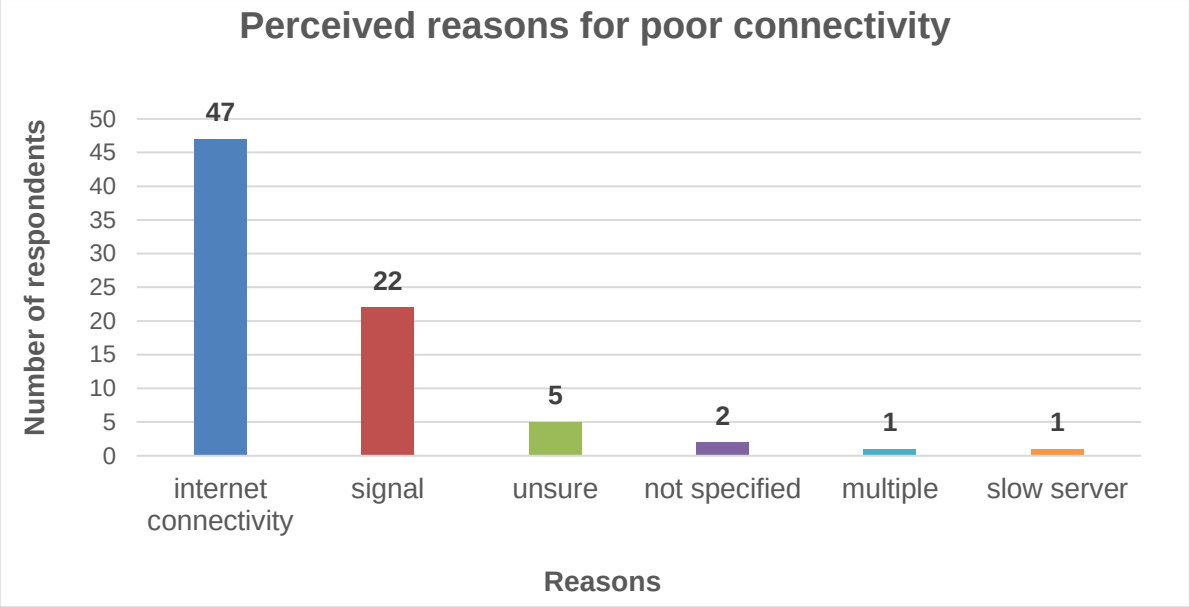

Figure 13: Graph to show reasons for poor connectivity.

Most (47) respondents (60.3%) felt that the poor connectivity was due to poor internet connection, whilst 22 (28.2%) felt that it was due to the quality of phone signal (figure 13). Many respondents said that they had problems with connecting to other systems, for example, the Corpuls system which records patient observations e.g. heartrate and then uploads the data onto that patient's ePCR. In cases where the ePCR loses connection, the Corpuls system does not upload the information. The Paramedic must then manually upload the information. Some respondents also said that the ePCR sometimes lost signal mid-way through completion which caused a loss of information on that patient record. For both cases, there is a risk of inaccurate or incomplete information being held for the incident.

Of the 78 respondents, not all had used a handheld tablet previously:

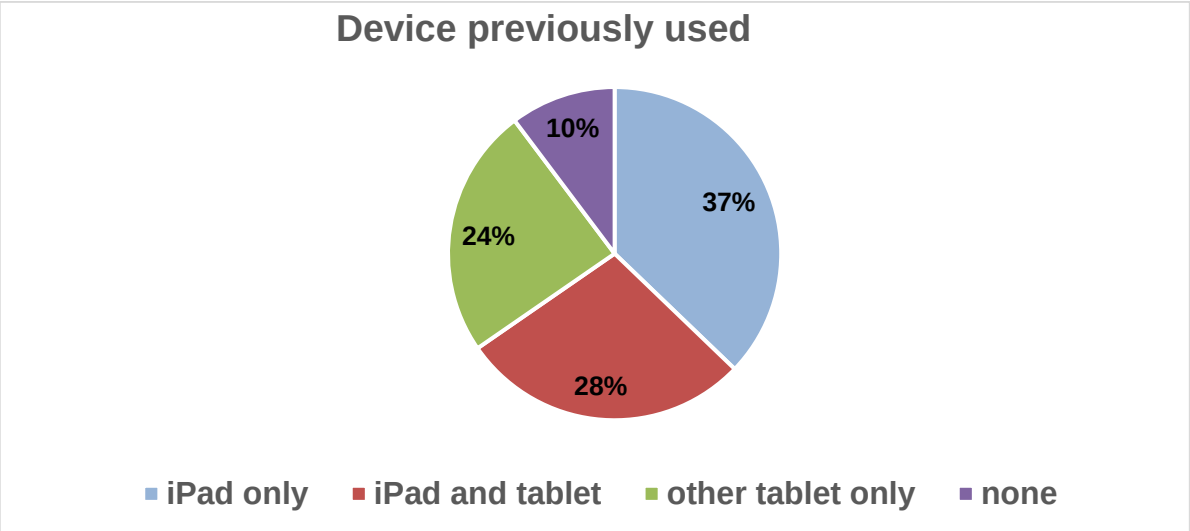

Figure 14: Pie chart to show devices previously used.

When questioned whether they had used an iPad or other handheld tablet, 29 respondents stated that they had previously used an iPad, 22 said they had used both an iPad and another handheld tablet, 19 said that they had used a handheld tablet, and 8 respondents said that they had not used either an iPad or a handheld tablet previously (figure 14).

The respondents were asked whether they felt that using the ePCR had led to an increase in time spent at the incident, and an increase in their stress levels:

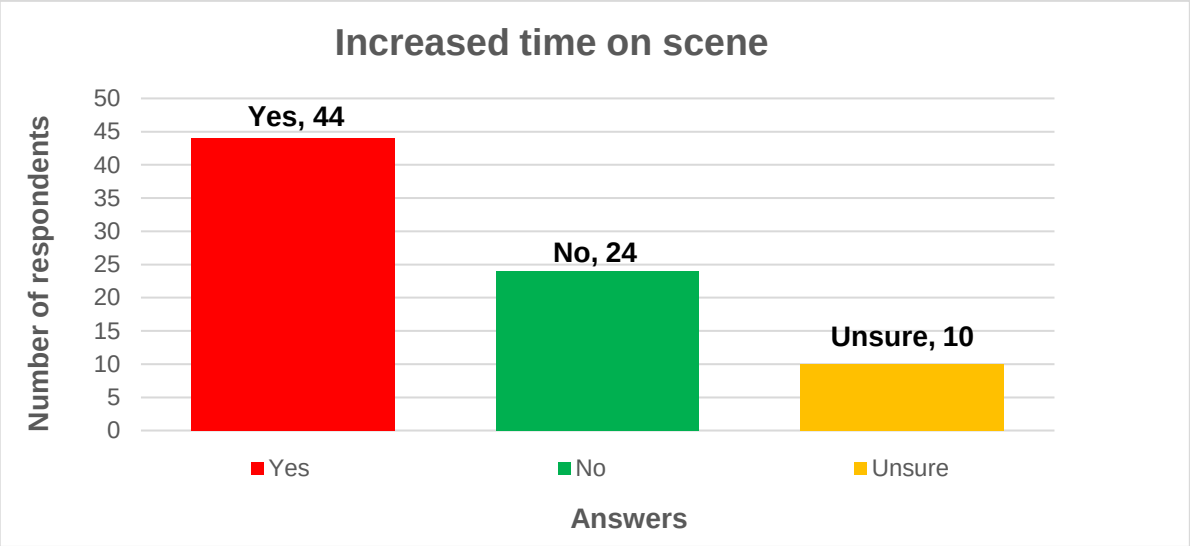

Figure 15: Graph to show increased time at scene.

Over half of respondents (56%) felt that ePCR had increased the time they spent at the incident scene. 31% felt it had no impact, and 13% were unsure (figure 15).

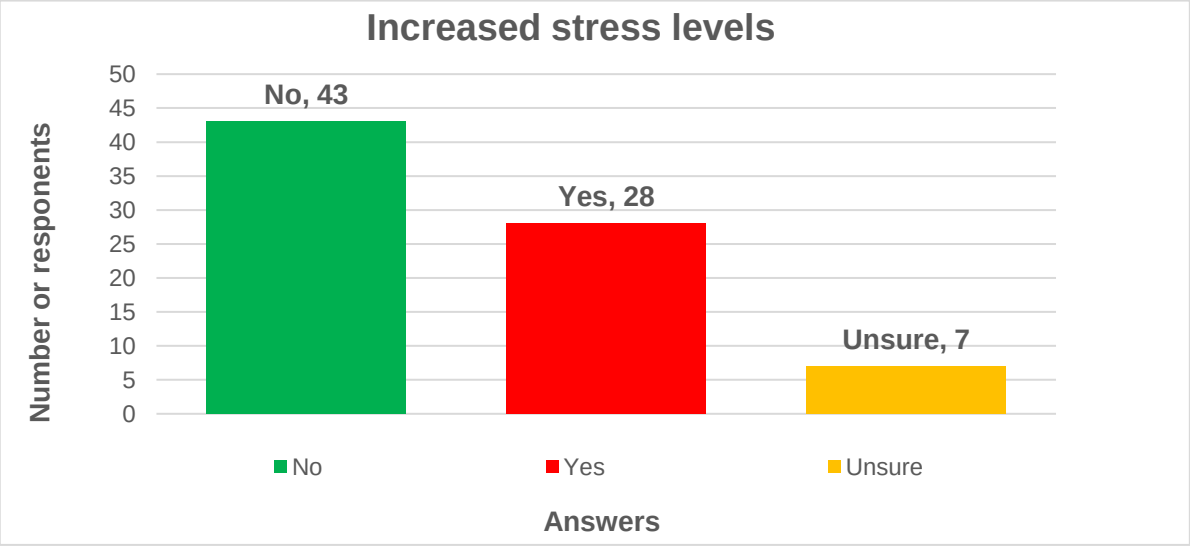

Figure 16: Graph to show if stress levels increased.

36% of Paramedics felt that the ePCR had increased their stress levels, 55% said it had not, and 9% said they were unsure (figure 16).

Due to the complexity of the ePCR, and the increase in the number of fields between the dPCR and the ePCR, the study aimed to find out whether Paramedics found the ePCR difficult to navigate. The Paramedics were asked to rate how they felt.

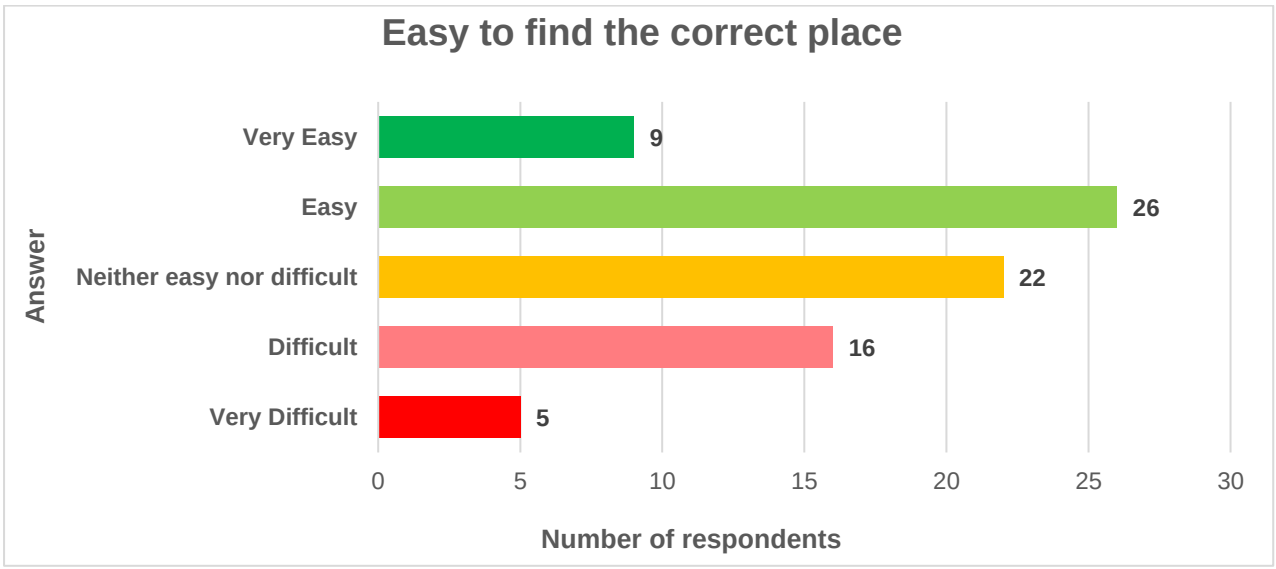

Figure 17: Graph to show ease of finding the correct place.

28% of Paramedics found the ePCR neither easy, nor difficult to find the correct place, most found it either easy (33%) or very easy (12%). However, over ¼ of respondents found it either difficult (21%) or very difficult (6%) to find the correct place (figure 17).

The Paramedics were asked what specific features they liked and disliked about the ePCR.

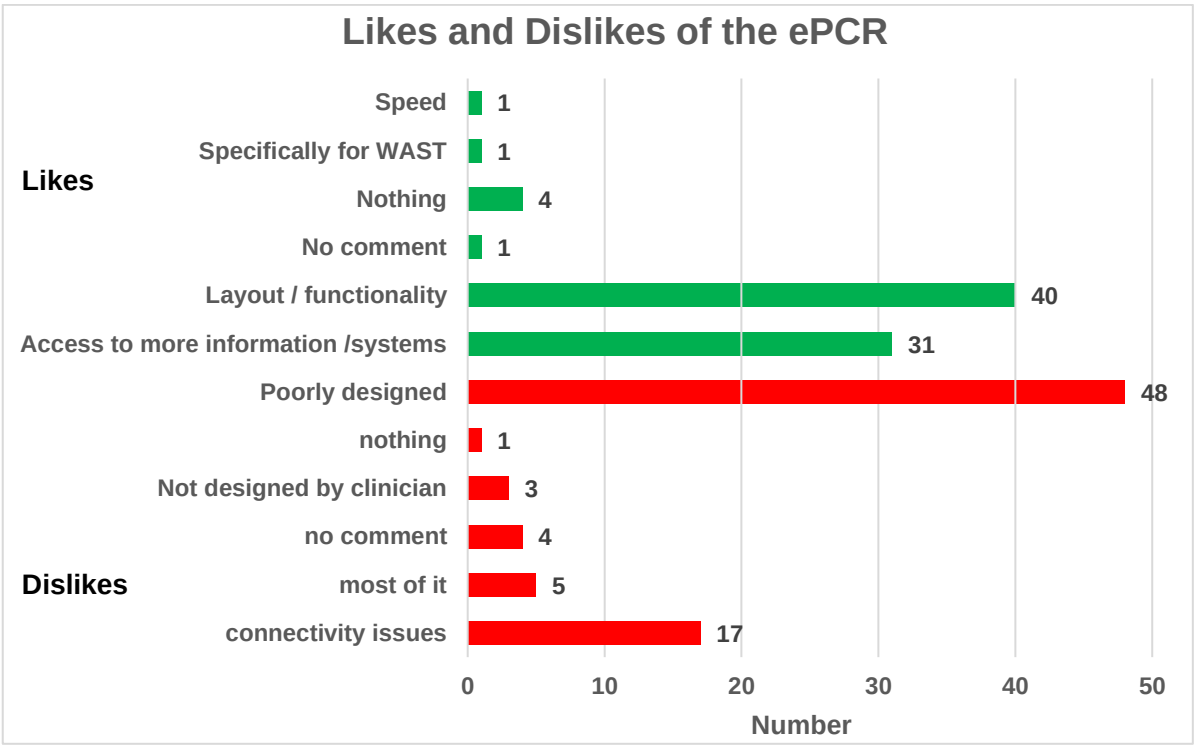

Figure 18: Graph to show ePCR likes and dislikes.

Whilst most Paramedics felt that they liked the layout and functionality (40), most also felt that it was poorly designed (48), and could be improved upon, for example, whilst Paramedics felt that some elements of design were good, for instance, the side bar being an easy reference point, some felt it lacked free text fields in which to write extra comments, or some observations like the temperature being recorded in a strange place (figure 18).

When questioned if they felt anything can be done to improve upon the ePCR design, 61 (78%) Paramedics said there could, 5 (6%) said there couldn't, 11 (14%) were unsure, and one did not answer.

Of the 61 Paramedics who said that the ePCR system could be improved upon, reasons were (table 8):

Table 8: Comments for improvement.

Comments from responders	Number
Improve user interface issues	42
Improve connectivity problems.	6
Increase the battery life.	1
Complete redesign of the ePCR.	3
A laptop would be better than an iPad.	1
Artificial intelligence (AI) would be helpful, for example, automatically transferring ECG and G.P. records.	1
Improve the layout of the final version of the ePCR that the reader (doctors, nurses etc.) sees as currently it is not laid out in a reader–friendly format.	1
More reminders to prompt them to complete any missed fields.	1
No comment.	5

When questioned whether they felt that the ePCR had improved their clinical practice, 20 Paramedics felt it had, 31 felt that it had not, 11 were unsure, and 16 felt that there was no impact to their clinical practice (figure 19).

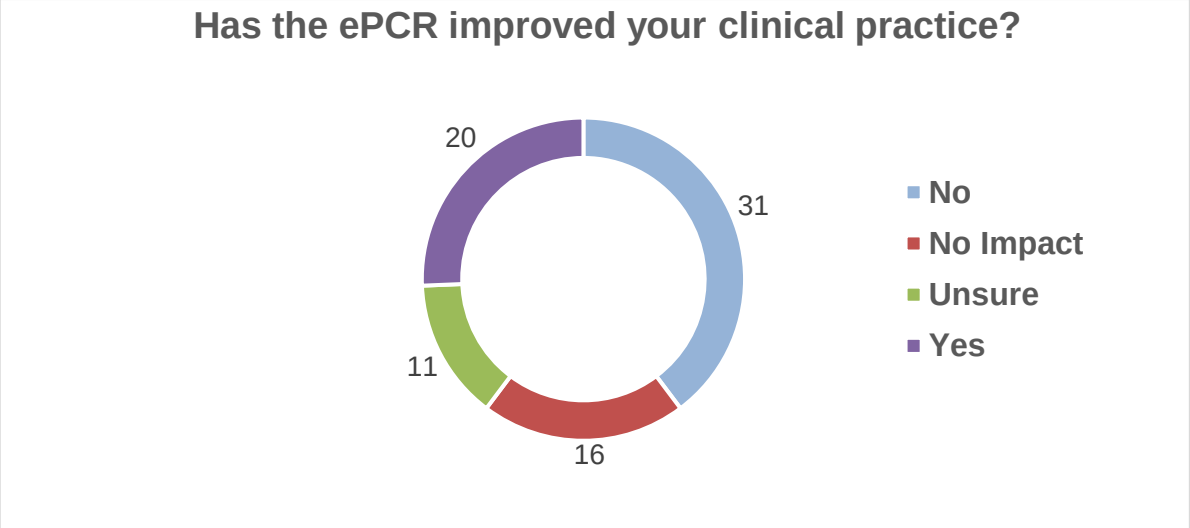

Figure 19: Doughnut graph to show if ePCR had improved clinical practice.

When asked for their reasons why they felt it improved their clinical practice, of the 20 who felt it had (table 9):

Table 9: Comments on how it had improved clinical practice.

Comments from responders	Number
There are prompts for clinical assessments that may otherwise have been missed.	12
Seeing previous records for the patient can help to see their medical history which helps with decision making and seeing other Paramedics practice can help you to reflect on your own practice.	4
Better documentation enables you to share more information with the hospital etc	1
Sped up the process	1
No comment	2

Of the 31 Paramedics who felt it had not improved their clinical practice (table 10):

Table 10: Comments on how it had not improved clinical practice.

Comments from responders	Number
Completing the ePCR made no actual difference to their clinical practice as it was merely a tool to collect the information.	15
It increased the time on scene at the incident, so they had less time to spend with the patient	8

Comments from responders	Number
Problems with connectivity had hindered their practice and increased stress levels as the record had to be completed retrospectively or long times were spent walking the street trying to get a signal for the ePCR to work.	2
Paramedic sought help from an Advanced Paramedic if they needed support with their clinical practice	1
It was no different completing the ePCR to the paper version in terms of the care provided.	1
the ePCR was too complicated to make any difference	1
No comment	3

Of the 11 Paramedics who were unsure whether the ePCR had made a difference to their clinical practice (table 11):

Table 11: Comments on how it had not altered clinical practice.

Comments from responders	Number
Commented that they were new to WAST	2
Still had the same level of clinical practice as before the ePCR	4
Prompts were useful, but that their clinical practice had remained the same	2
No comment	3

4.2 Summary of Questionnaire Results

Often when a questionnaire is analysed, there is a bias in the people who respond, as they can have a strong opinion of either for or against the topic. To mitigate risk of bias, a link to the questionnaire was distributed via the Health Board Clinical Leads within WAST who are based Wales–wide, with a description of why the results were required. The results of this questionnaire have proved positive when considering the author's bias, as the results do not show a strong preference. There is a mix of length of time the ePCR has been used, locality of the Paramedic completing the questionnaire, and whether the ePCR was easy to use. This shows that the sample was purely random from the author's perspective.

The results show the ePCR both as a positive and a negative tool. Whilst some Paramedics feel that it helps to remind them to ask certain questions and complete observations they may have missed, many feel that the ePCR is merely a tool for data collection. They feel that many questions are a waste of time and there is a lot of repetition. They like the fact that they can see previous patient records, and link to other

databases, however, this is often hampered by poor connectivity. The ePCR takes longer to complete than the earlier paper versions, therefore time is being taken away from patient interactions. Some feel that the ePCR is well laid out, however others feel it is difficult to navigate. There seems to be room for improvement in layout and fields for collection. The tool automatically calculates the national early warning scores (NEWS) from observations taken, which is liked, however the consent to treatment is difficult to remember due to where it is positioned on the ePCR. A theme from the respondents is that there should be more narrative, and the once available 'copy and paste' function should be reinstated as it proved useful, especially to those with dyslexia or neurodiversity.

Whenever there is a new intervention, users will usually have different views, some positive, and some negative. From the author's perspective, the answers appear to be truthful with a lot of comprehensive explanations which she has collated into themes.

Although there is nothing specific to capture the views of patients attended to by WAST Paramedics, the results show that patient care has been affected. Paramedics have commented that they have felt that completing the ePCR has led to them being disconnected from the patient which has a negative impact on the patient. However, they do appreciate being able to see previous patient records as it helps them to gain a better understanding of the patient's condition which enables them to provide better care to the patient. Also, respondents said that it increased time on scene with the patient. Whilst this may have improved the experience of the patient being treated, it will have a negative impact on any patients waiting for an ambulance and can pose an organisational risk for ambulance response times.

4.3 Clinical Indicators

Figure 20 below is a visual guide which was designed by members of the CIAT to remind Paramedics of the elements of the clinical indicators for which data is being collected within WAST. Each element of care should be completed in the relevant different coloured section to ensure the complete bundle of care has been carried out, for example, the blue hypoglycaemia section, where both a pre and post treatment blood glucose test should be carried out, in addition to the appropriate treatment provided where necessary.

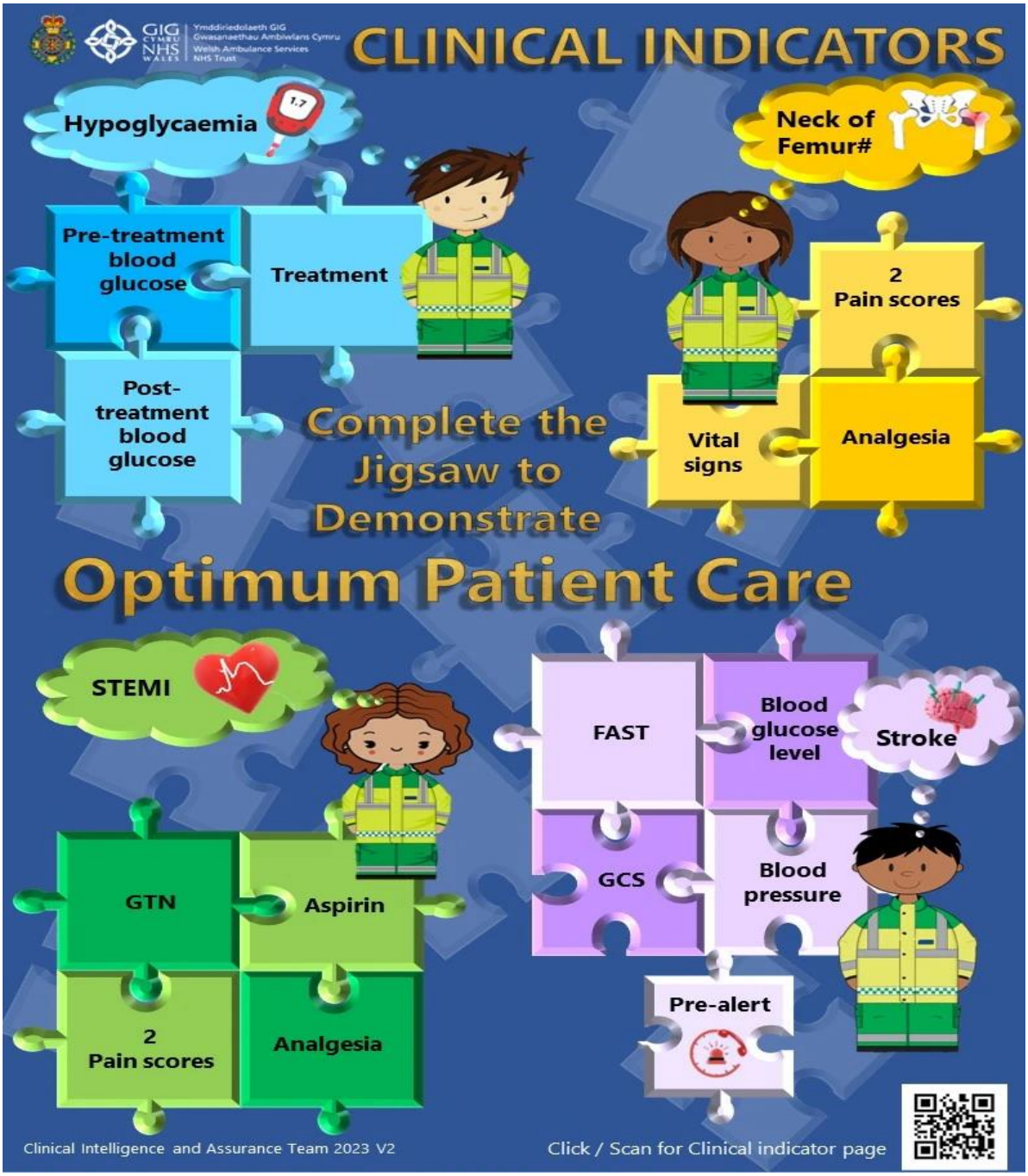

Figure 20: Clinical Indicators Visual Aid

4.4 Comparison of Clinical Indicator Data

Below, shown in the figures 21 to 28 are run charts that show the clinical indicator data for the dPCR and the ePCR for comparison for the four indicators mentioned above.

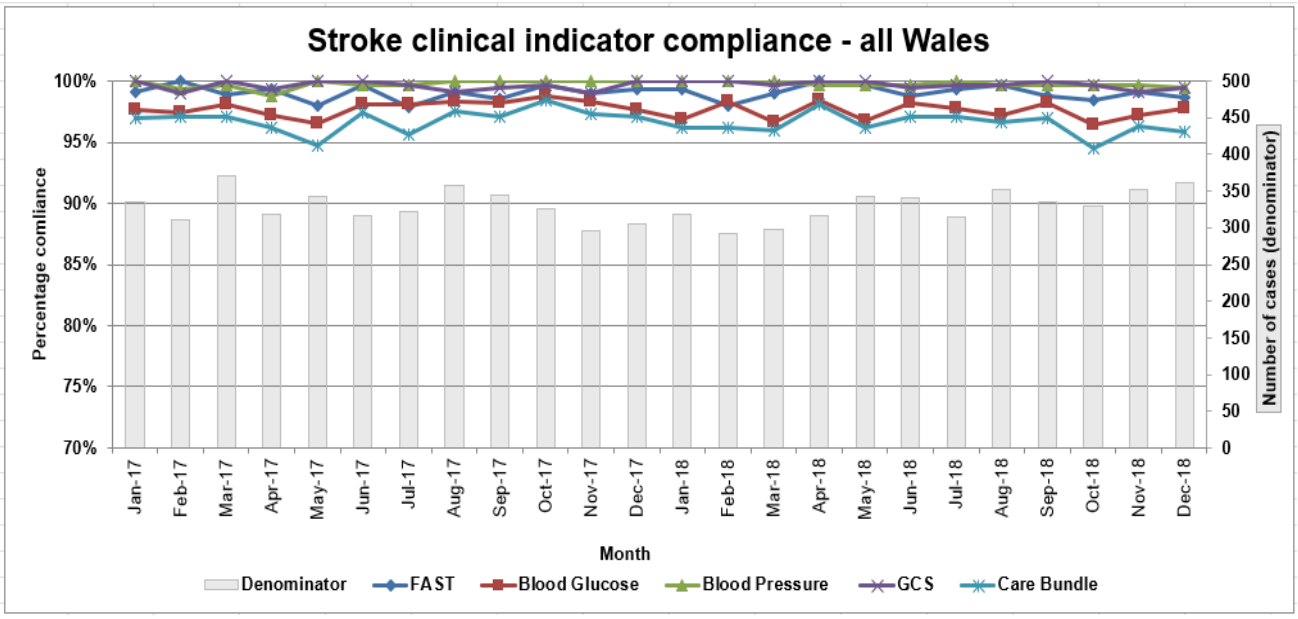

Figure 21: Stroke dPCR clinical indicator data.

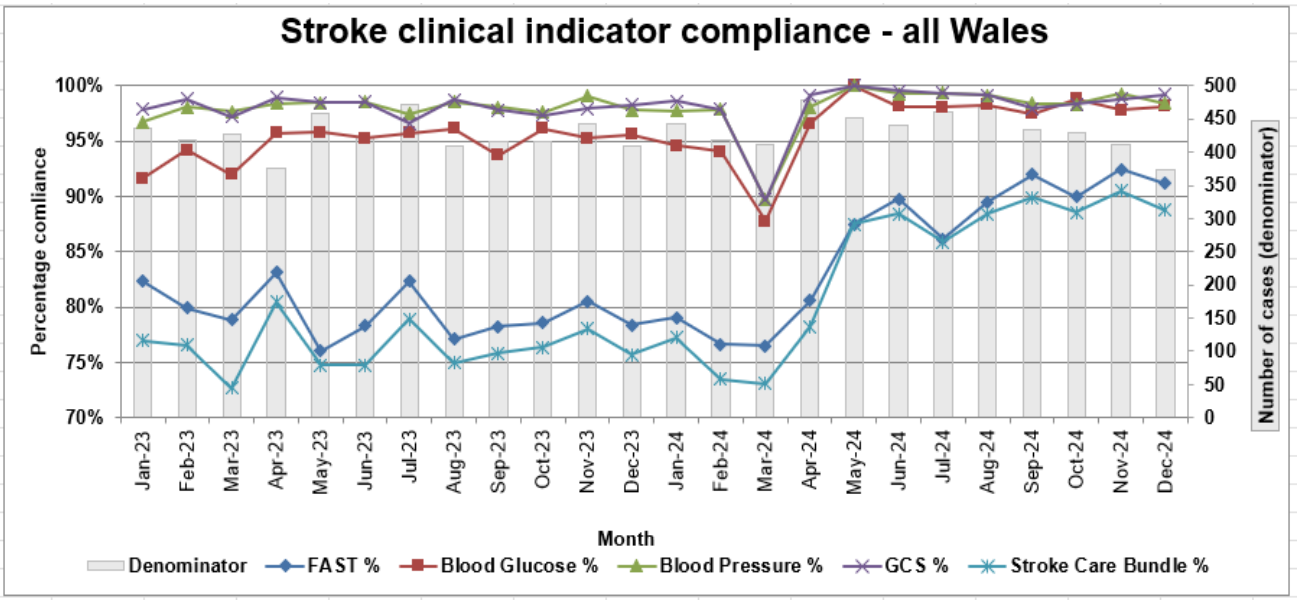

Figure 22: Stroke ePCR clinical indicator data.

The stroke care bundle must be completed for all patients who have been identified as having a stroke. The Paramedic must complete a FAST test (face, arms, speech), measure the patient's blood sugar levels, and blood pressure in addition to the patient's level of consciousness (GCS score). The number of patients identified as having a stroke has increased from the range of 292 to 371 for dPCR to the range of 373 to 478 for ePCR. This is a significant increase. As can be seen by the comparison of the stroke dPCR (figure 21) with the stroke ePCR clinical indicator graphs (figure 22), whilst the care bundle remains above 90% for the 2 year period for the dPCR data, it took a considerable time (14 months) before it started to improve. It has, however remained about 85% compliance for the care bundle since. There are various reasons which could account for this increase (figure 29). As can be seen, in March 2024, there was a drop in

compliance in blood glucose readings, blood pressure readings and GCS scoring. This will be investigated to ascertain the reason.

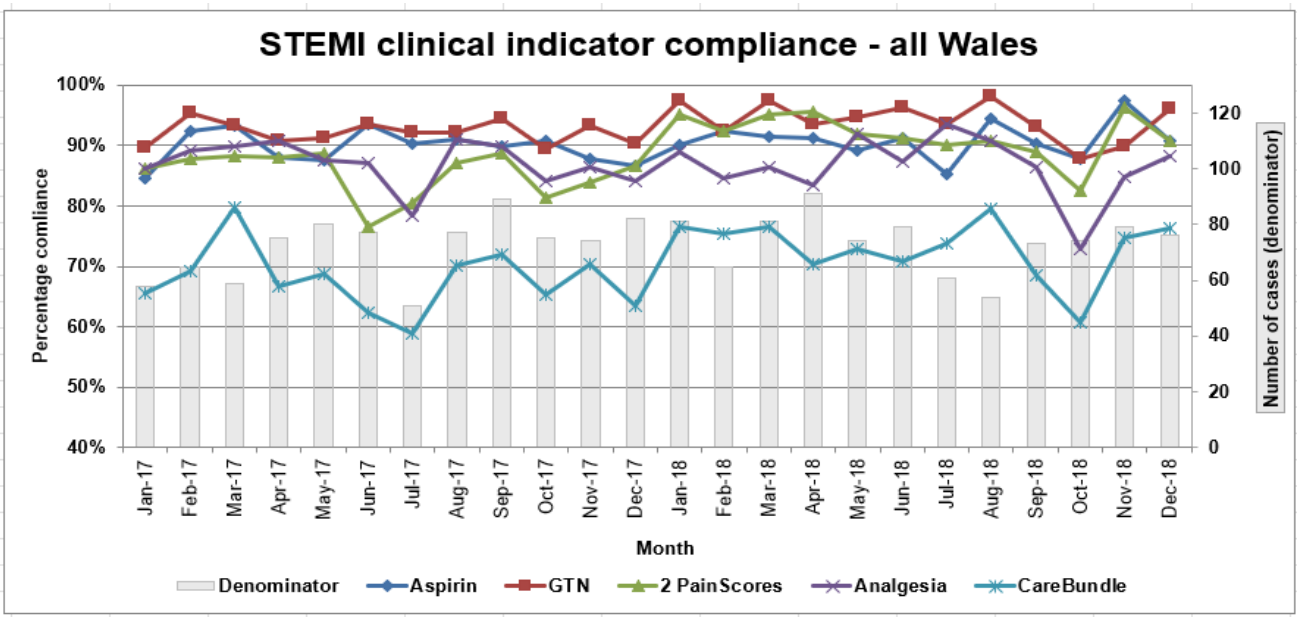

Figure 23: St elevation dPCR clinical indicator data.

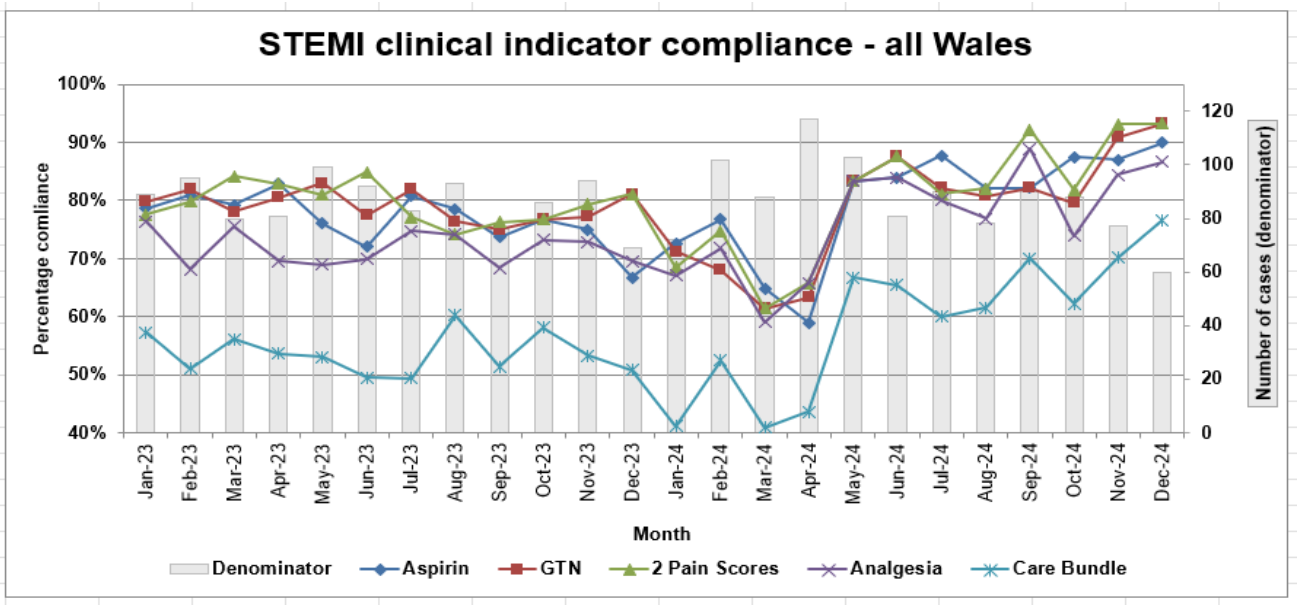

Figure 24: ST elevation ePCR clinical indicator data.

The STEMI (heart attack) care bundle consists of obtaining two pain scores between 0 and 10, and giving the patient Aspirin, GTN and pain relief, (Morphine or Paracetamol) as needed. As shown in figures 23 and 24 above, the care bundle compliance for dPCR starts and ends similarly to the ePCR, however, the dPCR stays at over 60% compliance for almost all the time (excluding July 2017), but the ePCR compliance ranges between 40% and 60% for the first 16 months. Again, there is a sharp rise in May 2024, which

may be attributed to the ongoing clinical indicator recovery work carried out, as shown in figure 29.

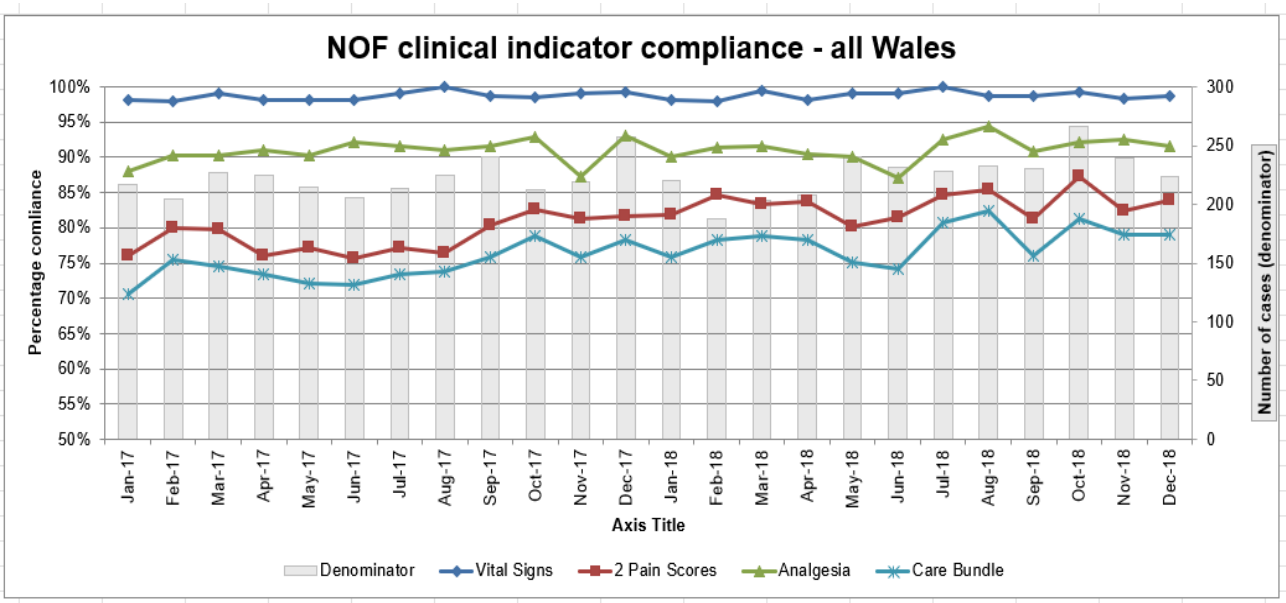

Figure 25: Fractured Neck of Femur (NOF) dPCR clinical indicator data.

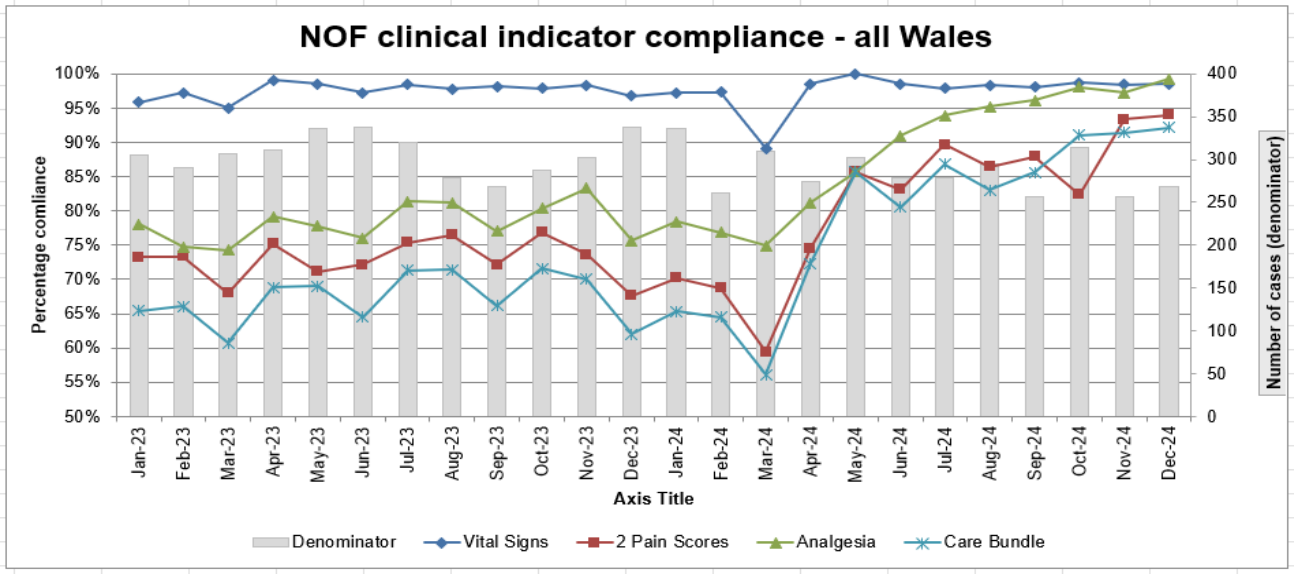

Figure 26: Fractured Neck of Femur (NOF) ePCR clinical indicator data.

For care bundle compliance with the fractured neck of femur (NOF), the Paramedic must record the patient's vital signs, pain scores, and give the patient pain relief when needed. The vital signs consist of measuring the patient's breathing rate, pulse, blood sugar and level of consciousness. The patient's pain is measured by the patient giving at least 2 numerical pain scores between (0 – 10). Best practice is to gain a pain score both before and after the pain relief is given.

The data shows a completely different pattern for the dPCR (figure 25) and the ePCR (figure 26). The recording of vital signs stays constant and comparable on both graphs;

however, both the pain scoring and administration of analgesia (pain relief) bring down the care bundle compliance greatly. Until the shift in May 2024, the care bundle compliance only ranges from between 56% (March 2024) and 72% (April 2024). The number of patients is similar in both datasets.

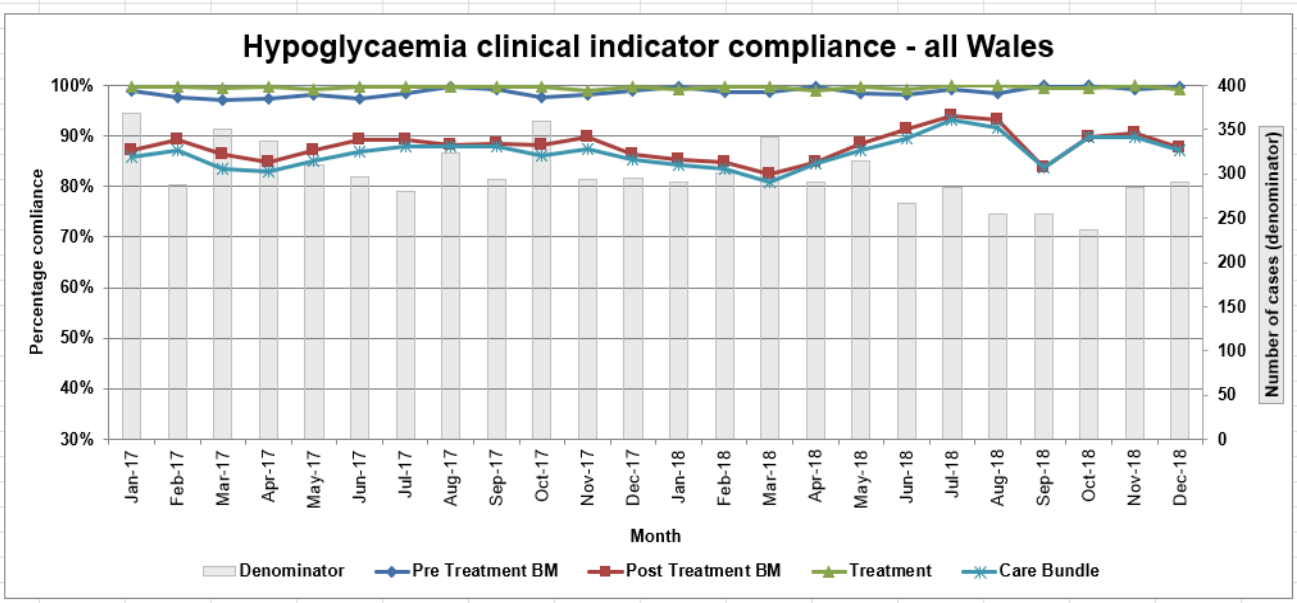

Figure 27: Hypoglycaemia dPCR clinical indicator data.

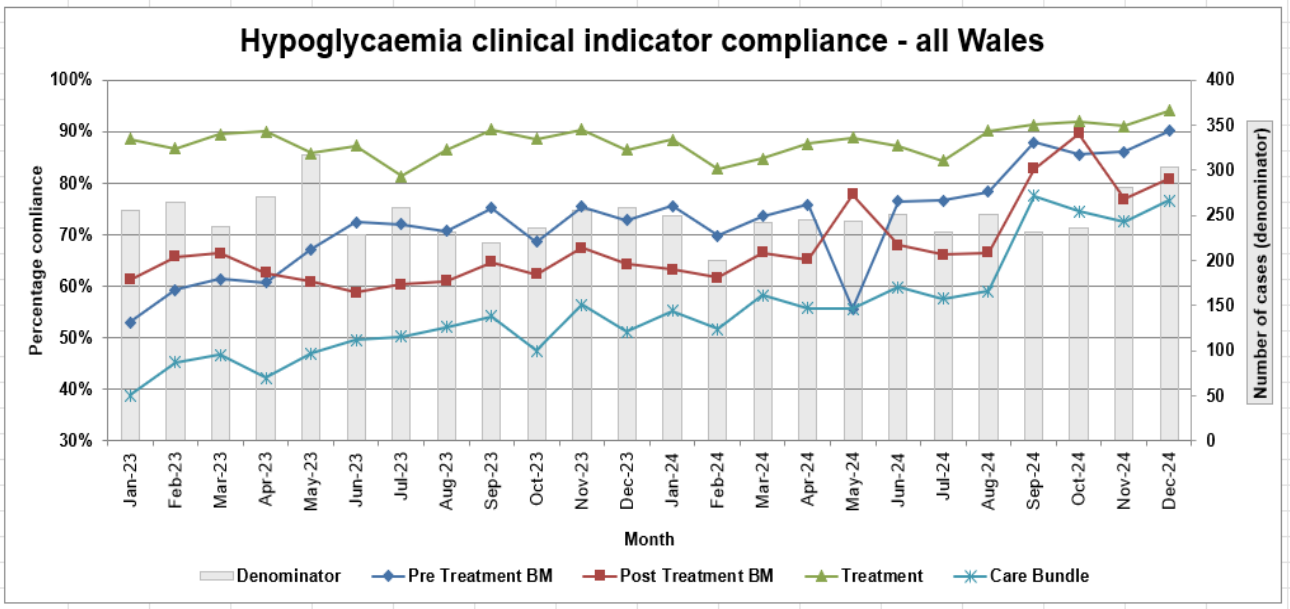

Figure 28: Hypoglycaemia ePCR clinical indicator data.

A hypoglycaemia care bundle must be completed for all diabetic patients who have a blood sugar reading of less than 4mmols. Both pre and post treatment blood sugar reading must be recorded, and any treatment given, for example, a sugary drink. The hypoglycaemia care bundle compliance varies vastly between the dPCR (figure 27) and the ePCR (figure 28). Whilst the dPCR care bundle constantly remains above 80%, the

ePCR commences at 39%, and never reaches 80%. The main causes for low compliance are the recording of a pre and post–treatment blood sugar (BM) reading.

It is important to note that to be compliant for the care bundle, all individual elements need to be achieved, for example, although the three criteria in the hypoglycaemia graph in figure 28 above are greater than 50% (53%, 61% and 89%) in January 2023, the bundle compliance is less than 40% (39%).

4.5 Clinical Indicator Summary

The clinical indicator data represented in figures 21 – 28 above shows that there is a significant difference between compliance levels from dPCR and ePCR. This may be due to the data being audited manually for dPCR and not for ePCR. There were far less fields to complete in dPCR, and all justified exceptions were documented in the narrative section. As the narrative section is no longer considered when auditing clinical indicators in the ePCR, this could be the reason for lowering the compliance levels.

4.6 Deep Dive Audit

Due to there being an unexplained dip in compliance in the STEMI clinical indicator in January 2024, CIAT carried out a deep dive audit. The results showed that it was not only about the completion of the ePCR, but also, due to the complex nature of the ePCR, there were scripting errors, which meant that the data obtained was incorrect.

Following the audit, compliance to the STEMI care bundles had increased by 26 (36%). 13 of these were due to the information being documented in the narrative section of the ePCR, and 13 were due to errors found within the scripting (table 12).

Table 12: Causes for changes in non-compliance.

January records		Change in care bundle compliance
Type	**Description**	
Written in narrative	Aspirin	0
	GTN	1
	Justified Exception	9
	Pathway Obstruction	2
	Treatment not correctly recorded on ePCR.	1
Caused by scripting	ASP previously administered	5
	GTN contraindicated, but not compliant	2
	Aspirin, GTN, Morphine etc administered, but not shown as compliant	1
	Inter Hospital Transfer Criteria	5

4.7 Clinical Indicator Recovery Plan

In March 2024, due to the poor compliance levels for all the clinical indicators, there was an initiative to improve the results. A task and finish group was set up to establish reasons for the fall in compliance levels and put together a plan to improve them. The following diagram (figure 29) shows the interventions that were carried out over the 6 month period from April 2024 to September 2024. As demonstrated above, whilst it cannot be proved which intervention led to an improvement, or an entirely different unknown influencer, for example, familiarity with ePCR or actioned requests for change to the system, there has been a significant increase in the compliance rates for all the ePCR care bundles shown in figures 22, 24, 26 and 28 above.

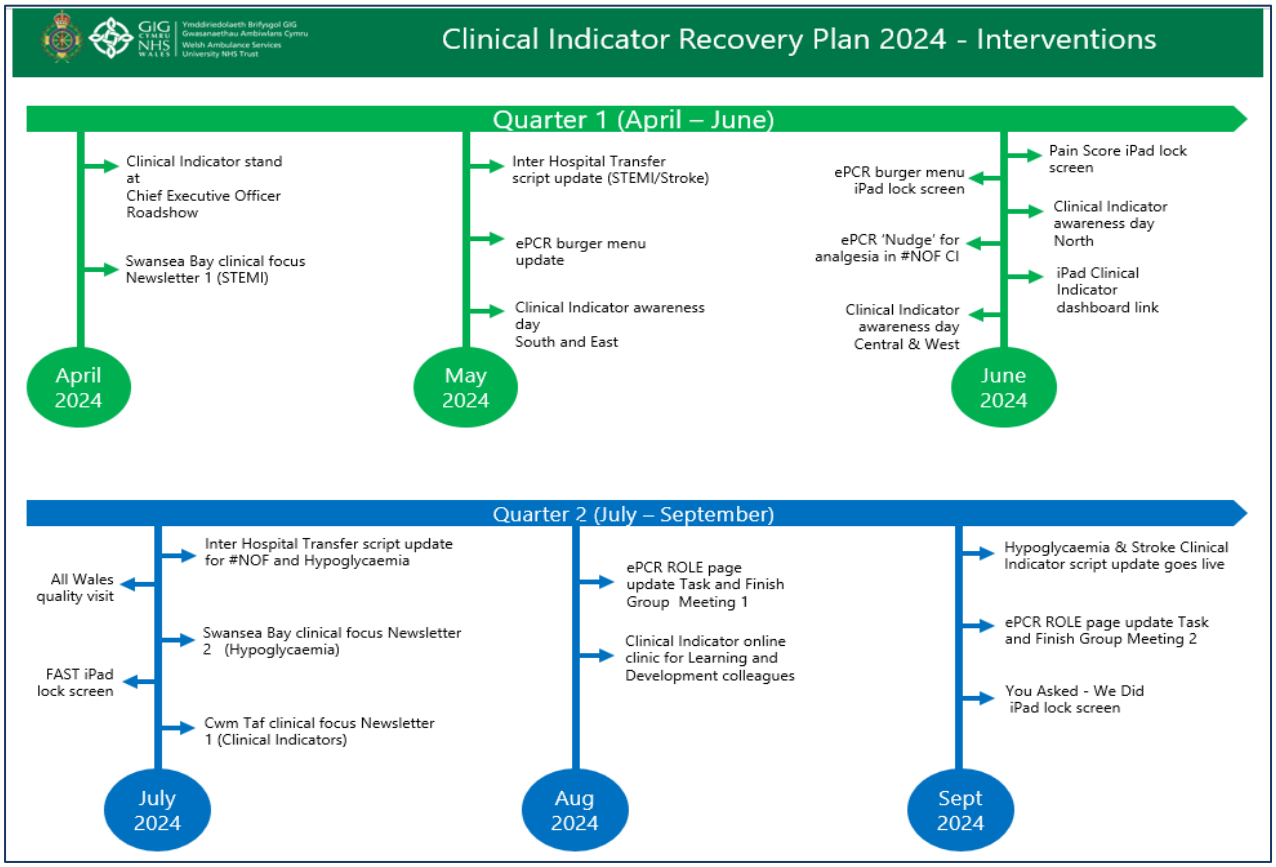

Figure 29: Recovery Plan.

4.8 Time based metrics

Since 1974, there has been an 8 minute ambulance response target of a minimum of 65% for all emergency life threatening (red) calls, such as cardiac arrest or choking (Durham, Faulkner and Deakin, 2016). The quicker the response time, the better the chances of survival are for the patient. Due to increased demand on WAST, there needs to be, not only a quick response, but also appropriate treatment of patients, and no wasted time at scene once the Paramedic is in attendance.

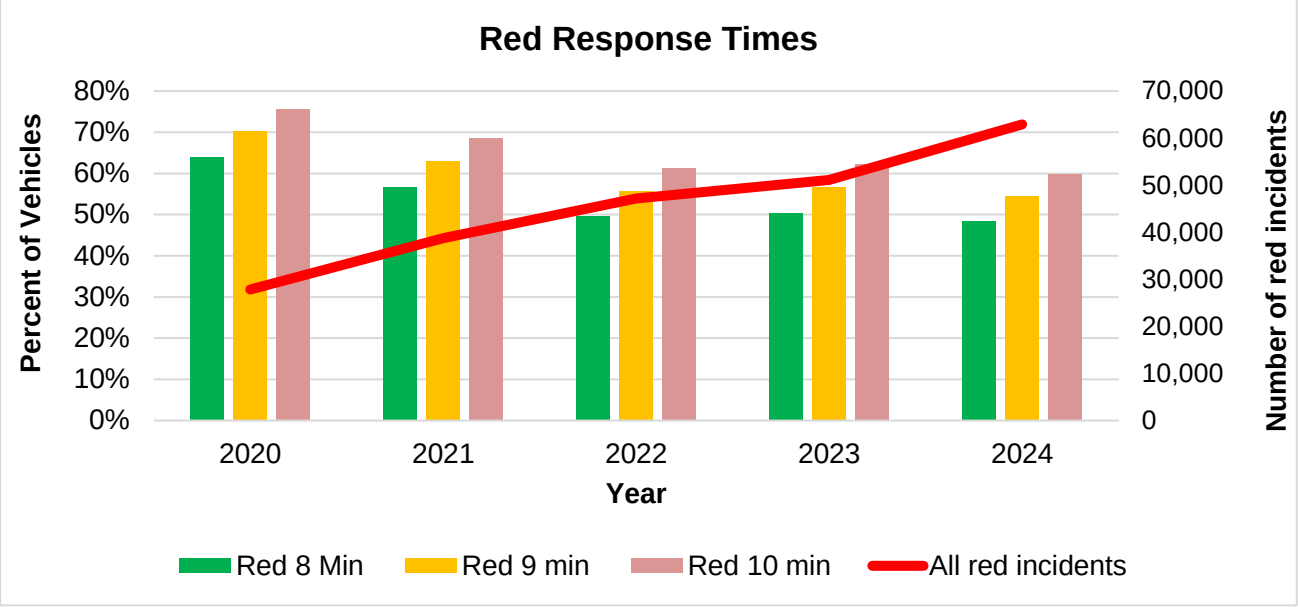

Figure 30: Red response graph.

The volume of calls categorised as red has increased year on year since 2020, however, the percentage of 8 minute responses has seen a decline from 64% in 2020 to 48.5% in 2024 (figure 30). Also, red 9 and 10 minutes responses have declined too (excluding 9 minute response in 2023) This suggests that there is a direct correlation between the rate of red response calls rising and the response times getting longer. There would need to be a significant improvement in response times to ensure patient safety.

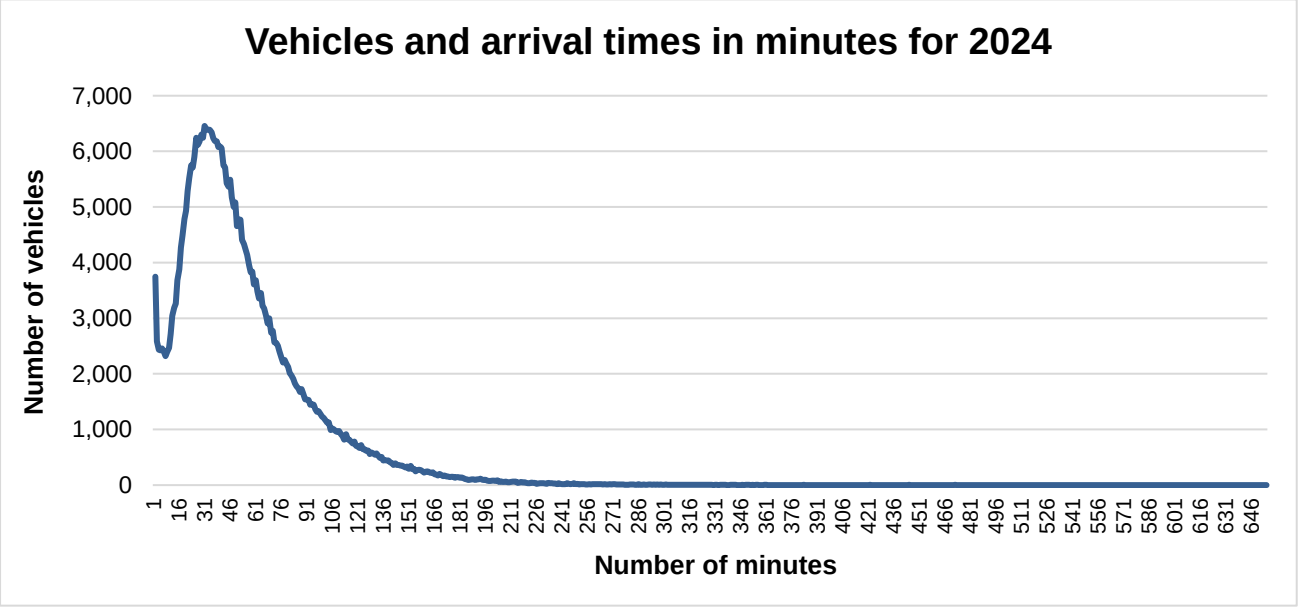

Figure 31: Vehicle arrival times.

The amount of time taken between the emergency 999 call and the time in which the ambulance arrived at the incident scene shows that the modal time for arrival of vehicles in 2024 is 30 minutes, with 6,456 vehicles arriving at scene at that time (figure 31). The longest arrival time is 1,439 minutes (this relates to one vehicle, however, due to the

scale of the number of vehicles, this is not visible). Time of arrival is critical, as reduced arrival times lead to increased survival rates, especially in cardiac arrest patients where the optimal response time is 4 minutes (Blackwell and Kaufman, 2002).

This data clearly shows that the ePCR has not improved the 8 minute response target. There is no clear explanation of the reason why there is an increase in the 8 minute response. It may be unrelated from the introduction of the ePCR, for example, due to poor communication (JASBI, Muthaiyah and Kyaw Zaw, 2021), an increase in mental health calls (Jones, Clarke and Amphlett, 2024), social care and an aging population requiring more ambulance care or delays at hospital causing extra handover times (Hughes, 2023).

Where there is a stroke suspected, research has shown that to get the best results for the patient, the patient's door to the time of the CT scan (DTC) should be less than 25 minutes (Sadeghi-Hokmabadi *et al.*, 2016), and the patient's door-to-needle (DTN) time should be less than 60 minutes (Jauch *et al.*, 2013). Each time the delay is reduced by 15 minutes, the estimated improvement in clinical outcome is 4%, and the risk of mortality is 5% lower.

The data below (figures 32 and 33) shows the call to door time, time at scene, and then call to hospital door time. The call to scene time is the time from the 999 call, to the first vehicle arriving at the patient's location. The time on scene is the time the conveying vehicle spends on scene. The time to hospital door is the time from the 999 call, to the patient arriving at hospital.

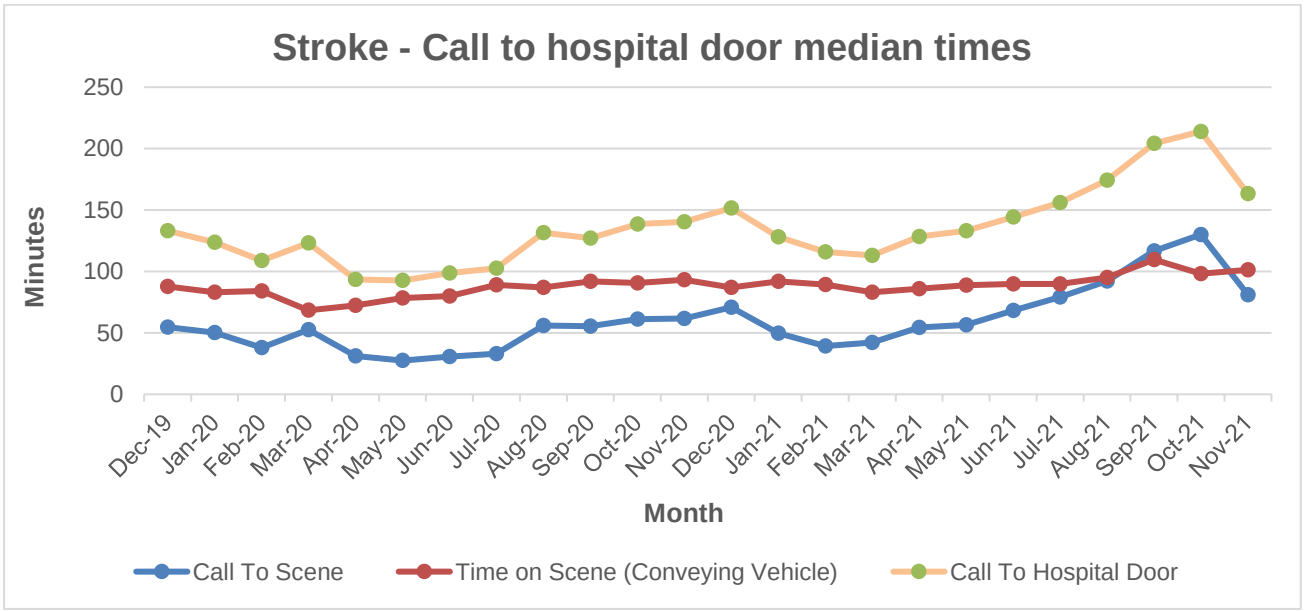

Figure 32: Stroke call to hospital door median times – dPCR.

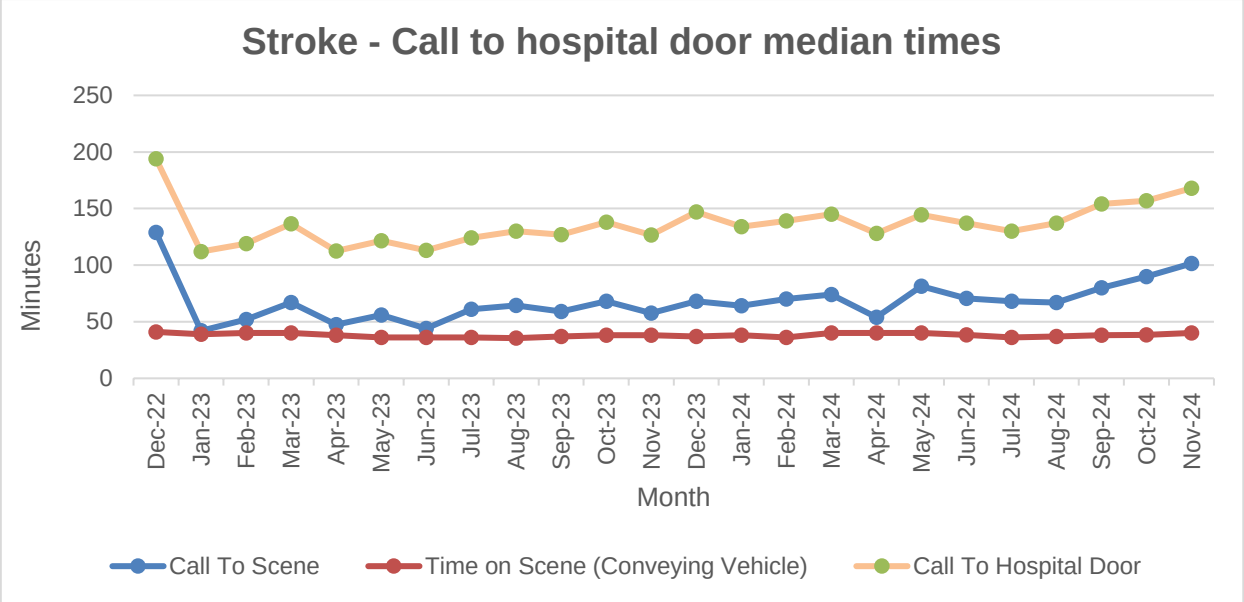

Figure 33: Stroke call to hospital door median times – ePCR.

The call to scene time has increased slightly between the dPCR and the ePCR (figure 32 and 33). There are, occasions (September, October 2021 and December 2022) where the time has increased significantly. The causes for these do not reflect any pattern, so are a “special” cause. The time on scene has almost halved since the introduction of the ePCR, however, whether this is due to the introduction of the ePCR cannot be assumed as there is no evidence to support it, and no different intervention, for example, increased emphasis on reducing time on scene for stroke patients. The call to hospital door times remain comparable and range mainly between 100 – 150 minutes for both the dPCR and the ePCR data. Thus, it cannot be concluded that the ePCR has produced better response rates for stroke patients attending hospital.

There can be no direct correlation obtained between the number of stroke patients and the timings above. The data has been obtained from a different system (computer aided dispatch system) to the clinical indicators; therefore, the clinical indicator numbers cannot be compared to the call to door times etc.

4.9 Patients Transported to Hospital

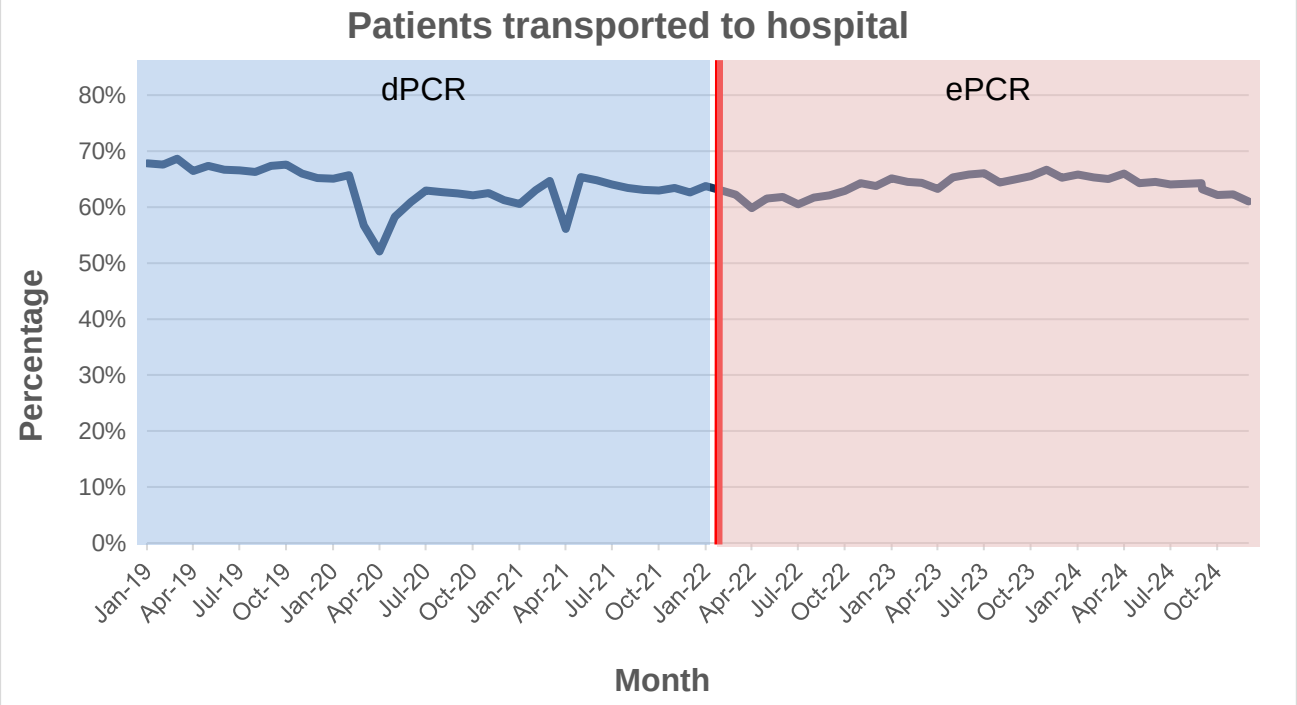

Figure 34: Graph to show patients transported to hospital.

Since the introduction of the ePCR, the percentage of patients transported to hospital by ambulance following a Paramedic face to face assessment has neither decreased nor increased significantly (figure 34). The rate of transportation stays consistent at between 60% and 70% for most months except in extraordinary circumstances for example, during the covid 19 pandemic in March 2020. This shows that the introduction of the ePCR has had very little effect on the transportation rate. The data, however, does not show the category of calls, for example, category A being immediately life threatening. Also, it does not show the number of calls but merely the percentage transported.

5 Discussion

5.1 Clinical Practice

This is the first introduction of an ePCR into WAST. Evidence has shown that there is usually resistance to change within healthcare (Shahbaz *et al.*, 2019).

The results of this study cannot prove conclusively that the ePCR has improved clinical practice as it does not solely depend upon ePCRs. There are both positive and negative factors that have an influence on clinical care.

From the literature reviewed:

5.1.1 Positive Factors

a) Clinical decision support software (CDSS) can help the Paramedic to choose the right path, for example, the major trauma tool shows the Paramedic the right course of action, dependent upon the situation, patient's injuries, and the mechanism of injury etc.
b) Increased use can help to improve the quality of data, therefore there should be an improvement in the data captured. The results of the fractured neck of femur clinical indicator have improved since the introduction of the ePCR.
c) Research has shown that ePCRs have reduced patient medication errors. The ePCR within WAST could be developed to use artificial intelligence (AI) to highlight any contraindications to drugs to help reduce medication errors, for example, if a patient has already had 300mg of Aspirin, they should not receive another dose.
d) Management through data, for example, clinical audit feedback can help an individual to improve their clinical practice. Positive reinforcement can help to improve practice and increase self-confidence, whilst learning can take place when standards are not achieved, for example, not documenting justified exceptions to care.

5.1.2 Negative Factors

a) Numerous changes have been made because of ongoing issues with the use of the ePCR. This has been a very lengthy process with a high cost.
b) Paramedics do not always record the data in the correct place, for example, the recording of drugs or temperature in the free text narrative section instead of the relevant drugs or observations section. Also, the copy and paste function can result in incorrect information being pasted into the wrong patient's record.
c) No comparison has been carried out to compare the ePCR with previous versions. This leaves a void in improvement measures.
d) There was minimal training provided to WAST staff on the use of the ePCR. More training could have resulted in better ePCR completion. Lack of training could make it difficult to use the ePCR appropriately and could increase the time spent with patients whilst trying to navigate it. Also, reported connectivity issues. One Paramedic described walking up and down the street holding the iPad in the air trying to get a connection to enable them to complete the ePCR.
e) Initial ePCR data showed that there was a reduction in clinical performance.

f) Due to the complex design of the ePCR, errors were found in the SQL queries which were used to obtain the clinical indicator data.
g) Deskilling of Paramedics who are only conducting routine observations whilst caring for patients for several hours outside hospital on most shifts due to large hospital delays and being expected to work outside their scope of practice (Li, Vanberkel and Carter, 2019).
h) Paramedics having differing views of what patient safety looks like (Shepard *et al.*, 2022).

From the Paramedics surveyed, the following information was gained:

5.1.3 Positive Factors

a) Previous patient record access can allow Paramedics to view a patient's previous medical history, for example, if a patient is a known diabetic and has contacted WAST on numerous occasions, the Paramedic can choose to refer the patient to a pathway based on their whole history instead of just one incident.
b) Most Paramedics felt that the ePCR did not increase their stress levels.
c) Computer links, for example, a clickable link to JRCALC can enable the Paramedic to find the guidance quickly and easily, instead of referring to a paper manual or computerised document. As JRCALC is interactive, selecting a topic can help the Paramedic to choose the correct drugs for height / weight etc.
d) Prompts (nudges) can be set up to remind Paramedics to do specific observations or treatments, for example, a blood glucose test for stroke patients, or giving Aspirin to STEMI patients.
e) Clinical Indicators can remind Paramedics to complete whole care bundles, for example, taking a pain score before and after administering pain relief to ascertain its effectiveness.

There are factors, both including and excluding use of the ePCR that may have a negative impact on a Paramedic's clinical practice, these include:

5.1.4 Negative Factors

a) Increased stress levels, both from pressure to assess patients, leave them at scene, and spend as little time with them as possible due to the increase in demand. There is also pressure due to increased use of data and electronic dashboards.
b) There are still other forms which need to be completed for certain patients, for example, every patient left at home needs to be left with a handwritten non–conveyance form. A handwritten recognition of life extinct form needs to be left with the police when a patient unexpectedly dies.

5.2 ePCR vs dPCR

From the literature reviewed, combined with the Paramedic questionnaire and the clinical indicator data, there are both positive and negative factors when comparing the ePCR to the dPCR:

5.2.1 Positive Factors

a) The ePCR is a more robust system which can provide reliable, timely, complete, readable data to advise of clinical practice with no need to manually verify the handwriting.
b) The iPad is more reliable than the digital pen which often needed replacing.
c) The ePCR nudges and layout can remind the Paramedic to complete observations, provide treatments, and enter data.
d) There are links to GP records, CDSS, referrals and JRCALC, thus making it possible to view patients' previous medical history, treat patients and send information.

5.2.2 Negative Factors

a) The ePCR data is reliant upon the data entered.
b) The ePCR is more complex and has more fields, therefore, completing the ePCR takes time, can be difficult to navigate, and the relationship with the patient is compromised.
c) There are still connectivity issues.
d) Some forms still need to be handwritten, then uploaded onto the ePCR system.

5.3 Other Findings

5.3.1 Other Factors

In addition to the introduction of the ePCR, there are also other internal and external factors that could influence the standard of care provided to WAST patients:

Although there are the same number of patients transported to hospital following a face to face assessment, this is not a measure of either an improvement or decline in patient care. The measure of improvement is leaving patients at home who do not require a hospital assessment or treatment. Also, admission to hospital is also difficult to measure, as patients may need treatment but not admission, for example, lacerations that need to be sutured (stitched up). They may also feel they need an ambulance when in fact they don't, especially if they cannot get the help they need elsewhere, which may result in higher demand on hospitals (Jones, Clarke and Amphlett, 2024). Another factor is age and frailty. A patient may need to be transported to hospital as they are not considered safe for the Paramedic to leave at home (Barrenetxea *et al.*, 2021).

Increased time on scene can have a contributing effect on the 8 minute targeted response rate, which in turn can cause more harm to the patient if left untreated. The ePCR has not improved the 8 minute response rates, despite the time on scene being reduced for stroke patients following the introduction of the ePCR.

Paramedic practice can improve if clinical feedback is given. In 2021, a Senior Paramedic role was introduced in WAST. They can accompany the Paramedic and assess their competence in providing appropriate care to patients. An internal audit found that more assessments and feedback were provided in specific areas of Wales (Lloyd,

Quance and Lewis, 2023). Therefore since 2023, this could play a large part in the quality of care provided to WAST patients.

Quality assurance found errors in the SQL queries when reporting clinical indicator performance. This suggested that patient care was poorer that it was. Also, there has been a task and finish group which has conducted several initiatives over a 6 month period, aiming to improve the clinical indicator performance (see figure 29).

Caution needs to be observed when looking at small data samples. Due to the nature of clinical indicator incidents, the sample size is often small, for example, in the STEMI clinical indicator where there are between 51 (July 2017) and 117 (April 2024) patients each month. Although the percentage of STEMI patients from the total WAST incidents is low, all STEMI patients are included, thus ensuring that the data collected is reliable. The questionnaires, however, have a far smaller percentage completion rate, but there are more than the recommended 30 respondents, therefore, the central limit theorem suggests that the average (mean) will follow normal distribution as the sample is random (Zhang *et al.*, 2023). There are saturation points in the data, for example, it would be too coincidental for all the 78 respondents (100%) that were questioned from different areas in Wales to have connectivity issues.

5.3.2 Missing Data

There is a large amount of data that is not collected, or is unknown This includes:

a) No like-for-like comparison of dPCR data versus ePCR data as the systems are completely different, for example, clinical indicators were manually audited, however the ePCR data is based on raw data which is not manually audited.
b) There are external influences, therefore, you cannot accurately compare two years of either response nor transportation data, for example, the weather in January 2023 could be different to that of 2024, as could the types of calls and patients. Also, there are different vehicles and staff, for example, an Advanced Paramedic Practitioner may be sent to a patient who is less likely to travel to hospital, therefore comparing their data to a larger ambulance where almost all patients are transported would not be an exact comparison.
c) Technology has improved, and there are dashboards within WAST where data is presented on a Power BI platform. Therefore, more data can be obtained this year than last, and the data obtained may be set around different parameters, and contain less or more ePCR fields, so would not be comparable.
d) Since WAST deals with emergency incidents, it would not be ethical to send out surveys to gain patients' or their relatives views on the service they have received. If patients had been severely ill, there may be a positive bias as they may have a better opinion of the service provided as were more grateful than those who were less ill. Surveys have also found that patient characteristics can influence satisfaction scoring, for example, age, where older patients provided better scores (Bogomolova *et al.*, 2016). Also, no two patients are the same, so two stroke patients may need different treatment due to other medical factors.
e) Audits are not conducted on all incidents; therefore, it is not known what level of compliance there is within WAST clinical practice.

f) There may be bias or inaccuracies in literature. An author may try to either prove or disprove a theory dependent upon their views or external pressures. Also, the only available literature may be old, so may not be representative of today.
g) The ePCR is a new piece of technology, which has also seen changes within other ambulance trusts in addition to WAST, therefore the longevity of use is still relatively unknown.

5.3.3 Action Taken Since the Survey

Due to some of the findings of the Paramedic user survey, the author has fed back some of the results to Health Board Clinical Leads:

a) When a second ePCR is created in cases where there are multiple patients at one incident, for example, a mother and baby at a birth, only the Paramedic who has created the second record can see it. Therefore, if a second crew transports the baby, they cannot see the record and therefore must create another record for the baby to complete any observations and treatments they have carried out. There has also been an ePCR designed specifically for a baby, so that can be used to enable the identification of babies born etc.
b) There was positive feedback about the reminder nudges, hence, there are currently no concerns regarding 'nudge fatigue.'

Also, the author will meet with the Assistant Director of Clinical Delivery to discuss the findings of this dissertation and formulate an action plan to take any recommendations forward, for example, further data to be collected, improvements which can be made to the ePCR, for example, layout, solving connectivity issues etc.

5.3.4 Further Action Required

Due to the findings, further actions are required to address the issues highlighted above:

a) Increased use of CDSS will enable more improved decision making, to be discussed at senior management team meetings.
b) Explore use of AI to help improve patient outcomes, for example, automatically highlighting contraindications to drugs like Aspirin if the patient is already taking anticoagulants (blood thinners).
c) CIAT to feedback clinical audit findings to individuals via their team leaders for all audits. Also, team leaders to promote clinical indicators to improve care bundle understanding and compliance rates.
d) Better methods of training to be researched to ensure that any new Paramedics are trained appropriately and future changes in ePCR are trained out effectively. Also, coaching sessions to be provided to help Paramedics complete the ePCR whilst still interacting with patients to enhance Paramedic - patient relationships.
e) Paramedics and Health Informatics staff to be involved in any future ePCR designs.
f) Connectivity issues to be addressed with telecommunications suppliers.
g) Team leaders to monitor on–scene and handover times, and process map incidents in a bid to reduce unnecessary times spent on scene waiting for ambulances or patient handovers at hospital.

6 Conclusions

From the results of this evaluation, it is not possible to determine whether the ePCR has led directly to an improvement in Paramedic clinical practice. The clinical indicator data has been turbulent on numerous occasions, with a sharp fall noted in addition to a gradual increase for the ePCR data. Unusual behaviour in data can be seen, for example, the STEMI dPCR analgesia data in October 2018 where there is an unexplained dip. Data needs to be interpreted with consideration to the quantity, as lower numbers may cause a higher percentage of inconsistency.

There is scope that if there is a newer version of the ePCR introduced that has been designed smartly with Paramedics at the forefront, appropriately trained in its use, who utilise the fields correctly, then, from a technological perspective, it has the potential to aid Paramedics in improving their delivery of patient care. Paramedics can do this by using various tools to enhance their clinical decision making, for example, using artificial intelligence which can check for contraindications against treatment or drugs etc, for example, as Aspirin is a blood thinner, it cannot be given to a patient if that patient is already taking blood thinners. AI can also be used to collect data and show trends to help forecasting, for example, to automatically flag if a patient has called 999 within the last 24 hours, or to show the number of patients presenting with stroke symptoms but being diagnosed with a urinary tract infection following a urine sample dip. Also, nudge tools can be set up to remind Paramedics of care bundles needed for different patient conditions, for example, if a Paramedic forgets to do a post treatment blood sugar test on a patient who has had a hypoglycaemic episode (low blood sugar levels) they can be reminded before they leave the patient.

The use of CDSS tools can help the Paramedic to decide whether it is safe the leave the patient at home or refer them to other agencies. They can be accessed via a link on the ePCR and be interactive and ask specific questions. The subsequent questions can depend upon the answers to the initial question. An example of a CDSS tool could be for an elderly faller who has been examined and has no injuries, a CDSS tool designed for elderly fallers can help the Paramedic decide whether to refer to a frailty team instead of taking the patient to hospital by advising further checks / questioning etc. Also, CDSS tools like the one used by Grout (Grout *et al.*, 2024) which alerted high scoring patients, enabling them to be treated with blood thinners to prevent strokes could be incorporated into the ePCR. This can prevent unnecessary ambulance journeys and reduce the number of patients in ambulances queueing outside hospitals. This can also enable Paramedics to both be confident about and keep their array of skills as they will be exposed to a greater variety of patients.

Data can be extracted from the ePCR to help advise on future decisions, for example, by looking to see which drugs are used most. This can help a Paramedic to decide which drugs to carry with them in the ambulance. Dashboards can also be set up to show immediate results routinely if required. These can help monitor performance in addition to the clinical indicator bundles mentioned above, for example, taking the temperature of a newborn baby and using the appropriate warming aids which can help to prevent unnecessary hospital admission.

Together, a redesigned ePCR can help Paramedics to achieve the WAST goals of providing the '*right care and advice, in the right place, every time by delivering quality driven, clinically led and value focussed services*' (Welsh Ambulance Services NHS Trust, 2024).

Along with other technology, improved clinical processes etc, the ePCR has the potential to aid in preventing unnecessary admissions to hospital via A & E departments, which in turn will help to prevent lengthy waits for ambulances.

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