

## TITLE

Who does what in pre-hospital critical care? An analysis of competencies of paramedics, critical care paramedics and pre-hospital physicians

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## **ABSTRACT**

### **Introduction**

Emergency medical services (EMS) in the United Kingdom (UK) are facing the challenge of responding to an increasing number of calls, often for non-emergency care, while also providing critical care to the few severely ill or injured patients. In response, paramedic training in the UK has been extended and there are regional strategies to improve pre-hospital critical care. We describe the clinical competencies of three groups of pre-hospital providers in the UK, with the aim of informing future planning of the delivery of pre-hospital critical care.

### **Methods**

We used a data triangulation approach to obtain lists of competencies for paramedics, CCPs and PHCC physicians of the Great Western Ambulance Service (GWAS). Data sources were professional guidance documents, equipment available to the provider, log sheets of pre-hospital care episodes, direct observations and a survey of providers.

### **Results**

We identified 389, 441 and 449 competencies for paramedics, CCPs and PHCC physicians, respectively. Competencies of CCPs and PHCC physicians which exceeded those of paramedics can be arranged in four distinct clusters: Induction and maintenance of anaesthesia, procedural sedation, advanced cardiovascular management and complex invasive interventions.

### **Discussion**

Paramedics possess a considerable number of competencies which allow them to diagnose and treat a variety of conditions. CCPs and PHCC physicians possess few additional critical care competencies which are potentially life-saving but are required infrequently and can carry significant risks. Concentration of training and

clinical exposure for a small group of providers in critical care teams can help optimizing benefits and reducing risks of pre-hospital critical care.

## **INTRODUCTION**

Emergency medical services (EMS) in England are facing two challenges relating to the skills and knowledge required from pre-hospital practitioners. On the one hand, emergency call volumes are increasing,[1] in particular for non-emergency care needs.[2] As a consequence, the traditional focus of paramedic practice, immediate treatment and transport of life threatening illness and injuries, has shifted towards assessment and treatment for a large variety of non-life threatening conditions.[2] The paramedic profession has responded to this challenge with enhancement of training requirements and sub-specialisation such as emergency care practitioners with additional primary care competencies.[3, 4] This increased volume of urgent care episodes, however, means that the individual paramedic will only rarely encounter critical illness or injuries, with important implications for skill maintenance.[5] On the other hand, reports over the last decade have repeatedly highlighted shortcomings in the provision of pre-hospital care for critically ill patients.[6] Developments to improve the situation in the UK included increasing utilisation of physicians to deliver pre-hospital critical care (PHCC physicians) and training programmes for critical care paramedics (CCPs).[7, 8] However, considerable controversy remains about what constitutes pre-hospital critical care, if it is needed in the UK and who should be providing it.[9] In 2008, The Great Western Ambulance Service (GWAS) established a critical care team (CCT), consisting of CCPs and PHCC physicians in Southwest England.[10] This study examines the clinical competencies of paramedics, CCPs and PHCC doctors working within GWAS with the aim of informing future discussions and planning around pre-hospital critical care.

## **METHODS**

### **Great Western Ambulance Service**

Great Western Ambulance Service NHS Trust provided pre-hospital care for the counties Wiltshire, Gloucestershire and Avon in Southwest England. The trust covered an area of 3,000 square miles with a population of approximately 2.4 million people. It operated 31 ambulance stations, two emergency operations centres and two air ambulances, the Great Western Air Ambulance (GWAA) and Wiltshire Air

Ambulance. Between 2011 and 2012 GWAS responded to approximately 273,000 emergency calls. In February 2013 it merged with the South West Ambulance Service NHS Trust, at this time data collection for this study was completed.

### **Paramedics**

Paramedics in the UK are registered health care professionals who can deliver care independently. Traditionally the route to becoming a paramedic was by working within a National Health Service (NHS) ambulance service, moving from a transport role to a provider role with increasing experience. This system has been replaced with university or EMS-based programmes in paramedic science, approved by the Health and Care Professions Council (HCPC), with the university programmes leading to foundation degrees and/or BSc honours degrees in paramedic science. The programmes last at least 2 years of full-time equivalent and include both theory and practical clinical experience, including several weeks in various hospital departments. Paramedics are able to administer certain drugs and deliver invasive interventions, following the clinical guidelines regularly reviewed and updated by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) and their employing ambulance service.

### **Pre-hospital critical care team**

In 2008 Great Western Ambulance Service NHS Trust (GWAS) established a pre-hospital critical care service provided by a team of senior physicians and specially trained “critical care paramedics”. The GWAS critical care team (CCT) attends all types of pre-hospital emergency including medical, trauma and paediatric cases. The service is delivered using a combination of helicopter transport (provided by the Great Western Air Ambulance) and fast response road vehicles covering the GWAS territory.[10] For roughly 80% of shifts the critical care team consists of one PHCC physician (senior trainee or consultant in Emergency Medicine, Critical Care or Anaesthesia) and one ‘Critical Care Paramedic’ (CCP). If no physician is available, two CCPs can form the team, however, certain interventions such as rapid sequence induction are not undertaken without a physician present. To undertake pre-hospital work the PHCC physicians complete a training programme with specified

competencies and mentored practice, coupled with theoretical and simulation training. Critical care paramedics are experienced paramedics who have completed a university-based theory and practical training course with mentoring and supervised experience, followed by the successful completion of a comprehensive qualifying assessment.

### **Data collection**

Between September 2012 and January 2013, competencies were collected for three pre-hospital provider groups: Paramedics working on GWAS ambulance and rapid response vehicles, CCPs and PHCC physicians working within the GWAS critical care team. For each group, competencies were determined from five data sources to allow for triangulation:

1. Professional guidance documents or standard operating procedures (SOPs)
2. Equipment available to the provider
3. Log sheets of pre-hospital care episodes
4. Direct observations
5. Survey of providers of each group.

One researcher (JVVF) analysed and coded all data.

For the paramedic group, competencies were extracted from the Joint Royal Colleges Ambulance Liaison Committee's (JRCLAC) 'UK Ambulance Service Clinical Practice Guidelines 2006'[11]. Equipment available on GWAS double-crewed ambulance (DCAs) and rapid response vehicles (RRVs) and the content of the GWAS paramedic drug bag represented the second source of data. GWAS 'patient care forms' (PCFs) were chosen from a convenient sample of paramedic care episodes and analysed until saturation was achieved. Likewise, JVVF observed paramedics working on ambulances (paired with an ambulance technician) and on rapid response vehicles. All registered paramedics working within GWAS were eligible to participate and written consent was obtained. Saturation was defined as ten consecutive analyses of patient care forms or five consecutive direct observations not revealing any new competencies. Competencies were extracted following a previously published approach,[12] and were separated into five different

categories: Patients' conditions, diagnostic competencies, medications, therapeutic interventions and clinical decisions. See table 1 for an example of competencies identified from the JRCALC 2006 guidelines on chronic obstructive pulmonary disease (COPD).

**Table 1.** Example of paramedic competencies identified from the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guideline on COPD and their confirmation through the additional four data sources.

Category	Competency	Source				
		JRCALC guideline	Inventory	Patient care forms	Observation	Provider survey
<b>Condition</b>	COPD	•		•	•	•
	Dyspnoea	•		•	•	•
	Pneumonia	•		•	•	•
	Pneumothorax	•				•
	Heart failure	•	•	•	•	•
	Pulmonary embolism	•			•	•
	Lung cancer	•				•
	Anaphylaxis	•				•
	Airway obstruction	•	•	•		•
	Hypoxia	•		•	•	•
<b>Diagnostic</b>	Current medication	•		•	•	•
	Past medical history	•		•	•	•
	Timeline of events	•		•	•	•
	Airway patency	•		•	•	•
	Respiratory rate	•		•	•	•
	Breathing pattern	•		•	•	•
	Auscultation of lungs	•	•	•	•	•
	Cyanosis	•			•	•
	Pulse oxymeter monitoring	•	•	•	•	•
	ECG monitoring	•	•	•	•	•
<b>Medication</b>	Salbutamol (nebulized)	•	•	•	•	•
	Ipratropium bromide (nebulized)	•	•	•		•
	High flow oxygen	•	•	•	•	•
<b>Intervention</b>	Intravenous cannulation	•	•	•	•	•
	Oxygen (titrated to 90 - 92%)	•	•		•	•
<b>Clinical decision</b>	Clinical response to nebulized Salbutamol	•			•	•



For the CCP group, documents analysed were the 2006 JRCALC guidelines and the GWAS critical care team (GWAS CCT) SOPs. Equipment on the helicopter and rapid response vehicle available to the critical care team and the paramedic and critical care drug bags were analysed. Extraction of CCP competencies from PCFs and direct observations was undertaken as described for the paramedic group.

Documents analysed for PHCC physicians' competencies were the Intercollegiate Board for Training in Pre-hospital Emergency Medicine's (IBTPHEM) curriculum framework for sub-specialty training in pre-hospital emergency medicine[13] and the GWAS critical care team SOPs. Extraction of PHCC physicians' competencies from PCFs and direct observations was undertaken as described for the paramedic group.

During the next step of the triangulation process, three pre-hospital care providers of each group were asked to review a preliminary list of all competencies accumulated from the above process. They were able to either agree or disagree to each competency being accurate for their own professional group, as well as adding free text comments and adding competencies which were deemed to be missing from the preliminary list.

Finally, competencies were considered to be accurate for each group (paramedics, CCPs or PHCC physicians) if they were identified by at least two of the five sources of data. Competencies only identified by pre-hospital providers were also included if at least two providers of the corresponding group agreed on the inclusion. See table 2 for a summary of data sources for each professional group.

**Table 2.** Professional groups and respective data sources.

	<b>Paramedics</b>	<b>CCPs</b>	<b>PHCC physicians</b>
<b>Professional guidance and SOPs</b>	JRCALC guidelines	JRCALC guidelines GWAS CCT SOPs	IBTPHEM curriculum GWAS CCT SOPs
<b>Equipment</b>	DCA and RRV; Paramedic drug bag	CCT RRV and helicopter; CCP drug bag	CCT RRV and helicopter; CCT drug bag
<b>Log sheets</b>	GWAS PCFs	GWAS PCFs	GWAS PCFs
<b>Direct observation</b>	Paramedics on DCAs and RRVs	CCPs on RRVs	PHCC physicians on RRVs
<b>Provider survey</b>	Three paramedics	Three CCPs	Three PHCC physicians

List of abbreviations for table 2. SOP: Standard operating procedure. JRCALC: Joint Royal Colleges Ambulance Liaison Committee. GWAS: Great Western Ambulance Service. CCT: Critical care team. IBTPHEM: Intercollegiate Board for Training in Pre-hospital Emergency Medicine. DCA: Double-crewed ambulance. RRV: Rapid response vehicle.

## RESULTS

Saturation for competencies extracted from GWAS patient care records was achieved after 93, 55 and 53 care episodes for paramedics, CCPs and PHCC physicians, respectively. For direct observations, saturation was achieved after 35, 30 and 24 care episodes, respectively.

We identified 389, 422 and 449 competencies for paramedics, CCPs and PHCC physicians, respectively. In addition, CCPs possessed 19 competencies which required discussion with a senior physician (consultant) prior to execution. See table 3 for classification of competencies for each professional group.

**Table 3.** Professional groups and number of competencies.

	Paramedics	CCPs	PHCC physicians
<b>Condition</b>	187	189	189
<b>Diagnostic</b>	50	52	52
<b>Medication</b>	38	59*	62
<b>Intervention</b>	84	98**	102
<b>Clinical Decision</b>	30	43***	44
<b>Total</b>	389	441	449

\* Of which 10 require discussion with a consultant

\*\* Of which 4 require discussion with a consultant

\*\*\* Of which 5 require discussion with a consultant

### **Group-specific competencies**

We identified a total of seven competencies which were unique to paramedics. These were low-acuity conditions such as constipation, reduced mobility in the elderly (non-traumatic), cellulitis and wound infection, medications not used by the CCT (oral Morphine and Tetracaine gel) and the clinical decision of requesting CCT support.

Except for these seven competencies, CCPs' competencies matched those of their paramedic colleagues. CCPs' competencies included an additional 6 conditions, 2 diagnostics, 14 interventions, 23 medications and 14 clinical decisions. Thematically, these can be arranged into distinct clusters: Maintenance of anaesthesia in patients with return of spontaneous circulation who were intubated during cardiac arrest, procedural sedation, invasive interventions and advanced cardiovascular management. See table 4 for examples of competencies for each of the four clusters.

**Table 4.** Examples of additional competencies of CCPs compared to paramedics.

	<b>Maintenance of anaesthesia</b>	<b>Procedural sedation</b>	<b>Invasive interventions</b>	<b>Advanced cardiovascular management</b>
<b>Condition</b>	Awareness in paralysed patient			Torsades de pointes arrhythmia
<b>Diagnostic</b>	Waveform capnography			
<b>Intervention</b>		Large joint reduction	Thoracostomy*	External pacing
<b>Medication</b>	Rocuronium IV*	Ketamine IV*		Adrenaline 1:100.000 IV as vasopressor
<b>Clinical Decision</b>	Appropriate depth of anaesthesia	Risk/benefit of procedural sedation	Thoracostomy in trauma patient prior to air transport	Consider Magnesium Sulphate in cardiac arrest

\*After discussion with a consultant

PHCC physicians were able to provide all competencies identified for CCPs plus an additional eight competencies, see table 5.

**Table 5.** Comprehensive list of PHCC physician-specific competencies

	<b>Competence</b>
<b>Condition</b>	N/A
<b>Diagnostic</b>	N/A
<b>Intervention</b>	Fascia iliaca block Rapid sequence induction Thoracotomy Peri-mortem caesarian section
<b>Medication</b>	Etomidate IV Propofol IV Suxamethonium IV
<b>Clinical Decision</b>	Risk/benefit for rapid sequence induction

## **DISCUSSION**

### **Paramedic competencies**

GWAS paramedics possess a considerable number of diagnostic and interventional competencies which allows them to diagnose and treat a large variety of conditions in the pre-hospital environment. The number of paramedic competencies found (389) is comparable to the results of a study of Dutch EMS, which used similar methods and identified 438 competencies for Dutch ambulance nurses and 500 competencies for Dutch pre-hospital physicians.[12] While the methodology of the studies does not allow comparison between different systems, it is re-assuring that the amount of provider competencies found are similar for comparably advanced EMS.[3, 12] Paramedics are often the first point of contact between the patient and the healthcare system for acute episodes of illness, and information at the time of dispatch is often limited.[14] It is therefore essential that paramedic competencies enable them to assess and initiate treatment for conditions ranging from epistaxis or a febrile child to immediate life-threatening situations such as major trauma or cardiac arrest.

### **Critical care competencies**

CCPs and PHCC physicians of the GWAS CCT possess a relatively small number of additional competencies which relate to induction and maintenance of pre-hospital anaesthesia, procedural sedation, advanced cardiovascular management and complex invasive interventions. While only a small majority of patients for whom EMS are activated will require this level of support,[2, 15] the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) 2007 report identified the lack of these skills in the pre-hospital care of major trauma patients as an important contributor to unfavourable outcomes.[6] Further research indicates that severely ill or injured patients benefit from competently delivered pre-hospital critical care.[16-18] Views on how to best provide this level of care for a small fraction of patients differ.[9] Attempts to introduce critical care skills to the general paramedic pre-hospital provider were made in San Diego, but showed unfavourable outcomes for paramedic rapid sequence induction of anaesthesia (RSI).[19] This is likely due to the

inherent complexity of critical care interventions, which require extensive training, regular exposure and effective clinical governance to maximise benefits and minimise associated risks.[20] An alternative approach, which has been adopted within GWAS and other ambulance services in the UK and internationally, is the concentration of training and clinical exposure for a small group of pre-hospital providers in critical care teams.[10, 16] Dedicated dispatch of CCTs to severely injured patients, often covering large geographic areas by helicopter, has been shown to improve outcomes for trauma patients.[21]

### **Paramedics versus physicians in pre-hospital critical care**

While the benefits of pre-hospital critical care, if applied judiciously, are generally accepted,[17, 18, 21], controversy remains regarding which pre-hospital providers should be delivering it.[22, 23] The CCPs in this study possessed the same critical care competencies as the PHCC physicians with the exception of those needed for rapid sequence induction of anaesthesia (RSI), fascia iliaca nerve block, thoracotomy and peri-mortem caesarean section. To attain these competencies, GWAS CCPs receive initial practical and theoretical training, undergo a sign-off process during work-based placements and participate in regular audit and clinical governance activity. They regularly work alongside senior PHCC physicians and attend hospital shifts with the chance to get clinical feedback. In addition, 19 of the 59 CCP-specific competencies require the CCP to discuss the case and treatment plan with the senior consultant on-call. We believe that this combination of training, exposure and supervision allows successful paramedic-delivered pre-hospital critical care.[20] PHCC physicians play a vital role in pre-hospital critical care, their experience from hospital-based critical care allows them to undertake interventions that are currently beyond the scope of CCP training. In addition, physician supervision of CCP practice has been shown to be beneficial.[24]

## **LIMITATIONS**

The methods of data extraction from the different data sources in this study depends to a certain degree on subjective interpretation. It is therefore entirely feasible that another researchers' findings would differ at least marginally.[12] We therefore cannot view the presented competencies as absolute findings which can be used to compare between EMS. However, comparison between the groups in this study remains valid, as data for all groups have been reviewed by the same investigator. Also, this study does not evaluate the quality of performance for any given competence, nor does it investigate complex interactions such as leadership, teamwork or non-medical aspects of pre-hospital care such as patient extrication.

## **CONCLUSION**

Paramedics in the UK possess a considerable number of diagnostic and interventional competencies. CCPs and PHCC physicians possess additional competencies enabling them to undertake pre-hospital anaesthesia, procedural sedation, advanced cardiovascular management and complex invasive interventions. The optimal training, skill maintenance and delivery to the scene of these competencies needs to be considered by ambulance services to provide effective pre-hospital critical care.

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