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Service Evaluation of the Emergency Medical Retrieval & Transfer Service (EMRTS) Cymru

ELUSEN AMBIWLANS AWYR CYMRU
WALES AIR AMBULANCE CHARITY

Prifysgol Abertawe
Swansea University

NHS Wales

Service Evaluation of the Emergency Medical Retrieval & Transfer Service (EMRTS) Cymru

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Corresponding Author

David Rawlinson

david.rawlinson@wales.nhs.uk

03003000057

EMRTS, C/O

Wales Air Ambulance

Ty Elusen

Ffordd Angel

Llanelli Gate

Dafen

Llanelli

SA14 8LQ

This report is a joint undertaking between EMRTS Cymru and Swansea University.

Authors include

Dr David Rawlinson, *Clinical Informatics and Research Manager, EMRTS. Honorary Clinical Research Fellow, Swansea University.*

Miss Jane Lyons, Research Officer and Data Scientist (Health Data Research UK). Swansea University.

Prof Belinda J Gabbe, *Clinical Professor of Public Health Medicine (Health Data Research UK), Swansea University, Swansea, UK. Head of the Pre-hospital, Emergency and Trauma Research Unit, School of Public Health and Preventive Medicine at Monash University, Melbourne, Australia.*

Prof David Lockey, *National Director EMRTS.*

Dr Richard J Fry, S*enior Lecturer in GIS and Health Geographies, Swansea University.*

Mr Ashley Akbari, *Senior Research Manager and Data Scientist (Health Data Research UK).*

Prof Ronan A Lyons, Clinical Professor of Public Health, Medicine, Swansea University.

Miss Marianna Dyer, Medical Student, Cardiff University.

Dr Nicola Schunke, Anaesthetist & EMRTS Clinical Attendant.

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Mr Chris Connor, CCP, EMRTS

Miss Tracy Phipps, CCP, EMRTS

Miss Megan Selby, Medical Student, Cardiff University

Dr Chris Hingston, Consultant, EMRTS

Dr Stuart Gill, Consultant, EMRTS

Dr Ami Jones, Consultant, EMRTS

Mr Mark Winter, Operations Director, EMRTS

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Executive Summary

This report sets out the findings from the second phase of the service evaluation of the EMRTS. It was commissioned to assess performance against key measurable benefits. During the period, there have been significant changes in EMRTS service configuration, some planned and some not predicted. The proposed measurable benefits were divided into three distinct areas: Equity, Health Gain and Clinical & Skills sustainability.

Key findings

Activity

During the period 27th April 2015 to 27th April 2020, the service responded to 9,952 emergency calls. Of those, 11.8% were paediatric (aged 17 or under). The patient age range was 0 to 101, median 48 years. 67.6% of patients were male. Of the calls, 91.1% were primary calls, and 8.9% were inter-hospital transfers (secondary). Of the calls attended, 82.4% were conveyed to hospital.

Equity

Measurable benefit: Introduction and expansion of EMRTS service will reduce the number of emergency interhospital transfers by 30%.

Result: Emergency inter-hospital transfers were reduced by 41%.

Measurable benefit: Improved equity of access to pre-hospital critical care in North Wales.

Result: After service introduction, there was more than doubling of the attendance of doctors attending critical incidents in North Wales, and an increase in available key interventions.

Measurable benefit: Access to specialist care and interventions.

Result: 42% of patients bypassed local hospitals to be taken directly to more specialist care. Very few patients attended required secondary transfer. When the service attended emergency patients,

critical interventions were available a median time of 29 minutes faster (air), and 41 minutes faster (road) than via the standard 999 response.

Health Gain

Measurable benefit: Critical Care Intervention outside standard ambulance service practice.

Result: 63% (6,018) of patients attended received interventions that are outside standard ambulance service practice.

Result: 313 patients received blood product transfusions

Result: 790 patients received pre-hospital anaesthesia

Measurable benefit: Reduction in mortality.

Result: For patients with blunt trauma, the 30-day mortality rate for patients treated by the service was 37% lower (adjusted odds ratio 0.63 (95% CI 0.41-0.97); p=0.037) than an equivalent population attended by the ambulance service only. The introduction of an emergency medical retrieval service was associated with a reduction in 30-day mortality for patients with blunt traumatic injury.

Clinical & Skills Sustainability

Measurable benefit: Increased consultant appointments, especially in Emergency Medicine.

Result: Twelve new consultants have been recruited into Wales due to the attraction of posts that include formal pre-hospital care sessions with EMRTS. Thirty-two part-time consultants who also work in key specialities in NHS hospitals are employed to deliver the clinical service. There are also well-established programmes developing the future medical workforce including Pre-hospital Emergency Medicine (PHEM) subspecialty training, clinical fellow schemes and the clinical attendant scheme.

Measurable benefit: Increased educational intervention to healthcare professionals.

Result: An average of 100 formal CPD events per year have been delivered and recorded, delivering structured educational interventions to healthcare professionals across NHS Wales. 71% of these

have been delivered to WAST ambulance staff. An estimated 600 Welsh ambulance staff have undergone formal training through such events.

Conclusions & Recommendations

Building on the year 1 evaluation, the results reveal positive delivery of both the core service and additional initiatives supporting the key investment objectives. Challenges relating to the ambitions of the original evaluation have resulted in modifications of the scope and methodology, as agreed by the EMRTS Delivery Assurance Group. The recommendations of the initial report have been realised, including expansion to North West Wales, and further evaluation of the unmet need outside of initial daytime operating hours. The latter has resulted in the first stage of a phased expansion taking place, still within its first 12 months at the time of writing. It is recommended that evaluation remains a core element of the service, supporting ongoing service improvement and expansion activities. Resource needs to continue to be incorporated into the EMRTS budget to continue to monitor the impact of the EMRTS service and to direct quality improvement.

Through a developing research portfolio, cumulative data will provide the foundation for collaborative research into specific areas. Outstanding evaluation of the Out of Hospital Cardiac Arrest patient cohort should be a priority included within the scope of this national workstream.

Glossary of Terms

Pre-Hospital Care

The term 'pre-hospital care' covers a wide range of medical conditions, medical interventions, clinical providers and physical locations. Medical conditions range from minor illness and injury to life-threatening emergencies. Pre-hospital interventions, therefore, also range from simple first aid to advanced emergency care and pre-hospital emergency anaesthesia. Care providers may be lay first responders, ambulance professionals, nurses or physicians of varying backgrounds. All of this activity can take place in urban, rural or remote settings and is generally mixed with wider, out-of-hospital and unscheduled care.

Primary Transfer

This is where a patient is retrieved directly from a pre-hospital environment.

Secondary Transfer

This is a transfer of a patient from one healthcare facility to another (interhospital transfer).

Retrieval

The use of expert medical teams to assess, stabilise, package and subsequently transport a patient from one healthcare facility to another. The aim is to replicate the delivery of initial critical care to the standard achieved in hospital emergency departments.

Pre-Hospital Critical Care

Draws on the experience of hospital critical care and resuscitation and translates this into pre-hospital medical care for those that require time-critical intervention before arrival in hospital.

Pre-Hospital Trained Critical Care Consultant

A doctor of consultant grade, trained to deliver decision-making and clinical interventions not delivered in standard paramedic practice.

Critical Care Practitioner (CCP)

These are healthcare professionals from a paramedic or nursing background who have been trained in enhanced decision-making and extended clinical skills, in addition to standard paramedic practice described in JRCALC guidelines. Currently, there is no national standard established for CCP practice.

HEMS

Helicopter Emergency Medical Service. Helicopters provide advantage of speed and access to difficult locations in order to reduce the time required for the patient to gain access to specialist intervention. They can also be used to transfer patients to hospital.

Mass Casualty Incident (MCI)

A mass-casualty incident is an incident in which emergency medical services resources, such as personnel and equipment, are overwhelmed by the number and severity of casualties.

Major incident

A major incident is defined as a significant event, which demands a response beyond the standard reponse of an emergency medical system.

Pre-Hospital Emergency Medicine

Pre-Hospital Emergency Medicine (PHEM) is a General Medical Council-approved sub-specialty of the specialities of anaesthesia, emergency medicine and intensive care medicine.

Injury Severity Score (ISS)

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. An ISS of 9- 15 implies moderate trauma and an ISS>15 implies major trauma.

WAST – Welsh Ambulance Service NHS Trust

TARN – Trauma Audit & Research Network

ICNARC – Intensive Care Audit and Research Network

WAACT – Wales Air Ambulance Charitable Trust

SAIL – Secure Anonymised Information Linkage

ALF – Anonymised Linked Field

ONS – Office of National Statistics

PEDW – Patient Episode Database for Wales

WDS – Welsh Demographics Service

WCCN – Welsh Critical Care Networks

GIS – Geographic Information Systems

JRCALC – Joint Royal Colleges Ambulance Liaison Committee

EASC – Emergency Ambulance Services Committee

WHSSC – Welsh Health Specialised Services Committee

WATCH – Wales and West Acute Transport for Children

Welsh Health Boards:

BCUHB – Betsi Cadwaladr University Health Board

Powys – Powys Teaching Health Board

HD – Hywel Dda University Health Board

ABMU – Abertawe Bro Morgannwg University Health Board (pre 1st April 2019)

CT – Cwm Taff University Health Board (pre 1st April 2019)

CTM – Cwm Taff Morgannwg University Health Board (post 1 April 2019)

C&V – Cardiff & Vale University Health Board

AB – Aneurin Bevan University Health Board

SBU – Swansea Bay University Health Board (post 1 April 2019)

Welsh Ambulance call categories (clinical model changed 1st October 2015):

Red – Immediately life-threatening (someone is in imminent danger of death, e.g. cardiac arrest).

Amber – Serious but not immediately life-threatening (patients who will often need treatment to be delivered on the scene, and may then need to be taken to hospital).

Green – Non-urgent (can often be managed by other health services) and clinical telephone assessment.

1. Background & Introduction

1.1. This is the second report of the service evaluation of the Emergency Medical Retrieval & Transfer Service.

1.2. An evaluation was commissioned to assess performance against the measurable benefits register. The first report provided an early overview of 1st year activity, qualitative results from stakeholder engagement, and outlined the intended quantitative methodology for certain aspects of the register.

1.3. Key findings and recommendations of the year 1 report included:

1.3.1. The service specification had been delivered.

1.3.2. Against the objective of Equity, the service achieved an enhanced timeliness and access to specialist care across Wales. However, deficiencies were noted in the North West of Wales, South East and outside of the 08:00–20:00 operating hours.

1.3.3. Against the objective of Health Gain, early realisations of benefits, such as critical care interventions, are evident, and stakeholder engagement revealed a generally positive view of the service in this area. Quantification of benefits such as functional outcome, mortality, and length of hospital stay were still to be realised, with ongoing work in providing comparators as numbers increase, and new data flows become established over the three-year period.

1.3.4. In respect of clinical and skills sustainability, there was an early indication of realisation of this area, with the caveat that more joint working with health boards needed to take place.

1.3.5. There was recognition of continued unmet need, whether in-hours (due to simultaneous incident), geographically and out of hours.

1.4. It was recognised that the new EMRTS service, delivered as a collaborative partnership between the third sector and NHS Wales, and working outside existing service models, would require a period of time to establish itself.

1.5. The delivery of complex, ambitious plans in a short timeframe was challenging, but it has been delivered. Feedback from stakeholders on the initial service delivery was positive.

1.6. Despite the service substantially improving equity overall, there remained residual inequity in provision in the North West, and expansion into this area was to be considered.

1.7. With regards to expansion of operational hours, there was a general consensus that this would be desirable and that a plan to investigate and address unmet need implemented.

1.8. Since the publication of the first report, significant service changes have taken place, some expected in line with the original Strategic Outline Programme, and some that were unforeseen. At the time of writing, the service has started the first phase of 24-hour working. Other key changes have been the introduction of the service into Caernarfon Airport, and the introduction of a dedicated transfer air ambulance to Cardiff Heliport. In addition, in two consecutive winters additional road-based resources have been provided in South Wales.

1.9. An overview of key service milestones can be seen in Appendix 1. In addition, a number of key documents and reviews relevant to this evaluation are listed in the bibliography.

Service Developments

1.10. In addition to the agreed Service Specification delivered at 'go live', the following key service developments have also taken place.

H-145 Aircraft

1.11. Three new state-of-the-art helicopters were introduced by the Charity. These have a number of benefits including increased range, capacity and night capability. These aircraft, operating from Caernarfon, Cardiff and Welshpool bases, operate on a Helicopter Emergency Medical Services (HEMS) basis.

Children's Wales Air Ambulance

1.12. The Charity funded a fourth aircraft (otherwise known as Helimed 67) based at Cardiff Heliport. This was mainly developed as the Children's Wales Air Ambulance.

1.13. Helimed 67 also currently supports the transfer and repatriation of some patients currently falling outside the scope of the EMRTS (e.g. neonatal and paediatric intensive care retrieval).

1.14. This aircraft operates in line with Air Ambulance regulations rather than HEMS and are considered as public transport flights. The Charity funds this project including base, aircraft, pilots, fuel, the fixed-term recruitment of four dedicated Helicopter Transfer Practitioners (HTPs) and medical equipment/consumables.

1.15. Clinical governance and operational responsibility lie with the EMRTS unless working with one of the neonatal or paediatric transport services.

1.16. It is important to note the purpose of this project. Throughout Wales, there is a need to transfer and repatriate critically ill patients over long distances (these are not time critical and, therefore, not currently within the scope of practice of the EMRTS). These transfers are currently undertaken by the Welsh Ambulance Service or St John Ambulance (often requiring a patient escort from the local hospital) and neonatal or paediatric intensive care retrieval services across Wales. The project is supported by the operational and administration infrastructure provided by the EMRTS.

1.17. This project aimed to support NHS Wales in:

1.17.1. Releasing Welsh Ambulance road assets to focus on tasks that are not appropriate for air transfer.

1.17.2. Allowing hospital staff to remain within their department and not being required to accompany patients during a long road transfer.

1.17.3. Managing capacity between hospitals.

NHS Wales Developments

1.18. Since the EMRTS service launch, there have been a number of key clinical service and policy developments in NHS Wales. These include:

1.18.1. The Out of Hospital Cardiac Arrest Plan (1).

1.18.2. Stroke Thombectomy commissioned pathways with North Bristol NHS Trust (2).

1.18.3. 24-hour Primary Percutaneous Coronary Intervention (PPCI) in North Wales.

1.18.4. 24-hour CHANTS neonatal service (South Wales).

1.18.5. Paediatric retrieval service (WATCh) (South Wales).

1.18.6. Launch of the South Wales Trauma network (SWTN) September 2020 (3).

1.19. In addition, changes that had been expected at the time of SOC and BJC development have not taken place, such as the reconfiguration of maternity services in North Wales.

1.20. From 1st April 2019, the responsibility for providing healthcare services for people in the Bridgend County Borough Council transfered from Abertawe Bro Morgannwg University Health Board to Cwm Taf University Health Board (4). The names of both health boards also changed to Swansea Bay University Health Board and Cwm Taff Morgannwg Health Board, respectively.

1.21. These changes have had varying impact on the delivery of the EMRTS, depending on the nature and timing, and should be considered when interpreting aggregate data across timeframes.

1.22. In the 'Case for Change' chapter of the Strategic Outline Case, a list of measurable benefits was described against key investment objectives. These investment objectives included equity, health gain and clinical and skills sustainability. As part of a benefits realisation workshop involving a broad group of stakeholders, these were further refined to ensure that they are measurable and capable of demonstrating future improvements. This register has been used as the basis of the evaluation report (5).

2. Service Activity

2.1.1. Five-year data is presented to give an overview of the service activity (27th April 2015–26th April 2020).

2.1.2. During the period 27th April 2015 to 27th of April 2020, the service responded to 9,952 emergency calls. 11.8% were paediatric (aged 17 or under), with an age range of 0 to 101, median 48 years. 67.6% of patients were male, 91.1% of calls were primary and 8.9% were inter-hospital transfers (secondary). Of calls attended, 82.4% were conveyed to hospital.

2.1.3. The geographical distribution of incidents attended is illustrated in a heat map (Figure 1). Distribution is by local health board and locality in Table 4 and Table 6, respectively. Incidents per 1000 population are detailed in Table 5 revealing the highest incidence in Powys (9.5). The lowest incidence is found in Cwm Taf.

2.1.4. The South Wales bases combined undertook 61% of activity. A full breakdown by base and calendar year is included in Table 1. 62% of incidents were responded to by air, with the remainder by road. A detailed breakdown of response mode by year is included in Table 3.

2.1.5. The nature of incident is revealed in Table 2, with trauma and cardiac arrest incidents making up the majority of work.

2.1.6. The destination health board of patients is seen in Table 7.

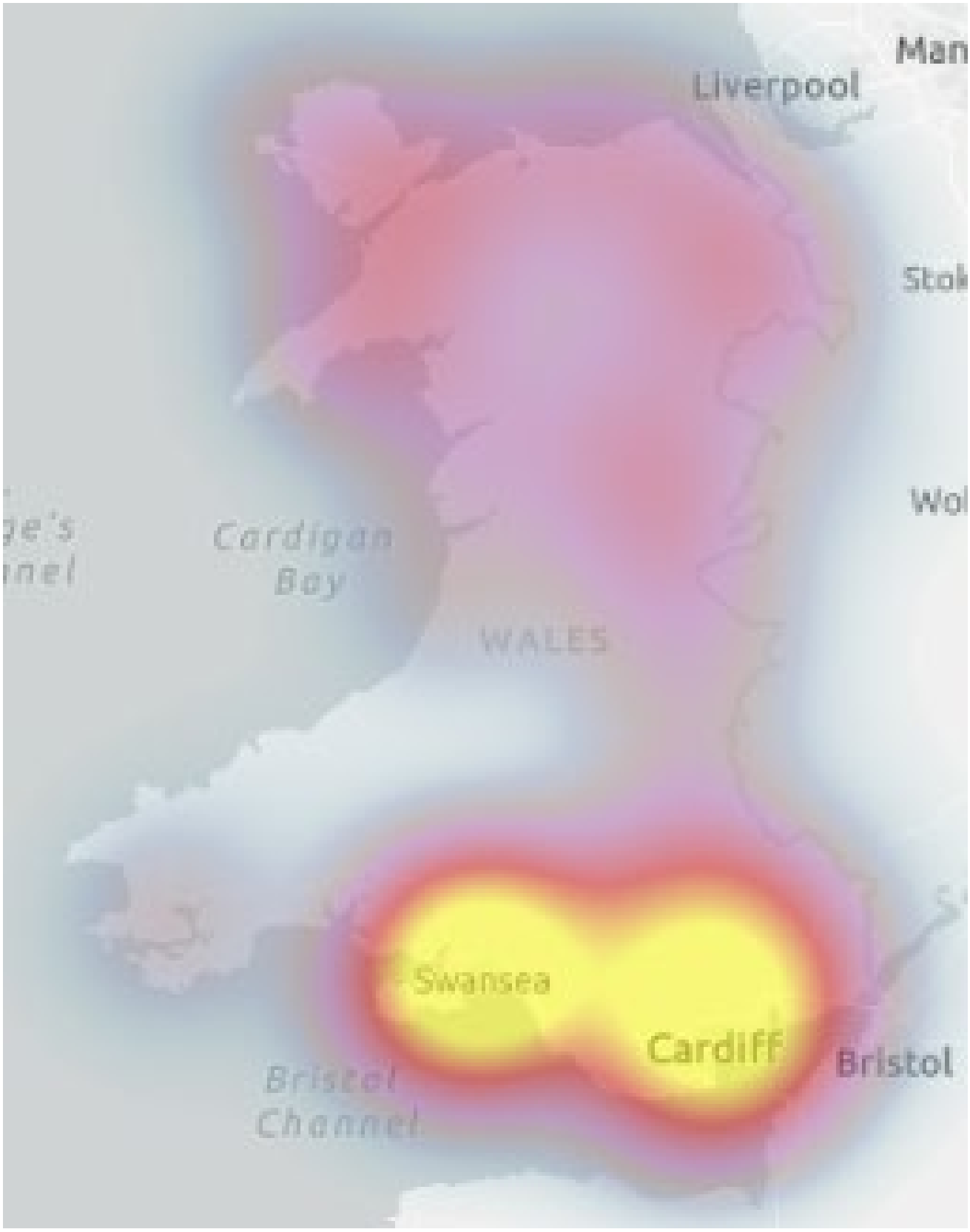

Figure 1 Heat map illustrating incident location

Base / year	2015 (8 months)	2016	2017	2018	2019	2020 (4 months)	Total
WAA Caernarfon (North)[1]	0	0	219	429	489	96	1233
WAA Cardiff (South East)	0	0	1	199	366	323	889
WAA Dafen (South)[2]	0	585	1073	986	1185	265	4094
WAA Swansea airport[3]	643	482	0	0	0	0	1125
WAA Welshpool (Mid-Wales)	340	532	519	519	593	108	2611
Total	983	1599	1812	2133	2633	792	9952

Table 1 Activity by Base (5 years)

NATURE	2015*	2016	2017	2018	2019	2020*	TOTAL
ANIMAL RELATED INJURIES	9	12	12	10	16	2	61
BREATHING PROBLEMS	27	58	82	110	147	35	459
BURNS OR EXPLOSIONS	18	14	34	44	62	12	184
CARDIAC ARREST	172	240	272	411	509	163	1767
CARDIAC RELATED	34	50	69	60	66	8	287
DROWNING	7	13	16	21	25	7	89
FALLS	112	208	226	215	252	104	1117
OTHER MEDICAL	16	37	20	44	83	34	234
OTHER TRAUMA	122	220	254	341	382	112	1431
PENETRATING TRAUMA	17	47	47	58	69	39	277
PREGNANCY OR CHILDBIRTH RELATED	8	5	8	7	13	7	48
ROAD INCIDENTS	275	404	409	398	499	103	2088
SEIZURES	22	52	59	64	108	30	335
STROKE	5	11	13	8	19	3	59
TRANSFER	103	162	165	194	203	59	886
UNCONSCIOUS	36	66	126	148	180	74	630
TOTAL	983	1599	1812	2133	2633	792	9952

Table 2 Nature of incident (5 years)

Response mode	2015*	2016	2017	2018	2019	2020*	Total
Air Ambulance	721	1041	1190	1403	1575	258	**6188**
Rapid Response Vehicle	262	558	622	730	1058	534	**3764**
Total	983	1599	1812	2133	2633	792	**9952**

Table 3 Response mode by year

[1] EMRTS from 1st July 2017

[2] Operations commence 1st June 2016

[3] Swansea airport vacated 31st May 2016

Health Board	n
Betsi Cadwaladr	2349
Hywel Dda	1524
Abertawe Bro Morgannwg*	1317
Powys	1257
Aneurin Bevan	1254
Cardiff and Vale	1007
Cwm Taf*	474
Swansea Bay	367
Cwm Taf Morgannwg*	301
Out of Area	102
Total	**9952**

Table 4 incidents by health board

**boundary change 1st April 2019*

LHB	per 1000
Powys Teaching Health Board	9.5
Swansea Bay University Health Board*	4.3
Hywel Dda University Health Board	4.0
Betsi Cadwaladr University Health Board	3.4
Aneurin Bevan University Health Board	2.1
Cardiff and Vale University Health Board	2.0
Cwm Taf Morganwwg University Health Board*	1.7

*Table 4 Incident per 1000 population *boundary change included*

Locality	n
Powys	1257
Swansea	926
Carmarthenshire	848
Gwynedd	807
Cardiff	705
Rhondda Cynon Taff	513
Neath Port Talbot	475
Caerphilly	411
Bridgend	375
Pembrokeshire	366
Denbighshire	337
Wrexham	330
Ceredigion	310
Conwy	304
Vale Of Glamorgan	302
Isle Of Anglesey	289
Newport	286
Flintshire	282
Monmouthshire	248
Merthyr Tydfil	170
Torfaen	155
Blaenau Gwent	154
Out of Area	102
Total	**9952**

Table 5 Incident location by locality

Health Board destination	pc
Abertawe Bro Morgannwg University Lhb	21.47%
Aneurin Bevan University Lhb	7.49%
Betsi Cadwaladr University Lhb	18.96%
Cardiff & Vale University Lhb	19.78%
Cwm Taf University Lhb	7.18%
English NHS Trust/ Out of Area	17.27%
Hywel Dda University Lhb	10.62%

Table 6 Destination health board

3. Equity

Critical Care Transfers

Measurable benefit: *Introduction and expansion of EMRTS service will reduce the number of emergency interhospital transfers by 30%.*
Result: *Emergency interhospital transfers were reduced by 41%.*

3.1.1. Analysis of the WCCN critical care transfer database was undertaken, examining cases where an emergency transfer had taken place for level 2 and 3 patients. Cases where EMRTS conducted the transfer were included to avoid skewing the data. This was to assess any reduction in the number of time-critical transfers conducted by hospital teams.

3.1.2. The time period covered under the evaluation agreement was April 2012–March 2018.

3.1.3. The activity for transfers is illustrated in Figure 2. There were 474 transfers in the 36-month period prior to EMRTS launch and 194 transfers in the 36-month period after launch. This is a 41% reduction in emergency inter-hospital transfers.

3.1.4. It is proposed that this is mostly due to attendance of EMRTS on scene and direct transfer to the 'right hospital, first time', thus avoiding undesirable secondary transfers. The target performance measure outlined in the BJC was 30%.

3.1.5. The North Wales EMRTS team only commenced operation in July 2017. A continued decrease in emergency transfers in this region would be anticipated, as an increased number of patients in this area are attended on scene and transferred directly to an appropriate hospital.

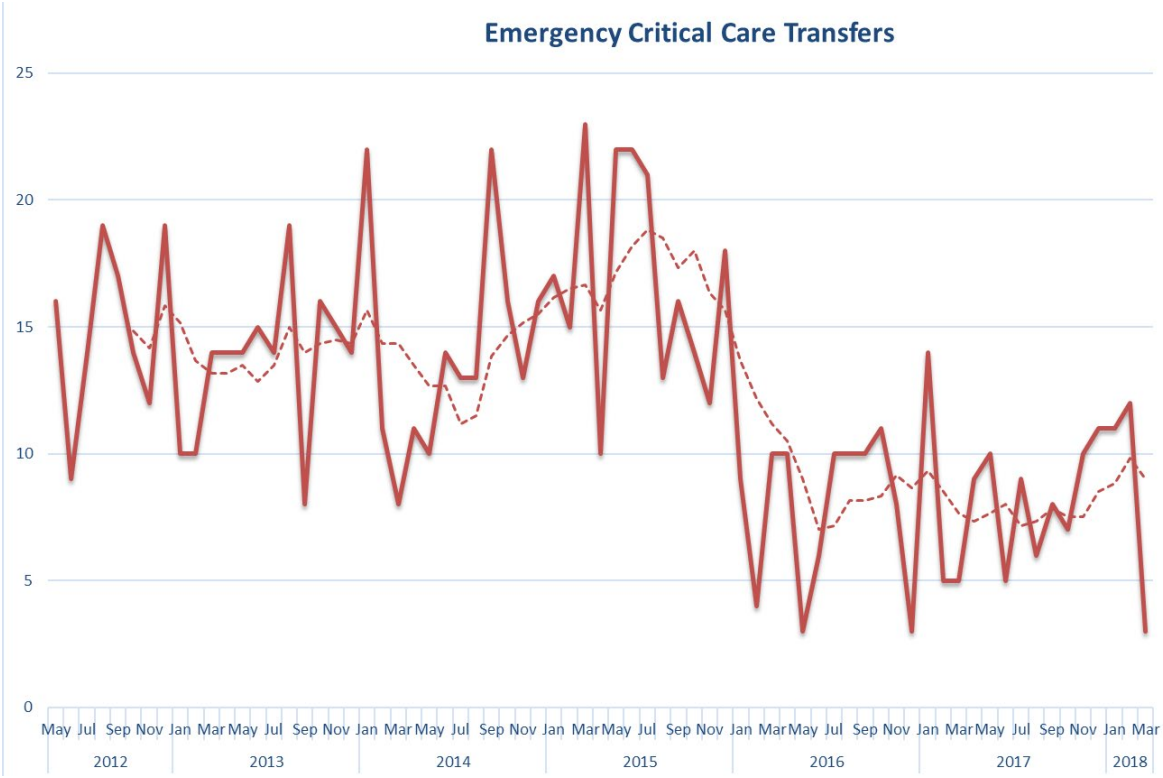

Figure 2 Emergency Critical Care Transfers

Measurable benefit: *Improved equity of access to Pre-Hospital critical care in North Wales.*
Result: *After service introduction, there was more than doubling of the attendance of doctors attending critical incidents in North Wales, and an increase in available key interventions.*

3.1.6. A recommendation of the year 1 evaluation was to expand into North Wales to improve equity (5). As outlined earlier, this took place in July 2017 following a period of planning by an independently chaired task and finish group. The group recommended the creation of a "hybrid model" of staffing (6), which provided a rotation of consultants across the Caernarfon and Welshpool bases. On any given day, one aircraft has a consultant on board, and the other is dual CCP staffed. This model is a result of limited critical care demand across Mid and North Wales, and a challenging consultant recruitment environment.

3.1.7. Following this development, an evaluation was carried out examining activity and interventions by crew's pre and post introduction of EMRTS in Caernarfon.

3.1.8. In order to set the baseline of clinical skill mix and interventions provided by Helimed 61, 925 anonymised Welsh Ambulance Service patient report forms (PCRs) were reviewed from April 2015 to June 2017.

3.1.9. Each PCR was identified by a unique identifier and coded. The information recorded from each PCR included the highest qualified attending practitioner (e.g. Paramedic, Cardiac First Responder or Doctor).

3.1.10. For each incident, the use of any of the following was coded: ketamine, tranexamic Acid (TXA), midazolam, intraosseous access (IO), tracheal intubation (TT), supraglottic airways (SGA), and rapid

sequence induction, as well as the occurrence of hospital bypasses. All these interventions were outside standard paramedic practice (although a minority are being incorporated into WAST paramedic practice) and, therefore, represent a higher clinical skill level than that provided by a standard ambulance crew.

3.1.11. Information on interventions was extracted from WAST and EMRTS PCR forms. Where information was incomplete, information was drawn from the incident description completed by the attending staff.

3.1.12. The pre-EMRTS data was then compared to the data after EMRTS incorporated Helimed 61 into the service (July 2017–April 2019).

3.1.13. 925 PCRs were analysed from the 27-month pre-EMRTS period and compared to 1,038 in the 22 months after EMRTS launched in Caernarfon in July 2017.

3.1.14. The raw data was collated from different periods (before and after methodology). The increase in relevant cases may be due to more efficient tasking, the increased capabilities of the Critical Care Teams, or an increase in the number of incidents occurring.

3.1.15. A key aim of integrating Helimed 61 into EMRTS was to increase the consultant input into the management of critically ill patients in North Wales.

3.1.16. Prior to EMRTS, Helimed 61 sometimes carried doctors from the Bangor ED Clinical Fellows Scheme. However, this was not a regular occurrence and doctors were non-training grades in emergency medicine rather than specialist PHEM trainees or consultants.

3.1.17. Results reveal that, prior to July 2017, only 170 (18.4%) of the incidents were attended by a doctor, but in the post-EMRTS period this increased to 505 (48.7%). This figure is consistent with the results of a hybrid model.

		Total	*Doctor Present*	*TXA*	*Ketamine*	*Midazolam*	*IO*	*ETT*	*SGA*	*Outside JRCALC*	*RSI*	*Bypass*
Pre	N	925	170	33	21	9	21	36	47	5	4	17
	%		18.4	3.6	2.3	1.0	2.3	3.9	5.1	0.5	0.4	1.8
Post	N	1038	505	26	26	29	59	57	7	83	32	328
	%		48.7	2.5	2.5	2.8	5.7	5.5	0.7	8.0	3.1	31.6

Table 7 H61 pre and post audit results

3.1.18. Table 8 shows the numbers of incidents at which each key additional intervention was performed. These percentages are illustrated in Figure 3. Most interventions were performed more frequently during the post-EMRTS period, when the flights carried doctors more regularly. The most significant increase is in hospital bypass, where patients are transported directly to more specialised centres rather than to the closest emergency after the attending critical care teams assess likely needs on scene. Some interventions have not increased over pre-EMRTS numbers. This is likely to be due to very limited demand for some interventions, and also due to the fact that more advanced airway management may have reduced the frequency of SGA use.

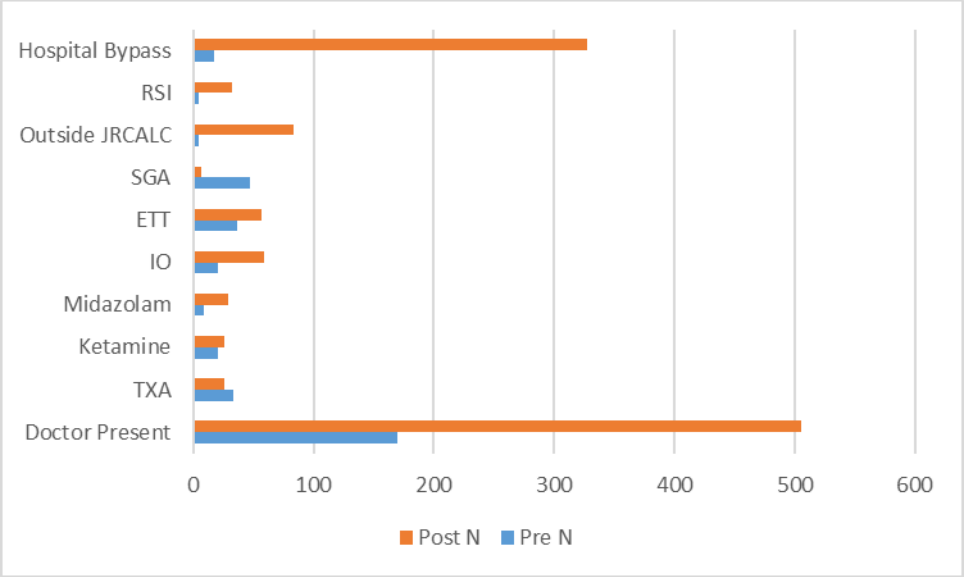

Figure 3 H61 interventions Pre and Post EMRTS

3.1.19. Some interventions are only required rarely, or for rarely occurring incidents (e.g. paediatric cardiac arrest and interosseous access). Despite infrequent use, their availability may be critical in a small number of high acuity cases.

3.1.20. The collation and coding of the pre-EMRTS data from April 2015 to June 2017 shows the baseline of doctor attendance to incidents and the audited interventions that existed prior to the incorporation of Caernarfon into EMRTS.

Measurable benefit: Access to specialist care and interventions.

Result: 42% of patients bypassed local hospitals to be taken directly to specialist care. Very few patients required a secondary transfer. On average, the service attended at scene and critical interventions were available a median time of 29 minutes faster by air, and by road 41 minutes faster than via the standard 999 response and conveyance.

3.1.21. A key proposed benefit of the service is the ability to take patients directly to specialist care, often outside the health board in which an incident occurs. This commonly relates to the provision of cardiac services, neurosurgery, paediatric intensive care, or major trauma centres. This includes cases where crews were able to bypass the local hospital. An assessment of these cases demonstrated that, overall, 42% of patients conveyed to hospital bypassed the local hospital. The remainder either attended local hospitals, or the specialist centre because it was close to the incident.

3.1.22. The highest proportion of cases bypassing are in Powys and Hywel Dda, as expected, due to the rural nature of both regions. The lowest proportions are found in health boards with specialist centres such as Cardiff and Vale, and Swansea Bay (Table 9). It should be noted that during the period there were multiple changes in service provision and clinical pathways at hospitals, which prevent comparisons over time.

3.1.23. Analysis of outcome data reveals the majority (99.7%) of patients conveyed to hospital received their definitive care at that site and did not require onward secondary transfer.

LHB	pc
Aneurin Bevan	48%
Betsi Cadwaladr	28%
Cardiff and Vale	9%
Cwm Taf	48%
Hywel Dda	59%
Powys	87%
Swansea Bay	19%
Overall	42%

Table 8 Hospital bypass

3.1.24. Building on previous work, further assessment of the time to definitive care was made by comparing the complete job cycle for ambulance service calls with the arrival at scene of the critical care team.

3.1.25. Baseline data from the WAST dataset revealed the timings in Table 10.

3.1.26. When considering time to availability of critical interventions (e.g. advanced drugs, anaesthesia and blood transfusions) where these are delivered at scene, a comparison has been made with the total time it would have taken for a patient to reach a local hospital based on historical records.

3.1.27. On average, the service attended at scene and critical interventions were available a median time of 29 minutes faster in air missions, and 41 minutes faster in road missions. This may be explained by the fact that car missions are often very close to bases and attended quickly.

3.1.28. In all cases, the team arrived in advance of the average time taken for patients to arrive at the nearest hospital following injury or illness.[4]

3.1.29. When looking at only those cases that received critical care interventions, it demonstrates an improvement of 33.7 minutes by air, and an improvement of 39.5 minutes by car in terms of timeliness to specialist care provision.

[4] Time from 999 call to arrival at hospital, "baseline job cycle"

3.1.30. For all categories, both air and road responses improved time to access to specialist care interventions compared to patients not attended at the scene.

	WAST/ HOSPITAL*		AIR TO SCENE		CAR TO SCENE		DIFFERENCE (MEDIAN)	
INCIDENT CLASSIFICATION	Mean	Median	Mean	Median	Mean	Median	Air	car
CARDIAC/RESP ARREST	69.2	63.9	30.0	27.1	24.4	19.7	-36.8	-44.2
MEDICAL	73	66.6	46.3	38.3	34.4	25.2	-28.3	-41.4
TRAUMA	78.6	71.1	40.4	34.1	32.9	25.4	-37.0	-45.7
ALL	74.5	67.7	46.0	38.7	35.1	26.6	-29.0	-41.1
PAEDIATRICS	74.5	67.7	46.3	38.9	35.1	26.5	-28.8	-41.2
***INCIDENT TIME TO ARRIVAL IN HOSPITAL BASELINE**								

Table 9 Timeliness comparison with ambulance service

	WAST/ HOSPITAL*		AIR TO SCENE		CAR TO SCENE		DIFFERENCE (MEDIAN)	
INTERVENTION	Mean	Median	Mean	Median	Mean	Median	air	car
CCI	74.5	67.7	42.4	34.0	36.4	28.2	-33.7	-39.5
RSI	74.5	67.7	36.3	33.6	41.1	35.9	-34.1	-31.8
BLOOD	74.5	67.7	39.4	33.7	38.1	34.6	-34.0	-33.1
***INCIDENT TIME TO ARRIVAL IN HOSPITAL BASELINE**								

Table 10 Timelines by intervention

Measurable benefit: Equity of access to care, requirement to evidence areas of unmet need to support expansion of the service.

Result: Analysis reveals unmet need of 1,796 cases per annum both in and out of hours as part of the service expansion review.

3.1.31. To support service planning, a review of unmet need was conducted in December 2018 as part of the service expansion review at the request of EASC. These results form part of the service evaluation and are summarised below.

3.1.32. The following analysis is based on updated modelling for a 24-hour period over 12 months. Data from multiple sources have been used including:

3.1.32.1. Trauma Audit and Research Network (TARN)

3.1.32.2. Welsh Ambulance Service (WAST)

3.1.32.3. EMRTS Strategic Outline Programme and Business Justification Case (to provide an up-to-date picture of activity)

3.1.33. This exercise excludes all neonatal data, emerging changes and developments in clinical pathways such as Stroke Thrombectomy, Vascular, Cardiac, and the South Wales Trauma Network as well as other large-scale service redesigns currently being considered by Health Boards.

1.1.1. The results demonstrated an estimated unmet need of 1,796 cases per annum (Figure 5) over the 24-hour period.

1.1.2. Figure 4 graphically represents the total EMRTS workload including the broad categories of trauma, medical and time-critical transfers. They detail the predicted demand and actual utilisation across a 24-hour period over 12 months with the current operating model.

1.1.3. It should be noted that the model assessed includes a partial year for the North Wales service, established at Caernarfon airport in July 2017 (i.e. July 2017–March 2018).

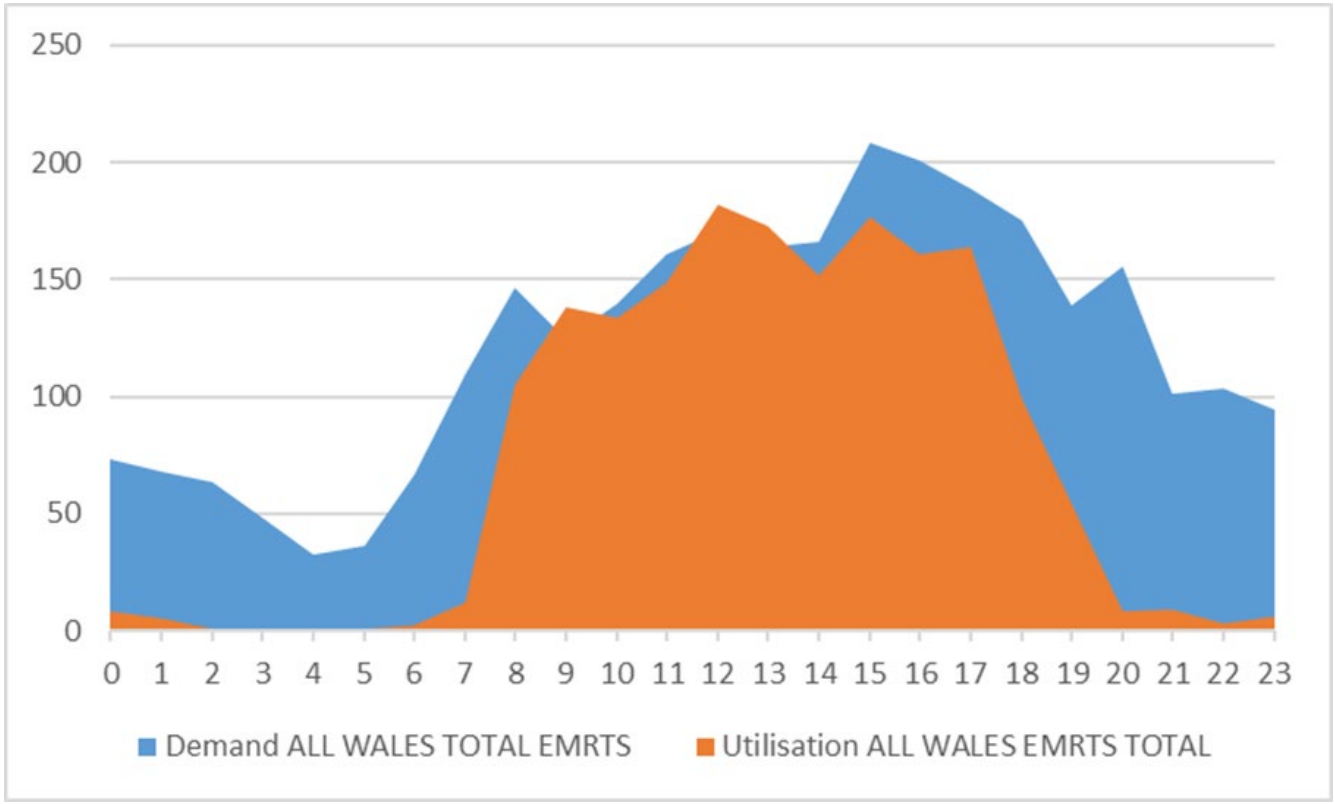

Figure 4 Total Demand versus EMRTS Activity over 24 hours (April 17-March 18)[5]

1.1.4. Figure 4 shows that, in addition to the extra workload outside the current operational hours, there is also some missed activity during peak periods of operational hours. This has been:

1.1.4.1. Identified from both the analysis of demand versus utilisation; and

1.1.4.2. Confirmed through day-to-day reporting of "missed taskings" by Air Support Desk staff.

1.1.5. The unmet need data indicates missed activity both during and outside current EMRTS operating hours. The main peak of unmet demand is between 15:00 and 00:00, but with good demand past midnight, particularly significant in the population centre of South East Wales.

[5] Current out-of-hours activity relates to overruns, and additional response car trials

1.1.6. Figure 5 provides an analysis of the overall unmet need per annum over a 24-hour period. This is broken down by:

1.1.6.1. Current EMRTS Operating Hours (0800–2000);

1.1.6.2. Outside Current EMRTS Operating Hours (2000–0800).

TYPE	0800-2000	2000-0800	Total
Time Critical Transfers	n/a	82	82
Trauma	668	497	1,165
Medical	137	412	549
Total	**805**	**991**	**1,796**

Figure 5 Total Unmet Need (24 hours)

1.1.7. This unmet demand is currently being managed within the existing system with WAST attending. In these cases, patients would not receive the advanced interventions provided by EMRTS and are likely to be taken to their local hospital, rather than the specialist centre that they require. The secondary transfer to definitive care will happen many hours later and is likely to require hospital staff to facilitate.

1.1.8. Table 13shows the unmet need by health board area.

LHB	TRAUMA	MEDICAL	TRAUMA	MEDICAL	T/C TRANFERS	TOTAL
	0800-2000		***2000-0800***			
ABERTAWE BRO MORGANNWG	100	35	96	73	18	**322**
ANEURIN BEVAN	163	0	103	73	10	**349**
BETSI CADWALADR	59	0	98	75	25	**257**
CARDIFF & VALE	145	68	78	90	7	**388**
CWM TAF	87	34	55	45	12	**233**
HYWEL DDA	114	0	55	41	10	**220**
POWYS	0	0	12	15	0	**27**
ALL WALES	**668**	**137**	**497**	**412**	**82**	**1,796**

Table 11 Breakdown of unmet need by Health Board

1.1.9. The main peak of unmet demand is between 15:00 and 00:00, and is most significant in the South East Wales area.

2. Health Gain

Measurable benefit: *Critical Care Intervention outside standard ambulance practice.*

Result: *63% of patients received interventions outside standard ambulance practice.*

Interventions outside routine ambulance care

2.1.1. The service aims to deliver hospital-level care to patients outside hospital where required, including those illustrated in Table 14. Since inception, a minority of these procedures have been introduced into standard ambulance practice. However, many of these interventions are not delivered in isolation and are part of a package of care which includes advanced decision-making. Interventions that have been introduced to the local ambulance service* include administration of tranexamic acid, pelvic binders and IO access.

Year	*pc*
2015	47%
2016	72%
2017	75%
2018	72%
2019	52%

Table 12 Critical care intervention rate by year

2.1.2. The year 1 report revealed an intervention rate of 63%.

2.1.3. The overall 5-year advanced intervention rate is 66%, with a breakdown by calendar year illustrated in Table 14.

Emergency anaesthesia	Chest decompression (thoracostomy)
Intraosseous (IO) access*	Administration of blood products
Advanced drugs (outside routine paramedic practice)	Dedicated pressure dressings*
Use of epistats and bite blocks	LUCAS 2/3 external compression device
Surgical airway	Resuscitative thoracotomy
Central venous access	Acute reversal of anticoagulation
Use of vasopressors/inotropes	Tourniquets and haemostatic agents*
Pelvic splintage*	IV antibiotics in neonates
Procedural sedation	Advanced warming techniques (neonates)
Sedation and paralysis	Advanced Decision Making (including hospital bypass)
Limb splintage*	Regional Anaesthesia[6]

Table 13 Critical Care Interventions

[6] Added and formalised during 2018.

Blood product transfusions

Measurable benefit: *Critical Care Intervention outside of standard ambulance practice*

Result: *313 patients received blood product transfusions*

2.1.4. EMRTS teams carry Packed Red Blood Cells, Lyoplas, Fibrinogen Concentrate and Prothrombin Complex Concentrates.

2.1.5. This intervention is also closely audited internally with external peer review, and governance oversight by the Welsh Blood Service.

2.1.6. Bangor blood bank started supporting the service in addition to Swansea and Wrexham, but otherwise the procedural aspects and audit process remained constant.

2.1.7. During the 4-year period, 313 patients received blood products, 69% were male, 31% female, 3.5% paediatric. The majority of cases related to traumatic incidents (86%), with the remainder being medical. Of the trauma patients, 90% were blunt, and 10% penetrating. The indications are broken-down in Figure 6.

2.1.8. The number of transfusions delivered by type and year are broken down in Figure 7, and the total quantity in Figure 8.

Indication	**n**
Crush	10
Fall	57
GI bleed	21
GSW	1
Neurology	8
Other	29
RTC	158
Stabbing	22
Unknown	7
Grand Total	**313**

Figure 6 Blood product transfusion indications

Year	PRBC	Lyoplas	Fibrinogen conc.	Beriplex
2015*	26	25	2	4
2016	46	43	2	3
2017	40	50	5	9
2018	58	59	9	12
2019	45	48	11	5
2020*	14	14	1	4
Grand Total	**229**	**239**	**30**	**37**

*Figure 7 Number of patient blood product transfusions by year and type *note partial calendar years*

Year	PRBC units	Lyoplas units	Fibrinogen grams	Beriplex international units
2015	59	49.5	8	8500
2016	114	101	5	5500
2017	95	101	9	20950
2018	139	125	28	26875
2019	103	98	33	11250
2020	32	31	2	6500
Grand Total	**542**	**505.5**	**85**	**79575**

Figure 8 Blood products quantity transfused

Pre-hospital Emergency Anaesthesia

Measurable benefit: *Critical Care Intervention outside of standard ambulance practice*

Result: *790 patients received pre-hospital anaesthesia*

2.1.9. Pre-hospital emergency anaesthesia is performed to take control of a patient's airway and breathing. The service audits all such cases and comprehensive data collection allows peer review of cases.

2.1.10. During the first four years, the service delivered anaesthesia to 790 patients. 69% of patients were male, and 31% female. The mean age was 51 (range 0-96).

2.1.11. The aetiology of cases is seen in Figure 9, with the majority of cases relating to road traffic collisions (26.3%) and medical cardiac arrest (16.6%). The indications are outlined in Figure 10.[7]

2.1.12. The injuries or conditions of these patients are outlined in Figure 11.

Mechanism	%
RTC	26.3
Crush	2.2
Drowning	0.3
Equine	2.0
Assault	1.4
Fall	6.2
Fall from height	7.2
Hanging	2.7
Medical Arrest	16.6
Medical - respiratory	2.2
Medical -intra cranial event	8.4
Medical - sepsis	0.9
Medical	6.1
Toxin	2.7
Burn	2.0

Figure 9 Aetiology Pre Hospital Anaesthesia

Indication	%
Airway comp	17.7
Anticipated Course	14.9
Aspiration risk	4.2
Combative	14.1
Emergency surgery	0.0
Flight safety	3.9
GCS	62.4
Humanitarian	2.4
Post RoSC	19.6
Impending airway comp	2.5
Vent failure	11.0
Seizure	3.8

Figure 10 Indication for anaesthesia

[7] Most patients have more than one indication.

Injuries	%
Abdo	3.8
Burn	2.0
Collapse	3.5
C-Spine	1.3
Head Injury	36.2
Hypoxic brain inj	1.6
Intra cranial event	2.2
Long bones	8.2
Pelvis	6.5
Seizure	1.1
Spine	0.6
Thoracic	13.0

Figure 11 Injuries of patients receiving anaesthesia

Improvement in outcomes

Measurable benefit: *Reduction in mortality.*

Result*: In blunt trauma, the 30-day mortality rate for patients treated by the service was 37% lower (adjusted odds ratio 0.63 (95% CI 0.41-0.97); p=0.037) than for a comparable patient group not attended by the service. The introduction of EMRTS was associated with a reduction in 30-day mortality for patients with blunt traumatic injury.*

2.1.13. Two patient groups were outlined in the evaluation proposal, major trauma and post-cardiac arrest. Whilst data analysis of the major trauma group is complete, the cardiac arrest group relies on a compilation of the Welsh registry, which is still under development.

Trauma

2.1.14. Findings of the peer-reviewed publication "The impact of a physician – critical care practitioner pre-hospital service in Wales on trauma survival: a retrospective analysis of linked registry data"(7) are included below.[8]

Summary:

2.1.15. The impact of the service on 30-day mortality was evaluated retrospectively using a data linkage system. The study included patients who sustained moderate to severe blunt traumatic injuries (injury severity score ≥ 9) between 27th April 2015 and 30th November 2018. The association between pre-hospital management by the Emergency Medical Retrieval and Transfer Service and 30-day mortality was assessed using multivariable logistic regression. In total, data from 4,035 patients was analysed, of which 412 (10%) patients were treated by the Emergency Medical Retrieval and Transfer Service. A greater proportion of patients treated by the Emergency Medical Retrieval and Transfer Service had an injury severity score ≥ 16 and

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Glasgow coma scale ≤ 12 (288 (70%) vs. 1,435 (40%), and 126 (31%) vs. 325 (9%), respectively). The unadjusted 30-day mortality rate was 11.7% for patients managed by the Emergency Medical Retrieval and Transfer Service compared to 9.6% for patients managed by standard pre-hospital care services. However, after adjustment for differences in case mix, the 30-day mortality rate for patients treated by the Emergency Medical Retrieval and Transfer Service was 37% lower (adjusted odds ratio 0.63 (95% CI 0.41-0.97), p=0.037). The introduction of an emergency medical retrieval service was associated with a reduction in 30-day mortality for patients with blunt traumatic injury.

2.1.16. Reducing the time from injury to definitive care is perceived to be associated with improved health outcomes (8). Organisation and enhanced models of trauma care, pre-hospital critical care and patient transport have been shown to improve equity of access to time-critical care provison, and reduce mortality and duration of hospital stay of patients with traumatic injuries (9–12). However, some studies have shown no significant change in mortality for patients with traumatic injuries transported by helicopter (13,14). These studies have predominantly involved transport modality comparisons of helicopter versus ground emergency medical services, or have only investigated in-hospital death rates due to a lack of access to data linkage systems. Changes in the organisation of care are more difficult to evaluate than therapeutic developments, due to differences pertaining to care provision, such as access to services, which may contribute to the inconsistencies in study findings.

2.1.17. It has been argued that all new healthcare services should have their performance, impact and population benefit evaluated (14,15). HEMS are relatively expensive to operate and, given the limited number of high-quality service evaluations undertaken, the impact of any new service introduced should be evaluated. However, the evaluation of such services rarely fits a randomised trial design and requires the ability to control for confounders, such as the presence of comorbid disease or injury severity.

2.1.18. The aim of this study was to evaluate the effect of the introduction of the EMRTS on 30-day mortality in patients who had suffered blunt traumatic injuries.

Methods

2.1.19. This study utilised anonymised and encrypted data sources held in the Secure Anonymised Information Linkage (SAIL) databank, a privacy-protecting trusted research environment (TRE) (16,17). Formal ethical approval for this study was, therefore, not required. The independent information governance review panel (IGRP) approved the utilisation of the SAIL databank for this service evaluation, as did the joint study review committee (JSRC) of the Swansea Bay University Health Board. This study follows guidelines for the reporting of observational studies(18).

2.1.20. The study design was a natural experiment of the EMRTS response using 30-day mortality rates to assess the impact of the introduction of the service. Helicopter transport is not always available due to relatively frequent adverse weather conditions and restrictions on service operational hours; in these situations, fast-response cars are used as an alternative. Multivariable logistic regression was used to determine the odds ratios for 30-day mortality in patients with traumatic injuries who were managed by the EMRTS and standard pre-hospital emergency services. All patients were transferred to hospital units that participate in the UK's Trauma Audit and Research Network (TARN)(19).

2.1.21. The SAIL databank contains routinely collected anonymised population-scale linkable health, demographic, administrative, and environmental data at the individual and household level for the population of Wales. The SAIL databank has supported many different study designs, including: large-scale community-based or condition-based observational studies; disease and injury surveillance; and a number of evaluations of natural experiments of service provision (20,21). This databank provides an infrastructure to create retrospective datasets from linking multiple data sources efficiently, including: demographic data (identifying Welsh residents for accurate

follow up); healthcare utilisation (attendance of EMRTS); and mortality outcome data.

2.1.22. Each data source included in this evaluation contained variables of interest to the research aim. The Welsh demographic service dataset (WDSD) provides demographic data (age, sex, date of death), address history to identify Welsh residency for accurate censorship of individuals, and the residential lower-layer super output area (LSOA) to identify patient socio-economic status, based on quintiles of the Welsh index of multiple deprivation (WIMD) (22). The EMRTS data provides information on all operational data since the service launched and was used to identify patients treated by the EMRTS (exposure variable), as well as the date of the trauma incident for appropriate follow-up. The TARN data provides information on trauma hospital admissions for Welsh residents or individuals treated in Welsh hospitals, and contains numerous clinically significant variables for trauma outcomes, including: injury severity score (ISS); Glasgow coma scale (GCS); pre-existing medical conditions (PMC) score; and modified Charlson comorbidity index. These variables are used widely to quantify, categorise and compare injury severity and pre-injury health (23,24). The Office of National Statistics (ONS) mortality data provides information surrounding the death of Welsh residents. The date of death variable was used to derive a dead/alive status variable at 30 days following the trauma incident.

2.1.23. Data linkage techniques were used to combine data sources, carry out data management and cleaning, and create the study population. All individuals living in Wales at the time of injury (27th April 2015–30th November 2018), who sustained blunt trauma resulting in a moderate to severe injury (ISS ≥ 9) and who were admitted to a TARN-participating hospital, were eligible for inclusion. Patients treated by the EMRTS were identified by fitting the inclusion criteria (Appendix 6) or by a record in TARN confirming EMRTS treatment. Patients who were not managed by the EMRTS and who met TARN inclusion criteria comprised the remainder of the study population. Only individuals with an appropriate identity match to the WDSD were included to

identify high-quality matching of personal identifiable data in creating the unique anonymised linkage field. The data cleaning methods applied are shown in Figure 2.

2.1.24. The primary outcome measure was 30-day mortality (measured from the date of injury). This was chosen as most trauma deaths occur in the initial weeks following the trauma incident (25). The ONS mortality data and the WDSD were used to timestamp the date of death regardless of in-patient or hospital discharge deaths. The exposure of interest was treatment by the EMRTS (defined above). Covariates included: age; sex; ISS; tracheal intubation; GCS; socio-economic status; and comorbidity. Age was grouped into five cohorts (0-16, 17-24, 25-39, 40-64 and ≥ 65 years) (26) and ISS and GCS were split into three categories (9-15, 16-24 and ≥ 25, and 3-8, 9-12 and 13-15, respectively). These are established categories that have been used widely in research studies. Tracheal intubation status was defined using TARN data and included pre-hospital or in-hospital intubation. Socio-economic status categories were defined using the WIMD; this is linked to the WDSD to assign the area level deprivation to each study participant's residency at time of injury. Comorbidity was calculated by TARN using the pre-existing medical conditions (PMC) score for each hospital admission. This is modified from the Charlson comorbidity index, with the scores categorised into three groups (0, 1-5, and ≥ 6) to match TARN grouping (0, 1-5, 6-9 and ≥ 10) [21-23]. Individual patients with high PMC scores were combined into a single group (≥ 6) due to small numbers.

2.1.25. Chi-square tests were used to assess the association between EMRTS treatment status with categorical variables. Formal sampling or size calculations were not necessary for this study design. Univariate logistic regression was used to identify potential confounders of the association between EMRTS treatment status. Multivariable logistic regression was used to determine the odds ratio for mortality, adjusting for potential confounders identified through the univariate analyses. Both the backwards elimination method, using the likelihood ratio test and a significance level of p-value <0.05, and the Akaike

information criterion (AIC) method were used to determine the best-fitting final model. Variance inflation faction (VIF) was used to check for multicollinearity in the final model. Statistical analysis was carried out using R packages Survival, Stats, lmtest and MASS.

Results

2.1.26. Between 27th April 2015 and 30th November 2018, 4,035 patients were identified in the databank for analysis. Of these, 412 (10%) were treated by the EMRTS. In general, patients treated by the EMRTS were more likely to be male and were younger than those receiving standard pre-hospital care (Appendix 4). A higher proportion of patients managed by the EMRTS were more severely injured as measured by ISS and GCS (Appendix 4). In terms of advanced interventions, 168 (41%) of patients managed by the EMRTS underwent tracheal intubation compared to 304 (8%) of patients receiving standard care. In patients who were managed by the EMRTS, 36 (9%) received a pre-hospital red cell transfusion and 293 (71%) were transported by helicopter.

2.1.27. The unadjusted 30-day mortality rate was 11.7% for patients treated by the EMRTS and 9.6% for patients who received standard pre-hospital care. The unadjusted odds ratio for 30-day mortality was higher for patients treated by the EMRTS (OR 1.25, 95% CI 0.90-1.71). After adjustment for differences in case-mix, patients treated by the EMRTS had a 37% lower chance of mortality compared to patients receiving standard care (adjusted odds ratio 0.63 (95% CI 0.41-0.97); p=0.037) (Table 3). Requirement for tracheal intubation, increasing age, ISS and PMC, and decreasing GCS were associated with a greater risk of mortality (Appendix 5). Sex and socio-economic status were not important predictors of mortality and were excluded from the final model (see Appendix 5).

Discussion

2.1.28. After adjustment for differences in case-mix, we found a 37% reduction in the adjusted odds ratio for 30-day mortality in patients with blunt traumatic injuries who were treated by EMRTS compared with standard pre-hospital care pathways.

2.1.29. It is important to evaluate new healthcare services to measure performance, impact and population benefit, particularly when interventions cannot be allocated randomly and where there is a limited supporting evidence base. There is conflicting evidence regarding the benefits of HEMS, with some studies showing improved survival (9–12) whilst others show no difference (13,27). The previous literature has evaluated HEMS in other countries with different operating procedures as well as using varying methodologies, including cohort transport modality comparisons of helicopter versus ground emergency medical services.

2.1.30. Improved survival with HEMS can be over-estimated due to over-triaging of less-severe trauma cases (28). However, in this study, we excluded minor injuries (ISS < 9) and adjusted for case-mix differences in evaluating the association between EMRTS treatment and mortality. As the EMRTS was implemented for life- or limb-threatening conditions, and in general should only treat more severely injured patients, the exclusion of minor injuries was appropriate.

2.1.31. There are a number of strengths to this study. The use of population-scale data linkage allowed for the creation of a population-level retrospective cohort, reducing systematic, recall, and loss of follow-up bias. The SAIL databank facilitated access to demographic and mortality data sources, which allowed: the identification of all individuals living in Wales at time of injury; near-complete follow-up across multi-sourced healthcare data; and the ability to capture deaths accurately, whether in hospital or after discharge/hospital transfer. Identification of Welsh residency allowed for consistency of care pathways between the two comparator groups. The use of TARN data allowed for access to important trauma profile characteristics and covariates that influence trauma survival such as ISS, GCS, PMC, and tracheal intubation status for both patient cohorts.

2.1.32. This study focused on blunt traumatic injuries only. Blunt trauma mechanism of injuries include falls, vehicle incidents/collisions, blast, blows and crush injuries. Blunt and penetrating injuries have differing care needs and survival pathways and, therefore, it is important to

study these injury mechanisms independently. However, it would be beneficial to review the impact of EMRTS on penetrating mechanisms of injury as EMRTS case numbers increase.

Conclusion

2.1.33. In conclusion, after adjustment for key differences in case-mix, the pre-hospital management of patients by the EMRTS following a moderate to severe blunt traumatic injury resulted in a significant reduction in 30-day mortality. This study was not designed to determine which elements of the care provided by the EMRTS was responsible for this improvement in clinical outcome. However, the proportion of patients with low GCS, high ISS, and who underwent tracheal intubation was significantly higher in the cohort managed by the EMRTS. It may be that the performance of time-critical interventions on scene, coupled with rapid transit to definitive care, could be explanatory factors for the improvement in mortality. Further studies should consider incorporating penetrating injuries to assess all trauma presentations in Wales.

Cardiac Arrest

2.1.34. Despite the OHCA registry not being available for analysis at the time of writing, summary statistics are provided here for reference.

2.1.35. During the period, the service responded to 1,767 cardiac arrests.

2.1.36. The age and sex distribution of this cohort is seen in Table 15, revealing the majority of patients were male (67%) and the most common age group was 2554 years (43.5%).

2.1.37. In adults, of patients attended, 61.4% achieved a return of spontaneous circulation (ROSC) to hospital.

2.1.38. Analysis of paediatric ROSC rates requires ratification of the OHCA registry.

2.1.39. The LHB of incident is included in Table 16.

Age band	**Female**	**Male**	**Grand Total**

LHB	**pc**

0-14 years	**2.6%**	**5.0%**	**7.6%**
15-24 years	**1.1%**	**3.5%**	**4.6%**
25-54 years	**17.2%**	**26.3%**	**43.5%**
55-64 years	**4.3%**	**9.3%**	**13.7%**
65 years and over	**7.8%**	**22.8%**	**30.7%**
Grand Total	**33.0%**	**67.0%**	**100.0%**

Table 14 Demographics of OHCA patients attended

Aneurin Bevan	**10.4%**
Betsi Cadwaladr	**26.4%**
Cardiff and Vale	**9.2%**
Cwm Taf Morgannwg	**7.5%**
Hywel Dda	**16.0%**
Out of Area	**0.7%**
Powys	**8.9%**
Swansea Bay	**20.8%**

Table 15 LHB of OHCA incidents

3. Clinical & Skills Sustainability

Measurable benefit: *Increased consultant appointments especially in Emergency Medicine.*

Result: *Twelve new consultants have been recruited into Wales to posts combining pre-hospital care and emergency medicine. Thirty-two part-time consultants are employed to deliver the clinical service, all of whom hold NHS appointments in their parent specialities (emergency medicine, intensive care medicine and anaesthesia). There are also well established programmes developing the future medical workforce including PHEM subspecialty training, clinical fellow schemes and the clinical attendant scheme.*

Measurable benefit: *Increased educational intervention to healthcare professionals.*

Result: *An average of 100 formal CPD events per year are recorded, delivering structured educational interventions to healthcare professionals across NHS Wales. 71% of these are delivered to ambulance staff. An estimated 600 Welsh ambulance staff have undergone formal training through such events.*

3.1.1. The EMRTS seeks to enhance both recruitment and educational opportunities for NHS staff across Wales. The benefits register has split this into two main areas: consultant recruitment and opportunistic, or structured, educational interventions. As the service has developed, other areas have arisen with relevance to this key benefit.

Medical Workforce

3.1.2. A proposed benefit of the EMRTS is to enhance consultant appointments in Wales through its novel job plans and close working relationships with health boards and NHS Trusts.

3.1.3. The service has run four selection rounds for consultant appointments during the evaluation period. On average, there are 10 applicants per selection. Selection consists of a comprehensive interview, and simulated scenario test, as well as fitness assessments. The service has employed a total of 35 consultants during the period.

3.1.4. Consultants commit to an average of 2.5 sessions per week to the service, often as extended job plans, which maintains their availability at their base hospitals.

3.1.5. A breakdown of base health board and speciality of those employed at 31st March 2020 is included in Table 17.

3.1.6. The process has supported the recruitment of 12 consultants into NHS Wales.

3.1.7. The majority of consultants live and work in Wales (Table 17).

3.1.8. During the period, PHEM placements have been facilitated, initially in support of WAST, but latterly the service has taken over employment and management of these trainees.

3.1.9. The EMRTS now hosts Welsh Deanery Pre-Hospital Emergency Medicine (PHEM) trainees.

3.1.10. PHEM is a GMC-approved sub-speciality of Emergency Medicine, Anaesthesia and Intensive Care Medicine. Higher specialist trainees from these parent specialities apply for a one-year PHEM training programme through national recruitment and complete Deanery-level training, with some nationally delivered training sessions.

3.1.11. A total of seven individuals have undertaken all or part of their PHEM training within EMRTS during the period.

3.1.12. Four previous trainees are now consultants with EMRTS, and some trainees who have completed PHEM training in England have been recruited as EMRTS consultants.

3.1.13. Clinical fellow schemes have also been incorporated as a legacy initiative from North Wales, with expansion to mid and South Wales. These posts are for doctors outside PHEM training, and are primarily aimed at increasing recruitment into hard-to-fill speciality posts in rural hospitals. 20% of time is spent with the EMRTS at no cost to the service, and the host health board can expect to see around £50k of savings per post when compared to locum appointments. The schemes remain popular and are often oversubscribed. A number of fellows have gone on to undertake formal PHEM training and/or become consultants within the service, supporting the main benefit. During the period, 55 fellows have been recruited and undertaken placements of 1 year to 18 months. This delivers a potential estimated saving to health boards of £2.75 million. This excludes ongoing placements in

North Wales for 2015–2017, for which there would be additional savings.

3.1.14. EMRTS Clinical Fellow Programmes are now underway in Betsi Cadwaladr, Swansea Bay University, Cwm Taf and Aneurin Bevan University Health Boards. These have had a very positive impact on medical recruitment in Wales, helping to fill rotas in Emergency Medicine and Intensive Care Medicine. In addition, they have given trainees excellent clinical experience.

3.1.15. Attracting high-calibre doctors to work in Wales, using the unique opportunities offered by EMRTS, is already showing benefits. A North Wales hospital which started a programme in 2017 has retained two of the three fellows it appointed: one as a permanent Emergency Department middle grade, and the other as an anaesthesia trainee.

Allied Health Professional workforce

3.1.16. Four rounds of CCP recruitment have been competitive with up to 100 applicants per round.

3.1.17. Twenty-six CCPs have been recruited into the service, including eight from outside Wales, further enhancing the NHS in Wales.

SPECIALITY	ANAESTHETICS	ED	ICM	GRAND TOTAL
ABHB	2	4	1	7
BCU	1	2	4	7
CAV	2		1	3
ENGLISH	6	2	2	10
HDDA	1			1
SBUHB	2	1	1	4
GRAND TOTAL	**14**	**9**	**9**	**32**

Table 16 Consultant location and speciality (nb. some are dual registered and this is not reflected here)

3.1.18. CCP education has gone through a number of changes since inception, with the original cohort undergoing an MSc programme through Cardiff University. With service expansion and staff joining who were already in various programmes, this has diversified. The

service entered discussions with Bangor University and has co-designed a bespoke Advanced HEMS MSc, which is into its second year. This is open to internal staff, as well as external applicants who receive placements within the service (29).

3.1.19. Although not part of the service specification, due to WAA developments the service supports a number of HTPs(30). There were eight employed in this role at the end of the evaluation period, and a number of CCPs have come via this route. The role has changed from its original vision and is now an integral part of career development and also operational support for the control room and emergency aircraft.

Clinical Attendant programme[9]

3.1.20. In order to support career development and recruitment, the clinical attendant programme was developed (31), building on early work of the observer scheme. This formalised the process to apply for experience and has supported recruitment of a number of individuals into the service.

3.1.21. The EMRTS Clinical Attendant programme was introduced to help foster mutual understanding across agencies, bring alternative points of view, and to allow medical professionals to take their impressions of the EMRTS to the wider community, as well as gaining insight into emergency clinical management and the acute patient pathway.

3.1.22. The Clinical Attendants are medical professionals (doctors, nurses, ODPs or paramedics) with an interest in pre-hospital and retrieval medicine that are invited to observe the EMRTS. A strict criteria has been set here, with applicants being required to provide a number of pieces of evidence (attendance at EMRTS clinical governance days, contribution to EMRTS audit/training etc) prior to selection.

3.1.23. The Clinical Attendants:

3.1.23.1. are expected to meaningfully contribute to the clinical care that a patient receives, under the direct supervision and guidance of substantive EMRTS staff;

3.1.23.2. are involved in the clinical care of the patients that are attended to;

3.1.23.3. work only within the scope of their practice and qualification.

3.1.24. The EMRTS Clinical Attendant programme allows EMRTS to work with others that have an interest in pre-hospital and retrieval medicine in order to broaden and share relevant skills and knowledge, to strengthen the interface between agencies and services in the pre-hospital and hospital setting, and also to aid sustainability of the future workforce by allowing prospective EMRTS recruits to experience working with the EMRTS.

3.1.25. Since inception in 2017, the programme has run two recruitment rounds, receiving a total of 169 applications. Their professional

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backgrounds are shown in Figure 13. Applicants come from across Wales and England, from a variety of healthcare employment settings detailed in Figure 13.

	2017	2018	TOTAL
ALLIED HEALTH PROFESSIONALS	25	38	63
DOCTORS	22	30	52
PARAMEDICS	21	33	54
GRAND TOTALS	**68**	**101**	**169**

Figure 12 Clinical Attendant Scheme applications by year

	TOTAL
ABERTAWE BRO MORGANNWG UNIVERSITY HEALTH BOARD	24
ANEURIN BEVAN HEALTH BOARD	10
BETSI CADWALADER UUNIVERSITY HEALTH BOARD	12
CARDIFF & VALE UNIVERSITY HEALTH BOARD	26
CWM TAF HEALTH BOARD	6
ENGLISH NHS AMBULANCE SERVICE	20
ENGLISH NHS HOSPITAL	21
WELSH AMBULANCE NHS TRUST	23
HYWEL DDA HEALTH BOARD	8
MINISTRY OF DEFENCE	5
OTHER AIR AMBULANCE SERVICE	1
OTHER	13
GRAND TOTALS	**169**

Figure 13 Clinical Attendant Scheme Applicant Background

3.1.26. Over the two recruitment rounds, feedback was gathered from candidates and revealed that the scheme was not only well received, but inspiring. This included themes of strong governance, being valued members of the team, and good levels of supervision.

3.1.27. Clinical Attendants were asked if they were likely to apply for a position within EMRTS in the future and unanimously they said yes. Similarly, when asked, all Clinical Attendants said they would be interested in more shifts should they become available.

3.1.28. Internal feedback was also sought from the hosting EMRTS teams:

3.1.29. 57% of survey respondents said that the Clinical Attendants they worked with were appropriately skilled for the position; however, there was a strong suggestion that the presence of a Clinical Attendant

did impact on the quality of their work. This is likely due to the intensive nature of supervision in the pre-hospital environment.

3.1.30. 100% of survey respondents said that they would champion the Clinical Attendant Scheme for potential applicants to EMRTS and other Air Ambulance services.

3.1.31. The internal feedback survey raised other suggestions for improvement, focused around the selection of candidates for the scheme and scope for utilising the scheme to engage key players from organisations that work synergistically with EMRTS such as frontline ambulance crews, Trauma Network leads, Critical Care Networks leads, blood transfusion service leads, key players from the Fire Service, and key clinicians from within the Major Trauma Centres. Broadening the scope of the Clinical Attendant Scheme in this way could benefit the service not only in recruitment, but in the overall interoperability of EMRTS within the wider emergency healthcare services.

3.1.32. The ultimate success of the scheme can be measured in those successful at gaining a substantive post in the service. To date, three consultants and five allied health professionals have secured this goal through engagement

From an Attendant's perspective: "As an established anaesthetic trainee considering a dual CCT in PHEM, facing a national PHEM selection round and the hard work that precedes submitting a competitive application seemed rather a gamble, having only just recently suffered the Final FRCA. Was I suited to the PHEM environment? Would I like it? Would my face fit? Would I enjoy working in the air or amidst the unpredictable nature of work? The EMRTS Clinical Attendant Scheme offered me the ability to 'try before I buy' a career in PHEM. I heard about the scheme through an EMRTS consultant I work with at my hospital trust, who encouraged me to apply over a midnight trauma call during my ST3 training. I'm so glad I followed this advice as the scheme has entirely proved that PHEM is for me. I plan to apply for a PHEM training number at the next selection round and feel the experience I have gained with EMRTS will place me in a solid position. Consultants within the service have offered to mentor me through the application process, which is ever increasingly competitive. Opportunities for quality improvement projects, presenting at clinical governance days and engaging with formal training have been plentiful since I engaged with EMRTS. The organisation of the Scheme was smooth and professional, I really felt like I was part of the team and introduced EMRTS as a future potential employer."

in the EMRTS Clinical Attendant Scheme, education and potential job application mentoring.

Medical Students

3.1.33. The service supports regular medical student placements, both short sessions at base, and latterly formal blocks of study. This includes opportunities to get involved in service evaluation, audit and research, as well as training and some clinical work in conjunction with WAST or consultants' base hospital. This includes both Swansea and Cardiff medical schools and, on occasion, external electives run in partnership with the Faculty of Pre-hospital Care, Royal College of Surgeons of Edinburgh.

Educational Interventions

3.1.34. External CPD is an integral part of delivering the key benefits. This includes ad hoc educational interventions at scene or in hospital, but also formal planned activities. These include simulation training days focusing on cardiac arrest and major trauma, referring hospital simulation days, and transfer training. The service has also hosted joint training with neonatal teams.

3.1.35. An average of 100 formal events per year are logged in the service records during the period. Events cater for staff across multiple health boards and into England, as seen in Figure 15. These events started in April 2016.

3.1.36. The majority of CPD events (71%) were delivered to ambulance staff (Figure 14). Events delivered to other agencies (17%) include police and search & rescue teams. The remainder (12%) were delivered to hospital staff.

3.1.37. Courses have been run for an estimated 600 WAST clinical staff. A number of control room staff have also spent time learning about the service through half-day visits and presentations at the three regional control rooms.

3.1.38. Monthly clinical governance days are open to all NHS staff and have been well attended, with an average of 60 attendees each month. These feature presentations of regular audits as well as educational sessions.

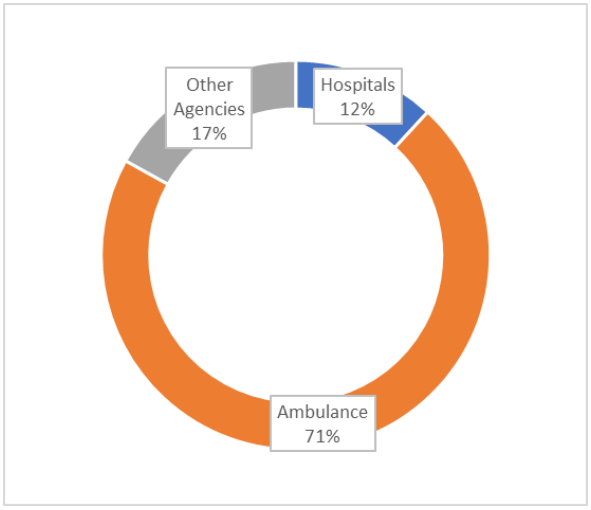

Figure 14 CPD events by professional audience 2016-2020

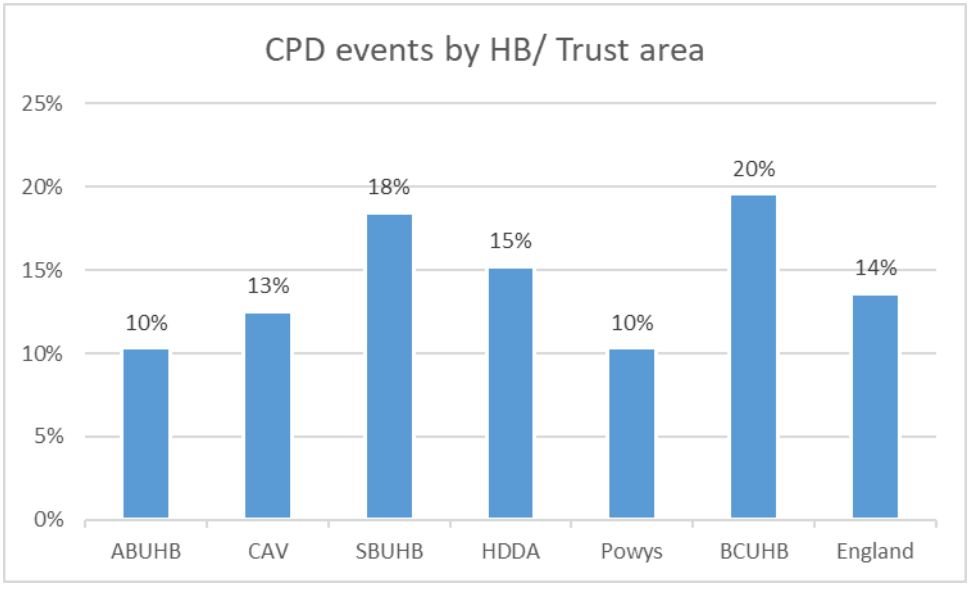

Figure 15 CPD events by area

4. Conclusions & Recommendations

4.1. This evaluation has reported on the performance indicators agreed in 2015 when the EMRTS service was launched. The results indicate that the service has delivered a positive impact on its objectives to the patient population and stakeholders.

4.2. Challenges relating to the ambition of the original evaluation have resulted in modifications of the scope and methodology, as agreed by the delivery assurance group.

4.3. The recommendations of the initial report have been realised, including expansion to North West Wales, and further evaluation of the unmet need outside of hours. The latter has resulted in the first stage of a phased expansion taking place, still within its first 12 months at the time of writing.

4.4. It is recommended that evaluation remains a core element of the service, supporting ongoing service improvement and expansion activities. This should be adequately resourced to realise its full potential.

4.5. Through a developing research portfolio, cumulative data will provide the foundation for collaborative research into specific areas.

4.6. Outstanding evaluation of the Out of Hospital Cardiac Arrest patient cohort should be a priority included within the scope of this national workstream.

4.7. We would value input from stakeholders on clinical and system performance indicators for future incorporation into the next EMRTS evaluation cycle.

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Appendix 1. Chronology of service development

Date(s)	Activity/Milestone
September 2012	Enhanced Care Service initial proposal paper published (2).
2013	Stakeholder engagement activities across Wales.
December 2013	NHS Wales Chief Executive board agree to proceed with Strategic Outline Programme service development. ABMU health board lead on this.
January 2014	Resource to undertake the Strategic Outline Programme agreed by Capital Estates and Facilities, Department of Health and Social Services, WG. Tendering process started for programme management support.
March 2014	Project Board established with Dr Grant Robinson as chair, clear Terms of Reference and representation from WG, WAST, Wales Air Ambulance, Health Boards and Networks. Ernst and Young appointed to undertake programme management support and economic analysis.
March 2014– July 2014	Strategic Outline Programme (guided by Joe Flanagan's team, WG) developed by the Project Board: • Clinical, operational and workforce models agreed by project board • Non-financial and financial options appraisal • Clinical flows modelling (in conjunction with all-Wales collaborative) • Evidence-based review.
July 2014	Strategic Outline Programme presented to WG, WAST, Wales Air Ambulance, Health Boards and participating NHS Trust(s). All stakeholders provided letters of support for the development. Infrastructure Investment Board scrutinised and approved capital spend.
September 2014	Deputy Minister for Health announces approval to proceed with establishment of the EMRTS. Additional resource agreed by Capital Estates and Facilities, Department of Health and Social Services, WG for BJC and implementation phases. Programme Board established as a continuation of the Project Board. Governance arrangements established with clinical, workforce and operational reference groups established (accountable to the Programme Board).
December 2014	BJCs submitted for Swansea and Welshpool developments, including comprehensive justification for investment, benefits realisation plan, risk register and addressing caveats raised by stakeholders at the SOP stage.

Date(s)	Activity/Milestone
January 2015	OGC Gateway Review undertaken (with a number of recommendations before service 'go live' date).
January 2015	BJCs approved and capital funding released to commence implementation of service.
January–April 2015	Reference groups continued to progress recruitment strategy, build clinical governance model and infrastructure development.
January 2015	Commissioning arrangements under WHSCC agreed.
February 2015	ABMU announced as host for the EMRTS following a competitive process run by WHSSC.
April 2015	Health Check undertaken to ensure recommendations agreed by OGC Gateway Review are addressed.
27th April 2015	Service Commences operations.
November 2016	Publication of Year 1 service evaluation.
May 2017	WG Gateway review.
June 2016	South Wales Team move from Swansea Airport to new base in Dafen, Llanelli.
July 2017	North Wales Expansion.
August 2017	Helimed 67 introduction.
December 2017	Cardiff Heliport expansion.
December 2018	Service Expansion Review.
Winter 2018 & 19/20	Twilight service (winter pressures funding).
July 2020	24-hour night service commenced by road (Cardiff Heliport).
December 2020	24-hour night service commenced by air (Cardiff Heliport).

Table 17 Chronology of service development

Appendix 2. Critical care interventions

Provided by the Emergency Medical Retrieval and Transfer Service (EMRTS). Some interventions have been introduced subsequently into paramedic practice in Wales.

Emergency anaesthesia (including sedation and neuromuscular bloackade)	Finger thoracostomy
Intraosseous access	Administration of blood products: • Red blood cells • Lyophilised plasma • Fibrinogen concentrate • Prothrombin complex concentrate
Advanced drugs (outside paramedic practice)	Dedicated pressure dressings
Use of devices for arrest of epistaxis and bite blocks	LUCAS (Lund University Cardiopulmonary Assist System)-2 external compression device
Surgical airway	Resuscitative thoracotomy
Central venous access	Acute reversal of anticoagulation
Use of vasopressors/inotropes	Intravenous antibiotics in neonate
Procedural sedation	Advanced warming techniques (neonates)
Limb splintage	Advanced decision-making

Appendix 3. Comorbidity conditions

Included by the Trauma Audit and Research Network (TARN) in calculating the pre-existing medical conditions (PMC) score.

Acute myocardial infarction	Cerebral vascular accident
Congestive heart failure	Connective tissue disorder
Dementia	Diabetes
Liver disease	Genito-urinary diseases/peptic ulcer
Peripheral vascular disease	Pulmonary disease
Cancer	Paraplegia
Renal disease	Metastatic cancer
Human immunodeficiency virus	Mental health
Blood disease	Bone disease
Neurological disorders	Alcohol abuse
Other conditions	Not classified

Appendix 4. Univariate logistic regression model results

For 30-day mortality rates in patients with moderate to severe blunt traumatic injuries. Values are unadjusted odds ratios (OR) (95%CI). EMRTS, Emergency Medical Retrieval and Transfer Service.

		OR (95% CI)	p-value
EMRTS treated	No	REF	
	Yes	1.25 (0.90-1.71)	0.174
Age; years	0-16	REF	
	17-24	0.88 (0.30-2.74)	0.824
	25-39	0.96 (0.38-2.71)	0.926
	40-64	1.20 (0.55-3.15)	0.674
	≥ 65	3.82 (1.82-9.81)	0.001
Sex	Female	REF	
	Male	1.01 (0.82-1.25)	0.898
Injury severity score	9-15	REF	
	16-24	1.69 (1.23-2.31)	<0.001
	≥ 25	6.63 (5.20-8.50)	<0.001
Tracheal intubation	No	REF	
	Yes	6.25 (4.94-7.89)	<0.001
Socio-economic status	5	REF	
	1	0.69 (0.50-0.96)	0.028
	2	0.76 (0.55-1.04)	0.088
	3	0.78 (0.56-1.07)	0.125
	4	0.86 (0.62-1.19)	0.375
Glasgow coma scale	13-15	REF	
	3-8	13.04 (10.00-17.02)	<0.001
	9-12	3.02 (1.92-4.60)	<0.001
Pre-existing medical conditions (PMC)	0	REF	
	1-5	1.89 (1.45-2.49)	<0.001
	≥ 6	4.12 (3.12-5.48)	<0.001

Appendix 5. Multivariate logistic regression full effects model

Results for 30-day mortality rates in patients with moderate to severe blunt traumatic injuries. Values are adjusted odds ratios (AOR) (95%CI). EMRTS, Emergency Medical Retrieval and Transfer Service.

		AOR (95% CI)	p-value
EMRTS treated	No	REF	
	Yes	0.65 (0.42-0.99)	0.047
Age; years	0-16	REF	
	17-24	0.75 (0.23-2.55)	0.631
	25-39	0.90 (0.32-2.78)	0.839
	40-64	1.69 (0.69-4.83)	0.289
	≥ 65	8.50 (3.45-24.45)	<0.001
Sex	Female	REF	
	Male	0.93 (0.72-1.20)	0.570
Injury severity score	9-15	REF	
	16-24	1.48 (1.06-2.06)	0.021
	≥ 25	3.72 (2.72-5.07)	<0.001
Tracheal intubation	No	REF	
	Yes	2.08 (1.30-3.30)	0.002
Socio-economic status	5	REF	
	1	0.93 (0.64-1.35)	0.705
	2	1.00 (0.69-1.45)	0.996
	3	0.86 (0.59-1.25)	0.432
	4	0.89 (0.61-1.29)	0.525
Glasgow coma scale	13-15	REF	
	3-8	9.70 (5.97-16.06)	<0.001
	9-12	2.69 (1.09-3.07)	0.020
Pre-existing medical conditions (PMC)	0	REF	
	1-5	1.27 (0.93-1.75)	0.134
	≥ 6	2.69 (1.92-3.79)	<0.001

Appendix 6. Activation criteria

Criteria for EMRTS dispatch. RTC, road traffic collision; WAST, Welsh Ambulance Service Trust; ROSC, return of spontaneous circulation.

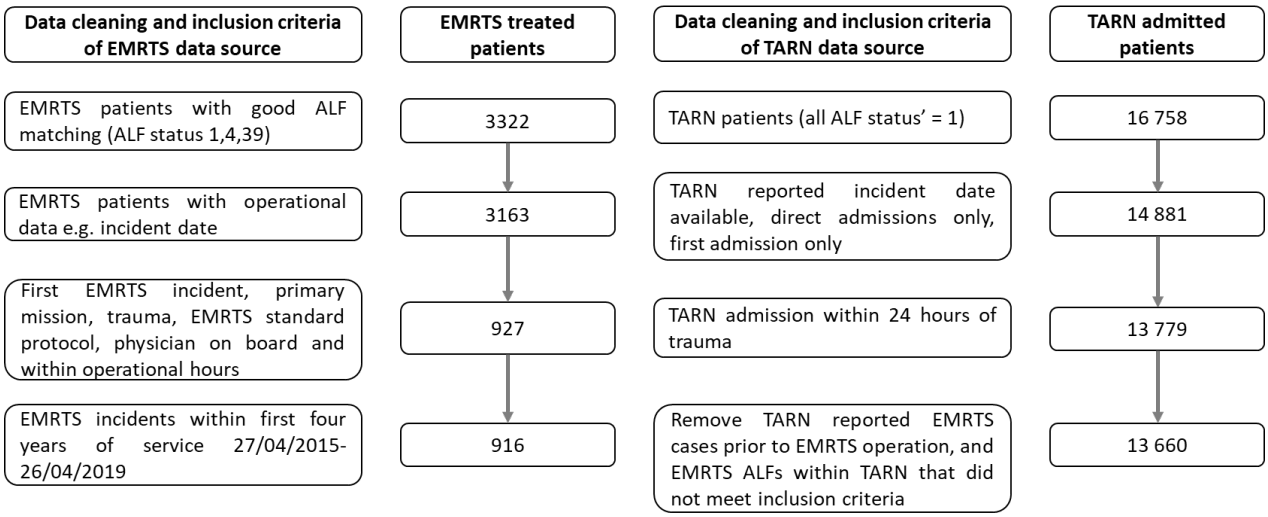
Immediate Dispatch Criteria:

- Serious RTC
- Patient unconscious
- Major chest/head/pelvic injury
- Airway compromise
- Significant burn
- Amputation above ankle or wrist
- Fall from height (>10ft or 1 story)
- Trapped in machinery
- Animal incident
- Aircraft/train/coach crash
- Request from non-WAST emergency service

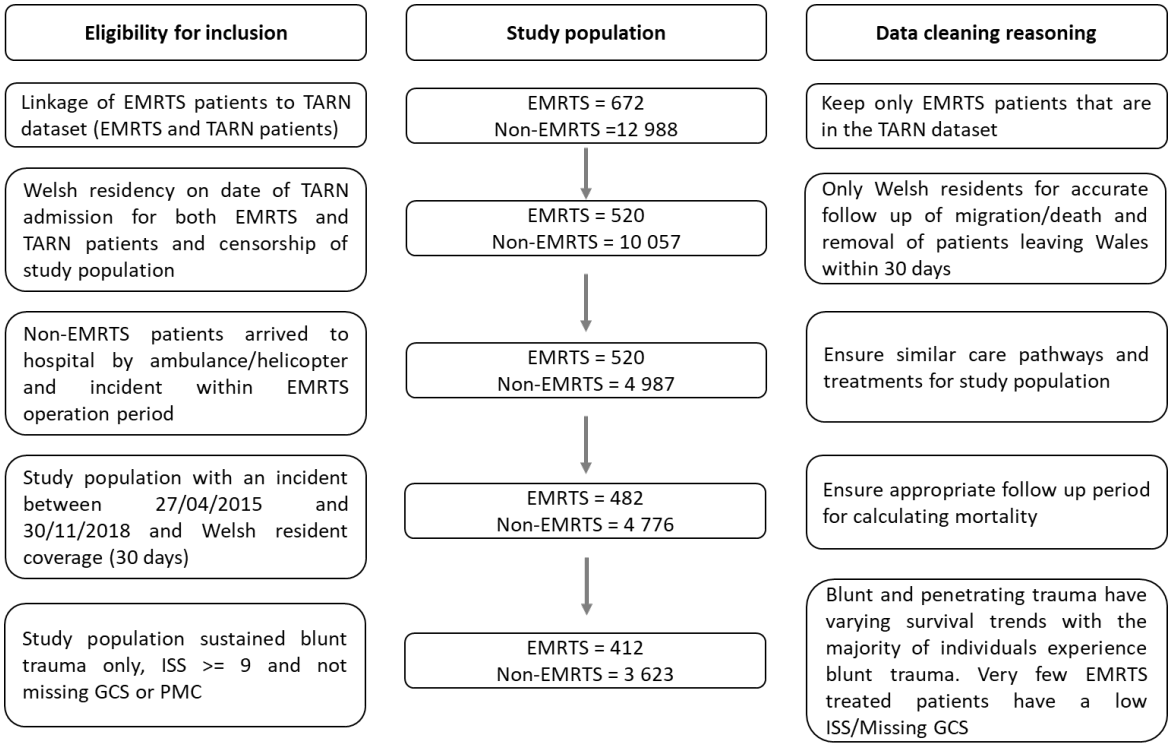
Interrogated Dispatch Criteria:

- Major incident (standby/declared)
- Vehicle or pedestrian RTC
- Industrial or agricultural accidents
- Diving emergencies
- Equestrian injuries
- Coastal/beach incidents
- 999 call originating from Midwife-Led maternity units
- Crew request
- Severe haemorrhage of any sort
- Traumatic injuries including: hangings, burns/scalds, drowning, electrocutions & spinal injury with paralysis
- Medical emergencies including: myocardial infarction, cardiac arrest & ROSC
- Patient agitated/combative
- Access issues

Appendix 7. Inclusion criteria



Inclusion criteria and data cleaning of Emergency Medical Retrieval and Transfer Service (EMRTS) and Trauma Audit and Research Network (TARN).



Inclusion criteria and data cleaning for the study population. EMRTS, Emergency Medical Retrieval and TransferService; TARN, Trauma Audit and Research Network; ISS, injury severity score; GCS, Glasgow coma scale; PMC, pre-existingmedical conditions.