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

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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 from a pre-hospital environment.

Secondary Transfer

This is a transfer of a patient from one health care facility to another.

Retrieval

The use of expert medical teams to assess, stabilise, package and subsequently transport a patient from one health care facility to another. The aim is to replicate the delivery of critical care that you would expect to receive at any major hospital facility.

Pre-Hospital Critical Care

Draws on the experience of hospital critical care and resuscitation and translates this into pre-hospital medical care.

Pre-Hospital Trained Critical Care Consultant

A doctor, who has the ability to make decisions and carry out interventions outside standard paramedic practice.

Critical Care Practitioner (CCP)

These are health care professionals from a paramedic, nursing or allied profession who have acquired enhanced decision-making and clinical skills outside JRCALC. Currently, there is no national standard established for practice.

HEMS

This stands for Helicopter Emergency Medical Service. This takes advantage of speed and access to difficult locations in order to reduce the time required for the patient to gain access to specialist intervention.

Mass Casualty

A mass-casualty incident (often shortened to MCI and sometimes called a multiple-casualty incident or multiple-casualty situation) is any 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 routine, resulting from uncontrolled developments in the course of the operation of any establishment or transient work activity. The event may cause, or have the potential to cause, either multiple serious injuries, cases of ill health (either immediate or delayed), or loss of life. Serious disruption or extensive damage to property, inside or outside the establishment.

Pre-Hospital Emergency Medicine

Pre-Hospital Emergency Medicine (PHEM) is a General Medical Council approved sub-specialty for anaesthesia and emergency medicine. As an approved sub-specialty, those who complete the sub-specialty training will have their Certificate of Completion of Training (CCT) in Anaesthetics annotated with the sub-specialty of P H E M .

Injury Severity Score (ISS)

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to one of six body regions (head, face, chest, abdomen, extremities including pelvis, external). Only the highest AIS score in each body region is used. The three most severely injured body regions have their score squared and added together to produce the ISS score. 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 – Swansea 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

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
CT – Cwm Taff University Health Board
C&V – Cardiff & Vale University Health Board
AB – Aneurin Bevan University Health Board

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

Red – Immediately life-threatening (someone is in imminent danger of death, such as a 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.

Executive Summary

Background to EMRTS

First conceived as an idea in 2013, then undergoing a Strategic outline programme and business justification cases, the Emergency Medical Retrieval and Transfer Service (EMRTS) for Wales went live on 27th April 2015. The service represents a joint partnership between NHS Wales, The Wales Air Ambulance Charity Trust (WAACT) and Welsh Government (WG).

The mission statement for the EMRTS is "to provide advanced decision-making & critical care for life or limb threatening emergencies that require transfer for time-critical specialist treatment at an appropriate facility."

The clinical service model consists of:

- Providing a Pre-Hospital Critical Care Team (Consultant and Critical Care Practitioner) to the scene of a seriously injured or ill patient requiring specialist interventions, drugs, or blood products together with senior decision-making skills. The aim is to bring the resuscitation room to the patient, providing rapid access to critical care interventions and safe transfer of critically ill or injured patients to the most appropriate centre.
- Stabilisation and retrieval of time-critical patients from local hospitals to major centres.
- Neonatal and maternal support for free-standing midwifery-led units and home births.
- Air transfer of neonatal teams for time-critical cases.
- Provision of medical support at major incidents and mass-casualty events.
- EMRTS also provide critical care support to major incidents and mass-casualty events.

The team provides a clinical service 12 hours per day, 7 days per week operating from two bases in Mid and South Wales. The two teams each consist of a Critical Care Practitioner (CCP) and Consultant. The latter have a background of Emergency Medicine, Anaesthetics or Intensive Care Medicine.

Introduction

The evaluation has been initiated by the EMRTS as per the funding terms set out by the Welsh government, funded as part of the BJC allocation, and in conjunction with Swansea University for external scrutiny of data. The report forms the first of a series of reports covering a three-year evaluation period. The relevant process has been adhered to in the conduct of the work,

including multiple information governance review panel approvals relating to various aspects of the work.

During the Evaluation period, commissioning transitioned from the Welsh Health Specialised Services Committee (WHSSC) to the Emergency Ambulance Services Committee (EASC). The main objectives of this report are as follows:

- To assess the first year of operations of EMRTS
- To assess the prescribed measurable benefits of EMRTS
- To consider evidence surrounding the potential expansion of the service
- To outline plans for further work.

The Evaluation period covered in this report is from 27th April 2015 to 26th April 2016. An assessment against three core investment objectives of Equity, Health Gain and Clinical & Skills Sustainability is reported.

Methodology

An evaluation of the EMRTS service was designed from the outset, including quantitative and qualitative aspects. The main quantitative evaluation will focus on a number of important outcomes such as survival, quality of life and functional capacity in survivors and changes in resource use over a three-year time frame. Qualitative components will involve assessing the views of stakeholders on the design, provision and acceptability of the service. Different components of the evaluation will occur over the three-year time frame. The first year will focus on establishing the system and the various data flows and linkages necessary for the evaluation, with some preliminary analyses on the distribution of interventions and related service changes (process measures) and the first stages of stakeholder engagement. The second year will focus on data integration and matching, evaluation of stakeholders' viewpoints and preliminary work on the patient-reported outcomes. Therefore, by the end of year three, the full evaluation on quantitative results will have been completed. In addition, a literature review has been undertaken and is referenced throughout the report.

Results

Over the first evaluation period (27th April 2015-26th April 2016), 1,285 patients had been attended by the service. The majority of these cases related to pre-hospital attendances (92%), with the remainder being secondary transfers.

Per population rate, Powys Health Board had the greatest number of users, followed by Hywel Dda. The smallest user was Cardiff and Vale Health Board.
Patients from the age of newborn to 97 years were attended, with 69% being male.
The service specification has been delivered.
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.
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 are still to be realised, with ongoing work in providing comparators as numbers increase, and new data flows become established over the three-year period.
In respect of clinical and skills sustainability, there is an early indication of realisation of this area, with the caveat that more joint working with health boards needs to take place.
There is a degree of unmet need, both in hours due to simultaneous incidents, geographically and out of hours.

Conclusions

Comprehensive monitoring of the first year's activity of the EMRTS has been undertaken, with this report forming the first part of a three-year study aimed at evaluating the implementation and outcomes of the service.
A key to delivery of the service is a collaborative partnership between the third sector and NHS Wales. New services need time to settle down into normal day-to-day operations. In the case of EMRTS, changes to existing services were extensive, including the coordination model, tasking model, workforce model, base infrastructure, clinical remit and many other aspects.
The delivery of such complex, ambitious plans in a short timeframe was an enormous challenge, but it has been delivered. Feedback from stakeholders on the initial service delivery is quite positive. The data flows and methodological infrastructure for the evaluation of patient outcomes are now in place.
The first year of activity reveals a high correlation with predicted overall service activity for the primary and, to a lesser extent, secondary mission presented during the business case phase. The neonatal component saw comparatively less activity, likely due to factors including

the later introduction of the service, and lack of predicted NHS service changes. The top cover component of the service, whilst fulfilling the strategic medical advisor role, was relatively under-used in the current service configuration and is a potential area for reconfiguration. The Air Support Desk (ASD) performed well, coordinating complex multiagency incidents, secondary transfers and providing clinician-led tasking of the teams. Major incident capability met and exceeded the service specification

Equity

The service has enhanced access and timeliness of delivery of specialist care to a number of patients, significantly enhancing this in rural areas of Wales. Whilst overall equity has improved, there is an inherent inequity due to the current hours of operation and geographical coverage, particularly in the North West of Wales and, to a lesser extent, the South East. This is reflected in both the quantitative and qualitative assessment of the first year.

There is a perceived risk that any delays in expansion in the North West particularly would be detrimental to the area covered by the Wales Air Ambulance Charities Caernarfon Aircraft, as already experienced to a degree since the introduction of the EMRTS.

The analysis of unmet need demonstrates there is a significant proportion of work not currently accessed by the current service configuration. This covers two key areas: night time (20:00-08:00), and the North West of Wales.

There is significant inequity of care over the out-of-hours period and geographically in the North of Wales and, to a lesser extent, the South East of Wales. This was echoed by stakeholders' views.

In addition, it is noted that there is potential demand for work outside of the current service specification, such as non-time critical transfers, and support for paediatric retrieval services. At the time of writing, it is noted that there is an ongoing pilot by the WAACT of a fourth aircraft with a view to supporting such work.

Health Gain

Whilst the evidence in the literature is still quite sparse and mixed with a limited number of high-quality evaluations undertaken, there is evidence that EMRTS-type services have produced health gain (reduced mortality) in a number of different locations. Each service

differs somewhat in its configuration and setting, however, making it difficult to compare service models.

Qualitative assessment reveals a perception by health professionals, health board representatives and patient representatives that the service is providing overall health gain. The range of critical care interventions offered is appropriate for the case mix. Data linkages are now in place for ongoing evaluation against the proposed quantitative outcome benefits, including functional status, mortality and length of stay comparators. Future releases of the three-year evaluation will provide an assessment of these areas.

Clinical & Skills sustainability

The service demonstrates an ability to enhance staff recruitment into NHS Wales, and the potential for further expansion in this area. There is strong support from health board representatives and health care professionals for this aspect of the service. To ensure this is realised in full, further work is required in a collaborative manner with health boards.

The service demonstrates a strong delivery of educational interventions, both opportunistic and structured, across various organisations. This programme of work appears to be going from strength to strength and will be vital for the long-term sustainability of the service.

Recommendations

With respect to the evaluation, as detailed in the methodology, there is a vast amount of data that is now becoming accessible to aid the ongoing evaluation work over the three-year period. Data sets including ICNARC, TARN, the EMRTS detailed clinical data and linked hospital, primary care and mortality data in SAIL, will provide valuable insights and assessment against the measurable benefits register going forward. The benefit of this linkage, the most extensive that exists anywhere in the world, has the potential to be used beyond the initial evaluation period. Services with the best outcomes, e.g. Victoria State Trauma Registry, are those that use data-driven continuous quality improvement methodologies. Consideration should be given to supporting such activities in the longer term. This would also benefit allied services, including critical care and trauma networks and, hence, a collaborative approach should be considered.

It is important to recognise that the service forms part of a complex health care system, which is in a state of flux with ongoing service changes. It is difficult to isolate some benefits solely as a result of this intervention.

Despite the service substantially improving equity overall, there remains residual inequity in provision in the North West, which should be addressed with expansion in this area strongly considered.

With regards to expansion in terms of operational hours, there is a general perception that this would be desirable; however, more evidence is needed to firmly recommend this. Planned work in respect of investigating this, utilising additional datasets, is due to the take place during the next stage of the evaluation.

Background to EMRTS

EMRTS was commissioned "to provide advanced decision making & critical care for life or limb threatening emergencies that require transfer for time critical specialist treatment at an appropriate facility."

The consultant-led service provides two clinical teams by land or air for 12 hours per day, 7 days per week, coordinated by a central communications hub.

The service provides a response to both the scene of incidents and to health care facilities across Wales and went live on 27th April 2015.

1.1. The process for the development of the new All Wales Emergency Medical Retrieval and Transfer Service (EMRTS) started in 2013, in the context of the following strategic areas:

- National Drivers for change
- NHS Wales Service Change Plans
- Development of Trauma Networks.

1.2. Key milestones included the approval of a Strategic Outline Programme (SOP) in late 2014 and approval of Business Justification Cases (BJCs) in early 2015. A full chronological summary of the process is included in Table 1.

1.3. An options appraisal was undertaken as part of the SOP, with the preferred option selected through a formal process.

1.4. The service was launched on 27th April 2015, commissioned by the Welsh Health Specialised Services Committee.

1.5. The service represents a joint partnership between NHS Wales, The Wales Air Ambulance Charity Trust (WAACT) and the Welsh Government (WG).

1.6. The mission statement for the EMRTS is "to provide advanced decision-making & critical care for life or limb threatening emergencies that require transfer for time-critical specialist treatment at an appropriate facility."

Table 1 Timeframes

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 the Strategic Outline Programme for the development of the service. 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.
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.

1.7. The clinical service model consists of:

- Providing a Pre-Hospital Critical Care Team (Consultant and Critical Care Practitioner) to the scene of a seriously injured or ill patient requiring specialist interventions, drugs, or blood products together with senior decision-making skills. The aim is to bring the resuscitation room to the patient, providing rapid access to critical care interventions and safe transfer of critically ill or injured patients to the most appropriate centre. Table 2 lists life or limb- saving interventions that the service provides outside standard paramedic practice. It should be noted that, since the register was created, some of these interventions have become standard paramedic practice in Wales.

Emergency anaesthesia	Finger thoracostomy
Intraosseous (IO) access	Administration of blood products
Advanced drugs (outside paramedic practice)	Dedicated pressure dressings
Use of epistats and bite blocks	LUCAS 2 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
Limb splintage	

Table 2 Critical Care Interventions

- Stabilisation and retrieval of time-critical patients from local hospitals to major centres.
- Neonatal and maternal support for free-standing midwifery-led units and home births.
- Air transfer of neonatal teams for time-critical cases.
- Provision of medical support at major incidents and mass-casualty events.
- EMRTS also provide critical care support to major incidents and mass-casualty events.

EMRTS Team

1.8. The team provides a clinical service 12 hours per day, 7 days per week operating from two bases, Welshpool in Mid-Wales and Swansea in South Wales. The two teams each consist of a CCP and Consultant.

1.9. It is provided by Consultants from Emergency Medicine, Anaesthetics and Intensive Care Medicine, supported by CCPs. Of note regarding the context of this activity, a further Wales Air Ambulance aircraft operates out of Caernarfon, which is principally operated by paramedics from the Welsh Ambulance Service.

1.10. All three Wales Air Ambulance Charity bases are tasked by a single ASD located at Vantage Point House in Cwmbran and operated by a CCP and Allocator. The staffing cost of this specialist desk is met by the charity. There is also a tier of Top Cover Consultants (TCCs) providing remote support and advice on call 24 hours a day.

Health Board Area	Acute Hospitals (Emergency Department/ Critical Care)	Remote Minor Injury Units	Remote Midwifery led Units	Population
Betsi Cadwaladr University Health Board	3	9	4	703552
Powys Teaching Health Board	0	4	6	168099
Hywel Dda University Health Board	4	2	1	381537
Abertawe Bro Morgannwg University Health Board	2	1	1	521814
Cwm Taff University Health Board	2	2	1	301179
Cardiff & Vale University Health Board	1	1	0	453180
Aneurin Bevan University Health Board	2	2	2	562675

Table 3 Health Boards

Geographic Coverage and context

1.11. The service provides coverage for the whole of Wales when operating by air, but range is relatively restricted when operating by road vehicle due to the timeliness constraints. Operational predictions of coverage of 95% of the population by air and 46% of the population by road were cited in the SOP(1).

1.12. Figure 1 demonstrates the location of the main hospitals in Wales and surrounding areas, and the three airports that host the WAACT aircraft. Table 3 summarises the health boards covered by the service, their medical facilities and population based on published mid-year estimates in 2015. The total population for Wales is, therefore, taken as 30,920,36. This doesn't take into account the transient seasonal population.

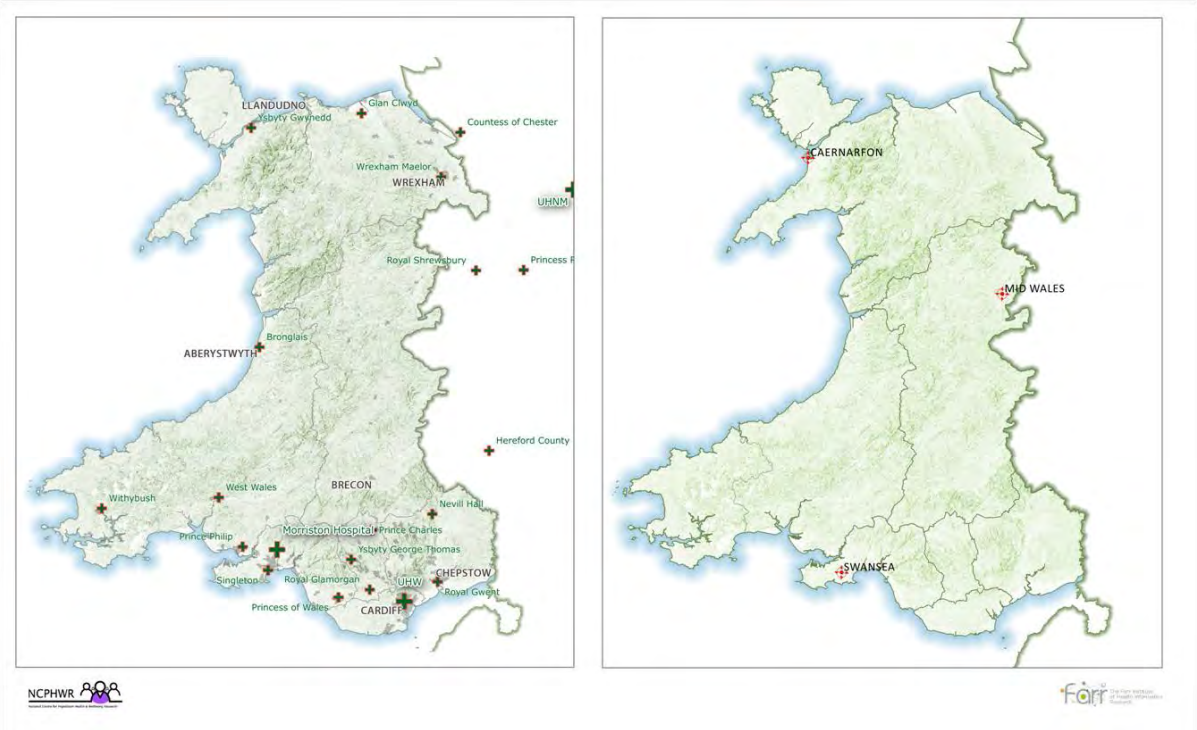


Figure 1: L: Map of Wales with main hospitals, R: Wales Air Ambulance Charity operational bases

Aircraft, Facilities & Equipment

1.13. Aircraft are provided by the Wales Air Ambulance Charitable Trust (WAACT), in the form of two Eurocopter EC-135 helicopters operated by Babcock International.

1.14. Five specially converted Audi Q7 4x4 vehicles are operated by the service providing road coverage.

1.15. In addition, the team have access to Search and Rescue aircraft on a case-by-case basis when required.

1.16. Mid Wales Airport facilities are provided by WAACT with some additional WG capital investment for office and storage space as part of the programme.

1.17. Swansea Airport facilities are provided by WAACT with the addition of administrative office and storage cabins from the EMRTS programme funds.

1.18. The South Wales service has since relocated to a purpose-built facility in Dafen, Llanelli, provided by WAACT. This base also houses the main management and administrative function of the service.

Operating Model

1.19. The service provides services under two broad groups, primary and secondary.

1.20. With respect to primary taskings, the service adheres to a dispatch pathway, as depicted in Figure 2. There are two main dispatch criteria, immediate and interrogated, listed in Figure 3.

1.21. For secondary taskings, whilst the ASD will attempt to pick out calls from the ambulance control system, the main method of activation is by direct request from the referring clinicians. All requests are put through a checklist shown in the appendix. The checklist ensures cases fulfil the criteria for EMRTS activation, and provides a clinical and operational aide-memoire for both the ASD and TCC.

Timeframes

1.22. Table 1 provides a chronological summary of key decisions and events leading to the commencement of the service.

1.23. The key milestones include approval of the Strategic outline programme and subsequent BJCs late 2014, followed by the commencement of service on 27th April 2015.

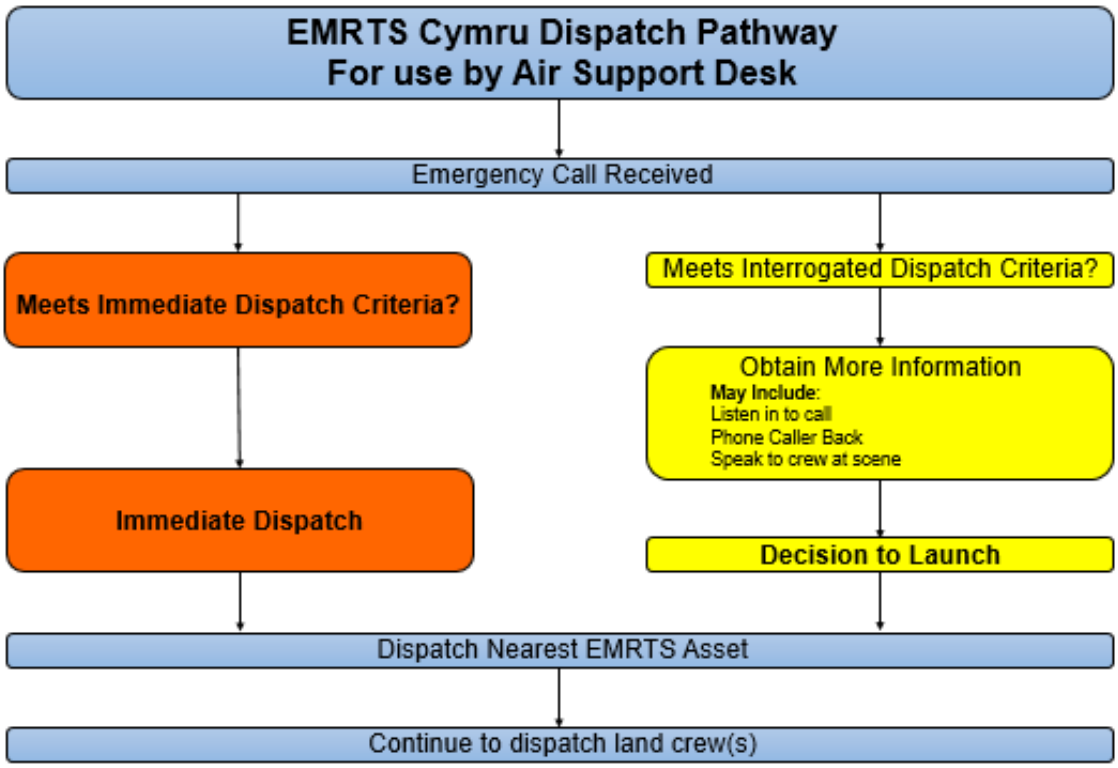


Figure 2 Dispatch Pathway

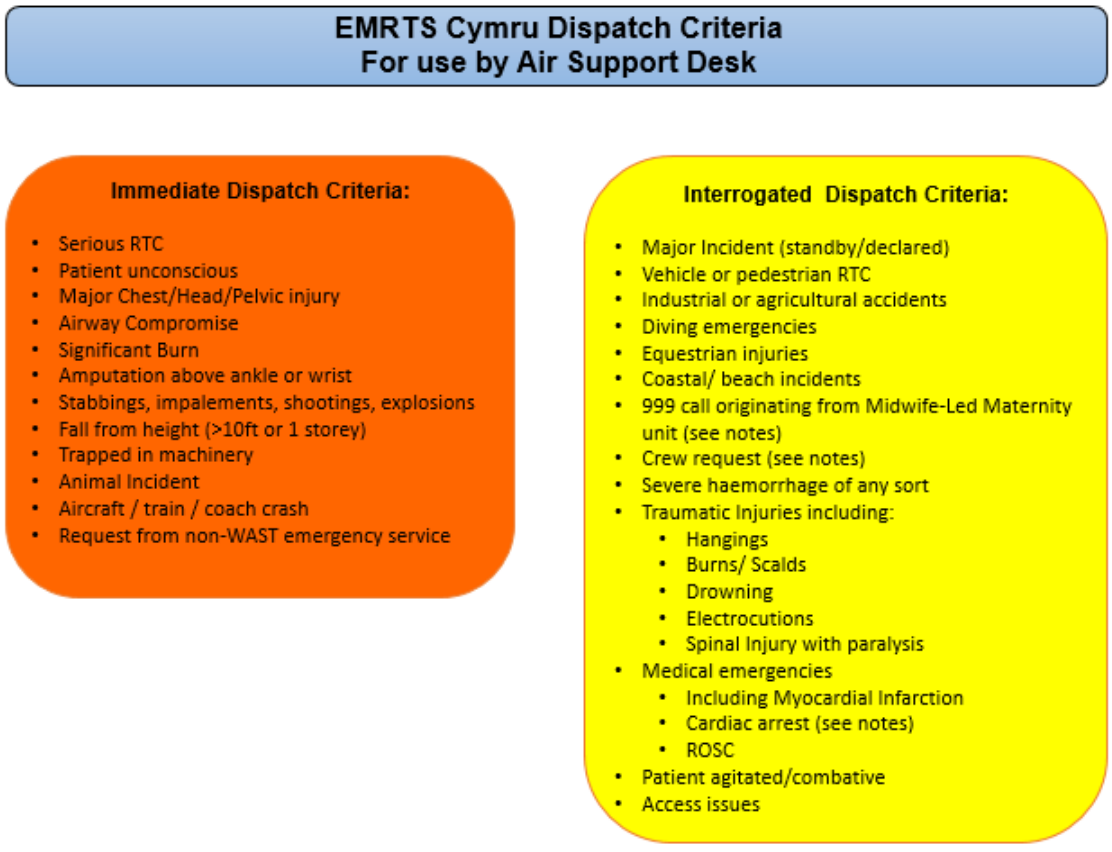


Figure 3 Dispatch Criteria

Introduction

The evaluation assesses the performance of the service against three key investment objectives: Equity, Health Gain and Clinical & Skill sustainability. It has been initiated by the service, with independent analysis and scrutiny of data and outputs by Swansea University.

2.1 The evaluation has been initiated by the EMRTS as per the terms of the WG capital investment programme (3), funding for which was included in the full BJCs. This is in conjunction with Swansea University in its independent scrutiny of the data. In addition, it is anticipated that a further OGC Gateway 5 review will be undertaken due to the critical nature of the programme. This report fulfils the requirement set out in terms of assessment of the measurable benefits register.

2.2 The original study design was approved by the EMRTS Programme Board in February 2015, and then latterly the EMRTS Delivery Assurance Group (DAG).

2.3 The evaluation team reported to the EMRTS DAG at regular intervals, which includes representation from health boards, the Welsh Ambulance Service and commissioners. This included approval of anticipated timeframes for the work.

2.4 The design was also ratified by the host health board's Joint Study Review Committee (JREC) as non-research.

2.5 In addition, work was also ratified by the relevant Information Governance Review Panels (IGRP) of individual data providers and SAIL. This includes senior representation from:

- British Medical Association (BMA)
- National Research Ethics Service (NRES)
- Public Health Wales
- NHS Wales Informatics Service (NWIS)
- Involving People.

2.6 During the Evaluation period, commissioning of the service transitioned from The Welsh Health Specialised Services Committee (WHSSC) to the Emergency Ambulance Services Committee (EASC).

2.7 The evaluation was overseen by Professor Ronan Lyons, Swansea University

2.8 The main objectives of this report are as follows:

- To assess the first year of operations of EMRTS
- To assess the prescribed measurable benefits of EMRTS
- To consider evidence surrounding potential expansion of the service
- To outline plans for further work.

2.9 The Evaluation period covered in this report is from 27th April 2015 to 26th April 2016.

2.10 As part of the development of the EMRTS, a series of proposed benefits were developed against the key investment objectives of equity, health gain, and clinical and skills sustainability. These proposed benefits were generated through a workshop involving a wide range of stakeholders, being published in the BJCs. A central goal of the benefit management process is to bring structure, accountability, clarity and discipline to the definition and delivery of the proposed benefits inherent to a service development such as this.

2.11 The comprehensive proposed benefits realisation register is summarised in Table 4.

2.12 Further details relating to each proposed benefit can be found in the results section for ease of reference.

	Benefit
Equity	1. Access to specialist care not available at patient's nearest acute hospital.
	2. Timeliness of access to specialist care for all patient groups.
	3. Enhanced perception of equity by health care professionals, Health Board representatives and patient representatives.
Health Gain	4. Improvement of patient functional outcome (two groups: Major Trauma, Cardiac Arrests).
	5. Reduction in mortality of various clinical conditions.
	6. Reduction in length of hospital stay.
	7. Critical care intervention or any decision outside of standard paramedic practice.
	8. Objective improvement in the clinical condition of patients.
	9. Downstream benefits in hospital.
	10. Avoidance of hospital transfer and emergency department admission.
	11. Enhanced perception of health gain by health care professionals, Health Board representatives and patient representatives.
Clinical & Skills Sustainability	12. Increased consultant appointments, especially in emergency medicine.
	13. Increased educational interventions to doctors/paramedics/ nurse practitioners /midwives

Table 4 Proposed benefits realisation register

Methodology

Summary

The evaluation uses a combination of quantitative and qualitative methods to assess performance against the proposed measurable benefits. The quantitative aspect utilises the facilities of the Swansea University Secure Anonymised Information Linkage system, and geographical information systems. In addition, a literature review of relevant areas is included. The first report of the three-year evaluation looks at the period 27th April 2015 to 26th April 2016.

Overview

3.1. An evaluation of the EMRTS service was designed from the outset, including quantitative and qualitative aspects. The main quantitative evaluation will focus on a number of important outcomes such as survival, quality of life and functional capacity in survivors and changes in resource use over a three-year time frame. Qualitative components will involve assessing the views of stakeholders on the design, provision and acceptability of the service. Different components of the evaluation will occur over the three-year time frame. The first year will focus on establishing the system and the various data flows and linkages necessary for the evaluation, with some preliminary analyses on the distribution of interventions and related service changes (process measures), as well as the first stages of stakeholder engagement. The second year will focus on data integration and matching, evaluation of stakeholders' viewpoints and preliminary work on the patient-reported outcomes. By the end of year three, the full evaluation on quantitative results will have been completed.

3.2. Evaluation of services such as EMRTS is challenging as these services are typically introduced as a geographically-based service enhancement. Hence, the gold standard designs suitable for testing new drugs, e.g. double-blinded randomised controlled trials, are infeasible. The accompanying literature review shows that few high-quality evaluations have taken place, while a comparison with such studies is also fraught

with the problem that no two service models or settings are alike. Some services are highly retrieval-focussed whilst others are more pre-hospital care focussed. As a consequence, it is necessary to adapt complex observational study designs to be used in rigorous evaluations, such as the MRC guidance on the evaluation of natural experiments, as a service development can be considered under this approach (4). These approaches take the form of self- or parallel-controlled before and after analyses, making use of historical data prior to service evaluation and contemporaneous data on individuals receiving, or who are eligible to receive, services.

3.3. The eligible, but not receiving, group include those who would use the service but don't do so due to operational reasons, such as restriction in helicopters flying at night or in bad weather, or lack of geographical coverage. During the planning phase, it was anticipated that this would happen around a third of the time. EMRTS is expected to attend some 300 seriously injured or ill people in a year. Data on approximately 600 people should be available for evaluation.

3.4. Due to the nature of services, such as EMRTS, in which retrievals are launched in anticipation of being able to provide benefit, but a proportion of cases have already died before the team can arrive, or are found not to be injured or warrant treatment, it is not sensible to evaluate some outcomes, such as health gain, for all cases. Selected categories of cases (those receiving the service) need to be matched with historical and contemporaneous controls based on similar diagnoses, distance/time from hospital and severity metric derived from a number of datasets, including those collected by ICNARC, TARN and ambulance datasets, such as WAST. The cases that have the potential to benefit and are most easily assessed are those due to moderate or severe injury (ISS>9, ISS>12) and out-of-hospital cardiac arrests. Other groups may benefit, but it is very difficult to appropriately match the controls due to data deficiencies. The key aspect of careful design is to reduce, as much as possible, selection and other biases that may confound the results of non-randomised studies.

3.5. Analysis needs to be undertaken in a stepwise fashion, initially based on exploring exposures/severity metrics (without looking at outcomes) to create appropriate comparator groups and carefully matching these variables. The ability to match particular variables cannot be decided until the data have been explored in depth. It also takes time to accrue enough cases and the longitudinal outcomes before there is

enough power and precision regarding effect sizes. Hence, the three-year evaluative framework was designed at the outset.

3.6. Statistical analysis will be undertaken using a mixture of approaches, depending on the distribution of data, but will include survival analyses and differences in proportions and rates using negative binomial regression and other approaches, adjusting for differences in baseline measures and/or propensity score matching.

3.7. Statistically assessed outcomes will include measures of uptake, geographical coverage and equity of the new service and its consequent impact on survival, quality of life, functional status, NHS resource use and costs. For some outcomes, for which no UK data currently exist, such as quality of life and functional status, comparison will also be made with similar services operating in Australia with the support of Professor Belinda Gabbe.

3.8. The evaluation of large-scale complex interventions, in which data have to be collected from many different organisations and based on thousands of patients, would normally cost in the region of £1m if based on traditional methods of data collection and integration. Fortunately, the development of privacy protecting data linkage systems and expertise in data linkage and analysis enables such projects to be evaluated at a fraction of the cost. Such systems have the following benefits:

- Reduced duplication of data collection with inherent potential for errors
- Merging data from multiple sources in a privacy protecting environment that would otherwise not be possible from an information governance perspective
- Consistent use of retrospective scoring tools to ensure comparison between patient groups is accurate
- Ability to enhance existing large-scale data collection projects through engagement
- Independent external evaluation and potential for replication of analyses
- Potential to provide new data to enhance existing research projects
- Reduction in staff costs and logistical problems involved with nationwide data collection
- Improved efficiency of data collection.

SAIL EMRTS overview

3.9 The EMRTS evaluation utilises the facilities of the Secure Anonymised Information Linkage (SAIL) system (www.saildatabank.com), a strategic component of the research infrastructure in Wales and the UK. It was developed in 2006 following a grant from the then Wales Office of Research and Development and has continued to receive infrastructure funding from Health and Care Research Wales (5,6). That funding covers the infrastructure costs, but not the costs of designing and analysing data. The expertise to do this comes from the Prudent Healthcare Intelligence Unit within the Farr Institute of Health Informatics Research, an MRC and multi-funder UK centre of excellence (7,8).The SAIL databank has an established data de-identification and linking service provided by NHS Wales Informatics Service (NWIS) and excellent long-standing relationships with the many NHS organisations who provide data to SAIL.SAIL's unique strength is that it has achieved, to a significant extent, the goal of linking health data from primary, secondary and tertiary sources. It contains over 9 billion linked, anonymised person-based records and receives extracts of all hospital inpatient stays, outpatient contacts, emergency department attendances, and critical care stays across Wales with primary care (GP) data from 76% of Welsh GP practices. There are numerous other data feeds, e.g. the national screening programmes, NHS Direct Wales, Welsh Ambulance Service Trust, ONS Births and Deaths, the Cancer Register for Wales, as well as over 200 project-specific datasets. Each dataset is anonymised, matched and linked at the individual level, so that SAIL currently represents the most complete population-based retrospective electronic patient history available anywhere in the world.It also has ISO27001 information security accreditation and an approved system level agreement with the Health and Social Care Information Service (now NHS Digital) to host data from England. This is an essential requirement due to the very large cross-border data flows in EMRTS.The evaluation of EMRTS Cymru fits under the Prudent Healthcare NHS service evaluation use case and has enabled a number of new datasets, such as extracts from the EMRTS clinical portal, Welsh Ambulance Service Trust datasets, and data from two UK national audits of critical care and trauma, TARN and ICNARC, to be brought into SAIL for the first time. Bringing in data requires very considerable discussion and negotiation with a variety of organisations; it also takes some time to develop trust and contractual paperwork for organisations that have not done this

before.SAIL has an established and state-of-the-art technical infrastructure based on underpinning hardware provided under the High Performance Computing Wales initiative. A user interface is provided via the "SAIL Gateway" – a secure remote access data-sharing platform, providing "from anywhere" access, without the data travelling leaving the secure servers (9). The Gateway is hosted on the UK Secure eResearch Platform (UKSeRP) funded by the MRC as part of the Farr Institute capital development. The Gateway also currently provides a range of analytical software, knowledge bases and collaboration facilities to enable users to work with complex datasets.A unique component of SAIL is the design of the privacy protecting multi-stage environment in which it is possible to link point source geographical data at a location or specific address level and import distances and GIS relationships into the database without risking disclosure (10). This has enabled SAIL to lead on the evaluation of non-healthcare interventions that influence health, as well as the integration of ambulance, ED, hospital and trauma system databases to support the undertaking and evaluation of a wide range of activities, including cluster RCTs of pre-hospital care, injury surveillance, the influences of social mobility on health and the creation of disease-specific cohorts (11–17). This two-stage privacy protecting GIS linkage facility is also key to the evaluation of EMRTS as it enables distances and travel times from pickup locations to a number of trauma units and centres to be accurately measured.SAIL is internationally recognised as a cutting edge privacy protecting system and has been highlighted and promoted in major reports from the UK, Ireland and Canada (18–20).The SAIL component of the evaluation is designed around integration and analysis of data from the following sources (details of each data source are to be found in the appendix):Data already in SAIL: Welsh Demographic Service (age, gender, date of death, deprivation scores, migration and loss to follow-up), Emergency Department Data Set (ED attendances), Inpatients (PEDW), Outpatient attendances (PEDW), ONS mortality, GP data (diagnoses and number of visits).

- Acute data collected on patients using EMRTS: physiological scores such as respiratory rate and blood pressure, working diagnoses; interventions such as intubation, defibrillation, use of fluids and medicines; time to arrival and on scene/handover.

- Follow-up data collected by EMRTS staff on survivors, including EQ5D measure of quality of life, Extended Glasgow Outcome Score (GOSE - a measure of functional independence) and return to normal activities that are collected by the Victorian State Trauma Registry (21). Details of the EQ5D questionnaire can be found in the appendix.
- New data flows into SAIL: ICNARC dataset (Intensive Care National Audit and Research Centre), a dataset already collected on all patients in intensive care, including measures of physiological status; TARN dataset (Trauma Audit Research Network), a dataset already collected on all trauma patients, including diagnoses and measures of physiological status; Welsh Ambulance Service NHS Trust (WAST) data on call-outs for ambulances (reason for the call) and patient report form (working diagnoses, interventions and physiological status measures).

3.18 As mentioned earlier, it takes a considerable amount of time to agree with third parties the provisioning of data, the splitting of data into the two files necessary to protect privacy, and the exploration of the data to ensure the datasets are correct and are accompanied by the necessary meta-data to identify all the correct codes and fields. Errors were found in the submission of several datasets and these had to be resubmitted, leading to considerable unanticipated delays. Funding covers a part-time analysis. The TARN data were supplied in July 2016 and, at the time of writing this report, the ICNARC data had not yet been received.

3.19 The preliminary report contains both a full-year analysis of operational data, and the first six months' analysis of areas where linked data are still awaited.

3.20 Over the three-year period (until April 2018), further reports will be provided on the analysis of service provision and outcomes.

WAST Emergency Ambulance Travel data & Geographical Information Systems (GIS)

3.21 The GIS analysis is aimed at providing baseline measures of spatial-temporal distribution of emergency incidents, requiring ambulance or EMRTS teams to attend, which occur across Wales. The initial analysis will be based upon two datasets: WAST data, which record all NHS emergency vehicle journeys in Wales, and EMRTS incident logs, which record all EMRTS-attended incidents. Some early outputs of this work will be used as workshop materials.

Stakeholder Engagement

3.22 Qualitative feedback will be collected during the evaluation period from health board representatives, health care professionals, and patient representatives through a number of means:

3.22.1 Direct contact

3.22.2 Telephone

3.22.3 Electronic mail

3.22.4 Online social media

3.22.5 A series of workshop

3.22.6 Educational and training events

3.22.7 A structured survey of staff distributed to all staff via electronic mail, consisting of a combination of closed questions and free text boxes.

3.23 In addition, workshop materials were also delivered to smaller groups as a means to facilitate discussions with the evaluation team.

3.24 The feedback will be collated and a thematic analysis conducted to draw out results against the core measurable benefits.

3.25 Further work is planned on a national basis with partner organisations to directly engage with patients in more detail.

Literature Review

3.26 When conducting an evaluation, it is important to review other similar works, as well as evidence pertaining to the basis of the service.

3.27 The review builds on an evidence-based review undertaken by the service as part of the SOC and BJC process. Further evidence has been published in this period, and additional areas reviewed.

3.28 To conduct this work, Dr Nathan West, a clinician external to the service, conducted literature searches using MEDLINE and other major available databases. Search terms included Advanced Life Support (ALS), Enhanced Care Team, Helicopter Emergency Medical Services (HEMS), Retrieval, Cardiac Arrest, Trauma, Physician, Paramedic, Critical Care, Ambulance, Costs, Immediate Care, Aeromedical. Bibliographies of relevant papers were also reviewed. The search results were reviewed by the evaluation team, and cross-referenced with searches conducted during the course of the evaluation work.

3.29 Papers were assessed for the level of evidence and a summary provided as to the type, aim, key results and conclusions. The full details of this can be found within the appendix.

3.30 The core themes of search results are summarised in Table 5.

3.31 Following the review, 11 papers were rejected.

3.32 The main focus of the review is that of primary missions, reflecting the bulk of the evaluation period workload, and also the general lack of published evidence relating solely to secondary transfers. It is, however, acknowledged there is a crossover between these areas.

3.33 The results of the review are included in the relevant sections of the results, matched where possible to the benefits register entry for ease of navigation.

Theme	Papers included
Physician-led Enhanced Care Team (ECT) vs Paramedic-led care	24
24 hour/night-time Enhanced Care Team (ECT) service	3
Paediatric Enhanced Care teams	2
Blood Product Administration	5
Other	3
Safety, economics & structure of HEMS/Enhanced Care Teams	8

Table 5 Reviewed paper themes

Other sources

Additional Literature and Sources

3.34 In addition to mainstream published literature, the evaluation team reviewed a series of reports relating to the development of the EMRTS.The series of reports start in 2012 with the initial proposal for an Enhanced Care Team for Wales (2), and are followed up by a Strategic Outline Programme (1) and Business Justification Cases (22)in 2014.A detailed summary of these in the context of the service development can be found in the background section of this report.

3.37 In addition, quarterly governance reports were reviewed alongside the service annual report.

3.38 Internal clinical governance reports have also been used, including those pertaining to blood products, emergency anaesthesia, neonatal & maternity work.

Case Studies

3.39 A number of case studies provided by the EMRTS clinical team provide an indication as to the service, and are based on real cases. Some details have been altered to protect confidentiality, with the exception of certain cases where the patient has expressed consent for a more detailed presentation. Case studies were used as material for the workshops, and are included throughout the report to illustrate the service.

Results

Summary

Over the first evaluation period (27th April 2015-26th April 2016), 1,285 patients were attended by the service. The majority of these cases related to pre-hospital attendances (92%), with the remainder being secondary transfers.

Per population rate, Powys Health Board was the largest user, followed by Hywel Dda. The smallest user was Cardiff and Vale Health Board.

Patients from the age of newborn to 97 years were attended, with 69% being male.

The service specification has been delivered.

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 out of the 08:00-20:00 operating hours.

Against the objective of Health gain, early realisations of benefits such as critical care interventions are evident, while 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, are still to be realised with ongoing work in providing comparators as numbers increase, and new data flows become established over the three-year period.

In respect of Clinical and skills sustainability, there is an early indication of realisation of this area, with the caveat that more joint working with health boards needs to take place.

There is a degree of unmet need, both in hours due to simultaneous incidents, geographically, and out of hours.

4.1 The following section describes the operational and clinical performance of the service for the period 27th April 2015 to 26th April 2016 inclusive. Data has been collated from internal EMRTS records, WAST operational datasets, and the EMRTS clinical governance process. In addition, the SAIL data analysis is included for the first six months or full year of operation, where available, and GIS results for the full period. The summary has been split into categories for ease of interpretation, but it should be recognised there is some overlap between the classifications due to the nature of the work. The section broadly covers:The number and type of missionsPrimary missionsSecondary missionsNeonatal & MaternityMajor incident & Mass casualtyAir Support DeskTCC (including Advice).Following on is the populated proposed measurable benefits register, with data presented on an All Wales basis, produced by Swansea University with SAIL and GIS data. Health board specific breakdowns are included in the appendix for ease of reference.

4.3 During the evaluation period, 1,285 patients were attended by the team.

4.4 The team were most commonly transported to the scene by air (72%), the remainder by car.

4.5 Incidents attended were most commonly road traffic collisions (29%) and cardiac arrest (16%). The remainder of incidents were split between traumatic in nature, medical and transfers. A breakdown can be seen in **Table 6**. For the purposes of analysis, certain classifications of incidents have been grouped together into the broader categories of medical, trauma, cardiac/respiratory arrest, and transfer/maternal.

4.6 Patients ranged in age from pre-term babies to 97 years of age, with a median age of 47 years. 16% of patients were paediatrics, aged 17 or under.

Category	%
Road Traffic Collision	29%
Other Trauma	14%
Falls	12%
Cardiac Arrest	16%
Other Medical	14%
Chest Pain	6%
Transfer & Health Professional admissions	8%
Maternity/Neonatal	1%

Table 6 Call Categories

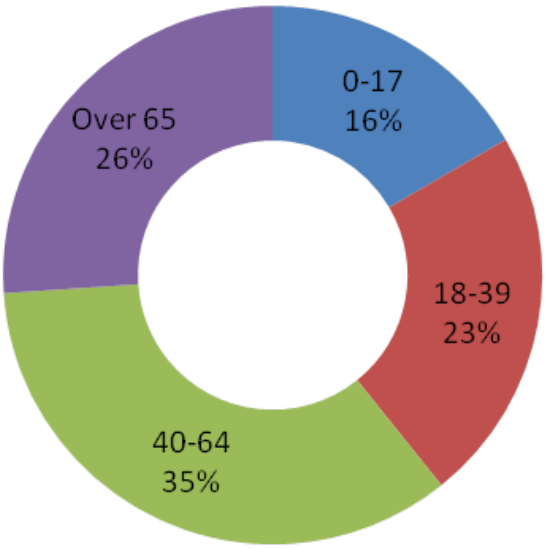


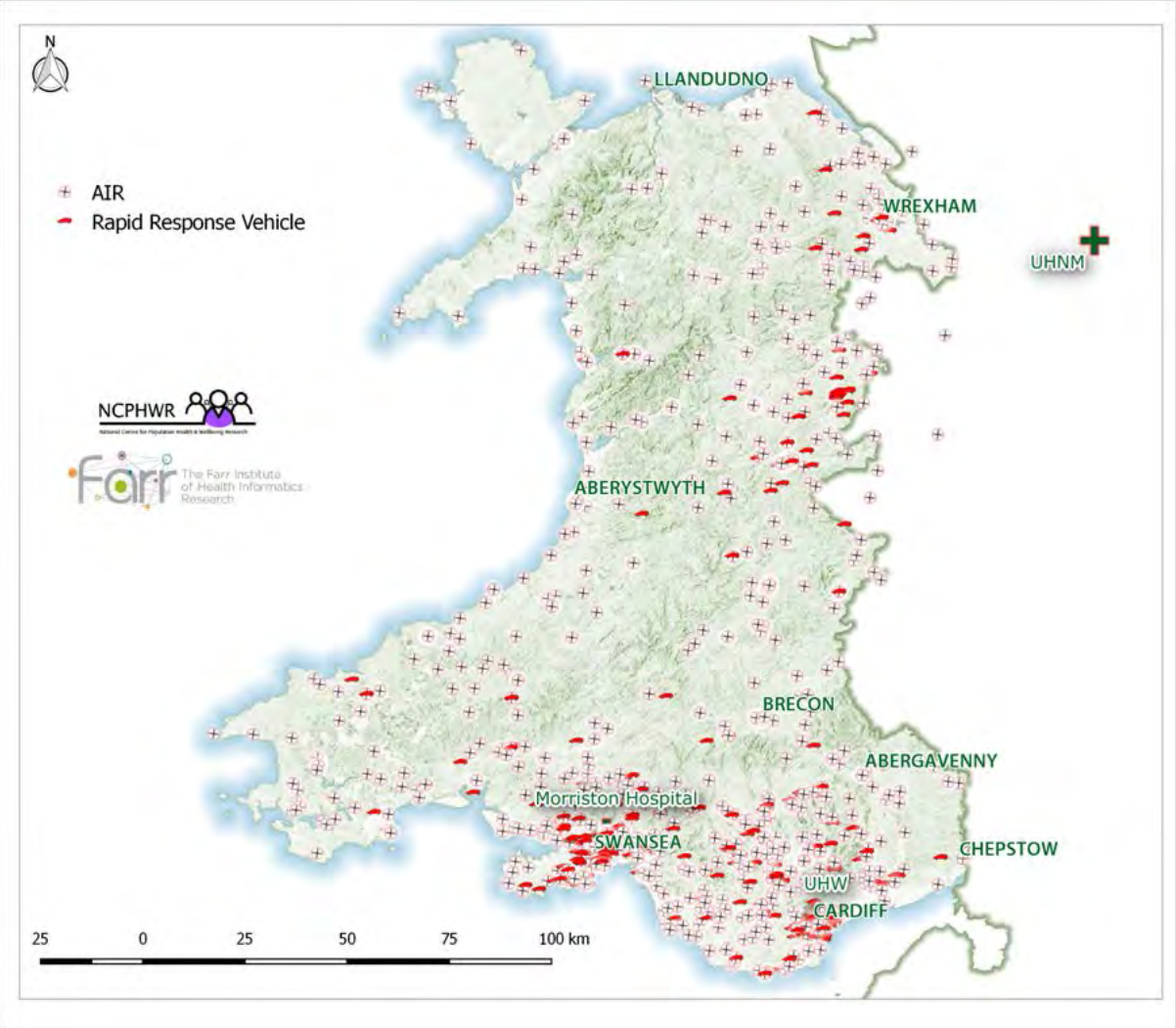
Figure 4 Age distribution

4.7 The activity rate ranked per 100,000 population for each health board is detailed in Table 7. Further work will look at this in the context of emergency ambulance activity to take into account population variations by time of day and year.

4.8 The distribution of incidents by time of day and month are shown in Figure 5 and Figure 6.

Health Board	Rank per 100,000 population
Cwm Taf	4
Aneurin Bevan	7
Cardiff and Vale	6
Betsi Cadwaladr	5
Hywel Dda	2
Powys	1
Abertawe Bro Morgannwg	3
[1]***Population based on 2014 data***	

Table 7 Rate of patients seen by EMRTS by Health Board of incident



Map 1 All incidents attended by EMRTS

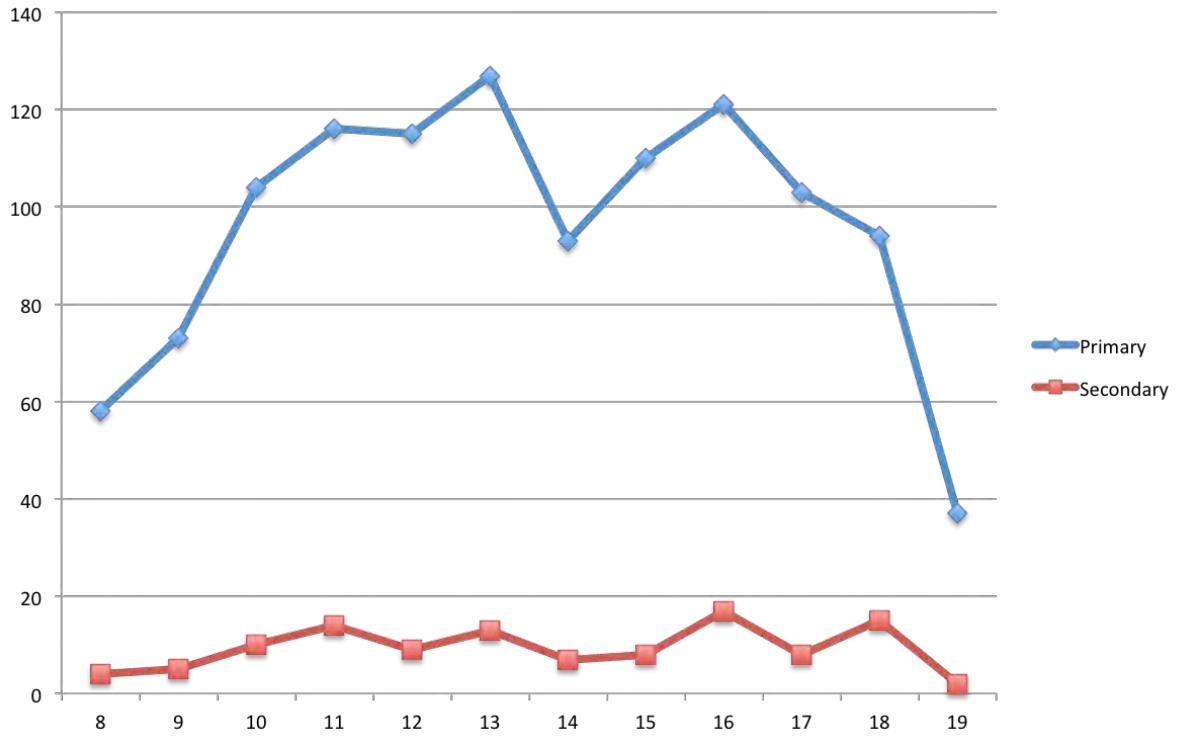


Figure 5 Incidents by time of day and type

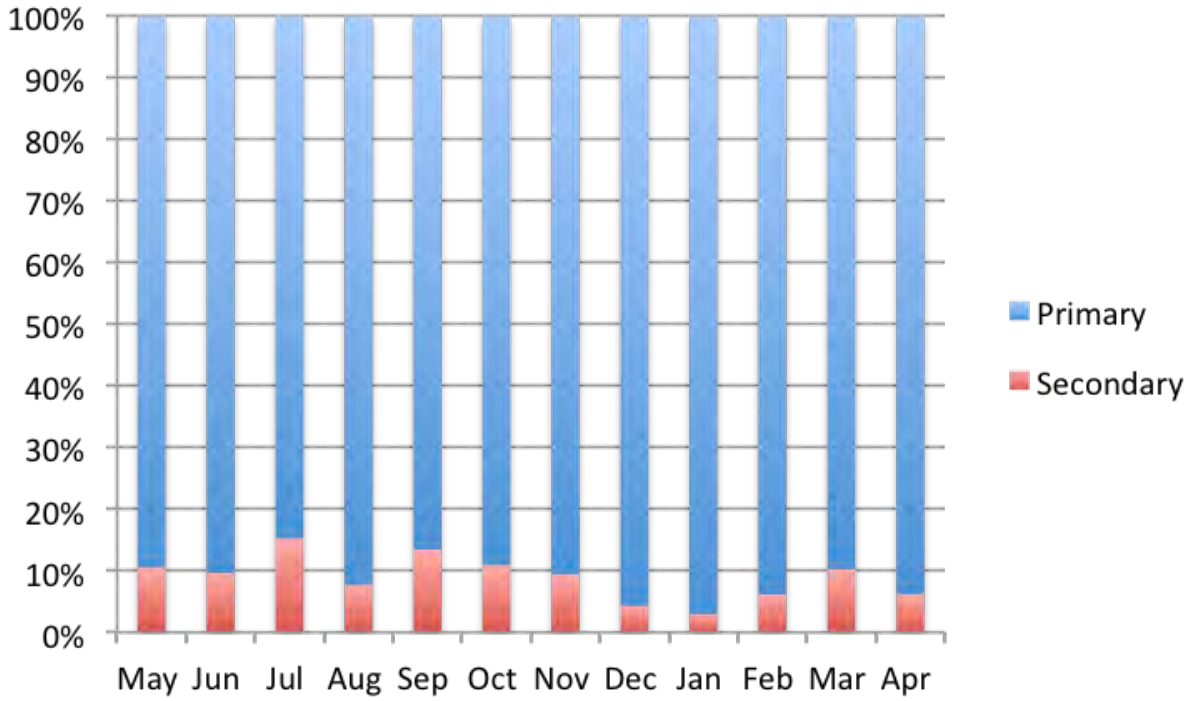


Figure 6 Incidents by month and type

Comparison against predicted demand

4.9 As part of the Strategic Outline Programme (SOP), a demand analysis was presented detailing the baseline activity and, thus, predictions of activity (1). Data pertaining to a 24-hour period was included from a variety of sources and presented under the following key areas:

- Pre-Hospital Critical Care
- Adults Transfers
- Neonatal
- Paediatric Transfers
- Top Cover role.

4.10 In order to benchmark performance against these predictions, each relevant section includes reference to these areas.

Pre-Hospital Missions

4.11 There were 1,157 patients classified as primary responses.

4.12 From the time of the 999 call, for all primary missions, response took a median time of 32 minutes by air, and 30.5 minutes by car. Due to changes in the WAST clinical model during the evaluation period, the call connect time has been used for the total period. Future reports will align with the new clinical model and may, therefore, see a reduced time for overall response time. An internal audit revealed 80% of activations resulted in mobilisation of the team in less than six minutes. Further detailed timings according to mission type, call category and intervention are included in the relevant subsections of this report. In addition, a full breakdown by health board can be found in the appendix.

4.13 For a 24-hour period, the SOP predicted 800 patient clinical contacts per year per base for pre-hospital care based on a comparison with existing services (1). When adjusted for hourly demand, 62% of this activity occurs during the operational hours of the service.[1] Overall, the service attended 1,157 missions compared to a predicted demand analysis of 992. When adjusted for critical care interventions taking place in

[1] AS1 verified incidents, Welsh Ambulance Services NHS Trust April 2015-2016.

63% of missions, the actual pre-hospital critical care activity for EMRTS equates to 73.5% of predicted missions during operational hours.

4.14 From the data available at the time of evaluation, it is not clear how the current hours of operation affect the ability to access all of the predicted cases. For instance, due to no incoming night shift, there may be a possibility of not tasking a crew due to potential knock-on effects of staffing and crew availability the following day. This, in combination with relatively higher rates of emergency calls later in the day, could account for some of the cases that are perceived to have been "missed".

4.15 Information regarding specific areas of pre-hospital missions are included in more detail in the measurable benefits register.

4.16 A case study is included here to illustrate the primary aspect of the service.

Case study of an Adult Primary Mission
Background
The Welshpool team were tasked to attend a male motorcyclist in his 50s in North Wales. He had been involved in a serious road incident resulting in multiple injuries to the chest and lower limbs. He had a severe haemorrhage from a partially amputated leg and a collapsed lung.
Action Taken
Following arrival by air, the team instigated a series of rapid critical care interventions to stabilise the man, including use of specialist haemostatic dressings, a pelvic binder, emergency anaesthesia, and a thoracostomy to treat a collapsed lung. He was evacuated to the major trauma centre, but en-route his condition deteriorated. He was transfused with red blood cells and LyoPlas, stabilising him prior to arrival at hospital.
Outcome
He required ongoing blood transfusions in hospital, and was rapidly taken to the operating theatre for surgery to his lower limb. Unfortunately, his limb was unsalvageable, but he has gone on to make a full neurological recovery.
Change in process observed
Avoidance of secondary transfer. Early delivery of critical care interventions not normally available pre-hospital. Rapid transfer to definitive care.

Case Study 1

Secondary Transfer

4.17 There were 128 patients classified as receiving a secondary response.

4.18 Transfers took place from across Wales. The bulk flows are depicted in a Sankey plot in Figure 9. *(Exclusion -Counts of less than five have been removed)*

4.19 All but one critical care transfers had a consultant on board. The one case related to a transfer by a double CCP crew with the assistance of a PHEM/anaesthetics specialist registrar in North Wales.

4.20 The service has an internal target relating to decision-making. The time from a call being received by a TCC and the decision-making to allocated an EMRTS asset should be <=15 minutes in 80% of cases. The service achieved this in 69% of cases.

4.21 In relation to a target total time at hospital of <=90 minutes, the service achieved a compliance of 74% against a target of 80%.

4.22 The median time spent at transferring hospital was 66 minutes.

4.23 The SOP presented a 5-year analysis of level 2 and 3 secondary transfers in Wales, revealing up to 160 level 3 cases per year that are transferred from Emergency departments (1).

4.24 The EMRTS conducted a total of 74 level 2 & 3 transfers during the evaluation period; of these, 54 were defined as time critical. Taking just the level 3 time-critical cases undertaken by the service (n=46), this equates to a 34% performance against predictions. This is for a 24-hour period on an All Wales basis. Unlike pre-hospital activity, it is currently difficult to isolate the true hourly predicted secondary transfer demand from current datasets. This is due to a lack of consistent use of coding systems, as well as the fact that time of call is poorly completed by clinicians in national audits. This, however, will be addressed with the use of data linkage in future reports. Summaries of these datasets can be seen in detail in the appendix.

4.25 Table 8 details the secondary workload. Included is a summary by intensive care classification as well as primary missions, where immediate response has been requested at health care facilities. An example of the latter would be cardiac arrest in a minor injury unit, or an unstable patient in general practice. Cases are further sub-divided into time critical, at risk of deterioration and non-urgent, with a cumulative total. Included in the counts are six paediatric patients, five of which were time-critical.

4.26 The referring unit is summarised in Figure 7.

4.27 60% of cases were transferred by air, with the remainder travelling by road in WAST vehicles escorted by EMRTS staff. In some cases, the critical care team were delivered to a hospital by air for rapid access, and then onward transfer took place by road due to the patient's condition or other logistical reasons.

4.28 The aetiology of cases is demonstrated in Figure 8.

	Time Critical	Risk of deterioration	Non-urgent	Totals
Level 1	34	5	1	40
Level 2	8	3	0	11
Level 3	46	13	4	63
Primary assistance	13	1	0	14
Total patients	101	22	5	128

Table 8 Secondary Missions

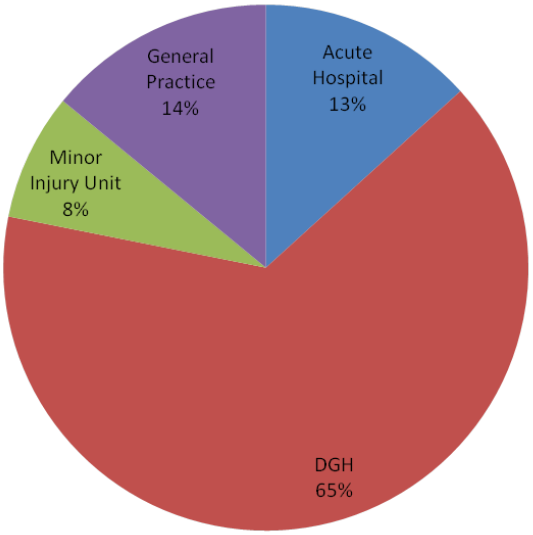


Figure 7 Secondary missions, referring unit

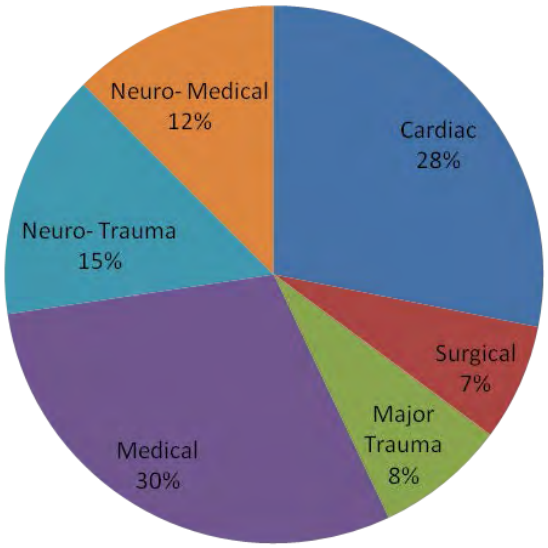


Figure 8 Secondary Mission Aetiology

4.29 A case study has been included to illustrate a secondary mission, showing a similar case to the first example presented, but a different process.

Case study of a secondary retrieval
Background
A male in his 20s was injured in a road incident in North West Wales overnight. He was initially attended by local ambulance crews and transported to the local designated trauma unit. He was discussed with the Major Trauma Centre and accepted for transfer to them for neurosurgical intervention.
Action Taken
The Welshpool team were tasked the following morning to the trauma unit, and provided consultant-level retrieval to the Major Trauma Centre. This included neuroprotective measures and air transport.
Outcome
The patient had suffered from a base of skull fracture and bilateral subdural haematomas. He underwent neurosurgery at the specialist centre and is now undergoing specialist rehabilitation following discharge.
Change in process observed
The patient was transferred to the Major Trauma Centre, with a total transport time of 40 minutes versus a predicted road transfer of two hours. He received critical care interventions en-route without having to denude the trauma unit of anaesthetic staff. An out of area transfer was avoided, thus releasing an ambulance back into the local area to provide cover. If a road transfer had taken place, this would have resulted in a minimum 4-hour roundtrip, impacting on local emergency ambulance provision.

Case Study 2

Figure 9 EMRTS activity for transfers from Health Board of incident to Health Board of hospital (27/04/2015-26/04/2016)

Neonatal & Maternity

4.30 The EMRTS neonatal service specification has two elements. First, to provide an enhancement of the pre-hospital care available for sick or injured babies. Second, to provide a transport platform for the urgent transfer of neonatal teams.

4.31 The service, as a pre-hospital first responder, is occasionally tasked to sick or injured children and babies. This includes babies who have been born in one of the 15 midwife-led birthing units in Wales. Neonatology is widely recognised to be one of the most challenging medical subspecialties, and clearly the level of response that a non-specialist can provide is limited. Nonetheless, the teams are regularly placed in the position of being the primary carer for a sick baby during their transit to hospital. This means that, to meet the service specification, processes need to be robust and capable of enabling a non-specialist to deliver an adequate level of care to bring an infant to hospital safely. Success requires well-developed standard operating procedures, specialised equipment, and targeted training, all of which need to be developed in partnership with specialists in neonatology.

4.32 A key partner is the Cymru Hospitals Acute Neonatal Transfer Service (CHANTS). All the equipment, procedures and training have been developed with their service lead consultant, Dr Jean Matthes. She has been supported by the CHANTS lead nurse, Claire Richards.

4.33 In addition, there is support on the EMRTS External Clinical Advisory Group from Dr James Tooley, the lead for the Bristol neonatology service, who has provided oversight of the Standard Operating Procedures.

4.34 The service has also worked in partnership with local neonatology services in North and South Wales, who have been kind enough to allow team members access to their units for training.

4.35 EMRTS has engaged with staff in birthing units. This has taken the form of meetings with senior midwives, attendance at training events, and the development of a process map to explain the nature of the service. More details can be found under the section Clinical & Skills Sustainability.

4.36 All consultants and practitioners underwent two days of bespoke training in neonatal response during March 2015. This training was developed

specifically for the service, using own equipment and procedures. In addition, staff with less experience underwent further training at their local neonatal units.

4.37 Regular base training takes place, with dedicated neonatal training equipment identical to live kit. This includes drills of aircraft reconfiguration, simulation of neonatal emergencies, and drills of neonatal procedures.

4.38 There is a dedicated section in the monthly clinical governance day for neonates. All cases are debriefed and lessons identified.

4.39 The EMRTS neonatal service is available from both Welshpool and Swansea bases, 7 days a week, from 8:00 until 20:00. This includes both elements of the service specification (i.e. attending neonates in the community/birthing unit, and providing air transport for neonatal teams).

Service Delivery: Attendance in community/birthing unit

4.40 EMRTS duty teams providing this service are supported by the following: bespoke cognitive aids within the service smartphone app; hard copies of these cognitive aids within the dedicated neonatal equipment pack; a full range of equipment and drugs to support airway, breathing, and circulation; a dedicated neonatal transport device (the BabyPod), which is designed to fit in an aircraft or ambulance; immediate access to neonatology advice, including advice on triage; standard operating procedures which underpin all of the foregoing. In addition, the ASD and EMRTS TCCs provide online support and advice – for example, by doing calculations remotely to relieve some of the cognitive load on teams on the ground.

4.41 Staff at birthing units are supported by a process map and by real-time advice from the EMRTS TCCs.

Service Delivery: Air Transfer of Neonatal Teams

4.42 This area of service is supported by: bespoke cognitive aids for the neonatal teams to help them deploy; a standard operating procedure; medical passenger training on the Wales Air Ambulance helicopter.

4.43 The neonatal response went live in August 2015, overseen by a lead consultant. This was four months after the go-live date for the adult service. This delay allowed time for staff to become familiar with the brand-new service as it applied to adults, without the added complication of neonates. It also allowed time for staff to complete their neonatal sign-off. In addition, many of the bespoke items of neonatal equipment had not yet been delivered and tested. This included the incubator, which remains outstanding. Fortunately, resilience has been provided by the WAACT-owned BabyPod, which has provided excellent service.

4.44 The Neonatal Team Transfer element went live in July 2015. This allowed time for agreement on the exact process for responding to requests for transfer, and to allow a sufficient proportion of the neonatology teams to undergo medical passenger training.

4.45 At the time of writing, the numbers of neonatal cases are small, preventing the release of detailed statistics at this stage. However, information from internal audit reveals the following:

4.46 There are very few attendances at remote midwifery-led units. This probably reflects the selection of cases for these units, and the fact that training of midwives in these facilities in Neonatal Life Support is of a high standard.

4.47 EMRTS attends approximately four cases per month in the community. These cases are largely of two types: SIDS, and what may be best termed as "transient alarming episodes". The former are clearly tragic cases, and teams provide largely pastoral support. The latter relate to 999 calls where the description is sufficiently alarming to deploy the team (for example, unresponsive episode or breathing difficulty). In the vast majority of these cases, the baby is much improved by the arrival of the team. On several occasions, however, the ability of EMRTS to deploy neonatal CPAP has provided benefit.

4.48 A case study has been included to illustrate this component of the service.

Case study of Neonatal case
Background
A baby was born prematurely at home, and 999 was called for assistance, with transport to hospital in mind.
Action Taken
The ASD intercepted the 999 call and activated the team, who arrived within 30 minutes of the 999 call, with specialist neonatal equipment including the BabyPod. Arriving shortly after the baby had been born, they were able to instigate Neonatal Life Support and, in liaison with the CHANTS consultant, then transferred the baby and mother to definitive care, bypassing local hospitals.
Outcome
The mother and baby have been discharged and are both doing well.
Change in process observed
The ambulance crew would have rapidly transferred the baby to the nearest hospital, and wouldn't have been able to instigate warming using the specialist equipment.

Case Study 3

Paediatrics

4.49 16% of patients attended by the service were 17 years or under. In terms of access to care times, this is included under measurable benefit number 2.

4.50 Due to the relatively small numbers matched in the SAIL system when broken down by category and area, a more detailed analysis cannot be presented in this report. However, this will be released in future iterations.

4.51 Case studies are included in the measurable benefits section illustrating paediatric incidents.

Major incident and mass casualty

4.52 The EMRTS Major Incident Plan has exceeded its service specification. The service was commissioned to provide a medical advisor at a major incident. This has been achieved.

4.53 The service is now recognised to be a crucial element of any major incident or mass-casualty event in Wales.

4.54 Staff take up key medical roles in an incident, and will be the provider of significant logistical support including drugs and blood products.

4.55 The service, as a pre-hospital first responder, will naturally attend any major incident or mass-casualty event in Wales. Recent international mass-casualty events have led to the sad realisation that such events are increasingly likely. Planning for the occasion has to be robust and detailed.

4.56 There are now well-developed standard operating procedures, appropriate equipment, and training, all of which were developed in partnership with other service providers, particularly WAST.

4.57 Close links with WAST resilience managers enable staff to take part in major incident exercises several times a year, working alongside other responding agencies, including the fire service and police.

4.58 All staff have undertaken two afternoons of bespoke training. This training was developed specifically for the service in partnership with WAST, using own equipment and procedures. In addition, TCCs have taken on extra training to meet their responsibilities in this area.

4.59 Regular training takes place, alongside other Tier One responders, at large-scale events designed to pressure-test the emergency service response.

4.60 Regular conference calls between the TCC group allow for discussion of plans and any cases that arise. Any changes to procedures are promulgated, and rehearsal-of-concept drills are undertaken.

4.61 The service is available 24 hours a day, 7 days a week. During duty hours, duty teams will respond, supported by off-duty personnel.

4.62 Out of hours, the TCC (on duty 24/7) will initiate a call-out of off-duty teams.

4.63 Testing of call-out suggests that the service will be able to provide up to ten duty teams to a live incident, irrespective of the time.

4.64 The service specification calls for a single individual (Medical Advisor). However, experience and training identified a number of further roles, to which the service has now committed. These are:

- Strategic Medical Advisor (a remote role)
- Casualty Clearing Station Medical Lead
- Forward Doctor (of which there may be several)
- Air Support Paramedic.

4.65 EMRTS duty teams providing this service are supported by the following: bespoke cognitive aids within the service smartphone app; hard copies of these cognitive aids within a dedicated equipment pack; standard operating procedures, which underpin all of the foregoing. In addition, the ASD and EMRTS TCC provide online support and advice.

4.66 A mass-casualty bag system is being developed by WAST, with input from key stakeholders including EMRTS. This will significantly enhance the capability within Wales to respond to a major incident, and is a great example of joined-up thinking. By using the resources of both WAST and EMRTS, there has been an opportunity to cut down on duplication and make significant efficiency savings compared to the equivalent model in England.

Air Support Desk

4.67 The Air Support Desk (ASD) went live on the first day of the service, staffed by a dedicated allocator, and CCP from the Swansea rota.

4.68 Hours of operation are 08:00-20:00.

4.69 A dedicated 0300 number was provided and publicised to health care professionals across Wales.

4.70 The desk is situated in Vantage Point House, Cwmbran, in the ambulance clinical contact centre (CCC).

4.71 Central coordination is cited in literature as being advantageous (23).

4.72 All activity of the Air Desk is logged on the WAST control system. For certain activities, a "H code" is applied manually to an incident record. Codes include:

- H007 Viewed by Air Desk
- H015 Call not suitable for air ambulance
- H016 Crew Request for air – Rejected.

4.73 These records reveal an entry in the records of an average of 111 calls per day. Overall, based on call volumes, staff will have sight of an average 776 calls per day during operational hours.[2]

4.74 A summary of these codes is included in Table 9 H code summary.

4.75 It should be noted that these codes are manually applied and dependent on the operator, who may choose to use a different interface for overall viewing of call activity, and not consistently record codes. However, the patterns of activity are thought to broadly represent the Air Desk activity.

4.76 Possible explanations for no codes being recorded during the period April-July 2015 include staff familiarisation with the control systems, refinement of dispatch criteria and, more pertinently, the introduction of the TCC rota in July.

4.77 By way of context, WAST received 454,487 verified 999 calls during the evaluation period. 283,301 of these were during operational hours of the service.

4.78 In cases recorded as not suitable for air, it is feasible to suggest that, without an ASD, the majority of these 726 calls would not have resulted in an air launch independent of the ASD. However, those recorded as rejected crew requests equate to 78 incidents where the air ambulance was not activated. This equates to a potential £117,000 in savings to the charity, based on a £1500 per mission estimate.

4.79 Stakeholder engagement found broad support for the ASD, recognising the advantage of central coordination in complex cases. Some feedback relating to this theme is included later in the report.

4.80 Internally, the staff survey revealed 77% of respondents felt the ASD was needed, but there was less support for the current staffing makeup. 41% felt the staffing wasn't right, and that the role could be performed with two trained operators and the removal of the CCP.

4.81 A case study of two simultaneous calls illustrates the ability of the desk to coordinate complex logistical and clinical processes.

[2] WAST operational Data 2014-2015.

Case study of simultaneous time-critical transfers
Background
Two patients presented with intra-cerebral bleeds in a hospital in West Wales at 18:30. Both had been accepted by the tertiary neurosurgical centre in Cardiff.
Action Taken
The ASD and TCC were able to accept and coordinate the timely transfer of both these patients to specialist care. This utilised both teams and made use of a newly commissioned helicopter landing site during the hours of darkness.
Outcome
The service prevented the district general hospital from losing its on-call anaesthetic team for two potentially very lengthy road transfers. It allowed both to occur within a very short space of time, and enabled equity of access to specialist care to the local hospital, in addition to allowing local services to continue.
Change in process observed
Without the service, there would have been two back-to-back transfers, utilising staff from two on-call shifts, and using an emergency ambulance for a protracted period of time. One of the patients, whose condition had already been deteriorating, may have had a poorer outcome. The ASD was able to coordinate a multiagency response, dealing with complex logistics and two time-critical transfers to tertiary centres. This required the skillset of control staff, combined with the clinical knowledge and experience of the CCP.

Case Study 4

Month - Year	ASD Viewed	Not suitable for Air	Crew Request Air - Rejected
May-2015	4599	0	0
Jun-2015	3482	0	0
Jul-2015	3407	0	0
Aug-2015	3776	53	13
Sep-2015	3004	177	25
Oct-2015	3427	85	10
Nov-2015	2681	98	1
Dec-2015	2742	62	6
Jan-2016	3961	64	4
Feb-2016	2864	52	8
Mar-2016	3284	82	11
Apr-2016	2975	53	8

Table 9 H code summary (April 2015 excluded due to incomplete month)

Top Cover Consultant

4.82 The Top Cover Consultant (TCC) role was introduced as per service specification on 1st July 2016 with 99.8% availability over 24 hours per day.

4.83 Available remotely, with no planned direct clinical care commitment, consultants provide advice to referring centres, service staff, and WAST.

4.84 During the period, the provision of advice to WAST crews, including Helimed 61 and road crews in specific circumstances, was introduced.

4.85 During the evaluation period, TCC interventions were recorded on the ambulance control systems, logged to an individual call sign, and also on a paper log at the ASD.

4.86 Limitations of this dataset include some inconsistencies of call sign recording during the early months, and reliance on a manual paper record transcription.

4.87 Analysis of these records reveal:

- 220 calls recorded (301-day period)
- A number of core themes emerged as per **Table 10**
- 12% of calls outside of operational hours of the clinical service
- Outcomes are summarised in Figure 13

- In a small number of cases, the consultant responded to the scene of the incident to provide additional assistance where it was in the local area; an example includes a traumatic cardiac arrest, where a decision was taken to cease resuscitation outside of JRCALC guidance
- 20 transfer requests were declined, with the reason recorded summarised in Figure 14.

4.88 Predicted demand for this service was outlined in the SOP and, in the main, it was an unknown quantity. The only areas with predicted numbers were coordination of time-critical transfers (n=220), and medical advisor role (n=6).

4.89 The results, therefore, indicate actual demand falls short of these predictions. However, it should be noted that part of the remit would be offering remote support to registrars, an area that was not introduced during the first year. In addition, with a late start of cover, the role took time to bed into normal operations both from a system and staff perspective. This is a complex area to study, with interplay between cases that may have been either primary or secondary missions affecting the need for a TCC discussion.

4.90 The staff survey specifically asked about the role. The majority of respondents (81%) felt that the role did too little, and the same proportion felt it needed to be re-organised in some way. 86% of respondents felt it was important to provide the strategic medical advisor role.

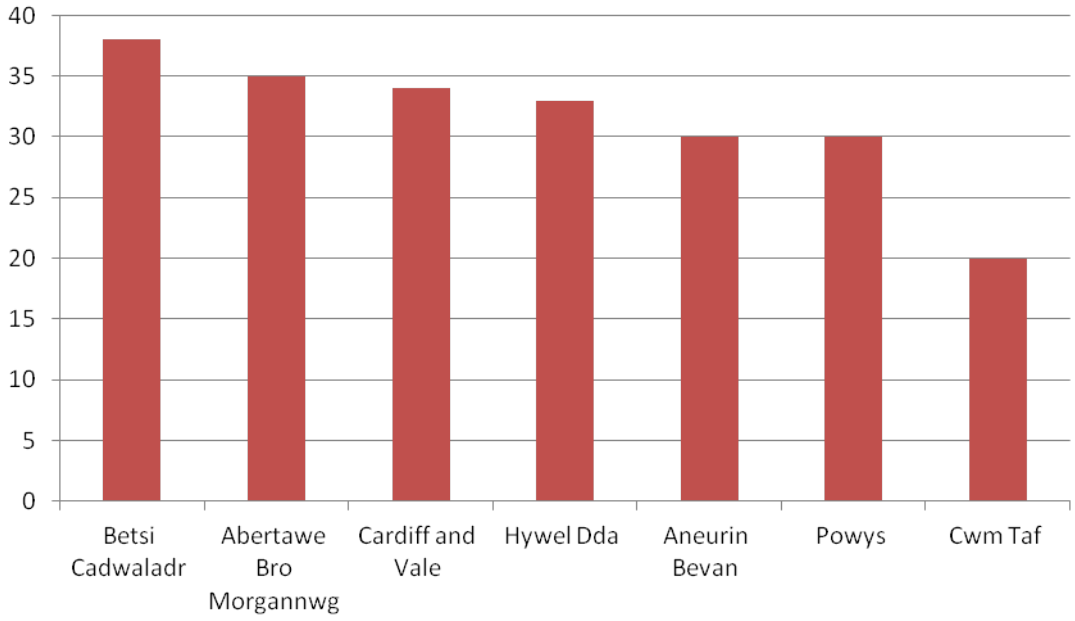


Figure 10 Top Cover Calls by LHB

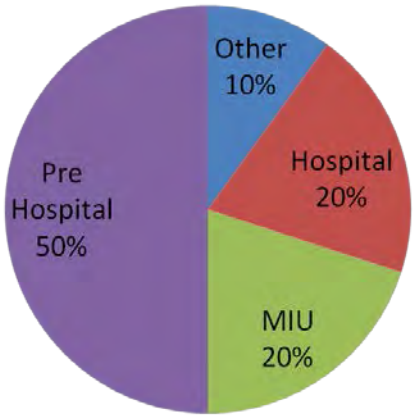


Figure 11 Top Cover call Origin

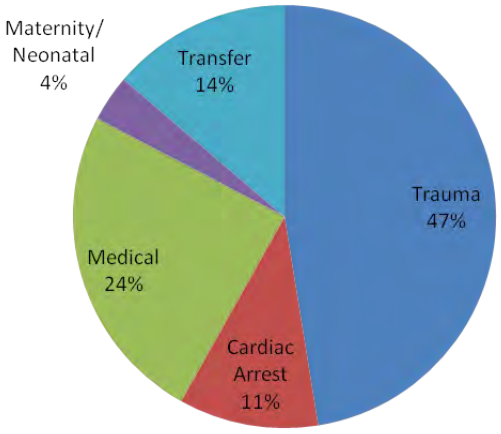


Figure 12 Top Cover call Category

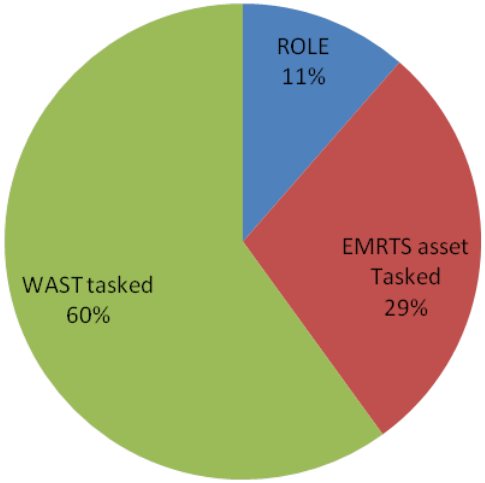


Figure 13 Top Cover outcome

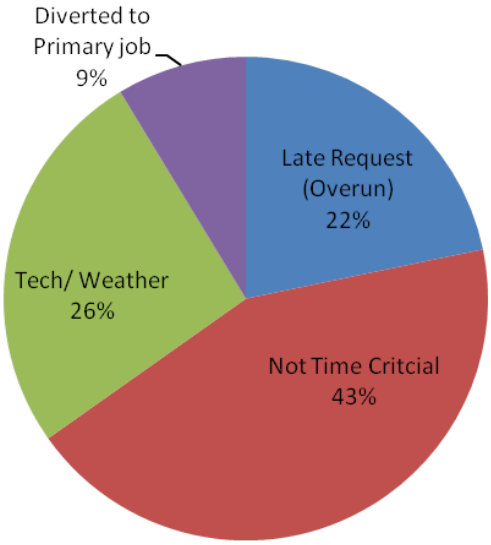


Figure 14 Declined Transfer Requests

Description	Note
Critical care requests	Accepted or declined with explanation
Air ambulance requests	Accepted or declined depending on time benefit conveyed
Hospital bypass local hospitals by North Wales Air ambulance crew	To go to definitive care in major trauma centre
Decision to extend hours of operation for certain incidents	E.g. later transfer request with guaranteed overrun.
Coordinating paediatric transfer	NWTS liaison
Accepting chargeable air transfer requests	Coordination and authorisation of charges
Search & Rescue taskings	Intercept for medical reasons/Joint logistics coordination
Clinical incident debriefing with crews	Distressing paediatric cases ROLE outside of JRCALC
Coordinating response to adverse events	E.g. equipment failure
Paediatric case advice	Critical care intervention decision-making in paediatric patients
Multi-casualty incidents	Passing Pre-Alert to hospital Updating tertiary units, e.g. burns
Management advice	Traumatic cardiac arrest

Table 10 Top Cover themes

Operational availability

Road

4.91 Road vehicle availability was 100%.

4.92 Road vehicles provided a response in 28% of cases.

Air

4.93 Air response to incidents occurred in 72% of cases.

4.94 Activity reports were reviewed to ascertain the air stand-down rate. Cases where a team had been activated and actually mobilised by air were identified. This revealed an aircraft stand-down rate of 25%, in keeping with accepted industry norms. This excludes cases where the team were stood down prior to starting the engines of the aircraft, representing potential costs incurred.

4.95 Costs reported by WAACT are to the order of £1500 per mission when the aircraft is used.

4.96 In the SOP (1), stand-down rates of 58% were quoted during 2013.

4.97 The Welshpool and Swansea aircraft were used for conveyance in 61% and 34% of missions, respectively. The remaining missions were either transferred in WAST road vehicles, or an alternative pathway was taken.

4.98 Reports obtained from the WAACT's aircraft operator, Babcock, provide a source of information as to the availability of the two aircraft utilised by the service. This report covers the period April 2015-March 2016, a slightly longer period than the evaluation (24).

4.99 Reports provide a breakdown of actual flying hours vs. availability, and take into account factors such as adverse weather, technical downtime and aircrew downtime (see Figure 15 and Figure 16).

4.100 Weather can impact the flight response capabilities of the aircraft. Over the evaluation period, such conditions resulted in the following downtime for each aircraft:

- Swansea: 393.15 hours out of 4352:55 hours available (9%)
- Welshpool: 161:36 hours out of 4311:12 hours available (3.7%)

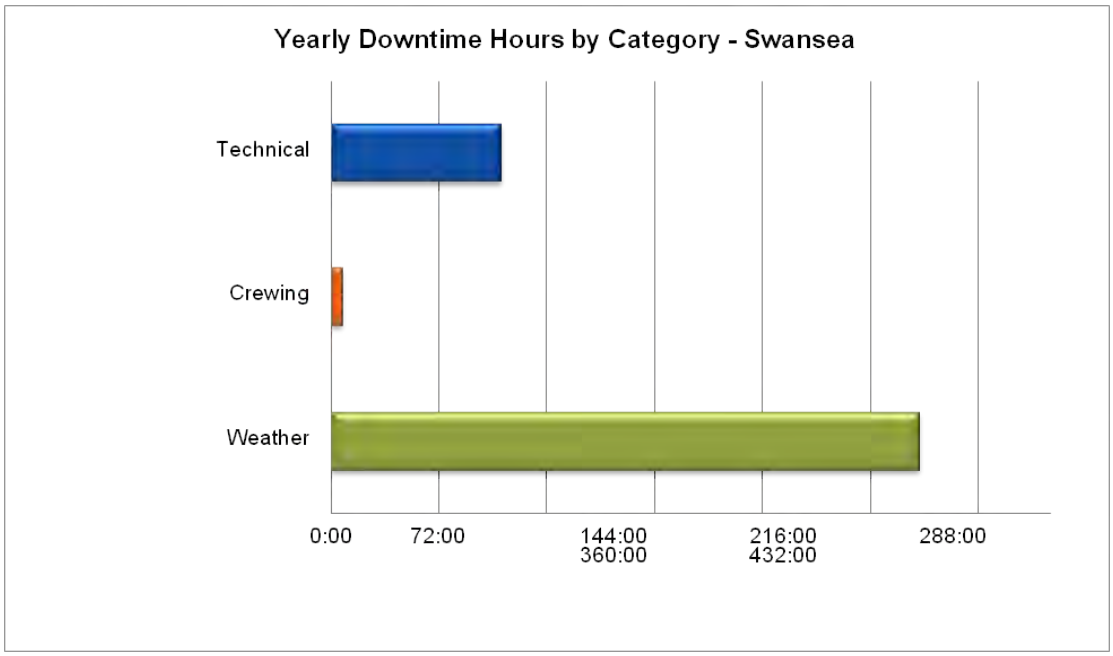


Figure 15 Downtime Swansea

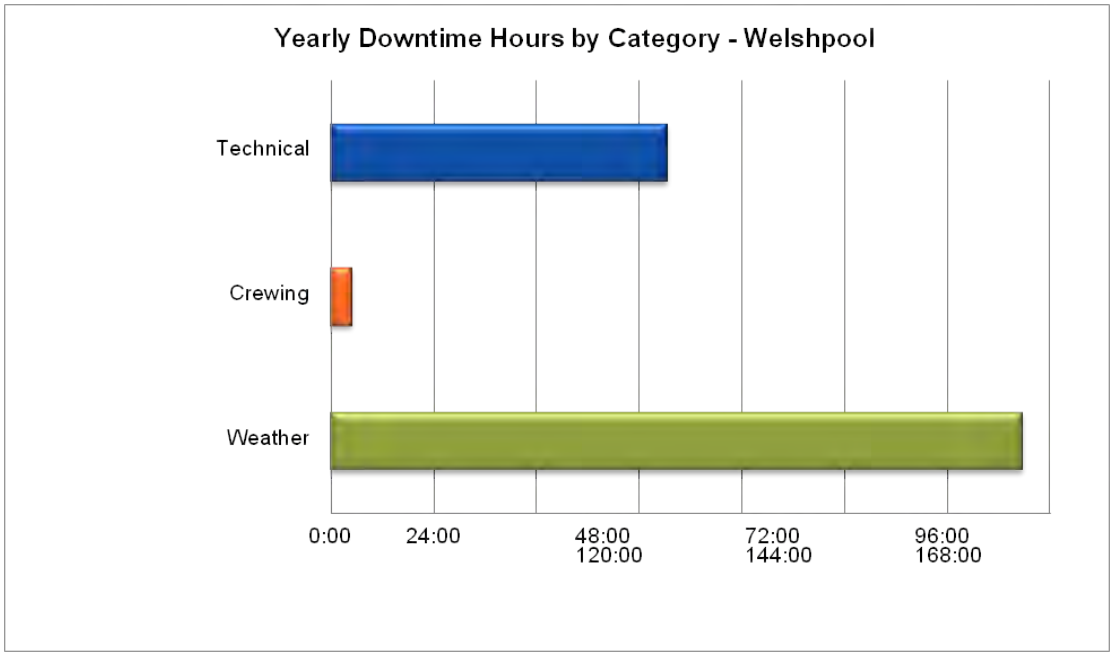


Figure 16 Downtime Welshpool

Advice Only

4.101 Whilst not part of the operational model outside of the top cover role, it was noted that advice-only calls were taken by duty crews in eight cases, reflecting historical practice at the start of the new service, and prior to the introduction of TCCs. In addition, six cases were brought directly to the airbases for advice (five in Welshpool), and onward transfer where appropriate.

Staffing

4.102 Consultant staff provided 99.5% availability.

4.103 CCP staff provided 99.7% availability.

Incident reporting

4.104 Incidents are reported using the DATIX system, an electronic report form and database widely used in the NHS.

4.105 Investigations were carried out as per NHS procedures.

The majority resulted in negligible or no harm (47), with seven resulting in minor or moderate harm (**Table 11 DATIX Incidents by Harm**Incidents by Harm.

4.106

4.107 Incidents are coded using the Common Classification System (CCS)(25). A summary of incidents by tier is included in Table 12.

Severity	n
Minor	4
Moderate	3
Negligible	1
No Harm	39
Grand	47

Table 11 DATIX Incidents by Harm

Complaints

4.108 During the evaluation period, two verbal complaints were received and investigated. Both related to communication and were closed satisfactorily and neither resulted in any patient harm.

Incident type Tier One	
Accidents/Falls	1
Administrative Processes (Excluding Documentation)	5
Anaesthesia Care	2
Behaviour (Including Violence and Aggression)	1
Blood/Plasma Products	1
Communication	3
Diagnostic Processes/Procedures	2
Medical Devices, Equipment, Supplies	10
Medication/Biologics/Fluids	7
Service Disruptions (environment, infrastructure, human resources)	10
Therapeutic Processes/Procedures (except medications/fluids/blood/plasma products administration)	5
Grand	47

Table 12 DATIX Tier One

Measurable Benefits Register

Summary

The proposed measurable benefits register aims to measure performance against three key investment objectives: Equity, Health Gain and Clinical & Skills Sustainability. Available evidence is presented under these sections, although many entries cross-populate. To avoid repetition, information is cross-referenced where appropriate.

For entries that are not fully measurable at the time of writing, due to data flows, or time required for numbers to be sufficient, alternative evidence is presented, and commentary on the future releases that can be expected. In addition, a commentary relating to each entry is included to aid understanding.

5.1 For each of the measurable benefit objectives, where relevant the following are presented:

- Relevant literature review findings
- Quantitative data analysis
- Qualitative evidence.

5.2 Due to the nature of the benefits described, there is significant crossover. Where possible, care has been taken to avoid duplication of information; instead, cross-referencing of register entries is used.

5.3 A summary of All-Wales activity will be provided, with additional health board-specific data being presented in the appendix. In the case of some data, due to SAIL privacy protection, data is excluded at this stage, i.e. small numbers. Summary boxes highlight the main findings

5.4 A number of case studies are provided to illustrate various case types and process. As with other results, these cross a number of the register entries and all health boards.

5.5 The qualitative aspect of the evaluation draws on a number of sources, and a summary of the participants is details in Table 13. Of note, some attendees had multiple roles in the consultation process. In addition, due to time

limitations, an online survey of external health care professionals and other agencies wasn't delivered for inclusion in this first report. This will be delivered during year 2, utilising this report as a basis for feedback.

5.6 Workshops were well-attended, representing a cross-section of stakeholders. This included representation from every Local Health Board in Wales and the WAST.

5.7 The internal staff survey administered by the service received 22 responses from across the staff groups.

5.8 Overall, 136 individuals were engaged in the process, as summarised in Table 13.

Group	Method				
	Workshop	Face to face/ telephone interview	Online Questionnaire	Self-instigated	Total
Health Care Professionals	16	2	n/a	13	31
LHB/WAST/ Other agencies/ Representatives	26	2	n/a	28	56
EMRTS staff	5	6	22	n/a	33
Patient/Reps	n/a	10	n/a	22	32
Total individuals	**31**	**20**	**22**	**63**	**136**

Table 13 Qualitative stakeholder involvement summary

Equity

Summary

When assessing access and timeliness of access to specialist care, the results reveal that EMRTS provide an improvement overall in Wales.

63% of patients received specialist care at the scene of incidents.

58% of patients were transported to a hospital with specialist care.

In 35% of incidents attended, the nearest hospital did not have critical care capability.

In 93% of cases attended, the patient's nearest hospital did not have neurosurgical capability.

Qualitative results reveal a perception of inequity in the North of Wales due to the exclusion of Caernarfon from the model, and across Wales there is a perception of inequity outside of operational hours.

6.1 This proposed measurable benefit pertains to equity cover the availability and timeliness of access to specialist care. Programme documents (1,22) point to cases where the nearest acute hospital may not necessarily have the specialist services that the patient will require. Specialist services include those pertaining to major trauma, cardiac disease and stroke. With NHS service changes ongoing, and the creation of trauma networks imminent, it was proposed there was an opportunity to improve equity of access through the creation of the EMRTS. With the service, a senior clinician is able to deliver advanced clinical interventions and decision-making at the scene, potentially justifying the added distance of transferring the patient to specialist care.

6.2 The registry entries covered in this section are:

1/Access to specialist care not available at patient's nearest acute hospital

2/Timeliness of access to specialist care for all patient groups

3/Enhanced perception of equity by health care professionals, LHB representatives and patient representatives.

1/Access to specialist care not available at patient's nearest acute hospital

6.3 A case study from Powys Health Board illustrates this entry:

Case study of adult primary mission
Background
A male in his 50s was severely injured in an industrial incident in mid-Wales. He had bilateral lower limb fractures, and a catastrophic haemorrhage resulting in a loss of cardiac output.
Action Taken
The ASD tasked the Welshpool crew to attend by air, with a second team attending by road due to training at the base. On scene, finding him in established traumatic cardiac arrest, the team were able to deliver a full range of critical care interventions including haemorrhage control, intubation, thoracostomies, and a transfusion of four units of blood and four units of LyoPlas. They successfully resuscitated him and then flew to the major trauma centre. Due to the weather conditions, the aircraft had to land short of the hospital; however, as a result of coordination by the ASD, they were able to transfer into a road ambulance for the remainder of the journey.
Outcome
On arrival in hospital, the patient received ongoing transfusion, and was transferred rapidly to theatre. Unfortunately, his limbs were unsalvageable; however, he has made a full neurological recovery and has been discharged from the major trauma centre for rehabilitation.
Change in process observed
This patient is very unlikely to have survived without the intervention of the service, and is a potential unexpected survivor from trauma. The case illustrates the importance of timeliness of access to specialist care, not only in terms of transport, but in terms of interventions at the scene of the incident. In addition, it represents health gain.

Case Study 5

Inclusion:

- Anonymised linked fields (ALF) with ALF status codes of 1,2,4 or 39 (high matching probability[3])
- Counts by distinct ALF and Incident ID
- Time span 27/04/2015-26/04/2016
- All ages.

[3] Definitions in appendix.

Exclude:

- Inappropriate stop codes removed (see appendix)

6.4 The EMRTS ALF table was linked to the EMRTS operational dataset, which was then linked to the WAST destination dataset to access the hospital destinations. The EMRTS operational dataset takes precedence over the destination dataset. Therefore, if data were missing from the operational dataset, but not from the destination dataset, then destination dataset data was imputed. Hospitals were grouped into specialist centres, e.g. District General Hospitals or Minor Injury Units (see appendix). 1.9% of ALFs were recorded as being conveyed to more than one hospital. It was decided that a specialist centre would take precedence over a District General Hospital if both had been recorded. If two specialist centres were recorded, the first arrival at hospital timestamp was used to select the hospital. The arrival at hospital timestamp from the destination dataset was used due to better coverage. Where the arrival at hospital timestamp was missing for Glan Clwyd Hospital Bodelwyddan, the left scene timestamp was used between 09:00 and 15:00. Therefore, this allowed for a two-hour window in order to transfer a cardiac patient to Glan Clwyd Hospital Bodelwyddan for specialist care.

Data Abnormalities

6.5 There was a 98.1% miss-match between the EMRTS operational dataset incident timestamps and WAST destination incident timestamps. This was identified as changes in reporting by WAST during the evaluation period relating to times recorded as “call pickup” versus “clock start” (mean: 1.4 minutes, median: 1 minute, IQR: 0-2(2)). Any erroneous dates were excluded.

Assessment of benefit: Avoidance of secondary transfer – Patients requiring a secondary transfer from a District General Hospital to a specialist centre

Inclusion

- All ages
- ALF with ALF status codes of 1,2,4 or 39 (high matching probability)
- Primary missions: Trauma, medical, cardiac/respiratory arrest
- Timespan 27 April 2015-26 October 2015
- Patients originally conveyed to a District General Hospital by EMRTS
- Secondary transfer to a specialist centre within 48 hours of incident
- Emergency admission to hospital only.

Results

6.6 Results reveal overall in Wales:

- 63% of patients received specialist care at the scene of the incident
- 58% of patients were transported to a hospital with specialist care. 29% were taken to a DGH, and 13% went via an alternative pathway such as discharge, or had died at the scene. This is depicted in
- Figure 17
- In 35% of cases, the nearest hospital did not have critical care capability
- In 93% of cases, the patient's nearest hospital did not have neurosurgical capability.

6.7 Across individual health boards, the proportion of patients accessing specialist hospitals varied, as expected due to the presence or not of a specialist centre within the respective area. A summary is included in Table 14. In addition, charts depicting these statistics on a health board level are included in the appendix.

6.8 Figure 18 shows that, during the first six months, of those patients that were taken to a DGH (29%), only 8% required a secondary transfer within 48 hours. Due to small numbers, a breakdown by patient group is not available for release at this stage. Ongoing work will look to compare this to baseline secondary transfer rates for specific patient groups. This also impacts on benefits 9 and 10.

6.9 In order to assess whether there has been an overall reduction in secondary transfers by the ambulance service, as a result of primary attendance, time needs to be allowed for sufficient numbers to be collated through SAIL, TARN, and WAST datasets for comparison. This will become available in future releases following patient matching. It is important that the outcomes of these patients are also linked with the change in flows, an area the SAIL system will facilitate.

Health Board Area	Specialist Care %	DGH %	Other %
Cardiff & Vale University Health Board	78	20	2
Abertawe Bro Morgannwg University Health Board	74	6	20
Hywel Dda University Health Board	63	24	13
Betsi Cadwaladr University Health Board	61	30	9
Aneurin Bevan University Health Board	53	34	13
Cwm Taff University Health Board	38	47	15
Powys Teaching Health Board	36	56	8

Table 14 Access to specialist care by health board

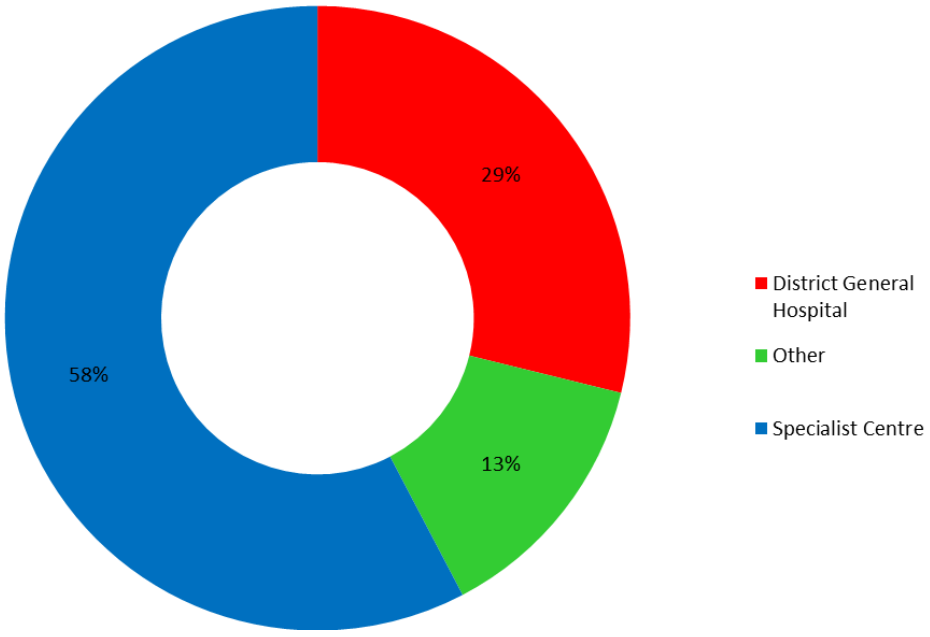


Figure 17 Proportion of patients attending a specialist centre or DGH for Welsh Incidents (79.3% of the other group have a stop code for died at scene, other or alternative pathway)

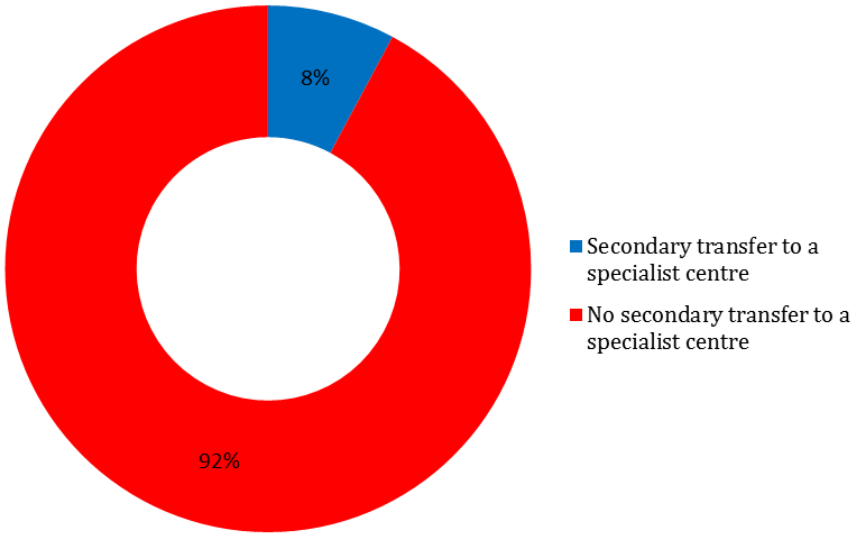


Figure 18 Proportion of EMRTS patients requiring a secondary transfer from a DGH to a specialist centre

Sankey diagrams for each Health Board

Inclusion

- Counts by distinct incidents
- Time span 27/04/2015-26/04/2016

Exclusion

- Missing location data have been removed
- Flows with small numbers.

Results

6.10 Sankey diagrams have been created to visualise the overview of EMRTS workload according to each health board. Each Sankey diagram should be interpreted independently. Sankey diagrams with similar ribbon widths from separate diagrams do not represent the same or similar magnitude. The ribbon width is in proportion with the particular diagram. EMRTS destination dataset location variables were imputed if missing from the EMRTS operational dataset.

6.11 Two Sankey diagrams have been included in the main report, with health board specific diagrams contained within the appendix. Figure 19 reveals the flows of patients by group and incident health board, whilst Figure 20 demonstrates the destination health board of patients.

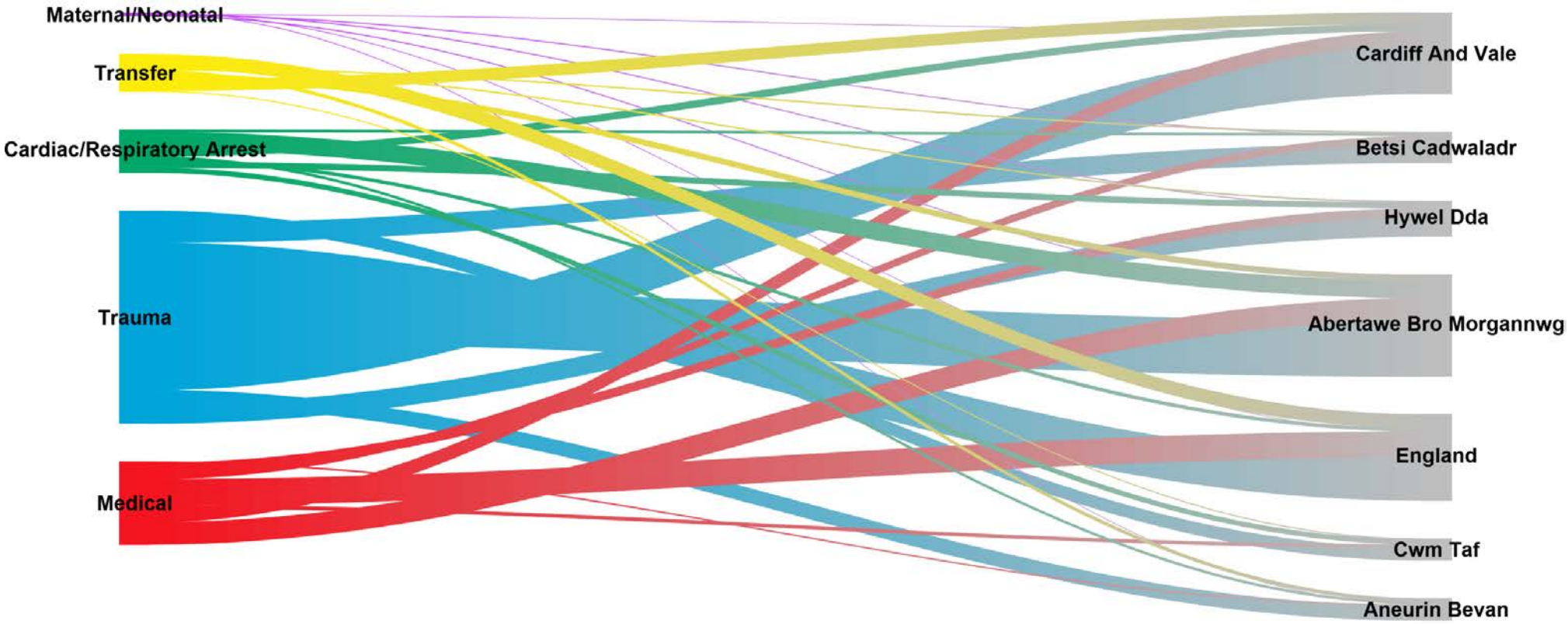


Figure 19 Welsh Health board incident data by patient group and Health board of hospital destination

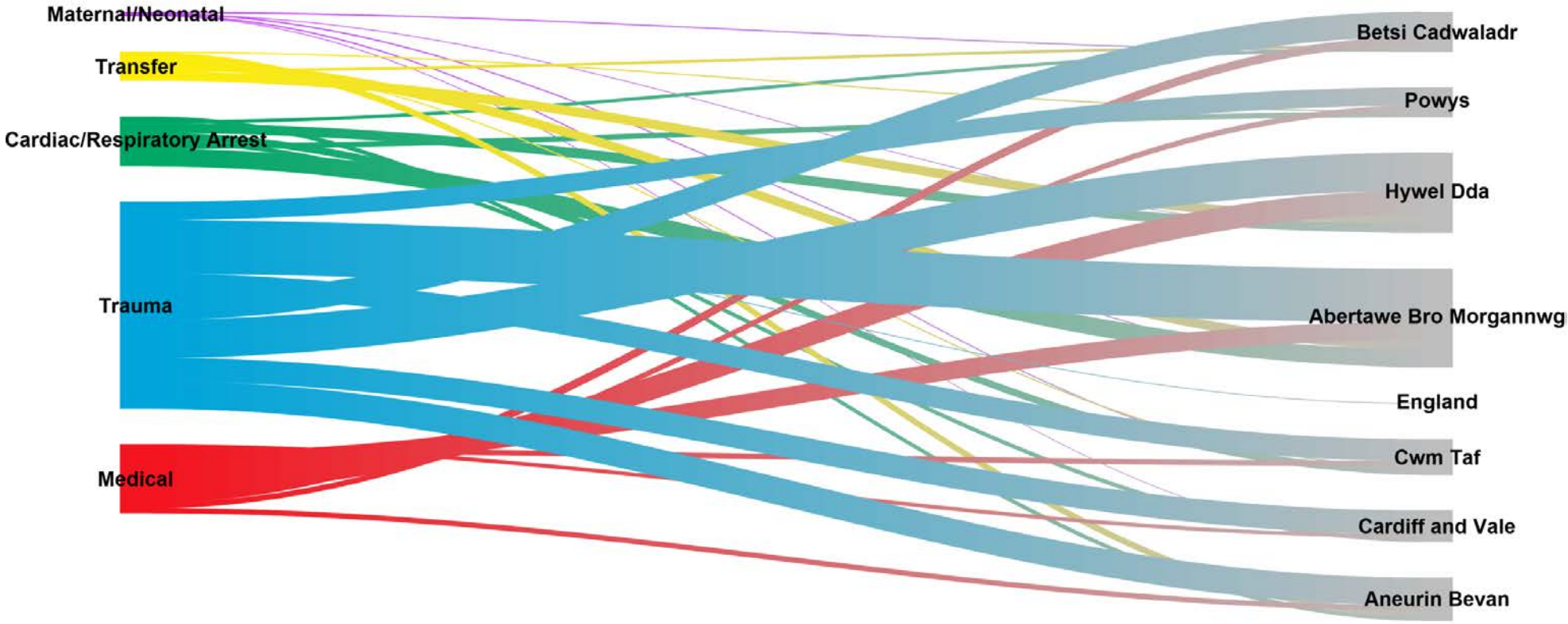


Figure 20 Welsh hospital activity by patient group and Health Board of incident

2/Timeliness of access to specialist care for all patient groups

6.12 Evidence points towards improved effectiveness of critical care interventions and reduced mortality by translating critical care interventions and senior decision- making forward in time (26). EMRTS aims to achieve this by bringing the Emergency Department Resuscitation Room to the patient.

6.13 In addition, by transferring patients in a timely manner to specialist care, time to access specialist care can be reduced.

6.14 A case study illustrates an aspect of this entry.

Case study of an Adult Primary Mission
Background
The team were tasked to a male cyclist in his 30s who had collided with a wall. He had been found by local ambulance crews to be unconscious and to have suffered head and chest injuries. The incident happened in a rural part of North West Wales.
Action Taken
The team rapidly assessed the patient, and delivered pre-hospital emergency anaesthesia at the scene in order to facilitate transfer directly to the major trauma centre in Stoke.
Outcome
The patient received critical care interventions in a timely manner, and was therefore able to bypass local trauma units, arriving at a major trauma centre in less than three hours from the time of the 999 call. This avoided a secondary transfer and, after a 15-day stay, he was transferred to his local hospital.
Change in process observed
Avoidance of Secondary Transfer. Early critical care intervention.

Case Study 6

Data analysis

Assessment of benefit: For various patient groups, and interventions, patients were attended by the team faster than they would have arrived at a DGH and MTC

Inclusion

- Counts by distinct incidents and ALF
- Time span 27/04/2015-26/04/2016
- Primary missions only (trauma, medical, cardiac/respiratory arrest)
- Age 0-17 (for paediatric analysis)
- Critical care interventions.

Exclusion

- Negative time difference excluded
- Out-of-hours EMRTS incidents have been removed.

Data abnormality/Issue

- A small number of incidents have multiple incident timestamps. Therefore, the first incident timestamp was chosen.
- 57.4% of patient ages reported in the EMRTS operational dataset matched when cross-referenced with WDS/EMRTS week-of-birth calculated age.

6.15 Time to scene was calculated as the time difference between incident date and time, and arrival at scene date and time. The WAST destination dataset was used to impute any missing timestamps in the EMRTS operational dataset. Time on scene was calculated as the time difference between arrival at scene and EMRTS left scene. Total time was calculated as the time difference between incident date and time and arrival at hospital date and time. The first incident date and time and arrival at scene date and time per incident and patient were included. Due to multi-person incidents and the analysis requiring a summary, all hospital arrival dates and times have been included.Time to hospital was calculated as the difference in minutes between incident date and time and arrival at hospital date and time. Any negative time

differences were removed and only incidents occurring between EMRTS operational hours were chosen (97.2% within operational hours). EMRTS out of operational hour incidents could increase the time to hospital due to delays in getting to the patient. Likewise, transfer and maternal/neonatal secondary missions have been kept separate from primary missions, and travel times have been separated by vehicle type.

6.17 For paediatric analysis, using week of birth, age was calculated as age at incident. WDS week of birth was used where the EMRTS-recorded week of birth was missing to calculate age at incident.

Results

6.18 Baseline data from the WAST dataset revealed the timings in Table 15.

6.19 When considering delivery of specialist care, e.g. critical care interventions, including 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. It is acknowledged that the time taken to deliver the intervention on arrival at scene or hospital is not accounted for, but this is accounted for in the data linkages in other parts of the report.

6.20 In all cases, the service attended scenes by air at a median time of 32.7 minutes faster, and by road 45.7 minutes faster. Car attendance should be interpreted with caution, as case selection tends to be limited by distance and, therefore, will skew results.

6.21 In all cases, the team arrived in advance of the baseline job cycle in Wales. When looking at only those cases that received critical care interventions, it reveals an improvement of 35.7 minutes by air, and an improvement of 37.2 minutes by car in timeliness to specialist care provision.

6.22 For all categories, both air and road responses improved the time to receiving access to specialist care interventions at the scene, versus transport to hospital. In the context of these interventions, it should also be noted that a number of patients attending the local hospital would also have to undergo a secondary transfer following the intervention, whereas EMRTS will generally transport to definitive care.

6.23 A full breakdown of timings on a health board level are included in the appendix. However, work is ongoing to ascertain the baseline at this level, as outlined in the GIS methodology.

	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	28.2	25	22.7	18	-38.9	-45.9
MEDICAL	73	66.6	51.1	49	38.1	31.5	-17.6	-35.1
TRAUMA	78.6	71.1	36.7	32	31.4	24	-39.1	-47.1
All	74.5	67.7	40.1	35	30.7	22	-32.7	-45.7
Paediatrics	74.5	67.7	35.1	30	28.1	22	-37.7	-45.7
***Incident time to arrival in hospital baseline**								

Table 15 Timings comparison *total job cycle (minutes)

	WAST/ hospital*		Air to scene		Car to scene		Difference (Median)	
Intervention	Mean	Median	Mean	Median	Mean	Median	air	car
CCI	74.5	67.7	37.7	32	37.2	30.5	-35.7	-37.2
RSI	74.5	67.7	37.2	32	34.9	35	-35.7	-32.7
Blood	74.5	67.7	33.2	29	65.3	48	-38.7	-19.7
***Incident time to arrival in hospital baseline**								

Table 16 Timings comparison intervention *total job cycle (minutes)

6.24 As expected, delivery of interventions outside of the normal pre-hospital practice tends to increase the time spent on scene. This is borne out in the data, which, on an All Wales basis, reveals on-scene times as detailed in Table 17.

6.25 The longest on-scene times were for cardiac/respiratory arrest, which, when taken in the context of patients who are commonly confirmed as deceased at the scene, is an expected result. On-scene times for car responses are all lower than by air, representing the additional preparation time required for aviation-related activities, both following landing and prior to take-off if air conveyance is chosen. In addition, response by road is almost always followed by road transport in an emergency ambulance; therefore, some interventions can be carried out en-route to hospital, which may not be possible in an aircraft due to restricted space. There is also often a longer distance between the response vehicle and scene to factor in when responding by air.

6.26 The total time to hospital is also noted to be shorter when response is by road compared to air, which is likely a function of case selection relating to distances involved. For example, when responding by road, cases in the South are inevitably nearer a hospital than those rural cases attended when responding by air. Ongoing GIS work will enable the accurate prediction of the best road response base going forward, as well as guide the decision-making as to vehicle use in marginal cases.

6.27 The total job cycle is detailed in Table 18, with a health board specific breakdown in the appendix. Of note, these times include cases where entrapment has occurred and should, therefore, be interpreted with caution. Through further analysis, these cases can be separated out.

Region	Response Vehicle Type	Nature of Incident	Mean time on scene (minutes)	Median time on scene (minutes)	Quintile(IQR) time on scene (minutes)
Wales	Air	Trauma	51.6	47.5	32.75-64(31.25)
		Medical	46.7	40	28-56(28)
		Cardiac/ Respiratory Arrest	52.2	44	32.25-62.25(30)
Wales	Car	Trauma	42.5	34	15.75-57.75(42)
		Medical	38.3	30	16-56(40)
		Cardiac/ Respiratory Arrest	49.9	39	28-66(38)

Table 17 Time from arrival at scene to EMRTS left scene for all incident and primary missions by Health Board incident location, Response Vehicle Type and Nature of Incident

Region	Response Vehicle Type	Nature of Incident	Mean total time (minutes)	Median total time (minutes)	Quintile(IQR) total time (minutes)
Wales	Air	Trauma	112.3	109	91.75-127(32.25)
		Medical	122	120.5	101.75-138.25(36.5)
		Cardiac/ Respiratory Arrest	94.4	98	73-120.5(47.5)
Wales	Car	Trauma	104.8	100	80-126(46)
		Medical	101.4	96	79-110(31)
		Cardiac/ Respiratory Arrest	78.2	76.5	64.5-93.5(29)

Table 18 Time from incident to arrival at hospital for all incident and primary missions by Health Board incident location, Response Vehicle Type and Nature of Incident

North West

6.28 The results reveal minimal road responses to the North West of Wales, as was expected due to the distance from the nearest EMRTS base. This confirms that, when weather or light conditions prevent the team responding by air, this area is disadvantaged and receives an inequitable service. When the air service is available to meet demand, there is also a generally longer response time to the scene. It is difficult to make a valid comparison with other health boards, due to the different geographical conditions and area coverage of BCUHB. Maps do, however, demonstrate comparatively fewer calls attended in the BCUHB area than other health boards, and the unmet need section of this report also provides an indication of this inequity.

GIS Results

6.29 The WAST data cover the period April 2008 to January 2016 and record 5,030,300 individual geocoded incidents. Cleaning of the data, so that only records with a complete job cycle were recorded, was performed, which reduced the number of available records for analysis to 2,206,390 over the eight-year period. For this report, only the emergency ambulance journeys

were analysed as, like the EMRTS Air Ambulance and Rapid Response Vehicles, they are predominately tasked with the retrieval of patients from the location of incident to hospital. Furthermore, the analysis only includes ambulance journeys made over the same time period as the EMRTS evaluation period, resulting in a final analysis dataset of 219,470 useable records. This period coincides with the introduction of the Terrafix system to record ambulance journey times, thus resulting in higher quality temporal data for journey time estimation. This analysis has been conducted in an ongoing consultation with WAST to understand the limitations around the data and how the data is managed and recorded. The EMRTS data comprise a similar dataset, but contain extra information on the types of treatment delivered by the EMRTS doctors at the scene. The EMRTS data consist of 1,284 useable records.

6.30 The outputs from the GIS models are a set of maps illustrating the spatio-temporal distribution of emergency ambulance and EMRTS incidents. Initial analysis on travel times to hospital for WAST-recorded emergency ambulance journeys (travel time isochrones) were built using small area census units to group incidents into small geographic locations. The average travel time and critical care travel times (the time difference from time of incident and arrival at hospital for an emergency ambulance, and time of incident and arrival at scene for EMRTS services) for incidents in these areas were calculated, along with the numbers of incidents. Using this aggregated travel time data, a convex hull was built around the areas (minus the areas with less than two incidents to remove outliers) to delineate baseline 45 and 60-minute travel time zones for the two proposed major trauma centres at Morriston and University Hospital Wales (UHW).

6.31 Limitations of the WAST data, which may affect the travel time isochrones, include:

- Unclear under what conditions a particular ambulance journey is made:
  - Whether there is a patient on board
  - Whether the patient has a serious medical or traumatic condition which would result in an ambulance travelling at slower speeds
  - Weather conditions, which may affect the speed at which an ambulance can safely operate

- Traffic conditions
- Variability in location and time-recording quality
- Data from West Midlands Ambulance Service, North Western Ambulance Service and South Western Ambulance Service were not available, which may account for the lower amounts of incidents in the Eastern regions of Wales.

6.32 We are working in collaboration with WAST and other ambulance services to resolve, where possible, some of these issues. This will enable us to build a more accurate road network model for isochrones generation, given certain conditions and times of day, which eventually will be able to inform the decision-making process on whether EMRTS attends an incident.

Results

6.33 The maps illustrate how EMRTS provides equitable access to emergency healthcare for the population across Wales, particularly to those who reside in rural areas.

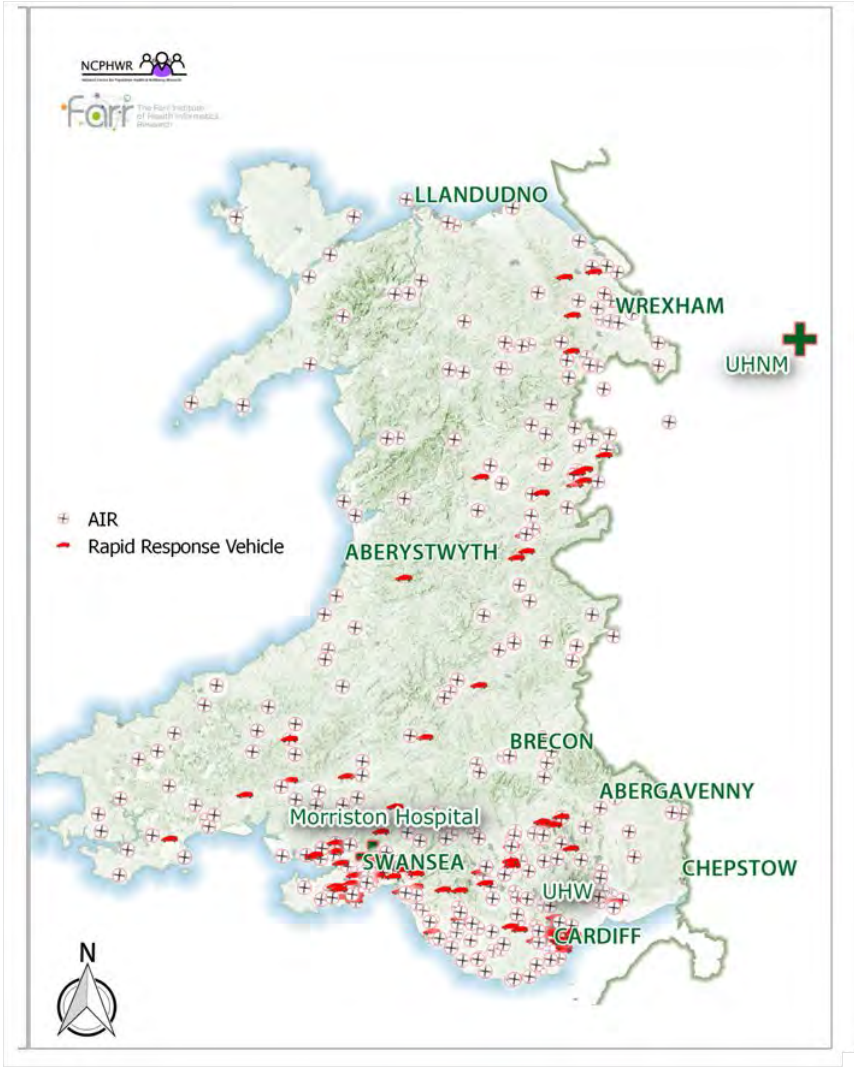
6.34 In particular, and relevant to the South of Wales, the maps illustrate how populations receiving major trauma care within 60 minutes are restricted to the immediate locality of the two proposed major trauma centres of Morriston and UHW when using emergency ambulance travel times (Map 2). In contrast, the delivery of critical care interventions to trauma patients by EMRTS is depicted in Map 3.

6.35 Ongoing work is being carried out to map the travel times to designated trauma units in the North of Wales, and will be included in future releases.

6.36 Individual maps of each health board revealing the incidents attended are included in the appendix.

6.37 Maps detailing the delivery of interventions by area have been included under the health gain section for ease of reference.

Map 2 WAST Emergency ambulance travel times to Morriston and UHW



Map 3 Map showing EMRTS trauma cases receiving critical care interventions within 60 minutes of call

3/Enhanced perception of equity by health care professionals, LHB representatives and patient representatives

Stakeholder Workshops & Interviews

6.38 Following the presentation of materials, group discussions took place with the outcome below.

6.39 The key themes covered were:

- Hours of access
- Timeliness
- Access to care
- Geography
- Transport method
- Patient groups
- Support for secondary care facilities
- Workload.

Hours of access

6.40 The current hours of operation were thought to create an inequity across the area.

6.41 Examples of in-hours cases known to attendees exemplified the level of service that can be offered during these hours.

6.42 There was discussion around whether extended hours or geographical expansion were more important if there was only one choice, and it was felt that it was too early to commit.

6.43 The staff survey reflected the views of hours of access providing inequity, citing that these should be extended to create an essential service.

Timeliness

6.44 For most of Wales, it was felt that the current service provides timeliness of access to specialist care, whether at the scene or by onward transfer. However, there was significant concern about the service not providing this equitably for the North West of Wales and, to a lesser extent, the South East.

Access to care

6.45 It was felt that the range of interventions offered were appropriate and provided equity to the intended recipients.

6.46 It was noted that the original plans for EMRTS were very ambitious. A health board representative commented that it had been an impressive undertaking and was felt to be successful in its first year of operations.

Geography

6.47 Whilst data detailing road responses vs air responses demonstrated a timeliness of access to those patients attended by either means, when compared with the mapping of incidents accessed it revealed a significant inequity whilst the aircraft was offline.

6.48 With respect to West Wales, there was a suggestion that a 24-hour transfer team be available to ensure equity in this region.

6.49 There was an opinion expressed that there was a need to avoid a "postcode lottery". This view was echoed in the staff survey.

6.50 In the North workshop, it was felt there was a definite inequity, particularly in the North West. The opinion was that the introduction of the service without the inclusion of the H61 base had seen a negative impact in the loss of staff and general lack of ownership. It was felt that, in order to restore equity, the base needed to be brought under EMRTS structure sooner rather than later.

6.51 It was noted that any change in governance shouldn't impact on existing opportunities locally for training posts already involved in the base, and that the planned introduction of a larger aircraft by WAACT would help mitigate this risk.

6.52 It was noted that there was interest from within BCUHB with respect to staffing a service in the North, and reference was made to a planned consultant recruitment drive to the current service.

6.53 These views were echoed in a report provided by EMRTS, citing similar stakeholder activities over a 2-year period by the author (27).

6.54 Many comments in the staff survey related to a strong desire for the inclusion of H61 into the service governance. This was seen as a priority over extended hours of operation by some respondents.

Patient Groups

6.55 There was a general consensus that the service should be engaged in both pre-hospital critical care for all age groups, and time-critical adult and paediatric retrieval. This was supported by 100% of the staff survey respondents.

6.56 It was recognised in the workshops and questionnaires that both main areas of operation could impact each other, for instance a secondary tasking preventing a primary response or vice versa. Some respondents suggested extra dedicated resources for the secondary work would mitigate this risk.

6.57 With respect to neonatal cases, it was felt by service users that there should be an increased uptake of the service, and that ongoing implementation of specialist equipment will aid this. It was also noted there are still expected service changes that would increase the utilisation of this.

6.58 In addition, there was concern by current staff that neonatal missions have the potential to impact on the core activities, and that this would be better suited to a dedicated extra transport platform. The majority of staff did feel that it was beneficial to provide both a neonatal response and support for existing teams.

6.59 The staff survey revealed, with reference to primary neonatal and maternity services, that 82% thought this should form part of the service model, while 77% thought transfer of neonatal retrieval teams should be included.

6.60 There was strong support for providing a 999 response to maternity and neonatal cases; however, it was suggested by some staff that support of retrieval services wasn't as desirable.

6.61 With respect to workload, 62% of respondents felt that the current workload was too little, and 38% felt it was about right. No one felt there was too much workload.

6.62 In order for the service to become an essential service, some respondents stated that there was a need to become a 24-hour service, and take on additional critical care inter-hospital transfers outside of the current service specification.

6.63 When asked about adding other patient groups, such as non-time-critical inter-hospital transfers, 57% supported the idea, while the remainder didn't.

Support for secondary care facilities

6.64 It was noted by one group that some hospitals, particularly in West Wales, don't have 24/7 critical care staffing, and this is an area the service could perhaps support in cases where this additional care and onward transfer is required. In addition, due to ongoing service changes, there may also be other areas the service can support in remote hospitals.

6.65 It was noted from experience in other health boards that the service is already able to provide this care during operational hours when required; thus, if it were made available out of hours, this would enhance equity.

Helimed 61 visit

6.66 A visit was made to the Caernarfon H61 base, where the workshop materials were presented to the duty crew. Discussions took place in a similar manner at the workshops.

6.67 With regards to the maps demonstrating the workload attended across Wales, the crew were able to identify a number of cases where joint working had taken place.

6.68 It was felt overall there was an inequity in access to EMRTS in the North West.

6.69 Similar to themes that came from the North workshop, the view was that the introduction of the service provided a level of inequity in the North. It was acknowledged that the other aircraft had accessed the area on occasion and that, in the most serious cases, the teams had worked well together for the benefit of the patient.

6.70 It was felt that the local workload had decreased during the first year and, on occasion when the other aircraft flew into the area, the crew were surprised they hadn't been tasked in the first instance.

6.71 There was a general feeling of dis-ownership of the base, with no clear ongoing governance framework or ways to progress whilst waiting for further EMRTS developments.

6.72 Due to staff vacancies, the current crew were filling rota gaps, which wasn't felt to be sustainable in the longer term.

6.73 Since the introduction of a consultant base lead, it was felt there was now a sense of direction and that a plan was starting to develop for the future.

6.74 The current crew would welcome development of the service to include the base in its operations.

Health gain

Summary

Evidence points towards a health gain to be realised for services such as EMRTS. Ongoing work as part of the evaluation looks to assess outcomes in terms of functional scores, mortality, length of hospital stay and physiological parameters. In addition, downstream benefits, avoidance of hospital transfer and the level of critical care interventions are assessed.

Results reveal an early indication of health gain. Initial data linkage also indicates downstream benefits, which will be further assessed as data is collected at SAIL.

Literature

Team Structure Physician-led versus Paramedic-led care

7.1 With respect to the instruction of a physician-led Enhanced Care Team (ECT), evidence points to the following:

7.2 In general, the UK historically has seen wide geographical variation in the availability of physician-led pre-hospital care (28,29). The landscape has significantly changed since the publication of this research, including the subject of this evaluation.

7.3 A systematic review revealed little evidence to support CCP-only delivery of pre-hospital critical care, identifying that the only intervention to be shown to benefit internationally was that of Rapid Sequence Induction of Anaesthesia (RSI)(30). This review supported physician-led models at the time of publication for head injuries.

7.4 Well-trained doctor paramedic teams, utilising standard operating procedures, can safely perform rapid sequence induction and intubation in the pre-hospital and emergency environment. A retrospective case review of 114 patients found complication rates were similar to in-hospital rates and other pre-hospital services (31). There was also evidence of high success rates and

consistent improvements in success rates (32,33). A small, descriptive study of paediatric intubations also revealed similar results in this population when attended by anaesthetists (34).

7.5 The use of standard operating procedures (SOP) was also supported (35,36).

7.6 The literature pointed to improved mortality when intubation was delivered by an experienced clinician (37).

7.7 With respect to cardiac arrest, evidence points to possible support for physician-led ECT attending post-ROSC patients to provide anaesthesia (38).

7.8 A number of systematic reviews support an improved survival benefit when physicians are deployed to the scene of incidents (39-41).

7.9 For paediatric patients, a retrospective matched cohort analysis found a marked survival advantage in paediatric trauma patients transported by HEMS (42).

7.10 A retrospective cohort study found that HEMS polytrauma patients were often sicker, with more interventions performed on scene and a greater need for transfusion. It supports HEMS being the preferred mode of attending, treating and transporting polytrauma patients (43).

4/Improvement of patient functional outcome (Two groups: major trauma and cardiac arrest)

7.11 Evidence from developed trauma networks such as the Victorian State Trauma Service in Australia has started to show improvements in functional outcome (44). This service includes an integrated pre-hospital critical care system and the ability to perform hyper-acute secondary transfers. Furthermore, a study from Victoria has also demonstrated better functional outcomes (measured using the Extended Glasgow Outcome Score), with a coordinated system of retrieval compared to those retrievals undertaken without coordination (23). Over time, it is the aim of the EMRTS to also demonstrate improvements in functional outcome using the internationally validated Extended Glasgow Outcome Score and EQ5D patient-reported outcome tools.

7.12 Two groups of patients will initially be examined: (i) major trauma and (ii) patients who are successfully resuscitated from out-of-hospital cardiac arrests. These patients will be regularly treated by the EMRTS, where critical care interventions have proven to make a difference.

7.13 For major trauma, interventions include pre-hospital anaesthesia, chest procedures, administration of blood products and splinting of fractures. This allows patients to be transferred directly to a major trauma centre to benefit from specialist care that they would otherwise not receive locally. This includes timely access to specialist rehabilitation. For patients who are successfully resuscitated from an out-of-hospital cardiac arrest, the ability to perform immediate critical care and transfer to a specialist cardiac centre gives them the best possible chance of making a good functional recovery.

7.14 There are, however, key dependencies on demonstrating improved functional outcomes, such as the development of other parts of the patient pathway (e.g. trauma networks). These proposed benefits, therefore, will only be fully realised when these pathways are created and are successfully implemented.

7.15 As per the methodology, functional outcome data will be available in future releases of the evaluation. This is a 3-year benefit entry.

7.16 Patients will be followed-up by telephone using a web-based questionnaire as part of the clinical database. GOS and EQ5D will be administered, examples of which can be found in the appendix.

7.17 In order to illustrate the early realisation of this entry, a case study has been included below.

Case study of a Paediatric primary mission
Background
A head-on collision between two cars in North Wales resulted in a number of casualties, including a 10-year-old boy.
Action Taken
The Welshpool team were tasked by air to attend, and provided emergency anaesthesia to the child to prevent further brain injury, prior to transferring him to definitive care in Alderhey, Liverpool.
Outcome
Following a short stay in hospital, he was discharged home and has a favourable neurological outcome. He has returned to school.
Change in process observed
Timeliness of access to specialist care. Avoidance of secondary transfer, with possible requirement for prolonged retrieval.

Case Study 7

5/Reduction in mortality (various clinical conditions)

7.18 Evidence points to a reduction in mortality from initiating timely advanced interventions and decision-making, prior to the arrival in hospital or a specialist centre, resulting in an increase in the number of 'unexpected' survivors (39,41,45). The evidence for this is strongest for major trauma patients, but also pertains to a number of other time-critical conditions such as acute myocardial infarction and respiratory distress (40).

7.19 Clinical scoring systems will be used to determine predicted mortality to define the baseline, and this will be compared to actual mortality. Similarly to functional outcomes, a reduction in mortality will be dependent on other pathways being developed.

7.20 In order to provide a comparator patient cohort, data from ICNARC and TARN are required. Due to the inherent delays in the way these retrospective audits are conducted and then transferred over to the SAIL system, the data will become available in future releases of the evaluation work.

7.21 Future releases will include data relating to probability of survival, and unexpected survivors when comparison is made.

7.22 To ascertain the baseline mortality of patients attended in the first year, the following method was applied to the data.

Inclusion

- 27 April 2015-26 October 2015
- Death within 24 hours
- Death within 28 days
- Welsh residents only
- ALF status codes of 1,2,4,39 (higher match probability)
- Primary admissions only (medical, trauma and cardiac arrest)
- First six months of EMRTS operation
- Stop codes: EMRTS treated, Died at scene, alternative pathway.

7.23 The date of death for Office of National Statistics (ONS) deaths was used in combination with the date of date from the Welsh Demographics Service (WDS). 'Died at scene' was defined as those who were recorded in the EMRTS dataset as having died at scene. 'Death within 24 hours' was defined as a death

on the same day, or day after EMRTS incident. To prevent any duplication, 'Death within 28 days' was defined as a death date 2-28 days post the EMRTS incident. 'Survived at 28 days' refers to anyone who did not have a date of death between these timelines. A small number of patients were coded as having both critical care intervention and standard care. The record with the critical care intervention was selected to be included in the analysis.

7.24 Initial results have been split into cardiac arrest, trauma and medical groups.

Cardiac/Respiratory Arrest

7.25 Early data reveals that 55% of EMRTS patients attended for cardiac/respiratory arrest survived to hospital, 33% were alive at 24 hours and 19% were alive at 28 days. The initial high number of patients surviving to hospital is likely to be a function of case selection, in that the service is preferentially tasked to patients who are having active resuscitation and have sustained a return of spontaneous circulation. Due to response times, over the large area covered, the service rarely provides the first response to incidents. Due to small numbers at this point, a further breakdown as to aetiology is not available, but the intention is to look at this during the three-year evaluation period in more detail. It will also be analysed in the context of those that were attended following successful resuscitation by the ambulance service, i.e. post-return of spontaneous circulation (ROSC). In addition, as time progresses, we can analyse those patients that survive to discharge and, as part of the functional outcome study, ascertain their outcomes. The cohort will be followed-up long-term through SAIL. In addition, for those patients that died, the cause of death will be looked at through ONS linkages. Also, the outcomes can be linked to interventions and the disposition of the patients in order to get a whole system's view of the patient's journey.

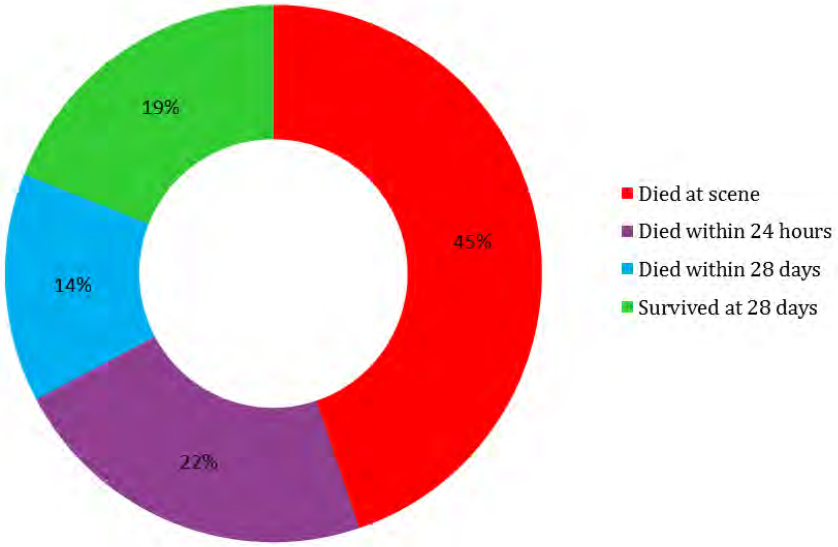


Figure 21 Mortality of EMRTS patients for cardiac/respiratory arrest incidents (27/04/2015-26/10/2015)

Trauma

7.26 Early data on the mortality of trauma patients reveal 99% survived to hospital, 4% had died within 24 hours and 8% had died at 28 days. Thus, 92% survived at 28 days. As with the cardiac arrest cohort, further work over the evaluation period will look at this in the context of the patient's severity of injury, as well as other factors such as clinical and logistical interventions. In addition, where TARN data are available, the probability of survival can be used to determine "unexpected survivors". Acknowledging that TARN doesn't currently capture all major trauma in Wales, work is ongoing to derive variables such as AIS and ISS for the patients not included in TARN. This can be validated against patients that also have a TARN record. It should be noted that this cohort doesn't include secondary transfers for trauma, which will require larger numbers before information can be released.

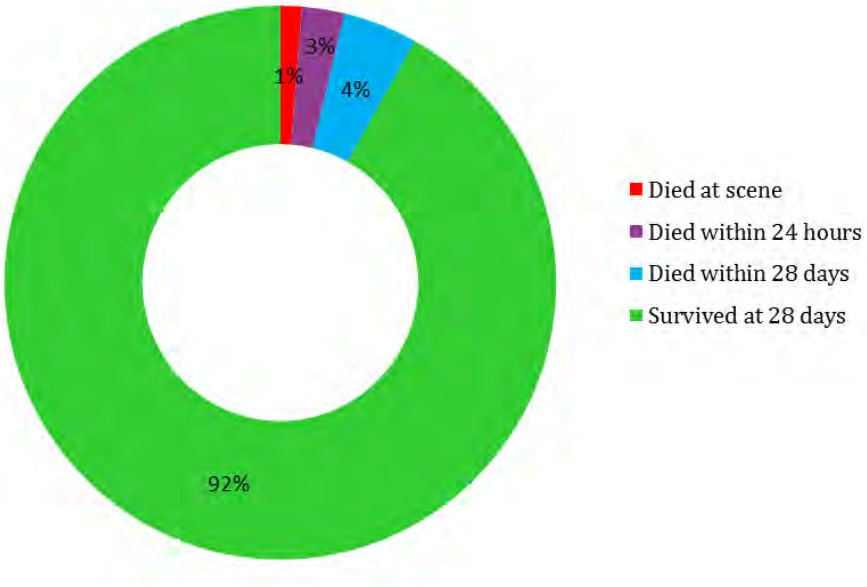


Figure 22 Mortality of EMRTS patients for trauma incidents (27/04/2015-26/10.2015)

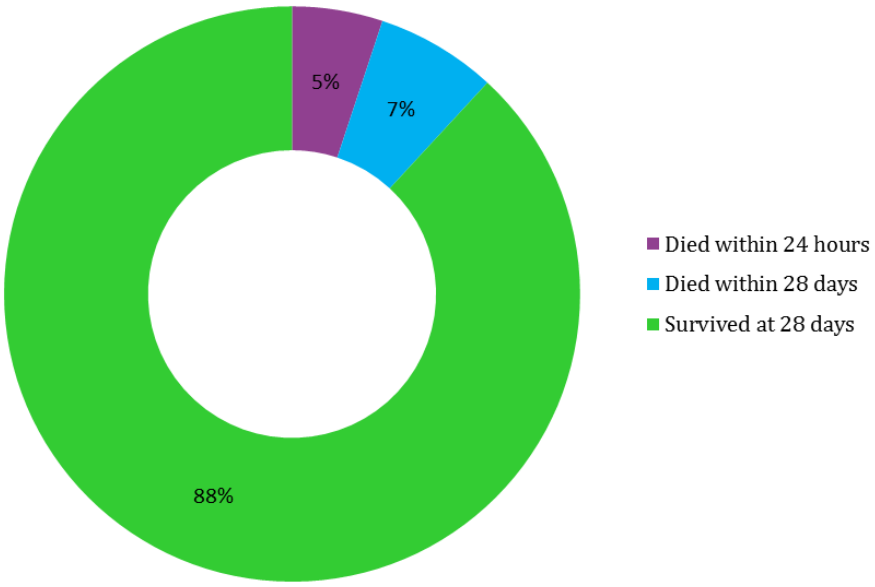


Figure 23 1. Mortality of EMRTS patients for medical incidents (27/04/2015-26/10/2015)

Medical

7.27 Early data reveal 88% of medical patients survived at 28 days. When the cohort has realised sufficient numbers to maintain anonymity, the intention is

to summarise patient outcomes by diagnosis, and look at the impact of interventions by the team.

7.28 In order to illustrate the potential reduction in mortality, a case study has been included. It should be noted that cases such as these also cross over into many of the other proposed benefits of the service.

Case study of adult primary mission
Background
Sonali, a 47-year-old lady, was crushed by a car at low speed in a car park, resulting in a significant chest injury.
Action Taken
The Swansea team attended and delivered emergency anaesthesia, surgical interventions to the chest, and then transferred her by road to the specialist centre. En-route, her condition deteriorated and the team were able to instigate a blood transfusion, thus improving her physiological condition.
Outcome
The patient went on to have novel chest surgery to fix multiple rib fractures. After a short intensive care stay, she has returned home and is now back at work.
Change in process observed
Prior to this, she may have been taken to her local non-specialist hospital, where she would have required a secondary transfer for definitive care. She may also have received normal fluids in response to her deterioration, and there would have been a delay in appropriate resuscitation.

Case Study 8

6/Reduction in length of hospital stay

7.29 Research undertaken by the South Central Strategic Health Authority (46) has demonstrated a reduction in overall length of stay in hospital and days spent on an Intensive Care Unit.

7.30 Length of stay can become an economic benefit if it is shortened by intervention.

7.31 As per benefits entries 4 and 5, comparative data is required, thus this benefit will be realised in future releases.

7.32 Early data pertaining to length of stay was, however, available for analysis, and a costing applied to provide baseline EMRTS impact. At this stage, only an overall summary is presented.

Baseline length of hospital stay

Inclusion

- Time 27/04/2015-26/10/2015
- ALF with ALF status code 1,2,4,39
- Emergency admissions only
- Admitted to hospital same day or day after incident
- Separate analysis for primary and secondary missions
- First six month of EMRTS operation only.

7.33 For primary missions, individuals were linked to the Patient Episode Database for Wales (PEDW) on the same day, or the day after incident date. For secondary missions, individuals were linked to the PEDW, where the incident date was between the PEDW admission and discharge date. These individuals were then linked to the critical care dataset. Exploratory work demonstrated small abnormalities, where patients were admitted to critical care units a day either side of their PEDW admission date. Therefore, to reduce loss of data, individuals admitted to critical care a day either side of PEDW admission or discharge dates were included. Also, the longest length of stay was chosen if there were multiple timestamps for one hospital admission. Negative lengths of stays were removed.

7.34 The results of this preliminary analysis are shown in Table 19, with costing in Table 20 and Table 21.

Patient group	Average length of inpatient stay in days	Median length of inpatient stay in days	Quantile (IQR) for inpatient stay	Average length of critical care stay in days	Median length of critical care stay in days	Quantile (IQR) for critical care stay	Average length of critical care stay in hours	Median length of critical care stay in hours	Quantile (IQR) for critical care stay in hours
Primary mission									
Cardiac/ Respiratory arrest	12.8	4	2-12.75(10.75)	8.8	5	2-16(14)	211.7	121	33-371(338)
Medical	9	3.5	1-11(10)	7.5	3.5	2-14(12)	206.8	120	39-385(346)
Trauma	16.6	7	2-19(17)	12.45	6.5	2-16.25(14.25)	297.4	154	43-388.5(345.5)
Secondary Mission									
Overall	25	8	3-26(23)	8.3	1.5	0.25-16.5(16.25)	211.6	47.5	23.8-408.6(384.5)

Table 19 Length of inpatient stay and critical care length of stay for patients in first six months of EMRTS operation by patient group for Wales

Due to information governance, a breakdown of length of stay at Health Board level is not possible currently.

Age group	Average cost of inpatient stay (£)[1]
Less than 1	3106
1 - 10	2271
11 - 20	3438
21 - 30	3942
31 - 40	3123
41 - 50	3616
51 - 60	3696
61 - 70	3190
71 - 80	3990
Over 80	5472

Table 20 Average cost of inpatient stay by age group for primary missions in first six months of operation, 27/04/2015-26/10/2015

[1]*Personal Social Services Research Unit: Unit Costs of Health and Social Care 2015*

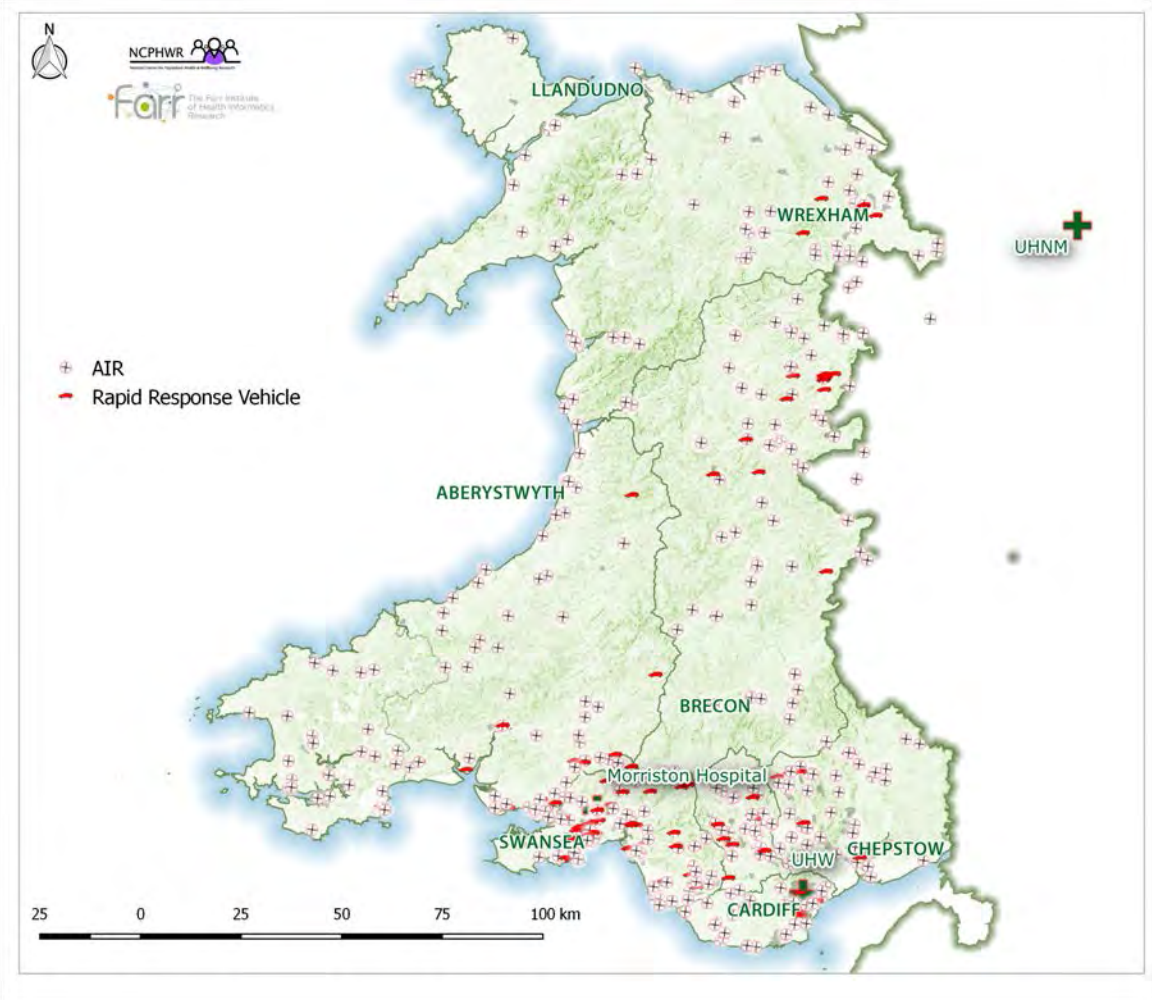
Age group	Average cost of length of inpatient stay (£)[1]
0-17	6441
18-39	4728
40-64	3918
Over 65	4625

Table 21 Average cost of inpatient stay by age group for secondary missions in first six months of operation, 27/04/2015-26/10/2015

Aggregated age groups due to small numbers
[1]*Personal Social Services Research Unit: Unit Costs of Health and Social Care 2015*

7/Critical care intervention or any decision outside standard paramedic practice

7.35 Critical care interventions were delivered across Wales, depicted in Map 4.



Map 4 Critical Care Interventions delivered

Data analysis

Inclusion

- Counts by ALF and incidents
- 27/04/2015-26/04/2016
- Primary missions: Trauma, medical, cardiac/respiratory arrest
- Stop codes: EMRTS: treated at scene, died at scene and alternative pathway

7.36 Overall, in the first year, critical care interventions were provided to 63% of patients attended by the service. This is depicted in Figure 25, and further broken down by health board in the appendix.

7.37 A summary of the frequency of interventions is included in Figure 24. In addition, a more detailed analysis of two key interventions below is included to illustrate the more complex cases attended.

- Rapid Sequence Induction of Anaesthesia (RSI)
- Blood & Blood product transfusion

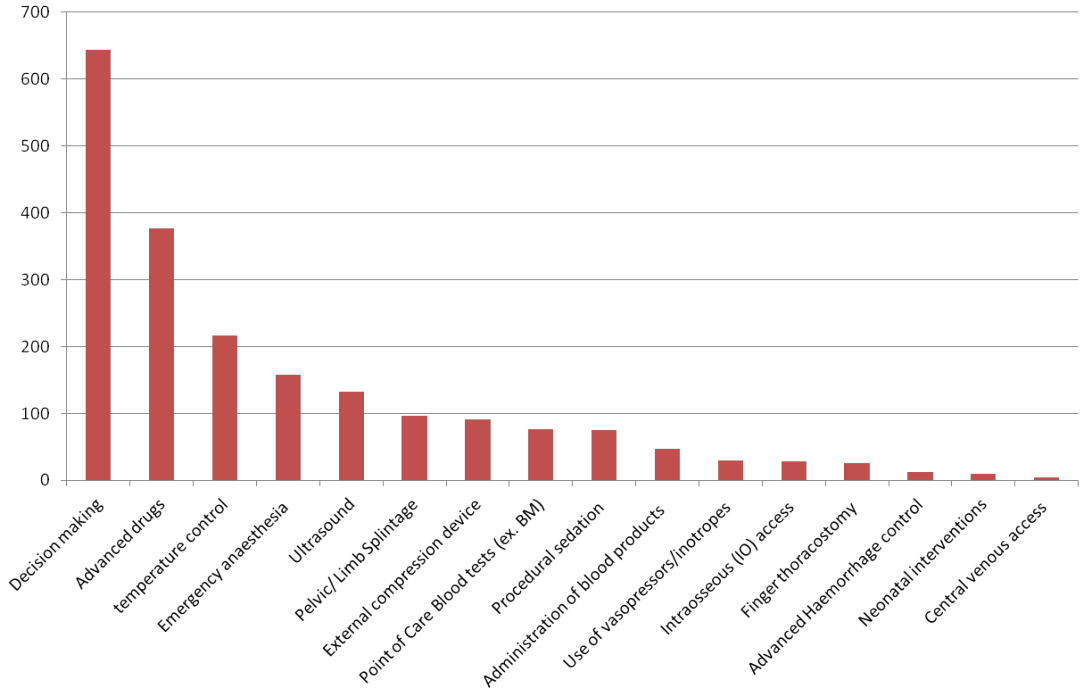


Figure 24 Clinical audit of critical care interventions

7.38 The clinical audit reveals the most common intervention outside of normal practice is that of decision-making by a senior clinician. The next most common interventions are that of advanced drug use outside of ambulance guidelines (JRCALC) (47), temperature control, and emergency anaesthesia.

7.39 With respect to cardiac arrest, 78% of cases recognised as died at scene were outside of JRCALC guidance, representing cases that may have been transported by WAST to hospitals with inherent costs associated. This is explored in more detail in register entry 10.

7.40 With respect to other advanced skills, procedural sedation was administered in 75 cases, mostly for trauma, but was also used to facilitate medical cases including external pacing, and medical extrication from a scene.

7.41 Of note, regional anaesthesia was also provided on an ad-hoc basis by suitably experienced clinicians in six cases, and is now in the process of being formalised into a standard operating procedure.

7.42 Lesser-used interventions include the use of central venous access, advanced haemorrhage control and neonatal interventions reflecting the case load.

7.43 A direct to CT protocol was developed for use in UHW during the first year, and is recorded as being used in 11 cases.

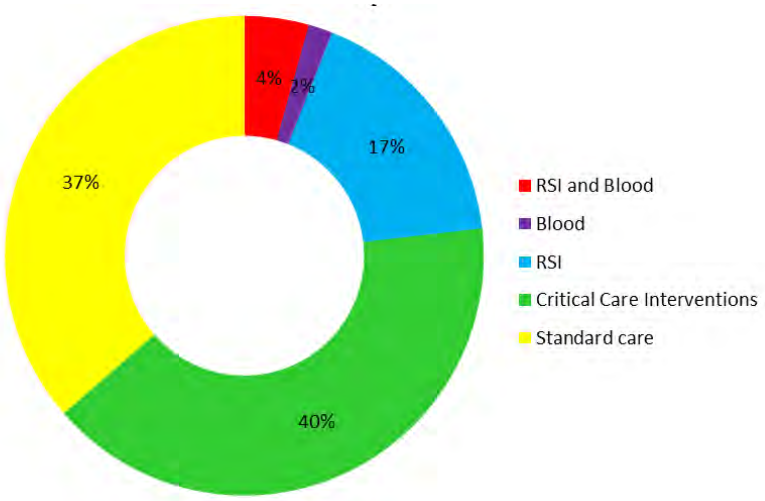


Figure 25 Proportion of patients receiving critical care interventions, Blood and RSI

Case study of adult primary mission
Background
A young competition trampoliner suffered an open fracture to her ankle, compromising the blood supply to the foot. She was in a great deal of pain, and was at risk of losing the limb.
Action Taken
The team were able to deliver powerful sedatives and pain-killing drugs, outside of the normal ambulance drug formulary. This allowed the team to re-align the ankle, preventing limb loss.
Outcome
The patient was then packaged safely and transferred to hospital by road.
Change in process observed
Previously, the patient would have had to endure a painful journey to hospital, and may have lost her limb.

Case Study 9

Emergency Anaesthesia

7.44 Emergency anaesthesia, often referred to as Rapid Sequence Induction (RSI), is carried out to take control of a patient's airway and breathing, usually in order to prevent further brain injury.

7.45 The service internally audits all cases of pre-hospital anaesthesia delivered. This is presented at monthly governance days, reviewed by an airway committee and externally peer-reviewed by the External Clinical Advisory Group (ECAG).

7.46 In cases of concern, full investigations take place and are fed back to the host organisation's Medical Director.

7.47 Indications for Emergency Anaesthesia are presented in Figure 27. This recognises that, in a number of cases, there may be more than one indication recorded.

7.48 62% of cases were traumatic in nature, while 38% were Medical.

7.49 The suspected injuries at the time of service involvement are presented in Figure 26.

7.50 The aetiology is represented in Figure 29.

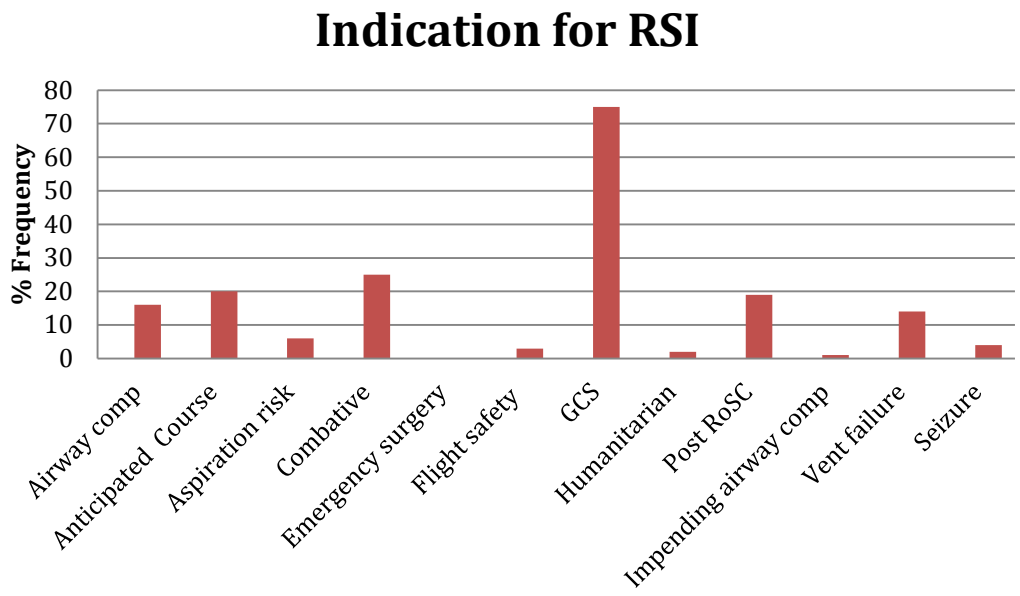


Figure 26 Indication for emergency anaesthesia

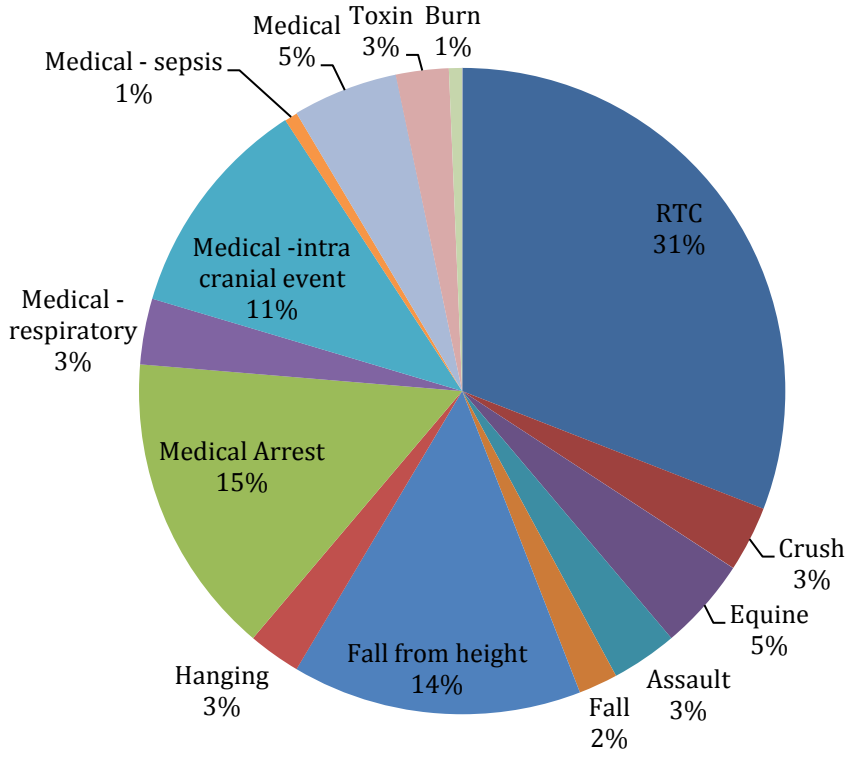


Figure 28 Aetiology of RSI patients

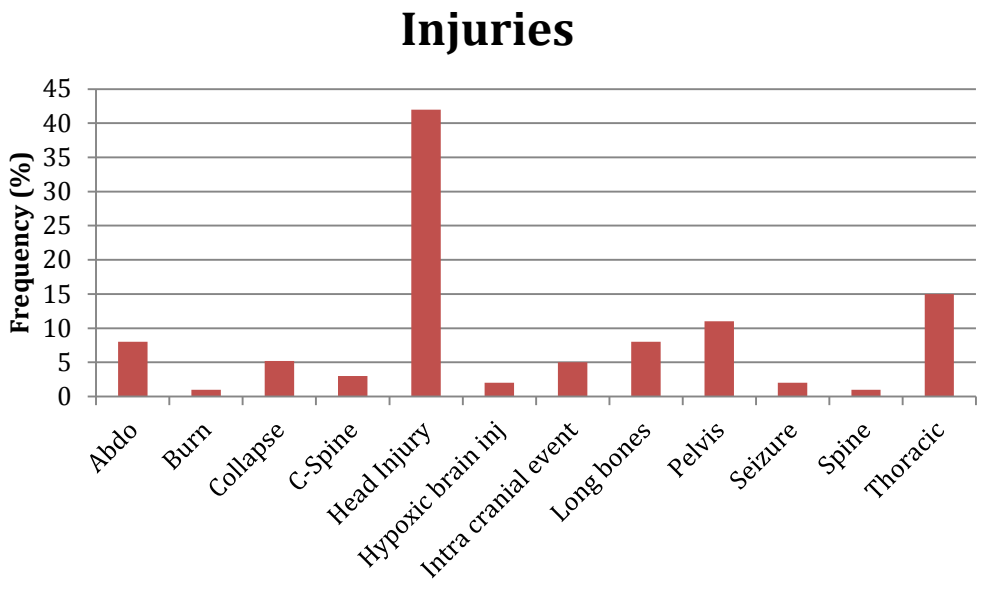
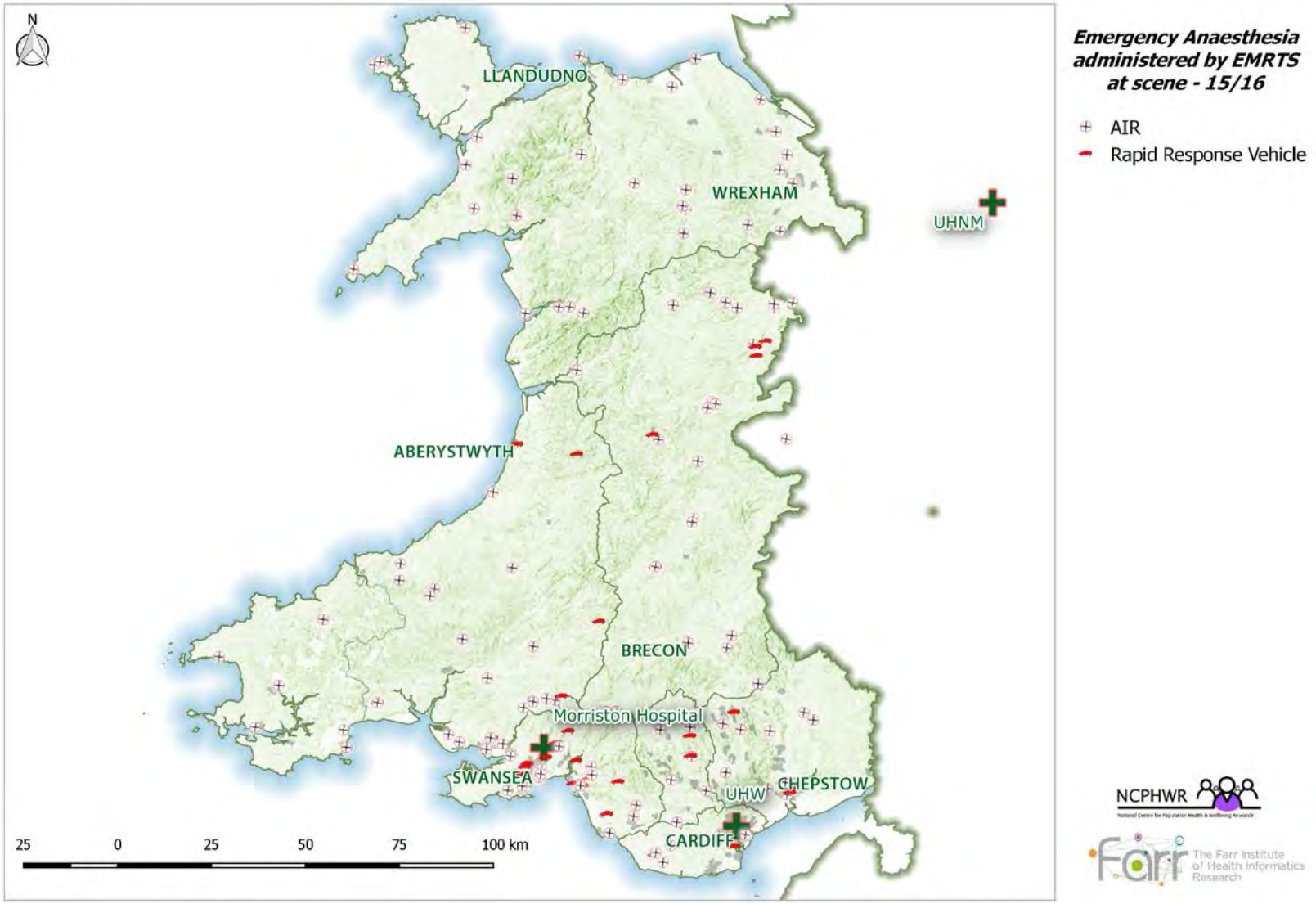


Figure 27 Injuries of RSI patients



Map 5 RSI administered by EMRTS at scene

Case study of paediatric primary mission
Background
An 11-year-old boy suffered a head injury whilst walking to school after being hit by a motorcyclist. He was found unconscious at the scene, and was being attended by local ambulance crews.
Action Taken
The ASD interrogated the call and launched the Swansea team to attend. On arrival, they were able to deliver an emergency anaesthetic, pelvic splintage and packaging, including temperature control.
Outcome
The child was transferred to definitive care in Cardiff and was found to have multiple bleeds on the brain. Following a period of time on the paediatric Intensive Care Unit, he is now undergoing rehabilitation.
Change in process observed
The child received emergency anaesthesia in a more timely fashion than a rapid transfer by road to hospital. He was delivered to definitive care with the avoidance of a secondary transfer.

Case Study 10

Blood & Blood Product Transfusions

Literature

7.51 A systematic review of blood product administration revealed a generally very low quality of evidence in this area. Citing 27 case reviews, and 11 comparative studies, it was found that pre-hospital blood administration had no associated survival benefit. It did, however, recommend awaiting the results of a higher level randomised trial (48).

7.52 There is a lack of level 1 published evidence for the administration of pre-hospital blood product administration. This is in the process of being addressed with the planned RePHILL trial (49). This is a multi-centred randomised controlled trial of blood product administration versus standard care for traumatic haemorrhage.

7.53 The search also found that there is evidence to support the fact that pre-hospital blood transfusion is safe and compliant with UK legislation (50) and that, where practised, levels of wastage were low (51).

7.54 Evidence from the military battlefield points to early survival benefits, but was unable to isolate blood products as the sole reason due to multiple confounding interventions in the cohort studied (52).

7.55 With respect to early notification of cases requiring ongoing transfusion in hospital, it was found that “code red” criteria in use demonstrated good accuracy in the prediction of patients requiring transfusion (53).

7.56 A case study of a patient receiving blood is included below.

Case study of adult primary mission
Background
Sarah, a young woman, was in collision with a tree, having lost control of her vehicle in the South East of Wales. She was found unconscious and trapped by her steering wheel, down a valley. She was unconscious and had a weak pulse.
Action Taken
The ASD interrogated the 999 call, and activated the Swansea team to the incident. On arrival, the consultant was able to make a rapid assessment and encouraged a quick release by the fire and rescue service. Whilst this was taking place, the CCP prepared an area to deliver a series of critical care interventions at the roadside. This included anaesthesia, thoracostomy, vascular access and a blood product transfusion.
Outcome
Her physiology improved following treatment, and she was flown to UHW in Cardiff. She has gone on to make a full recovery. She was found to have suffered from broken ribs, a collapsed lung and a traumatic brain injury.
Change in process observed
Prior to this intervention, she would have had a delay in access to critical care, and may have been taken to another hospital resulting in a secondary transfer. Due to entrapment, the delay would have been significant. With the physiology observed at the scene, she may also not have survived the journey to hospital without these interventions.

Case Study 11

Blood product use audit

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

7.58 A summary report is provided below of the so called “operation Vampire”.

7.59 Prior the start of the EMRTS, a systematic evidence-based review of pre-hospital use of blood and blood products demonstrated an improvement in short-term survival and in-hospital transfusion requirements. Studies also showed the feasibility of civilian Helicopter Emergency Medical Services carrying blood products, both in terms of logistics and cost-effectiveness. Therefore, in conjunction with the Welsh Blood Service and Blood Bank Services at Morriston Hospital and Wrexham Maelor Hospital, the project team from the EMRTS sought to establish the provision of blood and blood products to its Swansea and Welshpool bases. Through the Clinical Reference Group, it was agreed that the service would carry the following products:

- 4 units of Packed Red Blood Cells (PRBCs) carried in Credo ‘Golden Hour’ Boxes
- 4 bottles of Lyophilised Plasma (LyoPlas)

- 4 grams of Fibrinogen Concentrate
- 3000 International Units (IUs) of Prothrombin Complex Concentrate (for the emergency reversal of anticoagulation).

7.60 PRBCs would be supplied to both bases two to three times per week and, if not used by the service, re-circulated back into the blood donor pool, to minimise wastage. Emergency supply was also guaranteed immediately after use. For the first three months, PRBCs were supplied to both bases from Morriston Hospital by courier service (NHS Shared Services). Thereafter, Welshpool were supplied by Wrexham Maelor Hospital. A minimum stock level of all other products was stored at each base.

7.61 A number of operational and clinical standard operating procedures (SOPs) were developed to support 'Operation Vampire' for use by both the EMRTS and Blood Bank Services, with all SOPs aligned with in-hospital practice. Training of EMRTS teams was undertaken by Blood Bank staff in blood sampling and the process of checking blood products at scene. In addition, familiarisation sessions were undertaken with teams in relation to setting up the blood warmer/rapid infuser system and documentation process.

7.62 A series of audit standards were developed against which 'Operation Vampire' would be continuously evaluated:

- Use of blood products justified in all cases (if products would be considered clinically in-hospital, then it was deemed appropriate to give them pre-hospital)
- All PRBCs and LyoPlas given warmed
- Less than 1% wastage of PRBCs
- Completion of patient identifiers and traceability in all cases
- Completion of documentation in all cases (including the All Wales Transfusion Chart).

7.63 Audit results are presented bi-monthly at governance days and discussed at bi-monthly operational meetings with the Welsh Blood Service and Blood Bank Services at Morriston Hospital and Wrexham Maelor Hospital.

7.64 'Operation Vampire' went live on 27th April 2015 and, in doing so, the EMRTS became the first service in the UK to carry such a wide range of blood products. In the first 12 months of the service, 47 patients received blood and

blood products. The median age for patients was 47 years (age range 6 to 84 years), with 62% of patients being male and 38% being female. The majority received products pre-hospital (94%), with 6% receiving products in the context of a time-critical inter-hospital transfer, where the referring hospital had limited access to products.

7.65 Table 22 illustrates the total quantity of each blood product used.

PRODUCT USED	TOTAL QUANTITY
Packed Red Blood Cells	96 units
LyoPlas	82 units
Fibrinogen Concentrate	7 grams
Prothrombin Complex Concentrate	10,500IUs (5 uses)

Table 22 Total quantity of blood products used

7.66 There were 27 uses (57%) by the Swansea teams and 20 uses (43%) by the Welshpool teams during this period. Figure 30 provides a breakdown of the clinical indications for use.

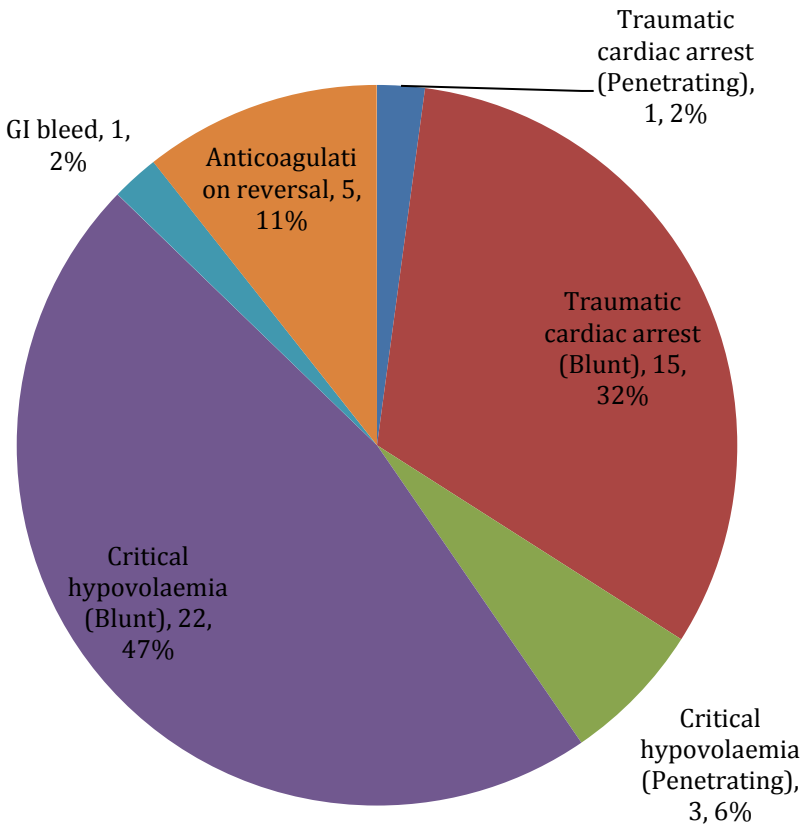


Figure 29 Clinical indication for blood product use

7.67 The main indication for use of blood products was critical hypo-volaemia from a blunt trauma, as illustrated above, with very few used for medical presentations.

7.68 The location of incidents where blood products were used is shown in Map 6.

7.69 98% of blood and blood products were given appropriately, demonstrating good adherence to the clinical standards instituted for use. No adverse reactions were reported from use. 96% of PRBCs and LyoPlas were given warm.

7.70 Table 23 illustrates the wastage rates for blood and blood products:

PRODUCT	Wastage
Packed Red Blood Cells	7 units (0.6%)
LyoPlas	2.5 bottles
Fibrinogen Concentrate	1 bottle
Prothrombin Complex Concentrate	500IUs

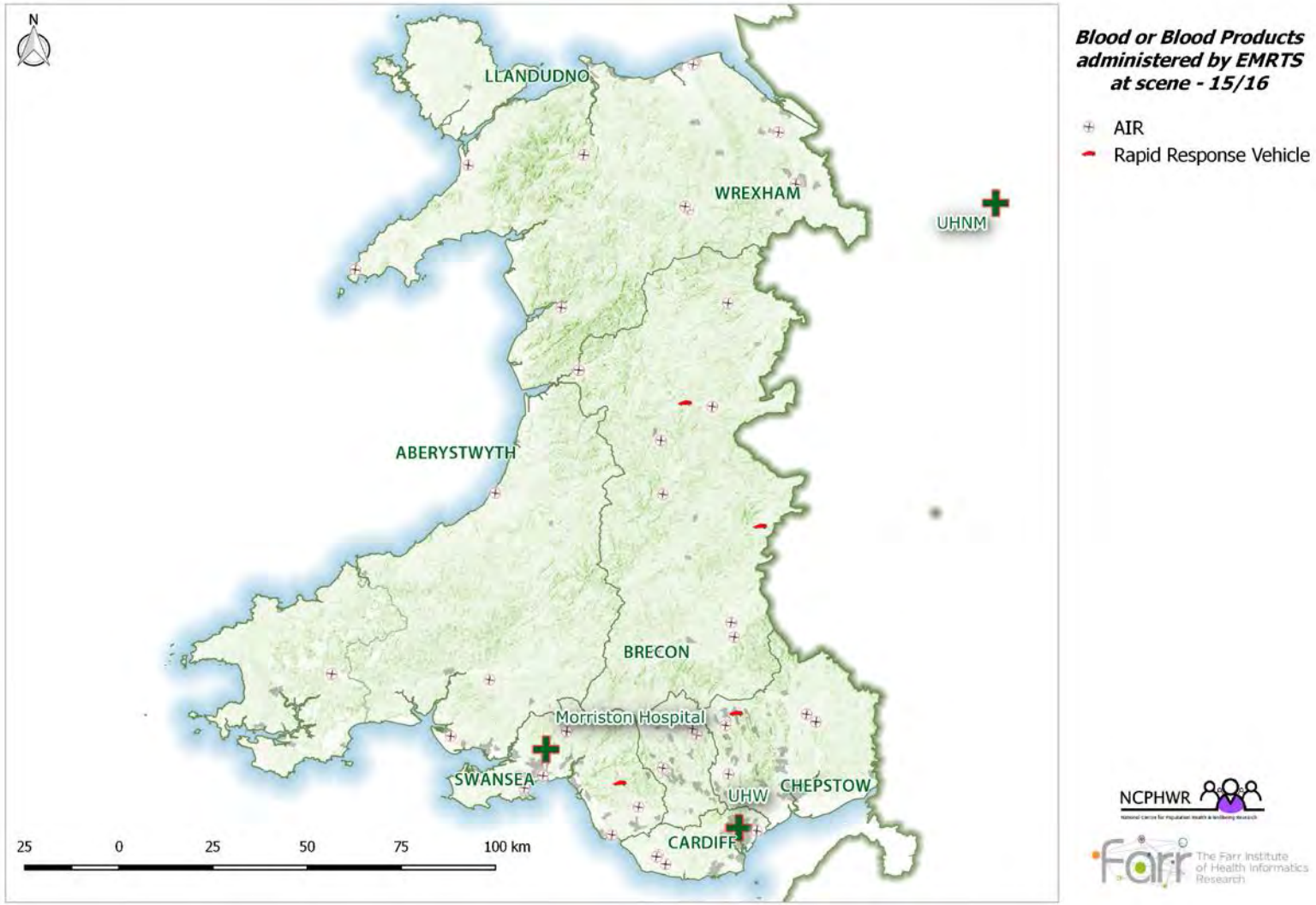
Table 23 Blood product wastage

7.71 For PRBCs, this is presented as a percentage of the total number of units recycled through the bases in the first year. 0.6% rate of wastage of PRBCs is comparable with evidence from other pre-hospital services and is in keeping with the internal audit standards. As a comparison, Holcombe *et al.* report a wastage rate of 1.9% of PRBCs and plasma in the largest pre-hospital civilian study undertaken to date (51).

7.72 Completion of documentation was noted in 96% of cases with 100% traceability achieved.

7.73 With respect to outcomes for the complete year, clinical records reveal 70% of patients survived to arrival at hospital. A longer-term outcome will be presented in future reports when numbers are large enough to avoid disclosure, according to SAIL policy.

7.74 In conclusion, the EMRTS has demonstrated excellent clinical and operational governance, with respect to the implementation of blood and blood products at its two bases, and has shown how this is feasible in a rural retrieval setting. It is essential that the impact of the use of blood products is considered in the context of other critical care interventions and not in isolation.



Map 6 Blood products administered by EMRTS

8/Objective improvement in the clinical condition of patients

7.75 Evidence suggests that a rapid improvement in a patient's condition will lead to better survival and functional outcome (54).

7.76 So as to measure this benefit, linkage with TARN and ICNARC are key, and case controls will be selected to provide comparators as per the methodology over the three-year period.

7.77 Key areas of interest from the register include patients that received a definitive pre-hospital airway, the time of delivery of this and physiological scoring on admission to hospital.

7.78 In addition to the RSI audit presented already, to start to understand what the service is achieving, the first export of TARN data was explored. ICNARC data are awaited, and will be included in further reports.

Exploration of TARN dataset

Inclusion

- ALF sts code 1
- Counts by distinct ALF and TARN arrival at hospital date
- Negative time differences removed
- Linked EMRTS individuals on same EMRTS incident dates as TARN, or EMRTS incident date either side of TARN incident date

7.79 The arrival date to hospital is the most populated time frame variable in the TARN dataset; therefore, it has been used to distinguish individuals with multiple entries.

7.80 When exploring the data linkage to EMRTS patients, there was no difference in numbers when linking EMRTS incident date to TARN arrival at hospital date.

7.81 At the time of analysis, TARN data are only available until the end of 2015 (does not completely cover EMRTS trauma patients). Further exports are planned as part of the ongoing evaluation.

7.82 The completeness of the overall TARN database for relevant health boards and trusts is presented in Table 24. It reveals a good level of completeness for the main receiving centres; however, DGHs in Wales have comparatively poor completeness

which may impact on results. However, where a secondary transfer has taken place to a tertiary unit, patients will be included in the dataset. Of note, Aneurin Bevan Health Board has only recently joined the TARN, so completeness is not assessed at the time of writing.

Hospital Name/Completeness of Data	2013-2014 (%)	2015 (%)
ABM University Health Board	84 - 100+	92 - 100+
Aneurin Bevan Local Health Board	n/a	n/a
Betsi Cadwaladr University Health Board	50 - 61	46 - 55
Cardiff and Vale University Health Board	77 - 93	86 - 100+
Cwm Taf Health Board	28 - 34	86 - 100+
Hywel Dda Health Board	13 - 16	57 - 69
Shrewsbury and Telford Hospital NHS Trust	55 - 67	84 - 100+
University Hospital Birmingham NHS Foundation Trust	71 - 77	83 - 90
University Hospitals of North Midlands NHS Trust	93 - 100+	100+
Worcestershire Acute Hospitals NHS Trust	64 - 77	80 - 96
Wye Valley NHS Trust	61 - 74	65 - 78
Birmingham Children's Hospital NHS Foundation Trust	81 - 98	100+

Table 24 TARN data completeness

7.83 Exploration of the TARN dataset reveals an increased proportion of male patients in the EMRTS cohort (69% versus 55.6%). In terms of Injury severity, the service attends 62.1% major trauma (ISS >15), 30% Moderate (ISS 9-15) and 8% ISS <9. The average ISS is 20.9, compared to 13 in the overall dataset. A comparison can be seen in Table 25. This early analysis should be interpreted with caution, as there is a disparity in size of non-EMRTS versus EMRTS datasets, and there has been no adjustment for case mix at this stage.

TARN exploration	Overall Proportion (%)	EMRTS Proportion (%)
Male	55.6	69
Female	44.4	31
Pre-EMRTS (<27-04-2015) pre-hospital Intubation[1] for Welsh Incidents	1.4	
Post-EMRTS (>=27-04-2015) pre-hospital Intubation for Welsh Incidents	3.8	
Patient receiving CT within 30 minutes of arrival to MTC	52.6	66.7
Patients receiving surgery within 6 hours of arrival at hospital	7.7	23
Patients receiving surgery within 24 hours of arrival at hospital	21.9	40
ISS groups		
ISS < 9	21	8
ISS 9 – 15	48.7	30
ISS > 15	30.3	62.1
Earliest GCS		
Mild (>=13)	89.5	77
Moderate (9-12)	2.6	8
Severe (<=8)	5.6	13.8
Missing/NA	2.2	1.1

Table 25 Exploratory figures from the TARN dataset for the overall dataset population (01/01/2012-31/12/2015) and successful EMRTS patient linkage

Pre-Hospital Intubation

7.84 The TARN data reveal a greater overall proportion of patients in the dataset have received pre-hospital intubation since the inception of the service. There is an increase of 2.4%. Whilst this may reflect the increased availability of the intervention in the context of RSI, it may also reflect the change in flows to health boards that have higher data completeness rates.

7.85 More work over the three-year period is required to further investigate this. In addition, cases where the procedure is performed by other services will need to be separated out though the use of the ALF linkage.

7.86 In addition, data presented in the register entry 2 reveal that the service facilitates this intervention earlier than the total time taken to arrive in a DGH by normal means.

9/'Downstream' benefits in hospital

7.87 The BJC cites that the intervention of EMRTS will result in patients being taken to the most appropriate centre from the outset and, as a result, there will be fewer requirements to undergo secondary transfers (55). This will help receiving specialist centres meet national standards in relation to specific clinical conditions (e.g. time to CT and surgical intervention). Hospitals who would have otherwise received these patients will see a reduction in secondary transfers undertaken by anaesthetic personnel (as outlined in benefit 1). These transfers often denude local hospitals of anaesthetic personnel, which can have significant deleterious effects on other services that the hospital provides. This reduction in secondary transfers could be quantified as a financial saving for the Welsh Ambulance Service and Health Boards.

7.88 This benefit entry has a two-year timescale recorded against it. However, early data relating to trauma cases is included here, alongside a medical case study. Data on more patients will be available for future reports, as well as through linkages on specific areas of interest, such as time from event to cardiac interventional procedures.

7.89 The potential cost saving in the case of a patient being transferred by the service versus normal mechanisms relates to the avoidance of loss of anaesthetic staff and theatre time in the main. Data from WAST records reveal the average time of an inter-hospital transfer is 119 minutes from leaving hospital to arriving at the destination. When taken in the context of build-up to this, turnaround at destination, and then return of personnel and equipment, a conservative estimate would put this at 268 minutes (x2 119-minute journey with a 30-minute turnaround). When this scenario is applied to a district general hospital, often with fewer staff, and further away from definitive care, this results in a potential loss of just under 4½ hours of theatre time. This is due to a tier of on-call staff being taken away from the hospital and remaining staff having to postpone non-life-threatening emergency work until the return of the team. It is noted that practice varies considerably in Wales, both on a hospital basis and, of course, the time of day or week. In parts of the country, there is a tier of on-call staff to cover this work.

7.90 A conservative estimate of cost puts the mean direct costs of staff time lost to theatres at £343 per hour.[4] Based on the 4.5 hours proposed lost time, this equates to just over £1500 per transfer. This does not include the costs of cancelled cases and knock-on effect of rescheduling.

7.91 At the time of writing, it would be unwise to commit to an overall cost-saving achieved, due to the wide variation in practice across health boards, and relatively small numbers per health board. In addition, it is more useful to look at this in the context of patient outcomes, as part of the wider work of this evaluation.

7.92 Likewise, where a patient is attended at the scene and transferred by the service directly to a specialist centre, bypassing local hospitals as detailed in entry 1, there is a potential cost saving to the local ambulance service (if the patient is flown), and local emergency departments, anaesthetic departments and critical care. It is acknowledged that these costs are then borne by the

[4] ABMU finance department.

receiving health board; however, with the avoidance of secondary transfer, the cost is not duplicated.

Case study of secondary retrieval
Background
A young lady who had suffered a myocardial infarction was in a cardiac centre in Wales. She was suffering cardiogenic shock and had been accepted in a tertiary centre in England for cardiac surgery, and was currently being supported by a specialist balloon pump.
Action Taken
The ASD were able to coordinate a team to attend the hospital by air, and then facilitate onward transfer by road with the consultant and a perfusionist from the hospital.
Outcome
The transfer was successful, and the patient went on to have successful surgery.
Change in process observed
This avoided hospital medical staff from having to accompany the patient on a long transfer, and provided the safety net of a critical care consultant being available in case of deterioration in the patient's condition. This enabled the hospital to continue its normal activities.

Case Study 12

CT scanning

7.93 Computer Tomography (CT) scans are important in the management of a variety of conditions, especially the management of major trauma and head injuries. In these cases, national guidance exists as to the timeliness of intervention in specific cases.

7.94 The service has developed a protocol with a receiving centre in South Wales, which allows patients to be taken directly to the CT scanner in selected cases.[5] These include non-trauma patients with suspected intracranial haemorrhage and major trauma patients. The impact of this for trauma patients can be assessed by interrogation of the TARN dataset. An early indication of this benefit is realised in successfully linked data. Relating to the target of patients receiving a CT within 30 minutes of arrival to MTC, EMRTS patients achieved this in 66.7% of cases versus an overall proportion of 52.6%.

[5] EMRTS Operational Standard Operating Procedure 021.

7.95 The average time for an EMRTS trauma patient to receive a CT scan of the head from arrival at hospital is 0.8 hours, compared with 8.8 hours for the overall TARN dataset.

7.96 For CT scans in general, 1.5 hours versus 13.1 hours is achieved.

7.97 When the time from the actual incident to time of CT is calculated, the average is 9.7 hours faster for general CT, and 10.5 hours faster for CT head.

Surgical intervention

7.98 For patients attended by the service, early data indicate they received surgery sooner than those that weren't. Against a measurement of 6 hours from arrival at hospital, 23% received surgery versus 7.7% overall. At 24 hours, 40% versus 21.9% had received surgery. This data may be skewed due to the relatively small sample at present, and may also represent the level of injuries present in the EMRTS population.

7.99 Table 26 details this comparative analysis, alongside average ISS.

7.100 The results reveal that there are a number of downstream benefits, and the early indication is they are being realised.

TARN exploration	Overall Averages	EMRTS Averages
ISS	13	20.9
GCS	14.2	12.9
Time (hours) from arrival at hospital to CT	13.1	1.5
Time from arrival at hospital to head CT	8.8	0.8
Time of incident to CT	18.2	
Time of EMRTS incident to CT		3.5
Time of incident to head CT	13.2	
Time of EMRTS incident to head CT		2.7

Table 26 Exploratory averages from the TARN dataset for the overall dataset population (01/01/2012-31/12/2015) and successful EMRTS patient linkage

10/Avoidance of hospital transfer and Emergency Department Admission

7.101 This proposed benefit has a number of aspects, and crosses into other register entries:

- Primary Incidents: avoidance of transfer and admission to any emergency department though advanced decision-making.
- Primary Incidents: avoidance of transfer and admission to local emergency department through hospital bypass (covered in benefit 1).
- Secondary cases: avoidance of local hospital staff carrying out the transfer.

7.102 Crossing a number of areas, advanced decision-making may avoid certain groups of patients being transferred by the ambulance service. There are two groups primarily of interest: those in cardiac arrest, and those suffering trauma. For those patients in cardiac arrest, advanced decision-making, as outlined earlier in the report, allows a change in patient journey, depending on outcome. For some patients, this will mean the bypassing of local hospitals to definitive cardiac care, while for others this may mean, despite best efforts, resuscitation is stopped outside of standard paramedic practice, as is usually done in hospital. For those suffering trauma, these patients can be split into two broad categories: those with minor injuries, perhaps as a result of a road traffic collision where there are multiple patients with suspected injuries, and those that are suffering major trauma and require definitive care in a specialist centre. Those that suffer minor injuries may be able to take an alternative pathway following advanced decision-making by the team, e.g. self-care or attendance at a general practice. This is an area that may become a disbenefit to the service if carried out too often, impacting on the availability for the main objectives. However, it is recognised that, in one multi-patient incident, there will be crossover between these areas and, depending on the number of staff attending, both areas can be addressed. Those more seriously injured may be taken directly to a specialist centre that has facilities to deliver care, e.g. neurosurgery in

the case of a head injury. This area is covered in benefit 1. This has been evidenced by other pre-hospital services and can be quantified as a financial saving for the Welsh Ambulance Service and Health Boards.

In the example of a cardiac arrest, a conservative estimate of the cost of ambulance attendance, conveyance and emergency department admission is £2504 based on the combination of an average see, treat and ambulance conveyance (£231) [6] and an average £2273 cost for cardiac arrest admission.[7]

For non-critical care cases, in the example of an avoided emergency department attendance, where the average cost of attendance is £388 (Ambulance £231 + Emergency department attendance £157), there is less of a gain for a service of this type.

In cases of primary attendance and consequent direct transfer to a specialist centre, these can avoid a cost locally for admission, including that outlined in benefit 9, acknowledging there will be a cost to the receiving health board, as predicted in the clinical flow modelling exercises during the service development. This is a complex area, but will become clearer with the inclusion of the additional datasets in a future analysis.

7.103 Data were analysed to look at the proportion of patients that took an alternative pathway, other than admission to hospital. The figures are broken down by cardiac/respiratory arrest, medical and trauma cases.

Inclusion

- Counts by ALF and incidents
- 27/04/2015-26/04/2016
- Primary missions

7.104 On an All-Wales basis, the largest group to be impacted by this is the cardiac/respiratory arrest group, where 39.4% of patients were declared deceased at the scene. Of these, 78% were outside of the JRCALC ambulance

[6] Health and social care costs 2014.
[7] HRG Average costs, 2014/15, NHS Wales.

guidance, representing cases that may have been transported to a local emergency department. The health board where this has the largest impact is BCUHB, where 80% of cases were declared deceased at the scene. With relatively small numbers, and without the diagnosis/comparator case control, it is difficult to draw any firm conclusions from this. Figures for all health boards are included in Table 27.

7.105 For trauma cases, 2.6% were referred to another pathway. This low number may indicate accurate case selection, and go some way to evidencing that there is low "mission creep".

7.106 With further work using the linkages, and larger numbers, the journey of these patients can be followed in more detail, including the proportion that then went on to be admitted to hospital. This will help assess the decision-making effectiveness of the service.

Health Board Of incident	Portion of patients died at scene (%)
Abertawe Bro Morgannwg	35.7
Aneurin Bevan	50.0
Betsi Cadwaladr	80.0
Cardiff and Vale	25.0
Cwm Taf	41.7
Hywel Dda	47.4
Powys	23.5
Wales	**39.4**

Table 27 Cardiac/Respiratory Arrest proportion of patients who died at scene by incident health board

Case study of Primary assistance at a minor injury unit
Background
An adult male presented to a minor injury unit in mid-Wales complaining of chest pain. He went on to suffer a cardiac arrest, and was given basic, then advanced, life-support by health care professionals in the unit, and by the ambulance service.
Action Taken
The 999 call was interrogated by the ASD, and the Welshpool team was deployed to provide assistance, with a view to onward transfer if required. On arrival, resuscitation was underway and the team were able to offer additional support in the form of critical care interventions. These included the use of an automated external compression device, and ECHO to rule out reversible cause of cardiac arrest. The consultant was also able to provide clinical leadership of the ongoing resuscitation attempt.
Outcome
Unfortunately, in this case, the team were unable to successfully resuscitate the patient. The team were, however, able to offer all investigations and appropriate treatment normally only available in an acute hospital emergency department. They were also able to facilitate a debrief with staff involved in the resuscitation.
Change in process observed
Timeliness of hospital level care. Potential to facilitate onward transfer and critical care if required in similar cases. Senior clinical decision-making in the community.

Case Study 13

Case study of a multiple-casualty incident
Background
Two cars collided on the motorway at rush hour, resulting in 6 casualties.
Action Taken
The ASD interrogated the call and, although there didn't appear to be any life or limb-threatening injuries, decided to dispatch the team in order to provide advanced decision-making, and avoid hospital admission if possible.
Outcome
The team attended by road and discharged 4 out of the 6 patients at the scene with self-care advice. The two that went to hospital required X-rays and were able to attend the local DGH.
Change in process observed
This potentially saved the ambulance service and local emergency department from transporting and assessing 4 patients.

Case Study 14

11/Enhanced perception of health gain by health care professionals, LHB reps and patient reps

Workshop, interviews and surveys

7.107 Evaluation workshops with stakeholders revealed the following key themes:

- Advantage of delivery of critical care to the scene of incidents
- Advantage of transfer to definitive care.

7.108 There was a consensus that the service provided a health gain for patients attended, especially those relating to trauma. However, more information is needed to ascertain the impact of this on other patient groups.

7.109 In respect of cardiac arrests near to acute hospitals, it was felt there should be a cut-off for attendance where the patient may be able to reach definitive care more rapidly without EMRTS. The health gain for rural incidents was, however, acknowledged.

7.110 In the North workshop, there was concern over case selection when close to an acute hospital, especially given the current time of travel from the mid-Wales base. It was acknowledged that some early cases highlighted this, and that the system had adapted to avoid causing a delay in time to care. In these cases, the group felt that a secondary transfer would be more appropriate if required.

7.111 It was identified that more work needed to be done with respect to communicating when the service should be called for cases in remote parts of North Wales. It was noted that, during the evaluation period, a consultant lead for the Caernarfon air ambulance base had been appointed and has started to make progress.

7.112 With a relatively small patient cohort compared to overall NHS workload, it was felt that it will be difficult to provide hard evidence of a health gain in the short term. There was general support for an ongoing programme of evaluation using the linked datasets.

7.113 There was a keenness to attach a cost to the benefits of the service to aid in economic evaluation.

7.114 It was broadly agreed that the following factors contributed to a health gain:

- Primary taskings
- Range of critical care interventions
- Timeliness of access
- Speed of transfer to definitive care.

7.115 It was recognised from case studies that interventions such as blood product transfusion appear to be beneficial and appropriate; however, more evidence is required to support their use. It was noted there are national trials ongoing in this respect, and the SAIL analysis will provide more information in the longer term.

7.116 There was a feeling that senior decision-making and a team-working approach ensured health gain.

7.117 With respect to critical care interventions, it was noted that the WAST clinical service had changed during the development of EMRTS and that some skills had now become common practice, such as pelvic splintage or IO access.

7.118 With respect to the measurement of critical care skills presented, it was felt by the North Group that all cases that receive a consultant at the scene should be recorded as having had an intervention in that they are receiving senior decision-making. The current way of reporting this looks at skills used as the main factor along with documented decision-making.

7.119 The issue of the aging trauma population was raised, and that tasking might need to take this into account.

7.120 It was also agreed that any net health gain will be dependent on other service changes, especially with respect to trauma networks in the South and intensive care facilities.

7.121 With respect to secondary transfers, it was felt that there weren't as many as expected, but the groups acknowledged there are wider systems processes that may impact on this, in addition to the service being a new entity.

7.122 For patients that unexpectedly survived compared to a normal pathway, there was concern in respect to the additional burden created on secondary care, particularly critical care. It was noted that the All-Wales critical care capacity was exceeded by demand over the winter period. This was noted to be a potential disbenefit in the register and should be monitored.

7.123 A health board representative praised the interventions now available to patients in rural parts of Wales, while transfers witnessed are often calmer and more controlled than alternative methods.

7.124 It was commented that there were downstream benefits seen in hospitals, with respect to the avoidance of depleting staff from a transferring hospital.

7.125 A representative from a neonatal network also commented on how the service avoided excessive loss of staff teams in respect to retrievals and a single case could save a full shift's loss of staff. The outcomes he had witness of cases were favourable, and that it was felt the service provides a health gain.

7.126 From the staff survey in respect of critical care interventions, 85% felt that the right level of intervention had been included in the specification.

7.127 All respondents felt that PRBCs and LyoPlas should be carried, but 19% and 5% felt that Fibrinogen and PCC shouldn't be carried respectively.

7.128 In terms of additional interventions, three respondents suggested ECMO should be added, but acknowledged this would not be compatible with the current hospital setup in Wales. Regional anaesthesia was also thought to be a valuable intervention. In addition, one respondent felt there should be more targeted tasking of resources to minor injury road incidents to assist with discharge at scene (referenced to benefit 10).

Feedback

7.129 Complimentary feedback was collected during the evaluation from a variety of sources and recorded by the admin team. The numbers are included in Table 28.

Group	Number
Patients	8
Patient representatives	14
Health Care Professionals	13
LHB/WAST Other agencies Representatives	28

Table 28 Complimentary Feedback recorded

7.130 Themes of feedback are centred around the following areas:

- Professionalism
- Skill level
- Team-working
- Thanks from patients
- Thanks from colleagues in health boards and WAST
- Wanting to develop closer links between organisations.

7.131 Some examples of feedback are included below

"I wanted to pass on the many thanks and appreciation from myself and my colleagues for your backup today at a cardiac arrest in a rural area; you and your team helped to provide us with some excellent patient care and exceptional team-working skills."

WAST Clinician

"Thank you so much to the crew that attended my teenage daughter after being hit by a car. You were amazing. We really thought we would lose her... You looked after her so well."

Patient's relative

"I am really grateful to you and the team for the support of your specialist team to what was an awful incident."

Health Care Professional

"I just wanted to say a huge thank you to the air ambulance for their speed, professionalism, care and attention when my 8-week-old daughter had breathing problems in a remote area of Wales."

Parent of a patient

"...the team delivered the baby to the neonatal unit in good condition and therefore should feel they did a great job."

Neonatal Unit

We were delighted that the baby was safely transported. She arrived here in first class condition with a temperature of 37 .1 degrees. I liked the telephone conference with the referring unit, EMRTS, and receiving unit as this is a most efficient way to share information. I would like to explore whether we could use conference calls in CHANTS."

CHANTS feedback

"I was very impressed by the EMRTS service on Monday morning, retrieving an 11-year-old child. Particularly impressed by the efficiency of packaging by the CCP."

Health Care Professional

"It was fascinating to see in action the amazing level of care that you are capable of delivering at the scene of an accident. I was hugely impressed by the professionalism of the team and the exemplary way in which you were able to manage the very challenging situation you were confronted with. Your skills with the patient, his family and the other emergency services in attendance were of the highest possible standard."

Health Board Representative

"From our point of view, we are very grateful for your involvement. As you know, time-critical transfers were usually done by us (ICU consultants), but these are infrequent and suboptimal because not all of us would be happy to transfer a small child; our ventilator is not great, there may not be a nurse with paeds experience and, if there is, they are likely to be the team leader. Both doing the transfer and looking after a child for a prolonged period is a significant drain on our resources with only two consultants to cover ICU obs and theatre and two often very junior trainees."

ICU consultant in DGH

"Thank you for your efforts at the RTC yesterday morning, quite frankly myself and the crews witnessed you truly bringing the A+E operating theatre to the roadside."

Fire & Rescue Service

"Hopefully, the case of the Cardiac baby at the MLU in Haverfordwest from yesterday is a great example of team-working between WATCH and EMRTS. These MLUs are really isolated with very little kit and, until EMRTS arrived, no one was able to even secure an airway in this baby, thus demonstrating a real need for your service in the neonatal arena. Can you thank the member of staff on the ASD as she was really great coordinating everything."

Health Board Representative

"I have been meaning for several weeks to write to thank you for the retrieval service - not just the speedy and efficient delivery thereof, but also the supportive attitude to us in the DGH."

Health Board Representative

"I was extremely grateful for your attendance and support at such a challenging and sensitive incident. I would also like to express that I was taken back by the way you both worked together and managed such a difficult job."

Minor Injury unit

"My impression is EMRTS is still underutilised in Wales and there is a massive room for improvement. EMRTS can help babies not only in remote areas and standalone midwifery-led units in pre-hospital care, but also to link North, Mid and South Welsh units for pre-hospital as well as repatriation services. Over the past year, we used your service to repatriate two babies to mid-Wales. Personally, I feel there is a strong argument that this was the best decision from the baby's perspective and also, interestingly, it would save money as well. On one occasion, we had a baby in Glan Clwyd that needed to go back to Glangwili and the arrangement was that both North and South CHANTS would send their medical teams and meet halfway to complete the 7-hour journey. After everything was agreed, I thought it might be more appropriate to use the medical expertise of the EMRTS team. Discussing the case and agreeing funding and so on with the South CHANTS team, I contacted the on-call consultant in EMRTS. I was happy to hear their acceptance. With the help of EMRTS, this baby arrived safely in 50 minutes!! If we consider the added costs of two fully-equipped medical neonatal transport teams supposed to be involved in this journey and the long-distance, bumpy ride in the back of the ambulance. Definitely, this was the right decision for the baby's safety, service management and also for saving money. All the team in the hospital praise members of EMRTS. Speaking on their behalf, I would say that we will be always delighted to have EMRTS stars in our unit."

Neonatal Consultant

Clinical and skills sustainability

The service specification has been fulfilled in terms of staffing, with a full complement. Progress has been made against the objective of increased consultant appointments in Wales. A significant level of both structured and opportunistic educational interventions has been made across Wales.

8.1 To provide the necessary cover outlined in the background section, the service employs a mixed workforce. Employing 43 staff, providing 30 whole-time equivalents (WTE) the makeup is summarised in Table 29.

Role	WTEs	Number of people
Consultants*	9	22
CCPs**	11	11
Clinical Team Leader	1	1
Allocators***	3	3
Management	4	4
Administrator	2	2
Total	**30**	**43**

**includes top cover 24-hour period, management and clinical commitment*
***12-hour base Welshpool, Swansea, ASD & Training*
****Funded by WAACT*

Table 29 EMRTS Staffing

8.2 In the staff survey, all respondents agreed the importance of the CCP Consultant partnership, but some felt that it would be beneficial to facilitate autonomous working by CCPs more regularly. In addition, it was suggested that the use of PHEM trainees is important, and that remotely supervised practice would be beneficial

8.3 For inter-hospital transfers, there was support for varied staffing models including the use of allied health professionals such as ACCPs, nurses and operating department practitioners. This view was not extended to their involvement in pre-hospital takings.

12/Increased consultant appointments especially in Emergency Medicine

Recruitment

8.4 The first rounds of consultant and CCP recruitment took place from December to February 2014. There were selection processes held in both Mid and South Wales and competition was fierce. The numbers of applicants far outstripped numbers of jobs, especially for the CCPs.

8.5 During the first round of the selection process, we successfully appointed 12 CCPS from a pool of around 90 applicants and 19 consultants from a pool of around 35 applicants.

Consultants

8.6 Positions were undersubscribed for consultants initially as there were no sufficiently experienced applicants during the first round, which meant that, initially, consultant cover was only provided from Welshpool for five out of seven days. This equated to 20 incidents attended with a double CCP crew.

8.7 Further recruitment rounds were held in the next six months for those consultants who had applied for new consultant jobs within Wales, as well as for a number of military consultants who wished to work for the service, which allowed a 7-day service in Welshpool from September 2015.

8.8 The service currently has a mixture of Emergency Medicine Consultants (EM), Anaesthesia Consultants and Intensive Care Medicine Consultants (ICM).

8.9 The current split of these specialities is outlined in Figure 31.

8.10 Currently, 13 consultants work within Wales; three work in Stoke, three are military doctors (two from Stoke and one from Birmingham), one from Bristol and one from Cornwall (see Figure 32).

8.11 The service has attracted two new EM consultants to Wales in the last 12 months. In addition, multiple adverts for new consultants in all three specialties have been advertised in a number of Welsh health boards as joint EMRTS jobs.

8.12 All consultants receive an annual 360-degree feedback and undergo a formal performance review, which feeds into their parent health board's NHS appraisal process. All consultants are in substantive consultant jobs with their own health board and currently hold honorary consultant contracts with EMRTS/ABMU, which are renewed on an annual basis.

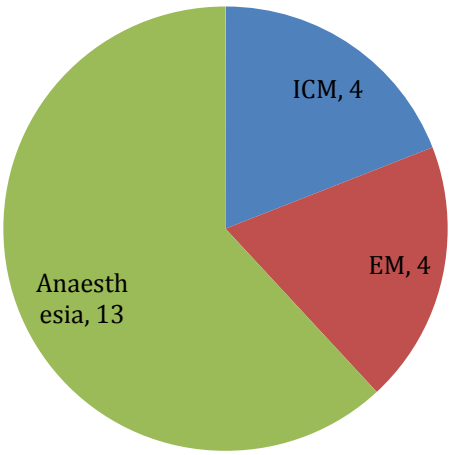


Figure 30 Consultant Specialty

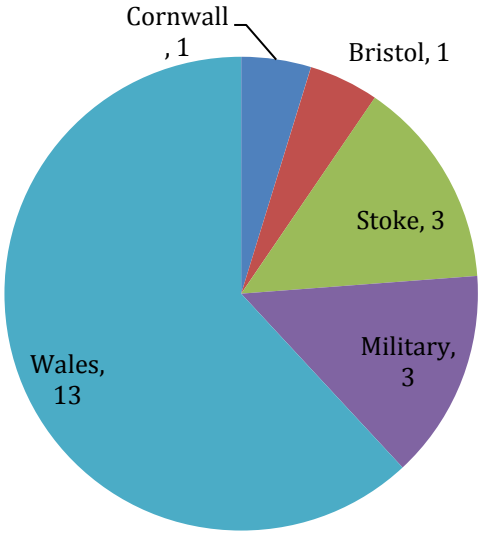


Figure 31 Consultant Base Hospital

Top Cover Consultants (TCCs)

8.13 The service provides a rota of nine TCCs for a 24-hour period, having recently run a second round of interviews to appoint current EMRTS consultants to TCC roles. It is anticipated with ongoing recruitment activities that the pool of consultants available for this role will expand.

CCPs

8.14 All CCP slots were filled in the first round of selection and all 12 of those CCPs are still working for the service.

8.15 A position of Clinical Team Leader was recruited for internally and filled during the evaluation period.

Trainees

8.16 In the second half of the first year, two PHEM trainees were hosted by the service, in a supervised capacity.

13/ Increased educational interventions to doctors/paramedics/nurse practitioners/midwives (either opportunistic or structured)

8.17 The service works alongside multiple agencies on a day-to-day basis, which facilitates both opportunistic and structured educational interventions.

Structured Educational interventions

8.18 The service recorded attendance at 95 educational events during the evaluation period, representing 62% of the overall events attended by staff.

8.19 Involvement ranged from presenting as part of a programme, to hosting the event. Examples include:

- Training sessions with WAST Hazardous Area Response Teams (HART)
- Junior doctor grand rounds
- Joint WAST and Cardiff Medical School rural trauma day
- WAST control room training
- London Trauma Conference
- Wales Emergency Medicine Conference
- Pan-Wales Merit Course
- Diploma in immediate care preparation sessions
- Ambulance station trauma training

Category	n
Health Boards	48
Ambulance	27
Clinical Networks	25
Conference/Associations	17
Governance Days	12
Fire & Rescue	10
Charity	7
Other	6
Police	3
Total	153

Table 30 Recorded Structured engagement

- Midwifery-led Unit study days
- Neonatal study days
- Rural General Practice study days.

8.20 Topics included clinical management, working in partnership, specific conditions, and lessons learnt from operations. Table 30 details the numbers of structured engagement events.

8.21 Feedback was positive from these events. Some examples of compliments are included below:

> *"Just to say thank you very much for your CPD presentation this week. It was very well-attended and received by our staff, who found it topical, informative and extremely interesting. Your presentations have proved to be very popular indeed."*
>
> **Ambulance service staff**

> *"Your presentation was informative and has only served to increase our awareness of EMRTS' capabilities substantially. Crucially, this will have a positive impact at incidents between ourselves."*
>
> **Fire Service**

> *"I just wanted to say thank you for your presentation last week. It received excellent feedback on the evaluation forms and everyone enjoyed learning about the role you perform."*
>
> **Health Board CPD event**

> *"The CPD presentation yesterday was very good and useful."*
>
> **Neonatal CPD event**

> *"Your talks were all very well-received, and played major roles in making the conference the success that it was. In particular, our registrars greatly enjoyed your input into their session"*
>
> **International conference organiser**

Internal Staff Training

8.22 All consultants and CCPs who were recruited during the initial round of selection processes undertook a two-week accelerated training programme, which included more than 50 simulated moulages and two days of advanced neonatal training, as well as Welsh blood training.

8.23 Subsequent consultants who have joined the service have undertaken their neonatal training at local NICUs, been given blood training by local transfusion practitioners and have undertaken the majority of the 50+ simulations during training shifts.

8.24 New consultants to the service typically undertake between 1 and 4 months' supervised training shifts with experienced consultants (depending on their prior experience), complete a competency pack and are subject to a multi-source feedback prior to undertaking solo shifts.

Opportunistic educational interventions

8.25 In addition to planned interventions, the service provides opportunistic educational interventions on a daily basis. Examples include:

- Debrief with an ambulance crew following an incident
- Over the phone when giving advice to hospital or ambulance staff
- Training with clinicians attending "observer" shifts
- During incidents whilst providing critical care interventions where appropriate
- Telephone feedback with clinicians.

8.26 As with structured events, feedback is also positive. Examples include:

> *"I just wanted to say it was an absolute privilege to meet the 'flying doctor' (a ITU consultant) who was extremely helpful, and taught me a huge amount in the short time he was on the ground at the hospital."*
>
> **Medical Student**

"Thank you once again to you all for being so welcoming and for taking the time to explain the intricacies of the service."

A Health Board representative

"The consultant and his team where absolutely fantastic and invested time in every member of staff on scene to gain knowledge and better understanding of the current situation."

WAST Emergency Medical Technician

Stakeholder Engagement Feedback

8.27 As part of the stakeholder workshops, interviews and questionnaires, there was an opportunity to gain further feedback on this aspect of the service.

8.28 A record of proceedings revealed the following key themes and discussion points.

Workforce

8.29 With respect to workforce, in the context of NHS-wide issues, the service was seen as a largely positive factor in the recruitment of medical staff.

8.29.1 "The workforce model gives it resilience and sustainability."

8.30 There was a perception from one group that there was not a net gain for the NHS in terms of recruitment. The group did, however, comment on a bigger gain to be had in the longer term.

8.31 With respect to the medical workforce, it was recognised there were PHEM trainees working on the service, but it was queried whether more recruitment at the registrar level should take place to increase the pool of applicants.

8.32 There were numerous comments regarding the benefit of skills transfer between EMRTS and hospitals due to the sessional nature of the consultant workforce.

8.33 The Medical Director of a health board highlighted that four of their consultants also work for EMRTS. Their involvement in the service was viewed as good for team discussions and sharing best practice. It made the unit attractive. In addition, trainee doctors have been attracted to the health board because they are aware of this link. He went on to state that he believes

that Wales is not taking sufficient advantage of this and that all new, appropriate consultant roles into Wales should include the option of sessions with EMRTS.

8.34 For health boards that only have one consultant committed to EMRTS, there was a concern about backfilling of sessions if they were included as part of the job plan. It was recognised that, in the longer term, with increased recruitment this issue will improve. Dependent on the individual, there may also be an opportunity to commit to the service in extended sessions, which wouldn't impact in the same way.

8.35 One health board representative felt that the service staffing should facilitate a wider range of critical care transfers, e.g. not just time critical, as hospitals are still having to staff additional on-call tiers to support these transfers. This is in the context of hospitals struggling to fill anaesthetic and allied staff posts.

8.36 The cross-cutting theme was that all work on workforce and recruitment needs to be done in partnership between the services. The extent of this varies between areas currently.

8.37 With regards to CCPs, the consensus was that the posts had improved recruitment into Wales.

8.38 The funded Diploma/Master's education provided was praised.

8.39 If defined development pathways were put in place, it would also make paramedic posts in WAST more attractive.

8.40 It was felt that the current CCP background of paramedic and nursing is appropriate, but there was concern from both workshops that, once qualified, staff may leave for higher-banded posts elsewhere. This may benefit other areas of the NHS, but the investment by the service could be lost.

8.41 WAST representatives queried whether there should be more autonomy of CCP staff and PHEM trainees with remote support from consultants.

8.42 There were queries regarding the possible expansion of allied health care professional staff groups, including the nursing contingent, Operating Department practitioners and the possibility of Physician associates.

Engagement

8.43 The workshop identified some perceived deficiencies in educational/outreach work, specifically in the North West of Wales and the South East.

8.44 It was suggested that individual links at various staff levels be developed, particularly in these areas to improve working relationships.

8.45 The governance process, including the monthly governance days, were commended for being open and transparent, with evidence of resulting changes in practice and process.

Support for Ambulance staff

8.46 There was also an appetite from WAST for expanding the scope of remote advice for ambulance crews outside that of the current protocols.

8.47 WAST representatives mentioned it was beneficial to have consultants in the service from a learning and skills transfer perspective.

8.48 WAST representatives believe that the joint training has made a positive impact on clinical and skills development within the ambulance service.

8.49 It was highlighted that the service should be careful not to de-skill other emergency services, particularly road ambulance crews, and that this can be mitigated through the ongoing engagement activities, both opportunistic and structured.

Unmet need

Summary

In order to ascertain the impact of the service on overall potential workload in Wales, a review of "unmet need" was conducted and reveals the following:

Pre-Hospital Care

During operational hours, across Wales there were 784 cases that may have benefited from access to EMRTS. These are cases that received an alternative response, such as non-EMRTS staffed air ambulance, BASICS doctors or WAST ambulance response. Looking specifically at the North of Wales, this equates to 430 cases (BASICS + Air ambulance). This figure excludes those cases that have been attended by EMRTS in the area.

Outside of operational hours, there were 226 cases identified that may have benefitted from access, but received an alternative response, and a further 608 cases based on demand predictions, of which 383 may have received critical care interventions based on current in-hours activity. A conservative estimate, therefore, puts the unmet out-of-hours pre-hospital critical care need at 609 cases across Wales (recorded cases + calculated critical care cases).

Where EMRTS has attended in the North of Wales, it is reasonable to expect that the time to scene would be improved if the critical care team were based within the local area.

Secondary Transfers

Of the predicted time-critical emergency department transfers, based on demand predictions, 114 cases were thought to have not been attended.

If the scope of the mission acceptance criteria were widened to include non-time-critical, intensive care transfers, then 446 cases were identified on an all Wales basis as unmet need. Due to deficiencies in time data, it is not possible to draw firm conclusions as to the timing of this workload at this time.

9.1 The potential unmet need in Wales during the evaluation period was researched using a combination of methods in order to ascertain the impact of the service, and also provide an indication as to the potential for further developments. Methods included direct reporting by staff, and database trawls. Future work will include more complex data linkage through SAIL, and analysis of TARN and ICNARC datasets now held by the evaluation team.

9.2 This area has been split into those that occurred out of hours, when the service doesn't normally operate, and those that occurred during operating hours. A further group, the North West of Wales, has also been isolated.

9.3 Data will be presented individually by method, and as an aggregate summary.

9.4 Caution should be exercised when reviewing this data, as this is a complex area, with interplay between concurrent demand, mission types and the ability to ascertain if a particular case would have benefited from the EMRTS.

9.5 The following data sources are explored below:

- Missed Tasking Log
- External datasets.

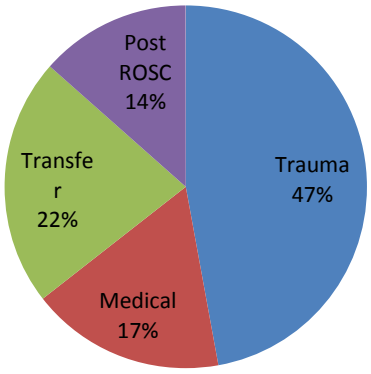
Missed Tasking Log

9.6 During the evaluation period, a record of missed taskings was made on the ASD, initially as a paper log, and then as an electronic form populating a database. During the latter period, this was also made available to colleagues from the ambulance service to record incidents.

9.7 46 Secondary taskings were recorded as missed using this method, the majority being due to the service being already committed to primary takings.

9.8 162 primary missed taskings were recorded.

9.9 20 additional taskings were also recorded as occurring out of operational hours using this method (excluded from Figure 34).



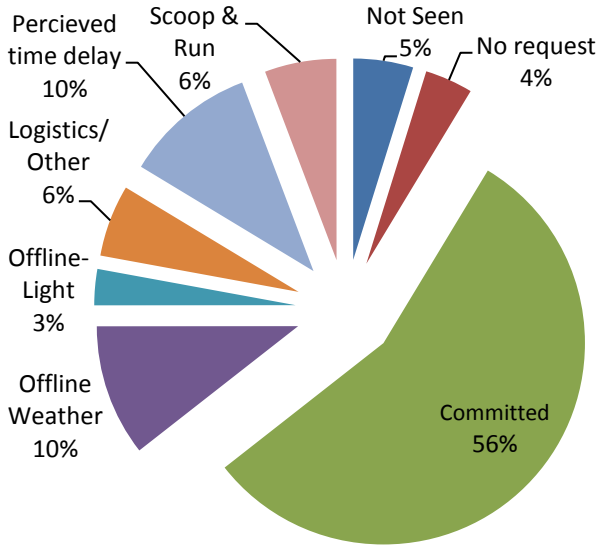


Figure 32 Missed Tasking record

Figure 33 Missed Tasking reason - In hours

9.10 From the internal record, 15 cases in the North were explicitly recorded as not being attended in hours.

9.11 During the evaluation period, there was an average of six overruns per month where the duty crew worked beyond the operational hours.

9.12 Adverse weather accounted for 10% of the records, in keeping with operational reporting detailed elsewhere in this document.

External Datasets

9.13 An audit of activity during the evaluation period provides an insight into the potential unmet need for the service. This looks at actual pre-hospital responses from other services, both by land and air, as well as secondary care datasets. Analysis has been split into pre-hospital (primary) and secondary (Transfers) workload.

Pre-hospital responses:

Air response

9.14 In addition to the two air ambulances used by EMRTS, air response is provided by a number of other resources. These include the Wales Air Ambulance Charity aircraft in Caernarfon, call sign Helimed61, and air ambulances bordering Wales, which occasionally respond into the area as mutual aid. In addition, several missions undertaken by search and rescue services, and police aircraft, may also be unmet need.

9.15 H61 provides a paramedic response on an EC135 helicopter and is coordinated by the EMRTS ASD. It provides cover 07:00-19:00, 7 days per week. It also carries doctors from the Bangor ED clinical fellow scheme, PHEM training and others from time to time. Depending on the skill level of the individual, this may result in paramedic level skills up to consultant level critical care. There is no consistent or guaranteed critical care physician cover or advanced equipment provision on a daily basis, however.

9.16 As the crew start one hour before the ASD, during this period the crew self-task to incidents using information systems provided by the ambulance service. During the one-year evaluation period, only seven incidents were tasked in this way before 08:00. Dependent on the time of year, in terms of light availability, the Welshpool aircraft provides geographical cross-cover for the one hour in the evening that H61 is not operating. It should be noted that, once a mission has started within the operating hours of the service, the crew will usually continue to attend to the patient, resulting in an overrun. Depending on the next duty crew, this may impact the next day's operating hours if, for instance, the same pilot is due on shift.

9.17 Several cases have resulted in joint working with EMRTS crews, for instance at multi-vehicle road incidents, or critically injured patients that require advanced interventions. This occurred on average once per week during the evaluation period.

9.18 Analysis of WAST data reveals that the H61 aircraft was tasked 413 times, resulting in 302 patient contacts. A breakdown by category is seen in Figure 35. 97% of responses were in the BCUHB area, with the remainder in Powys LHB.

9.19 In addition to the air response, it was reported that, from time to time, the H61 team had access to a road-based rapid response vehicle. Unfortunately, no activity data was available relating to this activity.

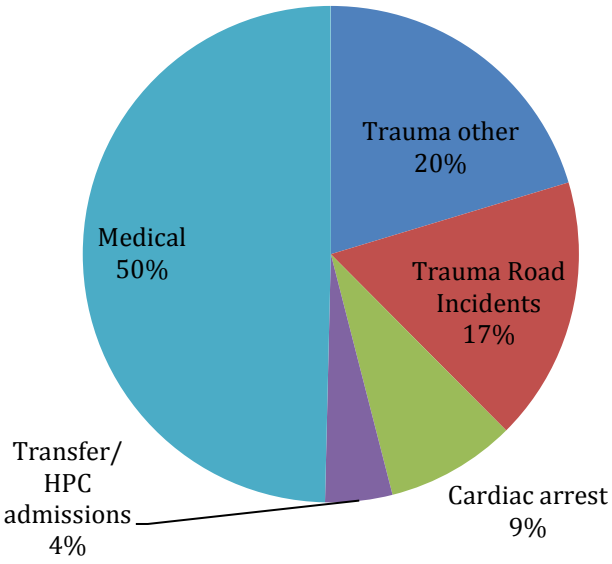


Figure 34 H61 workload

9.20 In addition to this resource, air response is also provided in mutual aid by neighbouring air ambulance services, some with critical care capability. There was also air response and transport provided by NPAS, the RAF and, latterly, Bristows Search and Rescue. Table 31 Other air support providers lists these services recorded as responding within the evaluation period. In total, 72 incidents were recorded, with 9 occurring outside of EMRTS operational hours. It should also be noted that some of these specialist resources have enhanced night and adverse weather operating capabilities, along with winch facilities, so may access cases in hours that were unreachable by the current WAACT air fleet.

9.21 It should be noted that air support from military or civilian search and rescue services is not guaranteed, as their primary tasking is to search and rescue.

9.22 A Regulation 28 coroner's report was recently issued, commenting on the lack of consistent access to air support for serious medical problems between the hours 20:00-07:00 (56).

9.23 This data, primarily taken from the WAST operational dataset, was cross-referenced with a data request to the Department of Transport, who are

responsible for civilian search and rescue services. This reveals a similar pattern of activity in Wales during the first year validating the WAST dataset.[8]

9.24 Negotiations are ongoing to secure access to more granular clinical data relating to other agencies' responses, a summary of which will be included in future releases of this evaluation.

Organisation	Type
Ministry of Defence **Royal Air Force** **Royal Navy**	Search and Rescue
Bristow's/Department for Transport **Civilian Search and Rescue Helicopter**	Search and Rescue (July 2015 based in Wales)
North West Air Ambulance	Air Ambulance
Midlands Air Ambulance	Air Ambulance/Critical Care Team
Great Western Air Ambulance	Air Ambulance/Critical Care Team
Police	Police air support, transport capable (ended 1st Jan 2016)

Table 31 Other air support providers

[8] DfT FOI response F0013797 26th July 2016.

Physician Land Response

9.25 Across Wales, three schemes exist that provide volunteer physician response to incidents, under the umbrella of the British Association of Immediate Care (BASICS). Cover is variable both in terms of hours of provision, and geographic availability, depending on the individual providing cover at any one time. Activation is via the regional ambulance control rooms, and response is conducted utilising a mixture of dedicated response cars, and own vehicles. Physicians responding include those from a general practice background, emergency medicine, surgical, and anaesthesia/intensive care medicine. The three main schemes are NWEDS, Montgomery MEDS and Medserve covering North Wales, Mid Wales and South Wales, respectively. Data has been analysed from ambulance control systems with the kind permission of these groups.

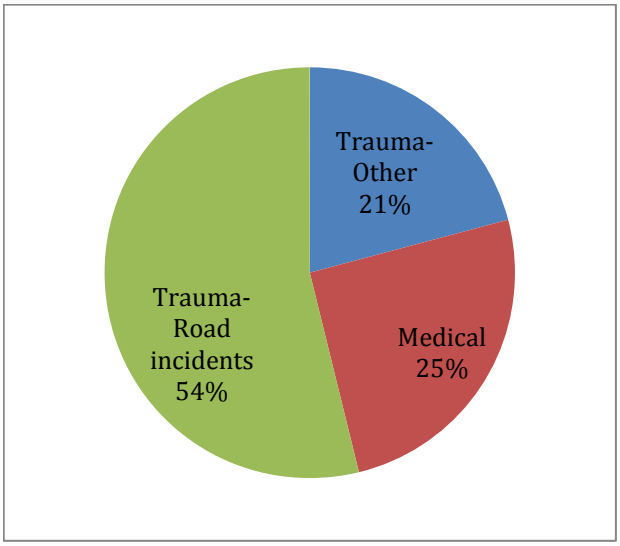


Figure 35 BASICS incident categories

9.26 Across Wales for the evaluation period, there were 840 responses by BASICS doctors, resulting in 639 patient contacts.

9.27 The majority of calls attended are of a traumatic nature (75%), with road incidents making up 54% of the overall workload. Figure 36 BASICS incident categories summarises the workload.

9.28 Of those incidents attended, 217 occurred outside of the operational hours of EMRTS (34%). Within the group that occurred during hours, it is recognised that a number will have also been attended by EMRTS. Data in this regard are not immediately available, but future releases will explore this area of joint work. When time is plotted, a peak around 18:00 of activity is revealed in Figure 37.

9.29 This activity, especially outside of operational hours, represents a potential unmet need. Further work is required though the data linkages to assess the journeys and outcome of these patients.

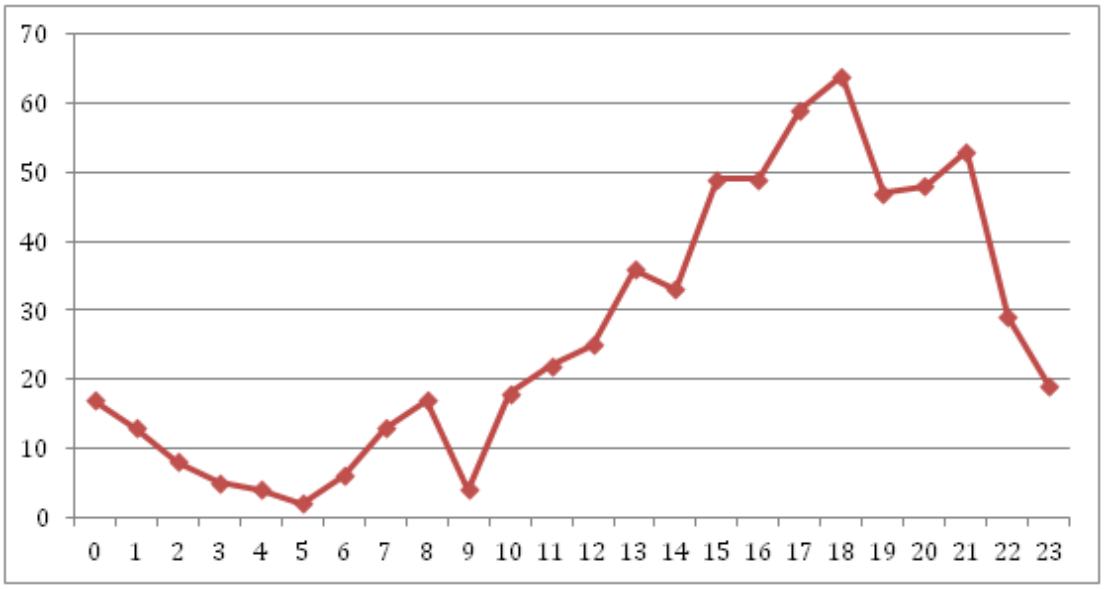


Figure 36 BASICS responses by hour

Secondary Transfers

9.30 Data held in a Microsoft Access database, were provided by the North Wales Critical Care & Trauma Network, detailing all level 2 & 3 Transfers in Wales from 2009 to 2015. Following the split file process, data were analysed in SAIL.

Inclusion

- Data from 2009 to 2015

9.31 53.4% of the Critical Care & Trauma Network dataset is missing ALFs. Also, due to multiple and separate transfer missions grouped under a distinct identifier, all analysis for the Critical Care Transfer Network is based on a one-row-one-count methodological approach. Using the Critical Care & Trauma Network week of birth, age was calculated as age at transfer date, whereas WDS was used for gender.

9.32 In Figure 41, a Sankey diagram reveals the overall flows of patients contained within the database, and thus the baseline secondary transfer activity across Wales.

9.33 Hospitals with counts of less than 10 were aggregated into a group referred to as 'other' in the Sankey diagram.

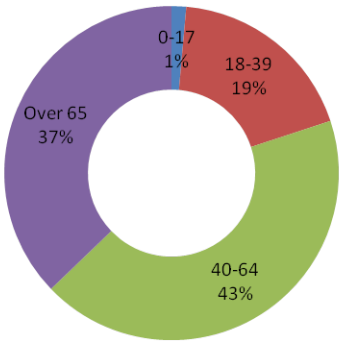
9.34 Analysis reveals 606 transfers in 2015.

9.35 The most common reason for transfer is consistently tertiary referral, accounting for 71% (Figure 39).

9.36 Assessment of time of day for transfers is difficult, as data completeness for time of transfer is low, with 44% missing this field. Further work is planned with the incoming datasets to assess this area. With available times, however, when plotted they reveal the highest proportion of activity occurs between 12pm and 12am, with a peak between 12pm and 4pm (Figure 40).

9.37 Age distribution of patients is summarised in Figure 38.

9.38 A full summary table of the data can be found in the appendix.



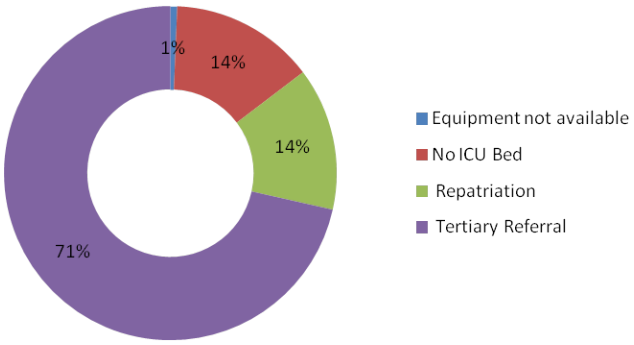


Figure 37 Critical care transfers by age **Figure 38 Critical care transfers by reason**

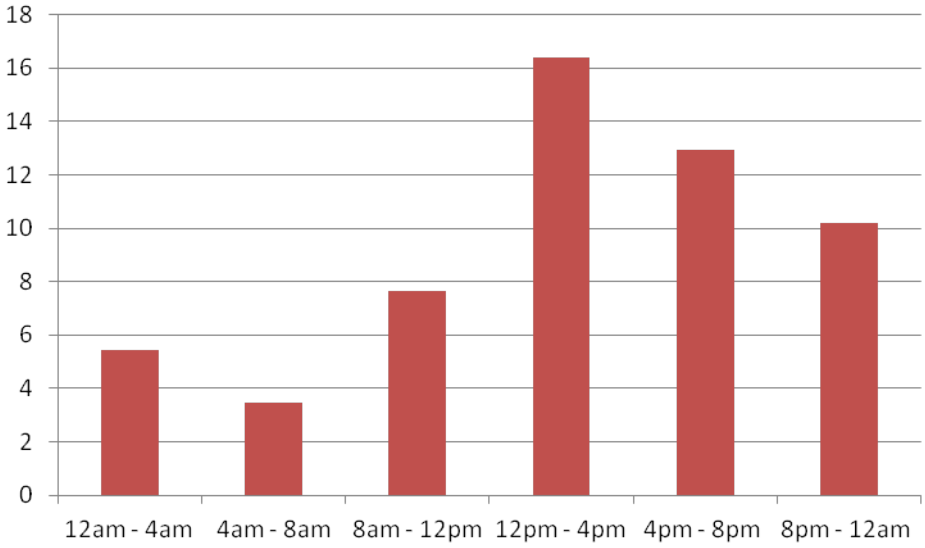


Figure 39 Critical care transfers by hour, 2015

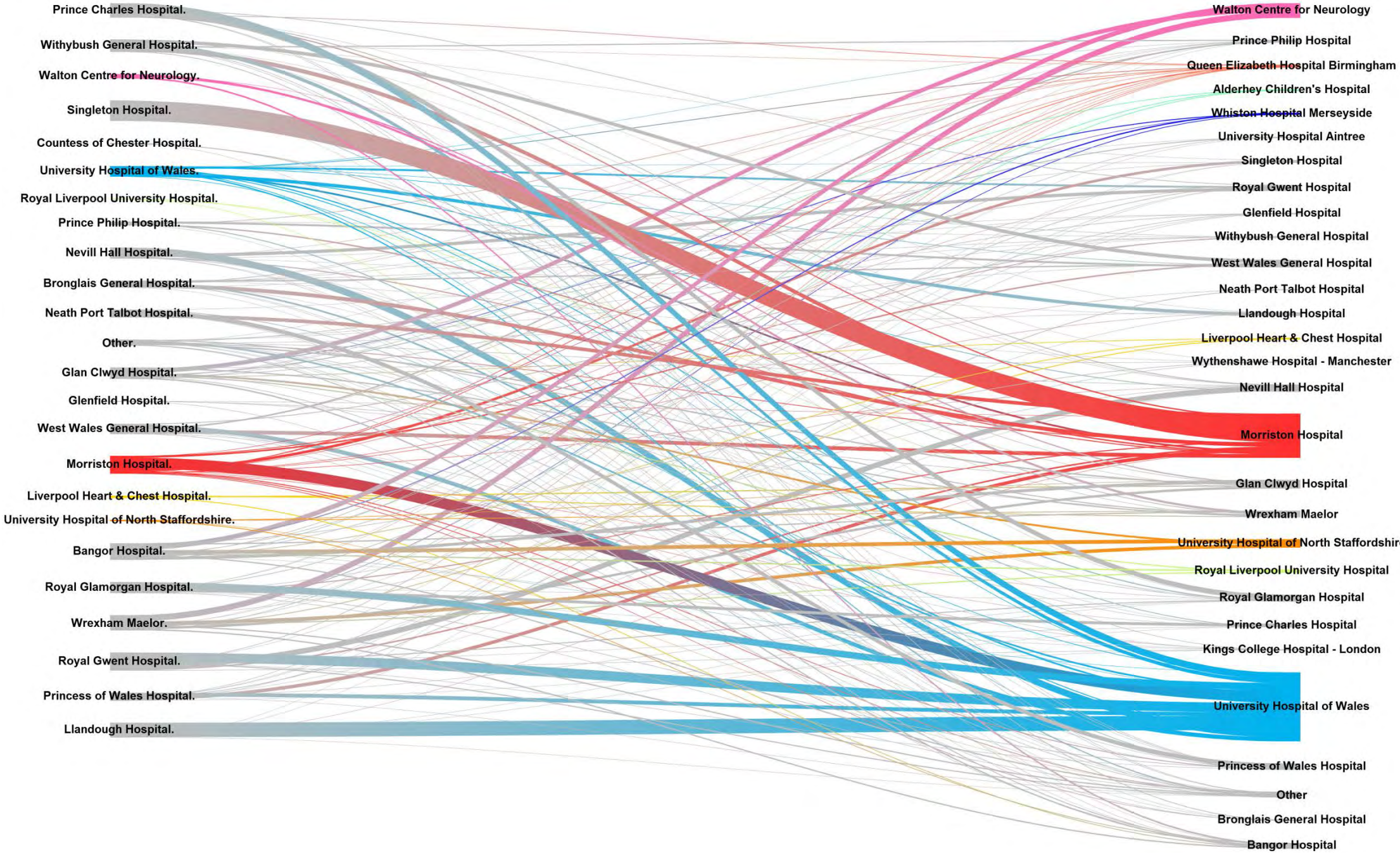


Figure 40 All Wales critical care transfers

Conclusions & Recommendations

10.01 Comprehensive monitoring of the first year's activity of the EMRTS has been undertaken, this report forming the first part of a three-year study aimed at evaluating the implementation and outcomes of the service.

10.02 A number of the proposed measurable benefits have been assessed.

10.03 A summary of the key findings is listed below.

General

10.04 A key to delivery of the service is a collaborative partnership between the third sector and NHS Wales.

10.05 New services need time to settle down into normal day-to-day operations. In the case of EMRTS, changes to existing services were extensive, including the coordination model, tasking model, workforce model, base infrastructure, clinical remit and many other aspects.

10.06 The delivery of such complex, ambitious plans in a short timeframe was an enormous challenge, but has been delivered.

10.07 Feedback from stakeholders on the initial service delivery is quite positive.

10.08 The data flows and methodological infrastructure for the evaluation of patient outcomes are now in place.

Activity and Service Specification delivery

10.09 The first year of activity reveals a high correlation with predicted overall service activity for the main areas of primary and, to a lesser extent, secondary missions presented during the business case phase.

10.10 The neonatal component saw comparatively less activity, likely due to factors including the later introduction of the service, and lack of predicted NHS service changes.

10.11 The Top Cover component of the service, whilst fulfilling the strategic medical advisor role, was relatively under-used in the current service configuration and is a potential area for reconfiguration.

10.12 The ASD performed well, coordinating complex multiagency incidents, secondary transfers and providing clinician-led tasking of the teams.

10.13 Major incident capability met and exceeded the service specification

Equity

10.14 The service has enhanced access and timeliness of delivery of specialist care to a number of patients, significantly enhancing this in rural areas of Wales. Whilst overall equity has improved, there is an inherent inequity due to the current hours of operation and geographical location of bases.

10.15 This is reflected in both the quantitative and qualitative assessment of the first year.

10.16 There is a perceived risk that any delays in expansion in the North West particularly would be detrimental to the area covered by the Wales Air Ambulance Charity Caernarfon helicopter (H61), as already experienced to an extent since the introduction of the EMRTS.

10.17 The analysis of unmet need demonstrates there is a significant proportion of work not currently accessed by the current service configuration. This covers two key areas: night time (20:00-08:00), and the North West of Wales.

10.18 There is significant inequity of care over the out-of-hours period and geographically in the North of Wales and, to a lesser extent, the South East of Wales. This was revealed to a degree in quantitative measures, and echoed strongly in qualitative results.

10.19 In addition, it is noted that there is potential demand for work outside of the current service specification, such as non-time-critical transfers, and support for paediatric retrieval services. At the time of writing, it is noted that there is an ongoing pilot by the WAACT of a fourth aircraft with a view to supporting such work.

Health Gain

10.20 Whilst the evidence in the literature is still quite sparse and mixed with a limited number of high-quality evaluations undertaken, there is evidence that EMRTS-type services have produced a health gain (reduced mortality)

in several locations. Each service differs somewhat in its configuration and setting, making it difficult to compare service models.

10.21 Qualitative assessment reveals a perception by health professionals, health board representatives and patient representatives that the service is providing overall health gain.

10.22 The range of critical care interventions offered is appropriate for the case mix.

10.23 Data linkages are now in place for ongoing evaluation against the proposed quantitative outcome benefits, including functional status, mortality and length of stay comparators. Future releases of the three-year evaluation will provide an assessment of these areas.

Clinical & Skills sustainability

10.24 The service demonstrates an ability to enhance staff recruitment into NHS Wales, and the potential for further expansion in this area. There is strong support from health board representatives and health care professionals for this aspect of the service.

10.25 To ensure this is realised in full, further work is required in a collaborative manner with health boards.

10.26 The service demonstrates a strong delivery of educational interventions, both opportunistic and structured, across various organisations. This programme of work appears to be going from strength to strength and will be vital for the long-term sustainability of the service.

Recommendations

10.27 With respect to the evaluation, as detailed in the methodology, there is a vast amount of data that is now becoming accessible to aid the ongoing evaluation work over the three-year period. Data sets including ICNARC, TARN, the EMRTS detailed clinical data and linked hospital, primary care and mortality data in SAIL will provide valuable insights and assessment against the measurable benefits register going forward. The benefit of this linkage, the most extensive that exists anywhere in the world, has the potential to be

used beyond the initial evaluation period. Services with the best outcomes, e.g. Victoria State Trauma Registry, are those that use data-driven continuous quality improvement methodologies. Consideration should be given to supporting such activities in the longer term. This would also benefit allied services including critical care and trauma networks and, hence, a collaborative approach should be considered.

10.28 It is important to recognise that the service forms part of a complex health care system which is in a state of flux with ongoing service changes. It is difficult to isolate some benefits solely as a result of this intervention.

10.29 Despite the service substantially improving equity overall, there remains residual inequity in the provision in the North West which should be addressed, with expansion in this area strongly considered.

10.30 With regards to expansion in terms of operational hours, there is a general perception that this would be desirable; however, more evidence is needed to firmly recommend this. Planned work in respect of investigating this, utilising additional datasets, is due to take place during the next stage of the evaluation.

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Appendices

Contents

A. Time Critical Transfer Activation Checklist

EMRTS TIME CRITICAL TRANSFER ACTIVATION CHECKLIST (use of every call)		
TICK	**CALL RECEIVED FOR POTENTIAL TIME CRITICAL TRANSFER BY ASD**	
	CCP at ASD immediately contacts Top Cover Consultant (TCC) to join conference call	
ACTIONS FOR CCP AT THE ASD (or TCC If CCP AT THE ASD BUSY)		
	Referrer name and grade Referring hospital and exact location Direct contact number	
	Patient name, DOB, Hospital number Approx. weight (kg) & height (ft/inches)	
	Provisional diagnosis & reason for transfer	
	Latest Obs (HR, RR, BP, SpO_2, GCS, pupils)	
	Brief past medical history (if appropriate)	
	Interventions and investigations so far	
	Receiving hospital and exact location Receiving consultant's name and specialty Direct contact number	
	Referring hospital planned handover site	
ACTIONS FOR 'TOP COVER'CONSULTANT		
	Check if 'YES' to all of the following: • Critically ill or injured and requiring level 2 or 3 care? • Time critical and requires intervention that can only be carried out at the receiving hospital OR not time critical but has a high risk of deterioration requiring care that is best carried out at the receiving hospital? • Referred and accepted by the receiving hospital?	
	If YES to above instruct CCP at ASD to allocate task to the most appropriate EMRTS team, with TCC in conference to troubleshoot any issues with transport platform. (BUT if *in extremis* appropriate team should be immediately deployed without patient being referred and accepted).	
	If NO (or undecided) further questions asked to determine decision and reasons given if declined: • Contact receiving centre to update.	
FURTHER ACTIONS FOR CCP AT THE ASD		
	Allocates most appropriate EMRTS team passing details given above as well as passing/establishing: • Job number • Weather issues • HLS site	
	Informs referring unit of ETA of EMRTS team by air or road and exact handover location. Receives update on patient condition.	
	Informs duty team of updated patient condition, and expands on history if appropriate.	
	Organises appropriate resources for secondary transfer at referring and receiving hospital(s) as appropriate.	
	Informs TCC if expedited immediate transfer (i.e. call gone direct to EMRTS team).	
	Record all information on EMRTS database and MIS Cad inc. any unattended calls.	
	Carry out actions as listed in Job Cycle section of ASD SOP.	
FURTHER ACTIONS FOR TCC		
	If aircraft unavailable, decide on most appropriate transport platform and take steps to activate it via CCP at the ASD.	
	Discuss any patient management issues with referring hospital prior to arrival of the EMRTS team.	
	Discuss patient management issues with receiving hospital (if appropriate).	
	Record all information on EMRTS database.	

B.Literature review summary

Literature Review Summary, June 2016.

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
Trauma Advanced Life Support vs Basic Life Support				
Jayaraman S, Sethi D, Wong R: Advanced Training in Trauma Life Support for Ambulance Crews. *The Cochrane Database of Systematic Reviews,* 2014.	I	Systematic review (level 2/3) to quantify the impact of Advanced Life Support (ALS) -trained ambulance crews versus crews without ALS training on reducing mortality and morbidity in trauma patients.	1 controlled before-and-after trial, 1 uncontrolled before-and-after study, 1 RCT. None demonstrated evidence to support ALS training for pre-hospital personnel. In the uncontrolled before and after study, sub-group analysis showed increase in mortality among patients who had a Glasgow Coma Scale <9 and received care from ALS trained ambulance crews. When the pre-hospital trauma score was taken into account the mortality in the patients receiving care from ALS trained crews increased significantly.	At this time, there is no rigorous evidence supporting and increased benefit of advanced life support training for ambulance crews. Large scale randomised controlled trials have ethical issues which are challenging to overcome. Significant advances in pre-hospital trauma care, including physician ECT models have been developed but not evaluated since the evidence in this review was published (1998, 2004, 2008 for three included papers).

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
Physician-led Enhance Care Team (ECT) vs Paramedic-led care				
Anaesthesia / Advanced Airway				
Gunning M, O'Loughlin E, Fletcher M, Crilly J, Hooper M, Elis D: Emergency Intubation: A prospective multicentre descriptive audit in an Australian helicopter emergency medical service. Emergency Medicine Journal, 2009.	III	Retrospective review of RSI by doctor/paramedic team (Care flight Medical Services, Queensland, Australia).	114 patients over a 9 month period, intubation success rate of 97%, 6 patients successfully intubated by doctor when paramedic failed.	Well-trained doctor paramedic teams, utilising standardised operating procedures can safely perform rapid sequence induction and intubation in the pre-hospital and emergency environment. Complication rates similar to in-hospital rates and other pre-hospital services.
Lossius H, Roislien J, Lockey D: Patient safety in emergency tracheal intubation: a comprehensive meta-analysis of the intubation success rates of EMS providers. Critical Care, 2012.	II	Meta-analysis. Patient safety in pre-hospital emergency tracheal intubation (ETI).	58 of 1070 studies met inclusion criteria. Median ETI success rates: Physician = 0.991; non-physician = 0.849. Weighted linear regression analysis demonstrated improved success rate in physicians 0.092 (p=0.0345); Three sub-categories (groups 1, 2, 3) of non-physician were identified based upon sophistication of drugs available for ETI. Median success rates were respectively 0.675, 0.810, 0.967. Significant difference existed between physician and the most sophisticated and best non-physician group 3 (muscle relaxant use) p=0.047.	Suggests consistent improvement in success rates of physician facilitated pre-hospital ETI when compared to all types of non-physician ETI.
Chester A, Keefe N, Mauger J, Lockey D: Prehospital anaesthesia performed in a	III	Retrospective cohort review of RSI by doctor-paramedic model rural and suburban environment	16 month period, 763 cases, 88 RSI's, no failed intubations, acceptable on scene times.	Demonstrated the successful introduction of a pre-hospital care RSI SOP, already tested in the urban trauma environment,

rural and suburban air ambulance service staffed by a physician and paramedic. Emergency Medicine Journal, 2014.		(already tested in urban environment).		to a rural and suburban air ambulance service operating a fulltime doctor – paramedic model.
Lockey D, Crewdson K, Weaver A, Davies G: Observational study of the success rates of intubation and failed intubation airway rescue techniques in 7256 attempted intubations of trauma patients by pre-hospital physicians. British Journal of Anaesthesia, 2014.	III	Retrospective analysis. Quantification of airway intervention and success with base specialty of training for pre-hospital physicians.	7256 of 28,939 (25.1%) trauma patients attended required advanced airway management. 46 (0.6%) required immediate surgical airway. Intubation successful in 7158 (99.53%). Rescue surgical airways in 42, with 100% success. Non-anaesthetist failed in 41 of 4394 (0.9%), anaesthetists file in 11 of 2587 (0.4%) p=0.02.	High intubation success rates exist, with non-anaesthetists more likely to require rescue airway techniques.
Andruszkow H, Hildebrnad F, Lefering R, Pape H-C, Hoffman R, Schweigkofler U: Ten years of helicopter emergency medical services in Germany: Do we still need the helicopter rescue in multiple traumatised patients? Injury, 2014.	III	Retrospective cohort study. Outcome of polytrauma patients in HEMS vs non-HEMS systems.	HEMS Injury Severity Score (ISS) 29.9, non-HEMS ISS 27.5 ($p<0.001$). Need for transfusion in hospital for HEMS 28.2% vs non-HEMS 18.5% ($p<0.001$). HEMS is independent predictor for survival after adjustment (OR 0.863).	HEMS patients were sicker, with more interventions performed on scene and greater need for transfusion. Multivariate logistic regression supports HEMS being an independent predictor for survival. Supports HEMS being preferred mode of attending, treating and transporting polytrauma patients.
Bossers S, Schwarte L, Loer S, Twisk J, Boer C, Schober P: Experience in prehospital endotracheal intubation significantly influences mortality of patients with severe traumatic brain injury: A systematic review and Meta-analysis. PLOS 1, 2015.	II	Systematic review and meta-analysis. Determination of effect of experience of intubating clinician upon outcome of patient.	733 studies were identified, 24 were included in the systematic review and 6 in the meta-analysis. Intubation by providers with limited experience was associated with increase in odds of mortality (OR 2.33, $p<0.001$); no evidence of higher mortality when intubation provided by experienced operators (OR 0.75, p=0.126). Meta-regression	Pre-hospital intubation by inexperienced (standard EMS) providers was associated with approximately a two-fold increase in the odds of mortality. Suggesting services with highly trained intubation personnel are preferable.

			confirmed experience is significant predictor of mortality (p=0.009).	
McQueen C, Crombie N, Hulme J, Cormack S, Hussain N, Ludwig F, Wheaton S. Pre-hospital anaesthesia performed by physician/critical care paramedic teams in a major trauma network in the UK. Emergency Medicine Journal, 2016.	III	Retrospective observational cohort analysis. Pre-hospital anaesthesia performed by physician/ critical care paramedic teams in the UK.	13.8% of MERIT attended incidents required rapid sequence induction of anaesthesia (RSI). 142 MERIT RSI procedures occurred, of which 1 failure of intubation (0.07%) occurred.	Rapid Sequence induction of anaesthesia in pre-hospital environment is relatively safe and has similar intubation success rates regardless of base specialty and seniority of operator provided adequate training and exposure is given, and standard operating procedures are followed.
Cardiac Arrest				
Chesters A, Harris T, Hodgetts T, Keefe N. Survival to discharge after cardiac arrest attended by a doctor-paramedic helicopter emergency medical service. Journal of Emergency Medicine, 2015.	III	Benchmarking retrospective cohort analysis. Survival to discharge after cardiac arrest by a doctor-paramedic helicopter emergency service. Multiservice review.	605 medical cardiac arrests (MCA) attended by pre-hospital ECT. 412 did not survive. 193 survived event, with 51 lost to follow up. 71 (11.7%) survived to discharge, 61 with cerebral performance category (CPC) 1 or 2; 9 with CPC 3 or 4, 1 with CPC 5. 30.6% Utstein comparator group survival rate.	Survival to discharge comparable to other physician based pre-hospital systems. Data may support physician ECT's attendance for those with return of spontaneous circulation (ROSC) to provide pre-hospital anaesthesia.
General				
Hyde P, Mackenzie R, Ng G, Reid C, Pearson G: Availability and utilisation of physician-based pre-hospital care to the NHS ambulance service in England, Wales and Northern Ireland. Emergency Medicine Journal, 2011.	V	Postal and telephone questionnaire to identify the current availability and utilisation of physician-based pre-hospital critical care across England, Wales and Northern Ireland	London only region with NHS funded 24hr physician led critical care availability. Apart from Wales and South West, all other regions have charity funded, physician led critical care services (either immediately or possible available).	Wide geographical variation in the availability of physician led pre-hospital critical care.

Vopelius Feldt JV, Wood, J, Benger J: Critical Care Paramedics: where is the evidence? A systematic review. Emergency Medicine Journal, 2013.	II/III	Systematic review to determine effectiveness of different clinical models of care. 12 papers, 1 Randomised Control Trial (level II), and 11 retrospective studies (level III)	CCP vs. Physician led service – 5 papers, 3/5 demonstrated improved outcomes with physician led service. 2 showed no difference. CCP vs. Standard paramedic service – 4 additional papers, 2 studies showed benefit, 1 equivocal and 1 no benefit (significant limitations). Additional CCP skills – 1 RCT showed benefit in head injuries.	Limited evidence to support the concept of critical care paramedic-delivered pre-hospital critical care. The only CCP trial showing benefit was with a procedure (Rapid Sequence Induction) that UK non-physicians cannot undertake. This further demonstrates that the doctor led model leads to improved outcomes in head injury.
Polytrauma				
Davis P, Rickards A, Ollerton J: Determining the composition and benefit of the pre-hospital medical response team in the conflict setting. Journal of the Royal Army Medical Corps, 2007.	II	Systematic review to determine composition and response of Pre-hospital Medical Emergency Response Teams (MERT) 15 articles (1 RCT – level 2)	1 RCT and several cohort studies support role of physicians with critical care skills in pre-hospital military setting.	Improved survival in victims of severe trauma when a doctor with critical care skills deployed with MERT.
Roudsari B, Nathens A, Cameron P *et al*: International comparison of prehospital trauma care systems. *Injury,* 2007.	III	International multicentre, retrospective review comparing trauma outcomes between physician operated EMS vs. technician operated EMS	Early trauma fatality rate was significantly lower in physician EMS systems compared with technician EMS systems (OR: 0.70, 95% CI: 0.54-0.91)	Findings suggest that pre-hospital trauma care systems that dispatch a physician to the scene may be associated with lower early trauma fatality rates, but not necessarily with significantly better outcomes on other clinical measures.

Botker M, Bakke S, Christensen E: A systematic review of controlled studies: do physicians increase survival with prehospital treatment. Scandinavian Journal of Trauma Resuscitation and Emergency Medicine, 2009.	II	Systematic review comparing survival with pre-hospital physician treatment vs. treatment by paramedic personnel in trauma and acute illness, 26 studies.	9/19 studies in trauma conferred a survival benefit of physician treatment compared to paramedic treatment 4/5 studies of cardiac arrest, physician treatment increased survival 2 unselected studies showed a survival benefit for acute myocardial infarction and respiratory distress.	Few controlled studies with varying quality, however a survival benefit seen most in trauma and cardiac arrest patients with physician treatment. 3 times more likely to survive if treated by a critical care doctor on scene.
Ringburg A, Thomas S, Steyerberg E, van Leishout E, Patka P, Schiper I: Lives saved by Helicopter Emergency Medical Services: An overview of literature. Air Medical Journal, 2009.	II/III	Systematic review give an overview of literature on the survival benefits of HEMS	16 studies met inclusion criteria (1 level II; 15 level III). All indicated that HEMS assistance contributed to increased survival. Between 1.1 and 12.1 additional survivors were recorded for every 100 HEMS uses. A combination of four reliable studies shows overall mortality reduction of 2.7 additional lives saved per 100 HEMS deployments, all used a doctors/paramedic model	Literature shows a clear positive effect on survival associated with HEMS assistance
Gomes E, Aruajo R, Carneiro A, Dias C, Costa-Pereira A, Lecky F: The importance of pre-trauma centre treatment of life-threatening events on the mortality of patients transferred with severe trauma. Resuscitation, 2010.	III	Retrospective registry review to determine survival in trauma by physician led pre-hospital care vs. in hospital care.	Mortality of Pre-hospital group 20% vs. 27% for first hospital group and 38% for trauma centre group. Patients whose life-threatening events were corrected only at the trauma centre had an odds of mortality 3.3 times greater than those from the pre-hospital intervention group.	In trauma patients requiring transfer to a trauma centre, pre-hospital interventions to treat life-threatening events may significantly decrease mortality when compared to similar interventions performed later at the trauma centre.

Yeguiayan J, Garrigue D, Binquet C, Jacquot C, Duranteau J, Martin C, Rayeh F, Riou B, Bonithon-Kopp C, Freysz M: Medical pre-hospital management reduces mortality in severe blunt trauma. Critical Care, 2011.	III	French prospective, multicentre cohort study comparing medical pre-hospital system (doctor + nurse) with non-medical (basic life support) pre-hospital management on 30-day mortality from trauma.	2703 patients included. After adjustment for clinical status and ISS, significant reduction in 30-day mortality (OR 0.55; p=0.03) in medical pre-hospital system compared to non-medical system.	This study suggests that medical pre-hospital management is associated reduced mortality in severe trauma.
Hesselfeldt R, Steinmetz J, Jans H, Jacobsson M-L, Andersen D, Buggeskov K, Kowalski M, Praest M, Ollgaard L, Hoiby P, Rasmussen L: Impact of a physician-staffed helicopter on a regional trauma system. Acta Anaesthesiologica Scandanavia, 2013.	III	Prospective, controlled observational study before and after introduction of physician-staffed HEMS.	1788 patients included. Demonstrated a decreased time to arrival at a trauma centre (218 to 90 minutes; p<0.01). Demonstrated in the severely injured a reduction in the number of secondary transfers required (50% to 34%; p=0.04), and reduction in 30 day mortality (29% to 14%; p=0.02).	Implementation of a physician based HEMS showed improvements in tie to trauma centre, mortality and secondary transfer required in the severely injured.
Apodaca A, Morrison J, Spott M, Lira J, Bailey J, Eastridge B, Mabry R: Improvements in the hemodynamic stability of combat casualties during en route care. Shock, 2013.	III	Retrospective performance evaluation examining the prehospital and admission shock index (SI) of three discreet forward aeromedical evacuation (FAME) platforms transporting casualties from the point of injury (POI) to a Role III MTF (equivalent to civilian level 2 trauma centre capability) in Helmand, Southern	No significant difference in mortality was demonstrated between groups. An improvement in the admission SI was observed across all platforms in the lowest ISS bin. Within the middle bin, both the MERT and PEDRO groups saw improved SI on admission, but not the DUSTOFF group. This trend was continued only in the MERT group for the highest ISS bin (1.39 T 0.62 vs. 1.09 T 0.42; P = 0.001), whereas a	Platforms with increased levels of clinical capability delivered significant hemodynamic improvements in patients upon admission to hospital. This extends work by authors demonstrating improved mortality in specific combat casualty sub-groups with improved clinical capability.

		Afghanistan, over a 2-year period (June 2009 to June 2011). MERT is a physician-led crew. PEDRO is a paramedic crew. DUSTOFF is emergency medical technician crewed.	deterioration was identified in the PEDRO group**.** The use of a Forward Evacuation platform with a greater clinical capability is associated with an improved hemodynamic status in critical casualties. The ideal prehospital triage should endeavour to match patient need with clinical capability.	
Morrison J, Oh J, DuBose J, O'Reilly D, Russell R, Blackborne L, Midwinter M, Rasmussen T: En-Route Care Capability From Point Of Injury Impacts Mortality After Severe Wartime Injury. Annals of Surgery, 2013.	III	Retrospective registry review comparing mortality by evacuation with Conventional Military Retrieval (CMR) methods vs evacuation with an Advanced Medical Retrieval (AMR) capability.	In the low injury severity score (ISS) cand the high ISS categories there was no difference in mortality between groups. However, in the mid-ISS bracket mortality was lower in the AMR group (12.2% vs. 18.2%; p=0.035). Time to operation was lower in both the mid (110 vs 117 min; p<0.001) and high (66 vs 113 min; p=0.013) ISS categories.	Conventional platforms are effective in most casualties with low injury severity. Much improved outcomes for severely injured patients (ISS >24) when treated by UK critical care Physician staffed system (MERT) compared to US special forces paramedics with extended skills. **The Welsh EMRTS model is based on the UK MERT model.**
Sherren PB, Hayes-Bradley C, Reid C, Burns B, Habig K. Emergency Medicine Journal, 2014.	III	Retrospective observational cohort analysis. Are physicians required during winch rescue missions in an Australian helicopter emergency medical service?	On-scene time for patient requiring POI 45 minutes vs 43 minutes for those not requiring POI (p=0.51). 48 of 120 patients required at least 1 POI (40%). POI were required by 38% (39 of 104) patients with normal revised trauma scores (RTS) and 78% (7 of 9), making them necessary in both groups but significantly more likely in those with high RTS (p=0.03).	Demonstrated requirement for physician only interventions (POI) in both severe and moderate trauma, with no difference between on-scene times when POI undertaken.
Hartog D, Romeo J, Ringburg A, Verhofstad M, Van Leishout E: Survival benefit of physician-staffed Helicopter Emergency Medical Services (HEMS) assistance for	III	Observational cohort study.	HEMS patients injury more severe with ISS 26 vs 22 for non-EMS (p<0.001). Crude mortality higher in HEMS (27% vs 21%, p=0.001). Adjusted odds ratio for survival with severely injured HEMS patients 1.501, with calculated average of	Supportive of physician-led HEMS services being beneficial for severely injured polytrauma patients.

severely injured patients. Injury, 2015.			5.33 additional lives saved per 100 HEMS dispatches.	
Funder KS, Rasmussen LS, Lohse N, Siersma V, Hesselfeldt R, Steinmetz J: Long-term follow-up of trauma patients before and after implementation of a physician-staffed helicopter. Injury, 2016.	III	Prospective observational cohort analysis. Long-term follow up of trauma patients before and after implementation of a physician-staffed helicopter. Using ability to work and social security payment dependence.	Statistically significant: 32% reduction in risk of receiving social security payments for more that 50% of time (3 years) after trauma (odds ration 0.68; p=0.03). Not statistically significant: 28% reduction in involuntary early retirement (HR 0.79; p=0.43), 22% reduction in reduced work ability (OR 0.78; p=0.20). Long term mortality reduction HR 0.92, p=0.66.	Support for physician model reducing societal burden over all. Also recognition that increased survival from improved services (e.g. physician models) may contribute to the societal burden present (i.e. supports Stoccheti's Hypothesis).
De Jongh M, van Stel H, Schrijvers A, Leenen L, Verhofstad M. The effect of Helicopter Emergency Medical Services on trauma patient mortality in the Netherlands. Injury, 2012.	III	Retrospective cohort study of HEMS (doctor/nurse service) on trauma mortality and the effect of pre-hospital time on the association between HEMS and mortality. Carried out in the Netherlands	The risk of in-hospital mortality was non-significantly higher for patients with TBI (traumatic brain injury) in the HEMS/EMS group (OR = 1.3; 95% CI 0.6–2.7; NNT: -15) compared to the EMS-only group and non-significantly lower for patients without TBI (OR = 0.9; 95% CI 0.3–2.5; NNT: 129). The authors attribute the increased risk of mortality in TBI patients to the increased pre-hospital time.	No demonstrable significant benefit or disadvantage of HEMS identified.
Traumatic Brain Injury				
Pakkenen T, Virkkunen I, Kamarainen A, Huhtala H, Silfvast T, Virta J, Randell T, Yli-Hankala A. Scandanavian Jounal of Trauma, Resuscitation and Emergency Medicine, 2016.	III	Retrospective observational cohort analysis. Pre-Hospital severe traumatic brain injury – comparison of outcome in paramedic versus physician staffed emergency medical services.	Standard Emergency Medical Services (EMS) vs Physician EMS (ph-EMS). Longer total mission times for ph-EMS (54 minutes EMS vs 72 minutes ph-EMS; p<0.001); Advanced airway management performed more by ph-EMS (98% vs 16% in EMS; p<0.001); Hypoxia on arrival to ED less common with ph-EMS (1% vs 10% in EMS; OR 10.05, p<0.001); Lower one-year mortality in ph-EMS (42% vs 57% in	Suggestive of outcome benefit for traumatic brain injury patients when treated by physician staffed pre-hospital teams with advanced airway skills. May support Stoccheti's Hypothesis.

			EMS; OR 1.86, p=0.001); Neurological outcome after adjustment for age more likely to be favourable in ph-EMS 38% vs 32% in EMS; OR 1.05, p<0.001).	

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
Blood Product Administration				
Weaver A, Eshelby S, Norton J, Lockey D: The introduction of on-scene blood transfusion in a civilian physician-led pre-hospital trauma service. Scandanavian Journal of Trauma Resuscitation and Emergency Medicine, 2013.	IV	Prospective case series study examining impact of pre-hospital transfusion on severe trauma patients.	Improved rate of return of spontaneous circulation (ROSC) in traumatic cardiac arrest, no demonstrated survival benefit.	Pre-hospital blood product transfusion is safe and compliant with UK legislation.

O'Reilly D, Morrison J, Jansen J, Apodaca A, Rasmussen T, Midwinter M: Prehospital blood transfusion in the en route management of severe combat trauma: A matched cohort study. Journal of Trauma and Acute Care Surgery, 2014.	III	Retrospective cohort study. Military only.	97 patients were paired (blood product vs no blood product). Mortality of blood product patients was less than half (8.2% vs 19.6%; p<0.001). Confounding interventions also occurred in the blood product group (more interventions, faster transit time, lower heart rate on admission).	In the military setting this is supportive of pre-hospital blood transfusion in severely injured patients as part of a package on interventions, but not determinant that blood product alone improves outcome.
Weaver A, Hunter-Dunn C, Lyon RM, Lockey D, Krogh CL: The effectiveness of a "Code Red" transfusion request policy initiated by pre-hospital physicians. Injury, 2015.	III	Prospective single centre cohort study.	176 declared "Code Red" (in need of blood product) patients; Mean Injury Severity Score (ISS) 29.1; Data for 126 available; 115 (91%) received transfusion, 11 (9%) did not; Mean packed Red Cell transfusion in first 24 hours 10.4 units. Using three pre-hospital clinical criteria demonstrated good accuracy in prediction of patients requiring transfusion (suspicion or evidence of active haemorrhage; systolic blood pressure <90mmHg; failure of BP to respond to intravenous fluid bolus).	Use of simple pre-hospital criteria by physicians is a good predictor of severe injury and requirement for blood transfusion. TRAIGE: It is both safe, accurate and time saving for physician pre-hospital service to provide early identification of requirement for blood on arrival to hospital.
Holcomb J, Donathan D, Cotton B: Prehospital transfusion of plasma and red blood cells in trauma patients. Journal of Emergency Medicine, 2015.	III	Abstract.	Pre-hospital transfusion was associated with improved acid-base status, decreased use of blood product in first 24 hours, decreased rates of bleeding (16% vs 23%, p=0.04) and decreased 6-hour mortality in the most seriously injured (OR 0.23, p=0.08). No difference in 24 hour or 30 day mortality. 1.9% wastage of blood product (expired).	Pre-hospital transfusion associated with improved physiological status and early mortality, but no demonstrable benefit in overall mortality. Supportive of low blood product wastage.
Smith I, James R, Dretzke J, Midwinter M: Pre-hospital	III	Systematic review. 27 cases included, of which 16	No prospective comparative or randomised studies identified. No	Pre-hospital blood administration appears logical, however evidence to date is poor

blood product resuscitation for trauma: A Systematic review. Shock, 2016.		were case series and 11 comparative studies (1 case control, 10 retrospective cohort). Of these, 9 were military and 18 civilian. Assessed evidence was generally very low quality.	association between pre-hospital blood administration and survival identified.	quality and has not demonstrated significant outcome benefits. Higher level randomised controlled trial evidence is awaited.

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
24 hour / night time enhanced care team (ECT) service				
McQueen C, Nutbeam T, Crombie N, Lecky F, Lawrence T, Hathaway K, Wheaton S: Enhanced care team response to incidents involving major trauma at night: Are helicopters the answer. Injury, 2015.	III	Retrospective cohort study	603 major trauma incidents during night time hours, with enhanced care team (ECT) attendance at 167 (27.7%). 36 (6%) with distance >45 minutes road transport; 13 of which (2.2%) had on-scene ECT requirements which ambulance personnel alone could not address.	Limited evidence supporting airborne (helicopter) ECT (cost/ risk/ outcome stratification) at night in West Midlands, where incidents requiring ECT's are primarily urban in location. Other geographical areas require individual analysis.
Lyon R, Vernon J, McWhirter E, Nelson M, Durge N, Tunnicliff M, Curtis L, Russell M: The need for a UK	V	Prospective simulation study. The need for a UK Helicopter Emergency Service by night. Study to determine and quantify	Total Calls received = 17565 Prospective tasking: 145 deemed appropriate, mean activation rate (MAR) = 1.2/night.	Positive recommendation for trail of night HEMS service for Kent, Surrey and Sussex Air Ambulance Service based on requirement for popuation.

Helicopter Emergency Medical Service by night: A Prospective Simulation Study. Air Medical Journal, 2015.		requirement for night time HEMS trauma response.	Subsequent analysis by 5 independent clinicians produced MAR of 0.6 to 1.0. Retrospective analysis: 208 of 17565 calls identified as potential for HEMS. 72 of the 208 (35%) were classified as definite or likely activations by 4/5 judges (MAR = 0.6 per night), 194 (93%) were classified as definite, likely or possible by 5/5 judges (MAR = 1.2 per night).	
McQueen C, Apps R, Mason F, Crombie N, Hulme J: 'Interception': A model for specialist pre-hospital care provision where helicopters are not available. Emergency Medicine Journal, 2013.	IV	Case review documenting example of 'interception' model.	Successful 'interception' of EMS team and patient en route to major trauma centre, and provision of emergency airway protection.	Use of centralised hub for communication, identification of time critical requirement for definitive care in isolated severe head injury, where pre-hospital intervention (RSI) has been shown to benefit.

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
Paediatric Enhanced Care Teams				
Tarpgaard M, Hansen T, Rognas L: Anaesthetist-provided pre-hospital advanced airway management in children: a descriptive study. Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine, 2015.	V	Descriptive.	24 of 25 children successfully intubated (96%); first pass success rate 75%; first pass success rate in under two's 54%. 20% total complication rate, 38% complication rate in under two's.	Intubation rate is comparable to adult pre-hospital services, however paediatric airway challenges are considerable even for experienced airway practitioners.
Brown J, Leeper C, Sperry J, Pietzman A, Billar T, Gaines B, Gestring M: Helicopters and injured kids: Improved survival with scene air medical transport in the pediatric trauma population. Journal of Trauma and Acute Care Surgery, 2016.	III	Retrospective matched cohort analysis. Outcome differences in paediatric trauma patients between Helicopter Emergency Medical Services (HEMS) and Ground Emergency Medical Services (GEMS).	25,700 matched pairs from 166,595 patients in USA from 2007 to 2012. 72% increase in odds of survival when using HEMS vs GEMS (adjusted OR 1.72, $p=0.001$) after controlling for in-hospital confounders. Mortality in first 24 hours greater with GEMS ($p<0.01$), but worse in HEMS from 24 to 48 hours with no difference thereafter.	Marked survival advantage demonstrated in paediatric trauma patients transported by HEMS, however underlying mechanism remains unclear. Number needed to treat = 41. Temporal survival differences require further investigation.

Reference	Level of Evidence	Type of study / aim	Key Results	Conclusions
Pre-hospital Ultrasound				
Canadian Agency for Drugs and Technologies in Health. Portable ultrasound devise in the prehospital setting: A review of Clinical and Cost-Effectiveness and Guidelines. 2015.	V	Descriptive review article.	Limited volume of low quality evidence exists suggesting pre-hospital ultrasound may improve patient care and management decisions. No economical evidence or evidence based usage guidelines were identified.	Whilst it is logical that portable ultrasound may assist with diagnosis and some interventions in the pre-hospital setting there is little evidence currently to back this up.
O'Dochartaigh D, Douma M. Prehospital ultrasound of the abdomen and thorax changes trauma patient management: A systematic review. Injury, 2015.	II	Systematic review of pre-hospital ultrasound (PHUS) usage in trauma patients.	PRIMARY OBJECTIVE: Does PHUS change trauma management. 992 citations, 8 met inclusion criteria (925 patients). No randomised controlled trials. 3 studies with 2+ rating by Scottish intercollegiate Guidelines Network (SIGN), each of which demonstrated changes in patient management.	Moderate evidence supporting use of PHUS now exists. PHUS can assist in determining whether certain invasive procedures are/are not required, whether resuscitation should be continued/stopped, and which destination is the most appropriate for certain patients.

Reference	Level of	Type of study / aim	Key Results	Conclusions

	Evidence			
Safety, Economics & Structure of Helicopter Emergency Medical Services / Enhance Care Teams				
Ringburg A, Polinder S, Meulman T, Steyerberg E, van Leishout E, Patka P, van Beeck E, Schipper I: Cost-effectiveness and quality-of-life analysis of physician-staffed helicopter emergency medical services. British Journal of Surgery, 2009.	III	Prospective cohort study to investigate the cost-effectiveness of physician staffed HEMS vs standard emergency medical services (EMS) in the Netherlands.	Over 4-year study interval, HEMS assistance saved a total of 29 additional Lives. No statistically significant differences in quality of life were found between HEMS and EMS groups. Incremental cost-effectiveness ration in favour of HEMS €28,327 EUR. Sensitivity analysis gave a cost-effectiveness ratio in favour of HEMS between €16,000 and €62,000 EUR.	The cost of HEMS per QALY remained below the acceptance threshold and was therefore considered to be cost effective.
Littlewood N, Parker A, Hearns S, Corfield A: The UK helicopter ambulance tasking study. Injury, 2010.	V	Telephone questionnaire to establish and compare the tasking criteria, dispatch arrangements and crew configuration for all helicopter ambulance services in the UK	Replies submitted by all 16 UK air ambulance services. Crew configuration varies between services. 9 services had paramedic only crew, 3 had physician/paramedic crew and 4 had a paramedic crew with variable physician input. Only 2 of the 16 services used a paramedic in the dispatch process. There were 67 different tasking criteria used for air ambulance dispatch across all air ambulances.	Given the financial burden and physical risk of air ambulance use, the authors recommendation is for a more standardised approach to HEMS tasking, dispatch and crew configuration across the UK.

Boyle J, Whyte R, Dickson E, Godden D, Heaney D, Munro D. Evaluation of the Emergency Medical Retrieval Service. Scottish Government Social Research, 2010.	V	Executive Report detailing economics, safety, structural, activity and outcome information about the Scottish Emergency Medical Retrieval Service (EMRS).	n/a	Detailed report covering rationale and performance of Scottish EMRS.
Hyde P. South Central Strategic Health Authority 2010	V	Pre-hospital critical care pilot project.	3 months in Hampshire, physician led, supported by paramedics. 27% discharged at scene, estimated annual saving to ambulance service of £260,000 & ED's of £125,000. 38% of patients were transferred directly to a specialist centre with no patient requiring secondary transfer. For trauma & medical patients, median reduction of 2 ICU days, total of £167,328 savings during pilot and estimated annual saving of £3.2m in Hampshire alone.	Physician led pre-hospital care might offer significant wider economic benefits for health care services.
Taylor C, Jan S, Curtis K, Tzannes A, Li Q, Palmer C, Dickson C, Myburgh J: The cost-effectiveness of physician staffed Helicopter Emergency Medical Service (HEMS) transport to a major trauma centre in NSW, Australia. Injury, 2012.	IV	Economic estimation of benefits of HEMS intervention and transportation direct to major trauma centre compared to ground transport or indirect transport to a referral hospital.	Adjusted probability of in-hospital survival in HEMS higher than non-HEMS ($p<0.05$); Odds of in-hospital death of non-HEMS 3.0 to 3.8 times more than HEMS (all patients 3.8, p=0.0003; serious injury 3.0, p=0.0031; traumatic brain injury 3.2, p=0.0173). Cost per life saved by HEMS: all patients $1,566,379AUD; serious injury $533,781AUD; traumatic brain injury $519,787AUD. Cost per life year saved by HEMS: all patients $96,524AUD; serious injury	HEMS are a high cost-per-mission resource, however HEMS intervention combined with treatment at a major trauma centre confers an improved survival rate which translates into a significant economic benefit for both cost per life saved and cost per life year saved. Estimated economic benefit of HEMS improves with increasing severity of injury. Transferability of this model to UK and Welsh populations and NHS services is unclear at this stage.

			$50,035, traumatic brain injury $49,159AUD.	
Gabbe B, Lyons R, Fitzgerald M, Judson R, Richardson J, Cameron P: Reduced population burden of road transport-related major trauma after introduction of an inclusive trauma system. Annals of Surgery, 2015.	III	10 year retrospective review of trauma registry data analysing trauma outcomes after the introduction of an integrated regionalised trauma system (including pre-hospital care).	Incidence of road transport-related mortality decreased, whereas incidence of hospitalised major trauma increased. Years of life lost decreased by 43%; Years lived with disability increased by 32%; Overall 28% reduction in disability adjusted life years over the time period. There was also cost saving per case of A$633,446.	Improved survival from major trauma does not necessarily equate to increased burden of disease. The impact of aggressive pre-hospital care in this study is difficult to isolate.
Chesters A, Grieve P, Hodgetts T: A 26-year comparative review of United Kingdom Helicopter Emergency Medical Services crashes and serious incidents. Journal of Trauma and Acute Care Surgery, 2014.	IV	Comparative study over 26 years (1987-2013) looking at differences in safety between UK and other established HEMS services.	Incident rates per 10,000 mission: UK 0. 57; Australia 0.6; Germany 0.57; USA 0.75. Fatal incident rate per 10,000: UK 0.04; Australia 0.2; Germany 0.11; USA 0.23.	Comparable or better safety record in UK demonstrating good comparative standard of safety governance.
Hirsch M, Carli P, Nizard R, et al.: The medical response to multisite terrorist attacks in Paris. Lancet, 2015.	n/a	Descriptive article detailing pre-hospital and hospital response to Paris terrorist attacks in November 2015.	Application of military strategy and logistics to a civilian setting.	Demonstrates necessity and usefulness of detailed logistical structures, planning and escalation models for coping with high levels of unplanned injuries.

Rehn M, Davies G, Smith P, Lockey D: The structure of Rapid Response Car Operations in an Urban Trauma Service. Air Medical Journal, 2016.	n/a	Descriptive article detailing London HEMS Rapid Response Car service.	Implementation of principles from motorsports used. 2,241 activations over a one year period with no serious incidents.	Thoroughly planned service and logistics resulted in safe and effective service.

C. Health Board Specific results

This appendix disaggregates data from the all Wales data presented in the main results section. Where applicable, tabular and graphical representation of data is presented for each health board. A summary of the expected results are provided below for ease of reference. For certain analysis such as length of stay, this data is excluded pending further information governance review process, with the intension of inclusion in future reports.

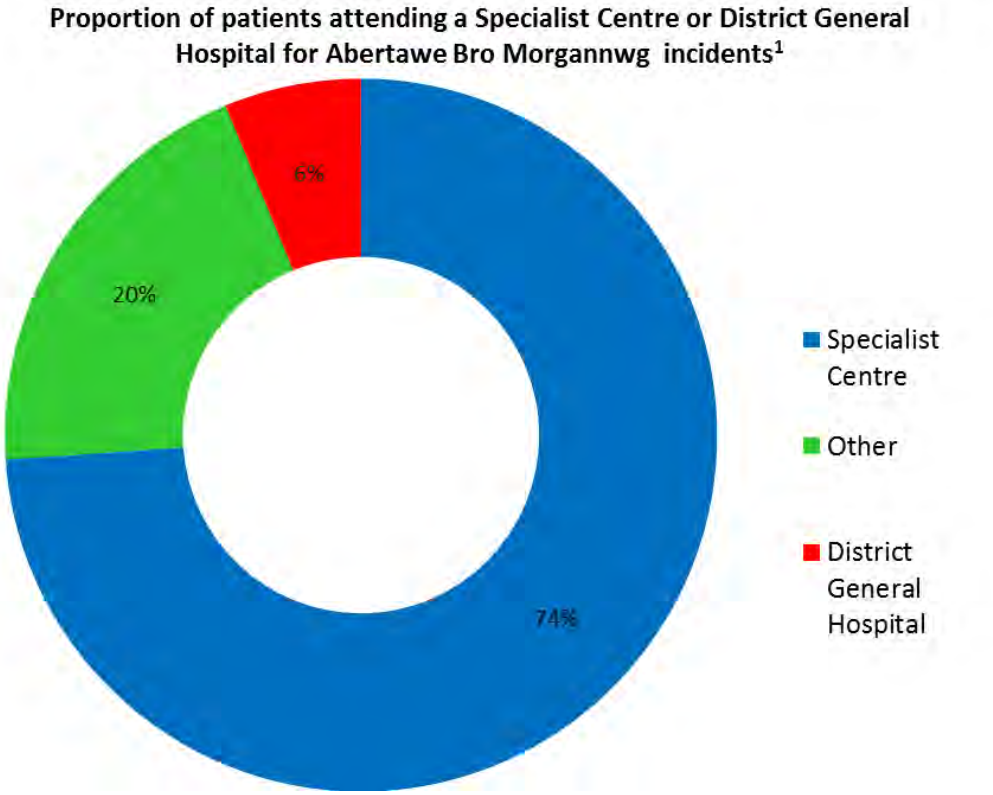
The following information is presented by health board

- Proportion of patients attending specialist care
- Critical Care interventions
- Sankey Diagrams
- Maps

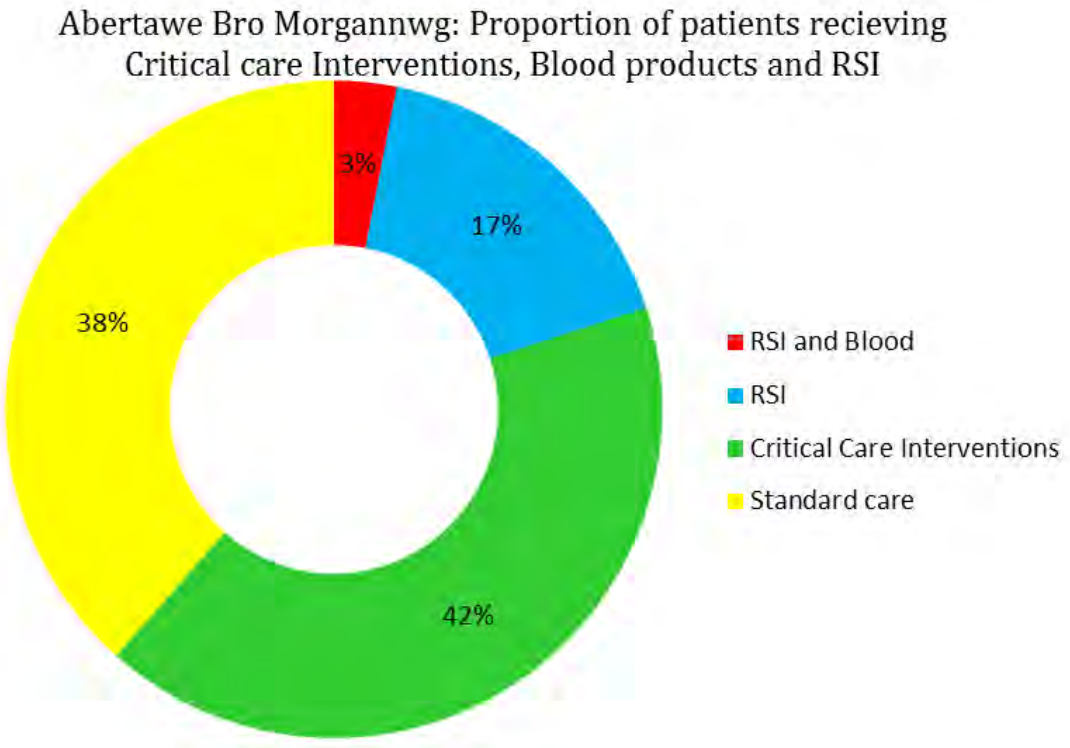
For ease of reference, the following are presented in a combined table of a all health boards:

- Mission Timings

Abertawe Bro Morgannwg



[1]87.5% of other have an EMRTS stop code for died at scene, other or alternative pathway



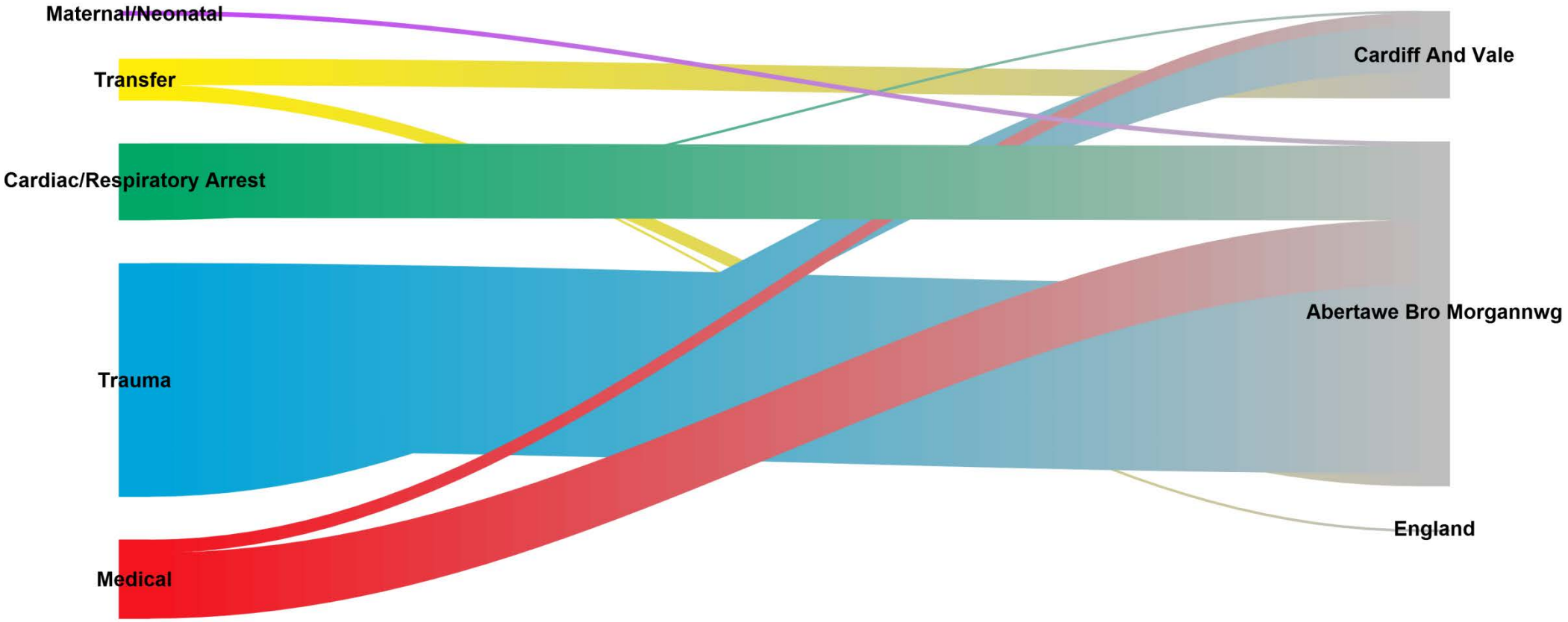
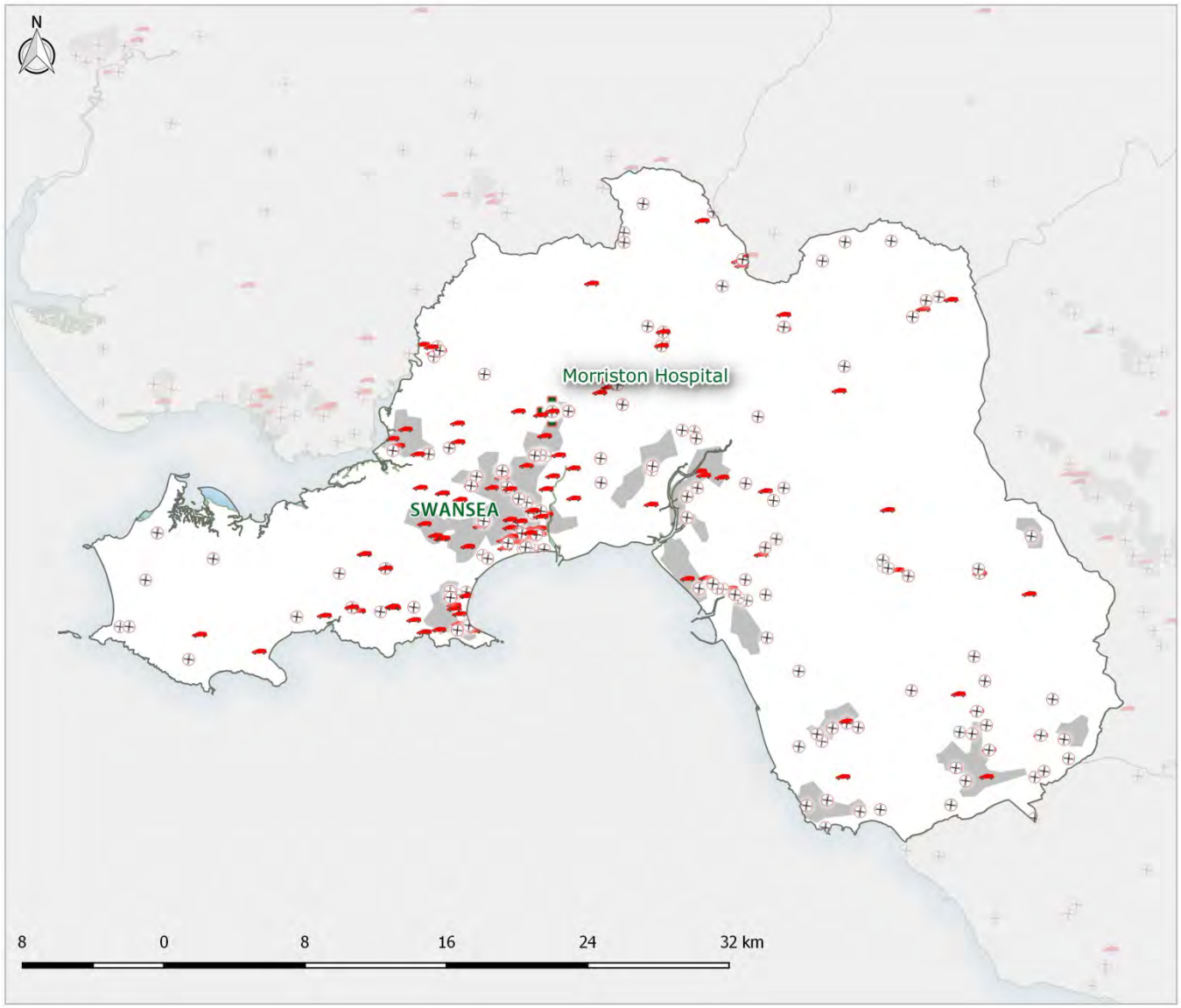


Figure 1 Abertawe Bro Morgannwg Health board incident data by patient group and Health board of hospital destination

Figure 2 Abertawe Bro Morgannwg hospital activity by patient group and Health Board of incident



Abertawe Bro Morgannwg University Health Board EMRTS Incidents Attended - 15/16

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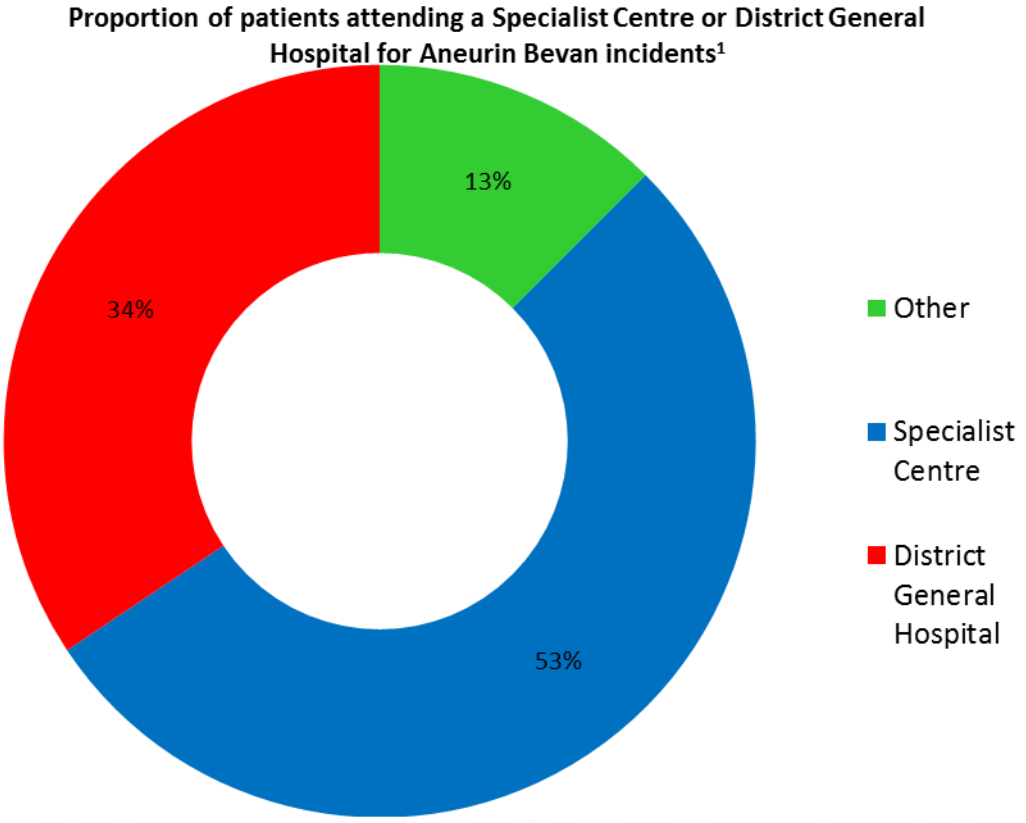
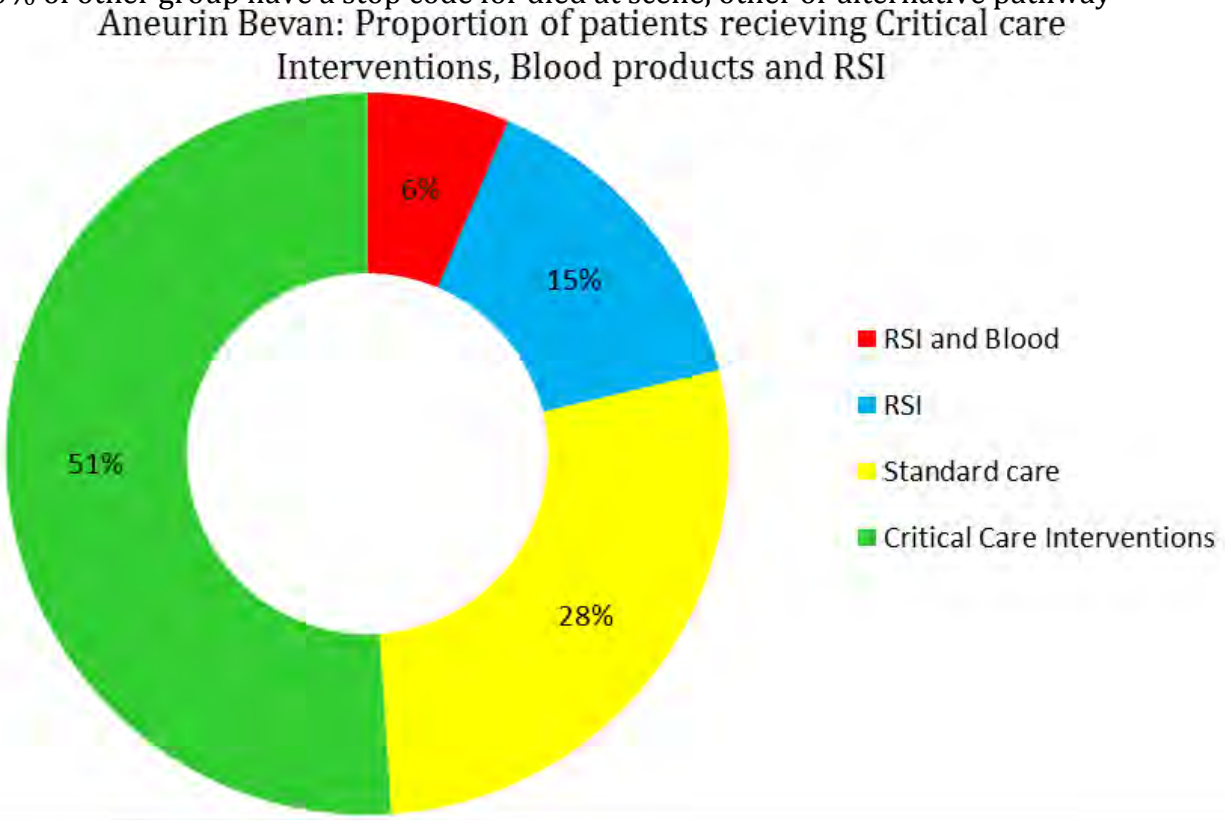
Aneurin Bevan



[1]100% of other group have a stop code for died at scene, other or alternative pathway



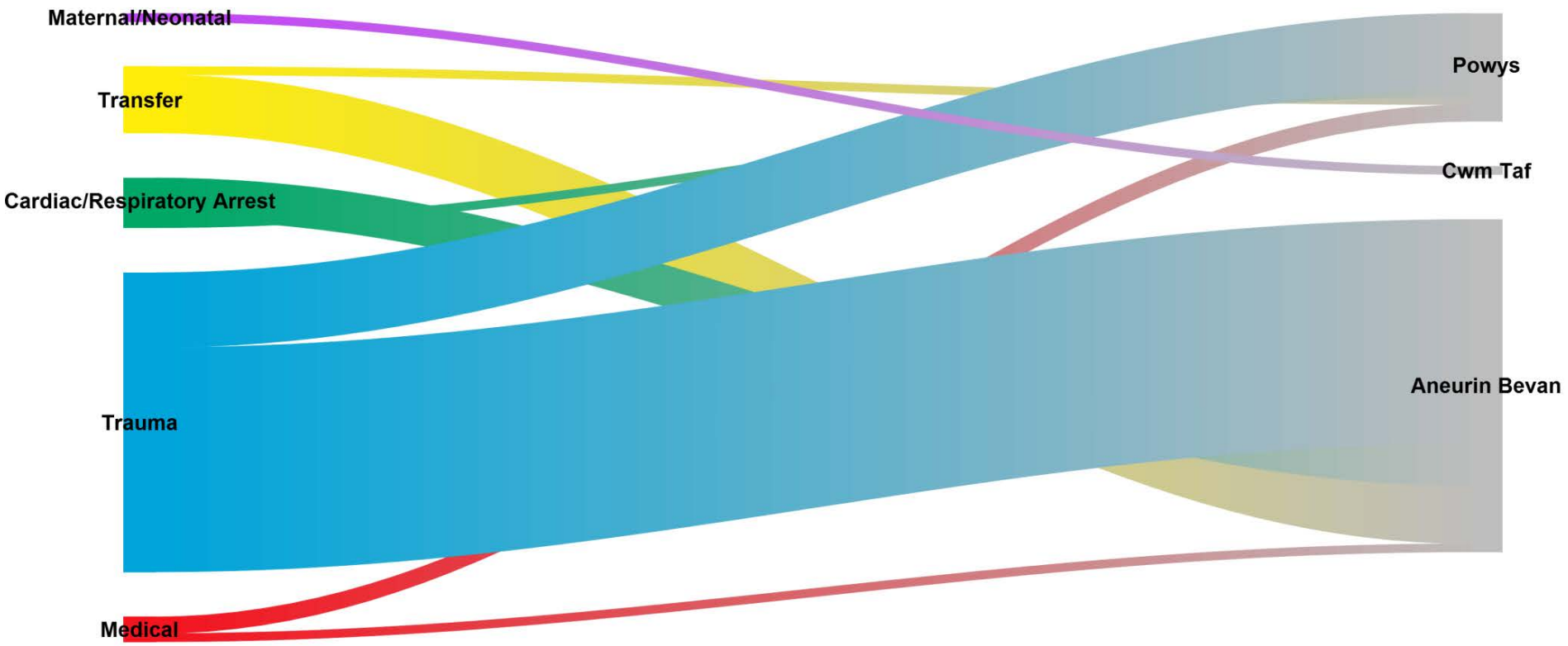
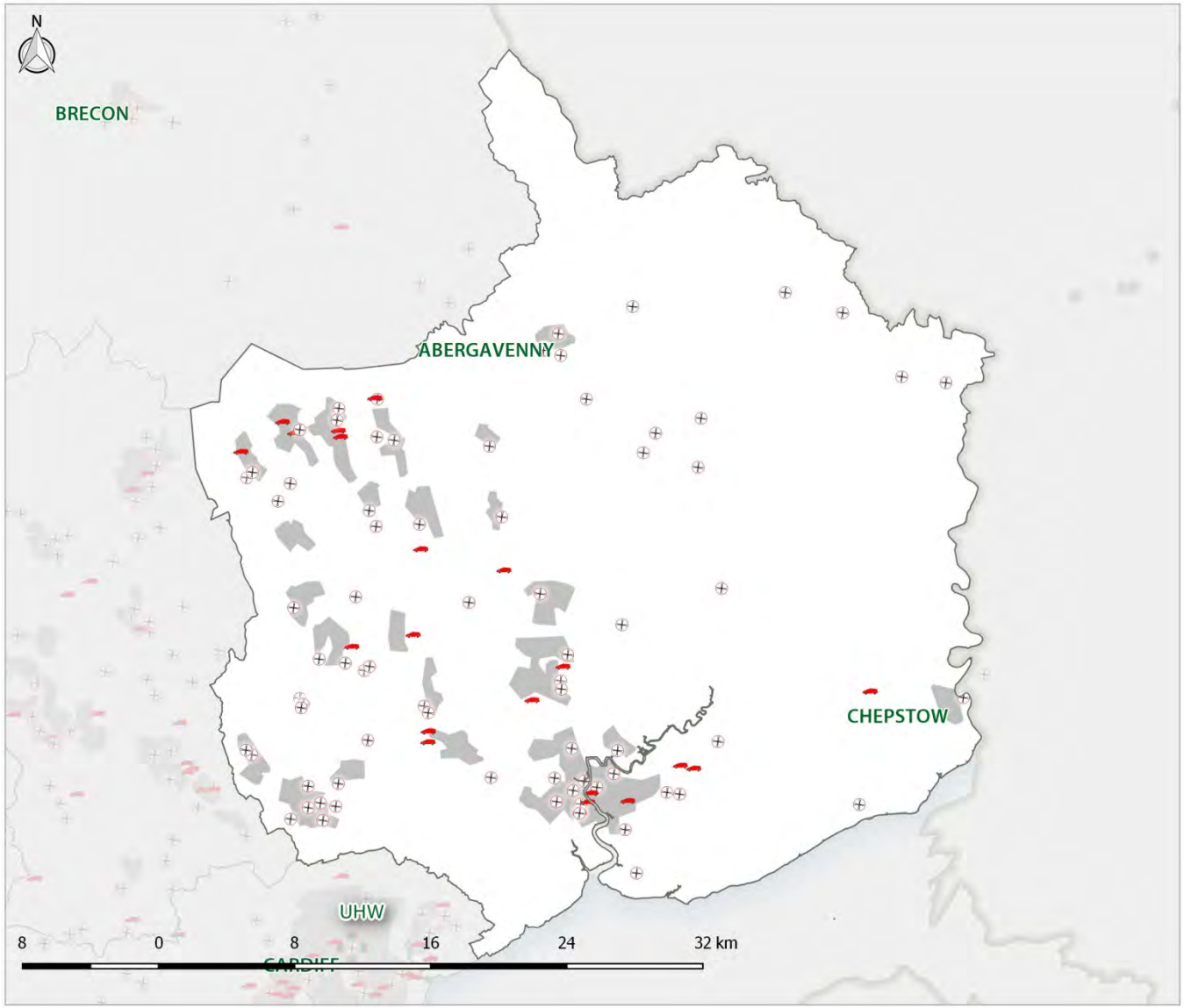


Figure 3 Aneurin Bevan Health board incident data by patient group and Health board of hospital destination

Figure 4 Aneurin Bevan hospital activity by patient group and Health Board of incident



Aneurin Bevan University Health Board EMRTS Incidents Attended - 15/16

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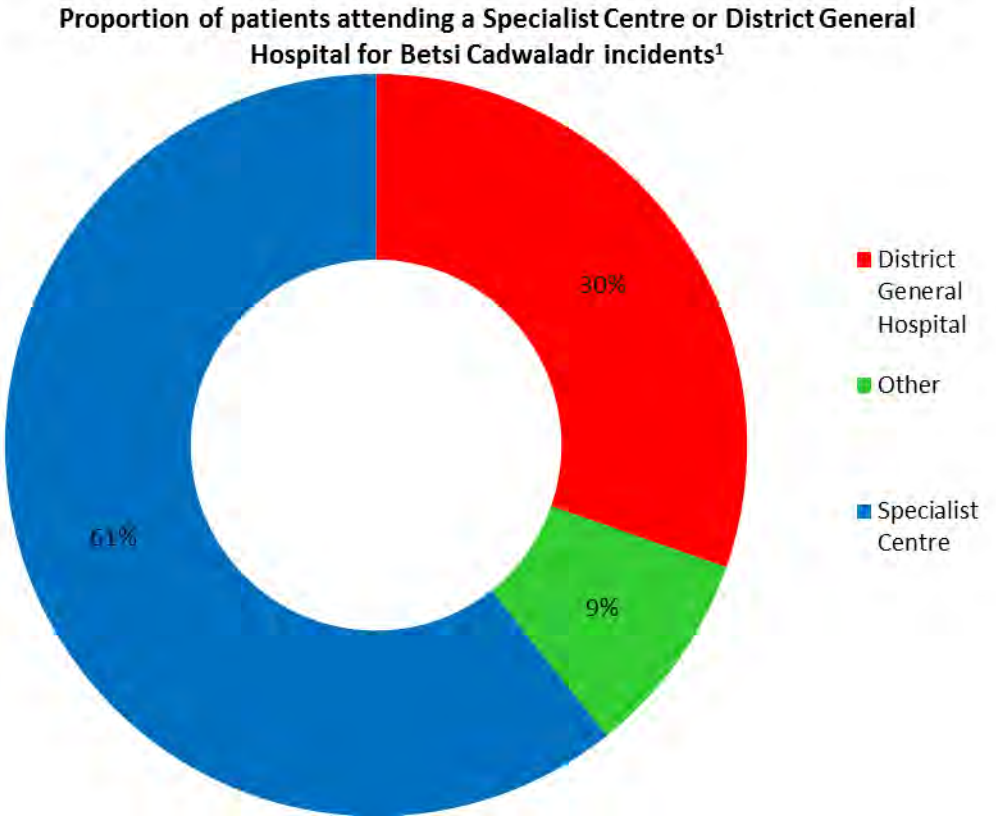
Betsi Cadwaladr



[1]50% of other group have a stop code for died at scene, other or alternative pathway

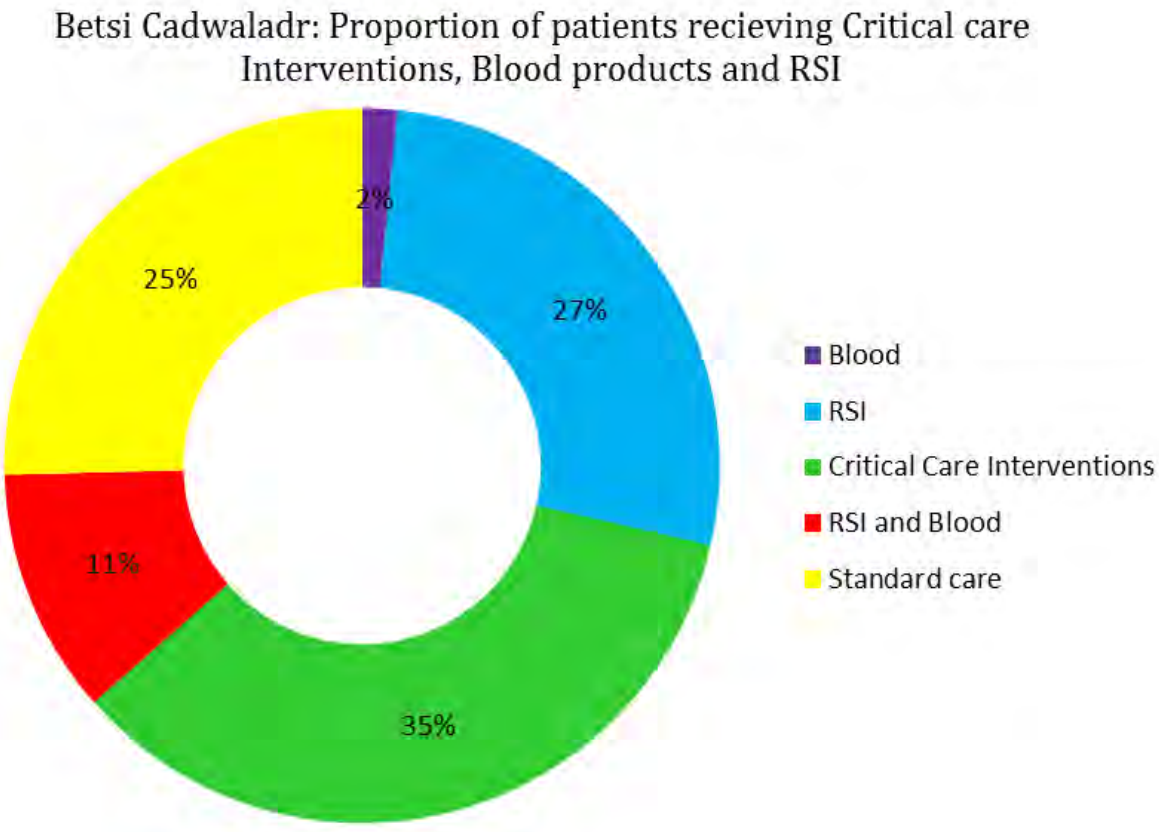
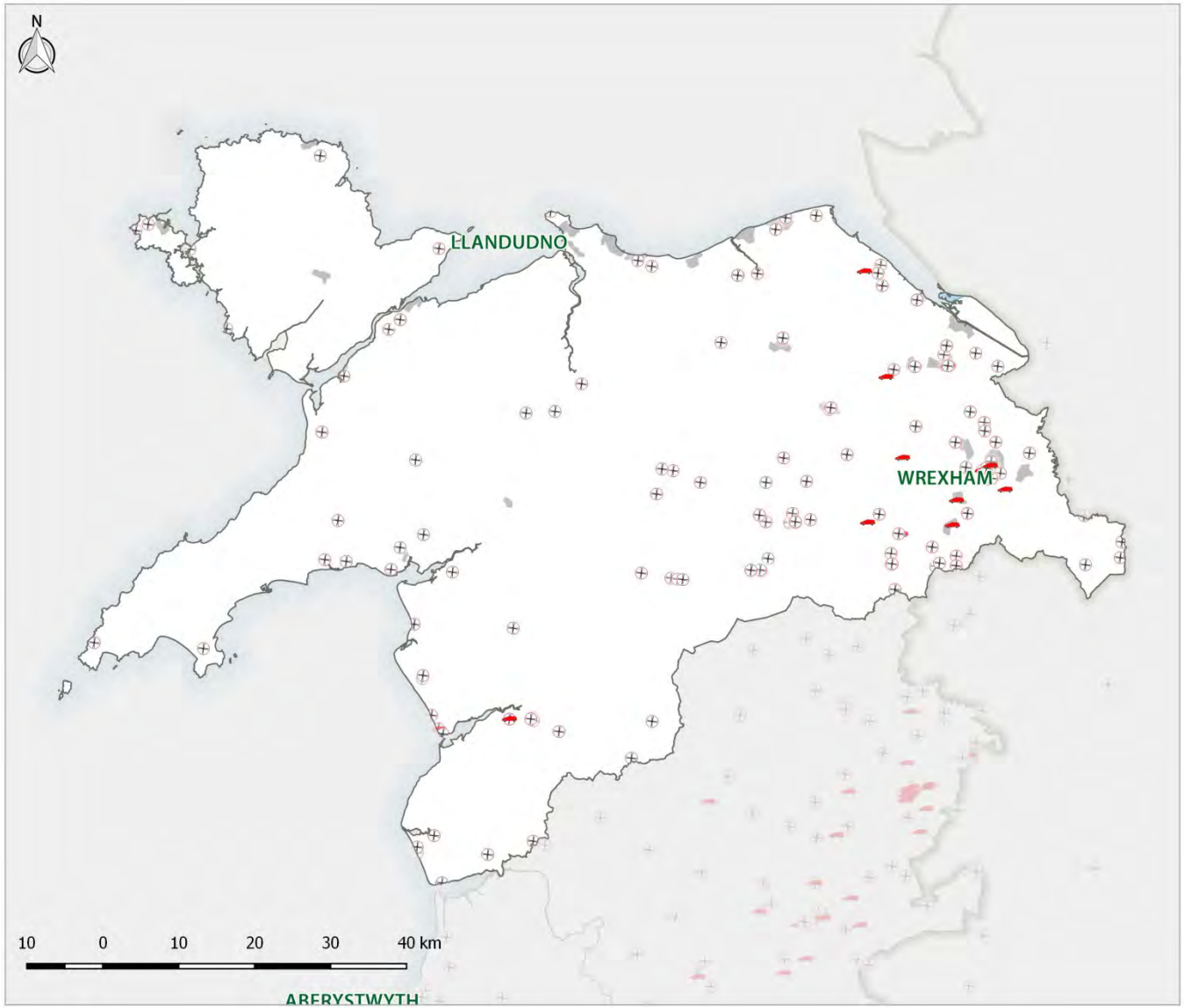


Figure 5 Betsi Cadwaladr Health board incident data by patient group and Health board of hospital destination

Figure 6 Betsi Cadwaladr hospital activity by patient group and Health Board of incident



Betsi Cadwaladr University Health Board EMRTS Incidents Attended - 15/16

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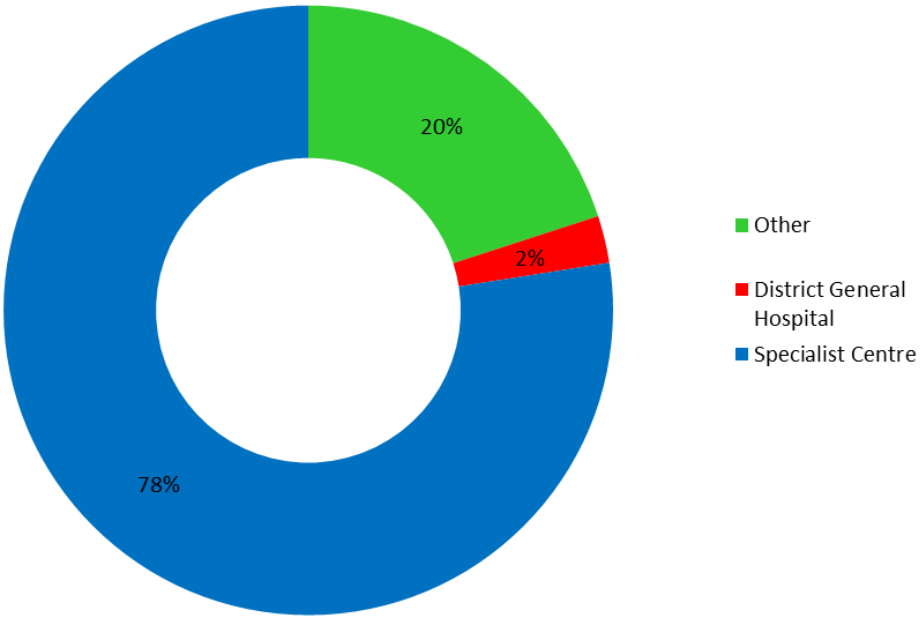
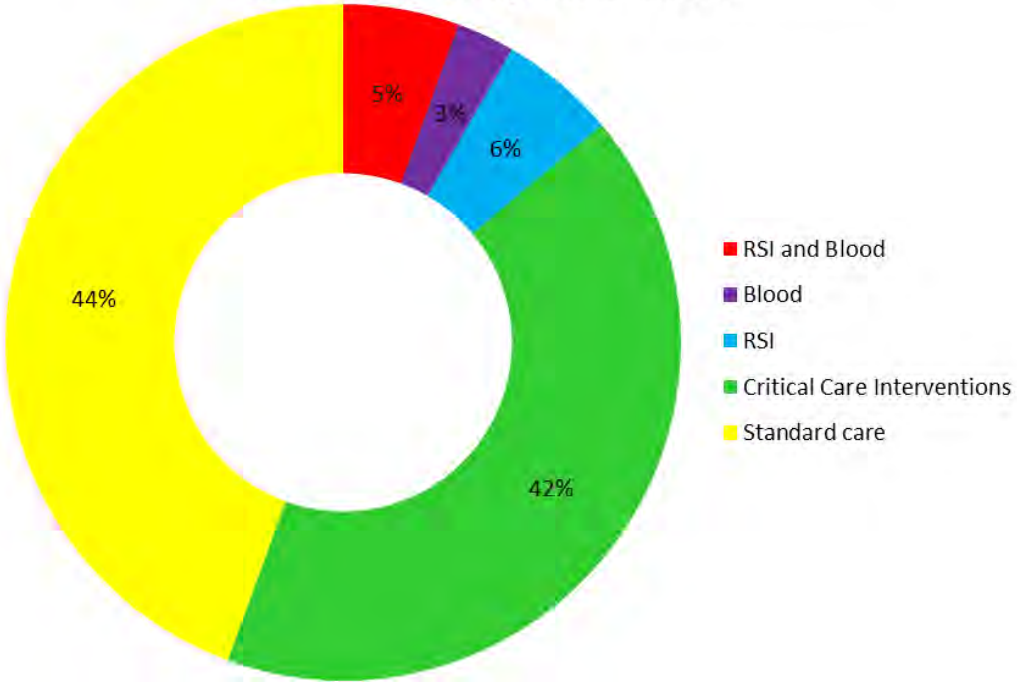
Cardiff and Vale

Proportion of patients attending a Specialist Centre or District General Hospital for Cardiff and Vale incidents[1]



[1]75% of other group have a stop code for died at scene, other or alternative pathway

Cardiff and Vale: Proportion of patients recieving Critical care Interventions, Blood products and RSI



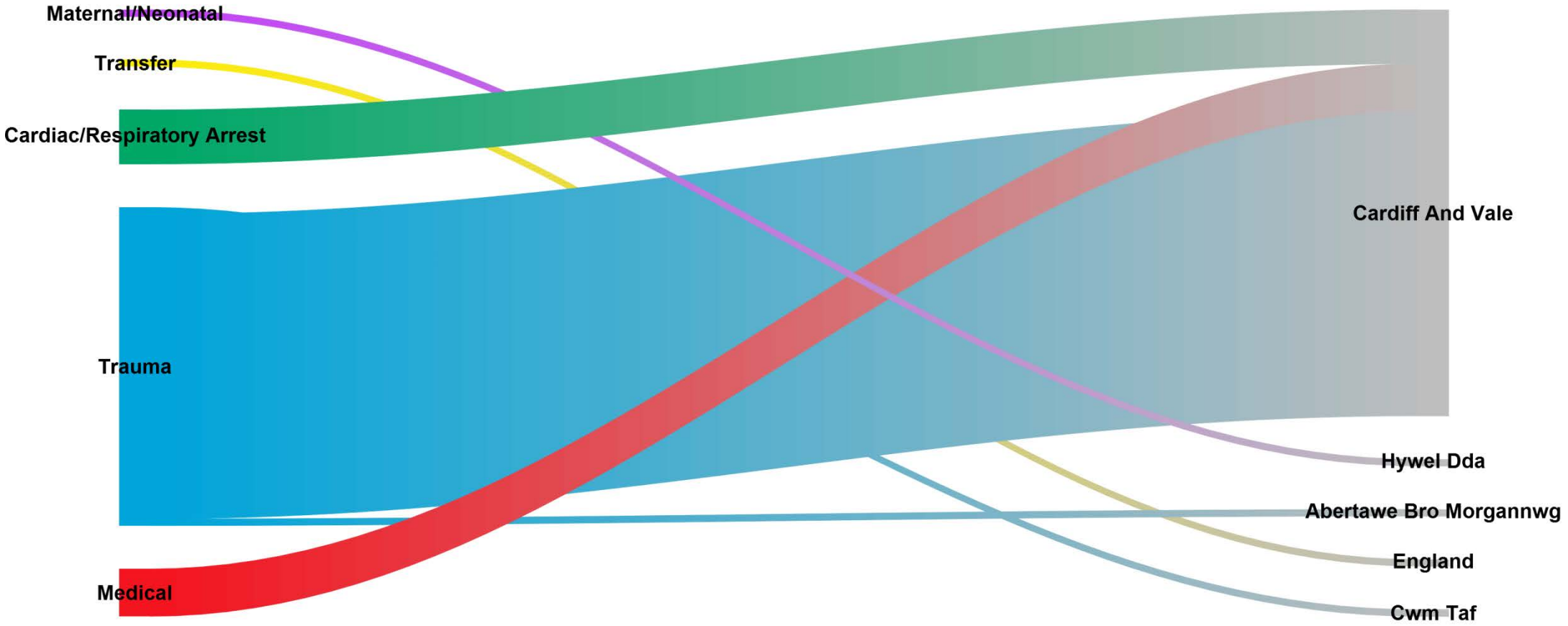


Figure 7 Cardiff and Vale Health board incident data by patient group and Health board of hospital destination

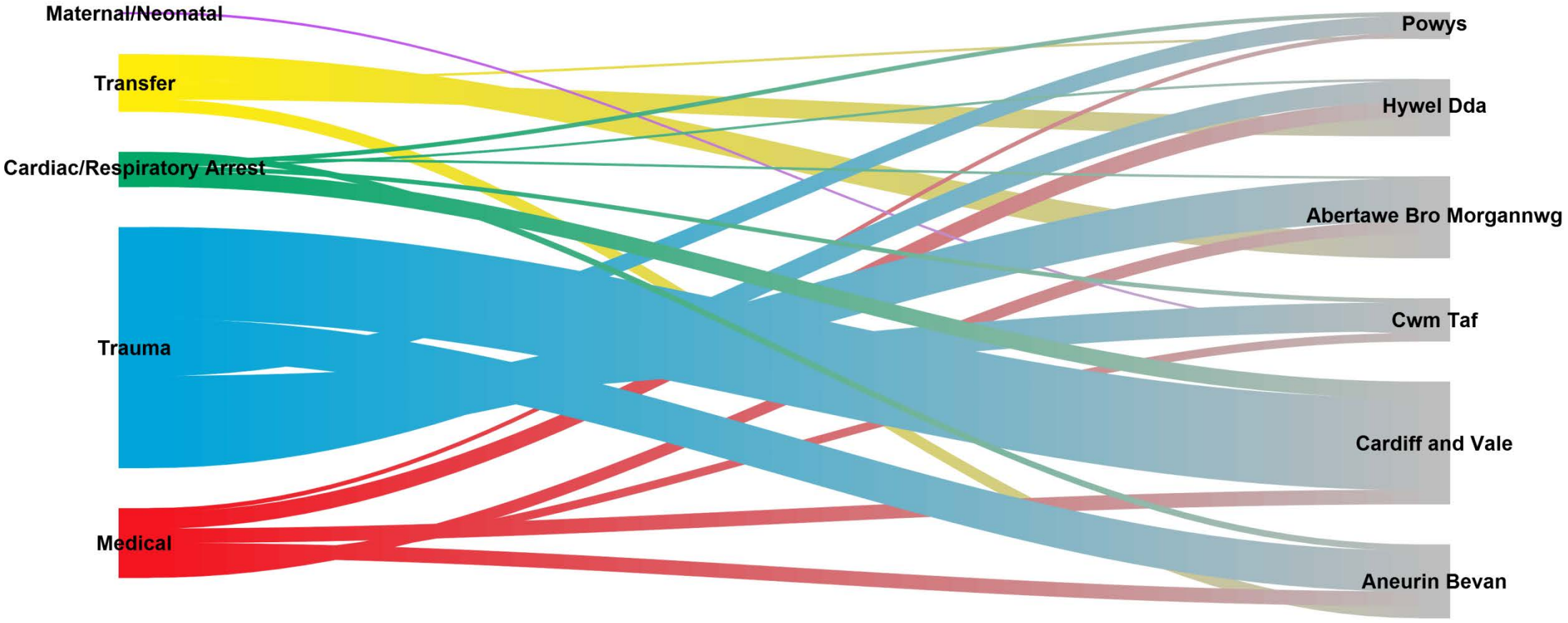
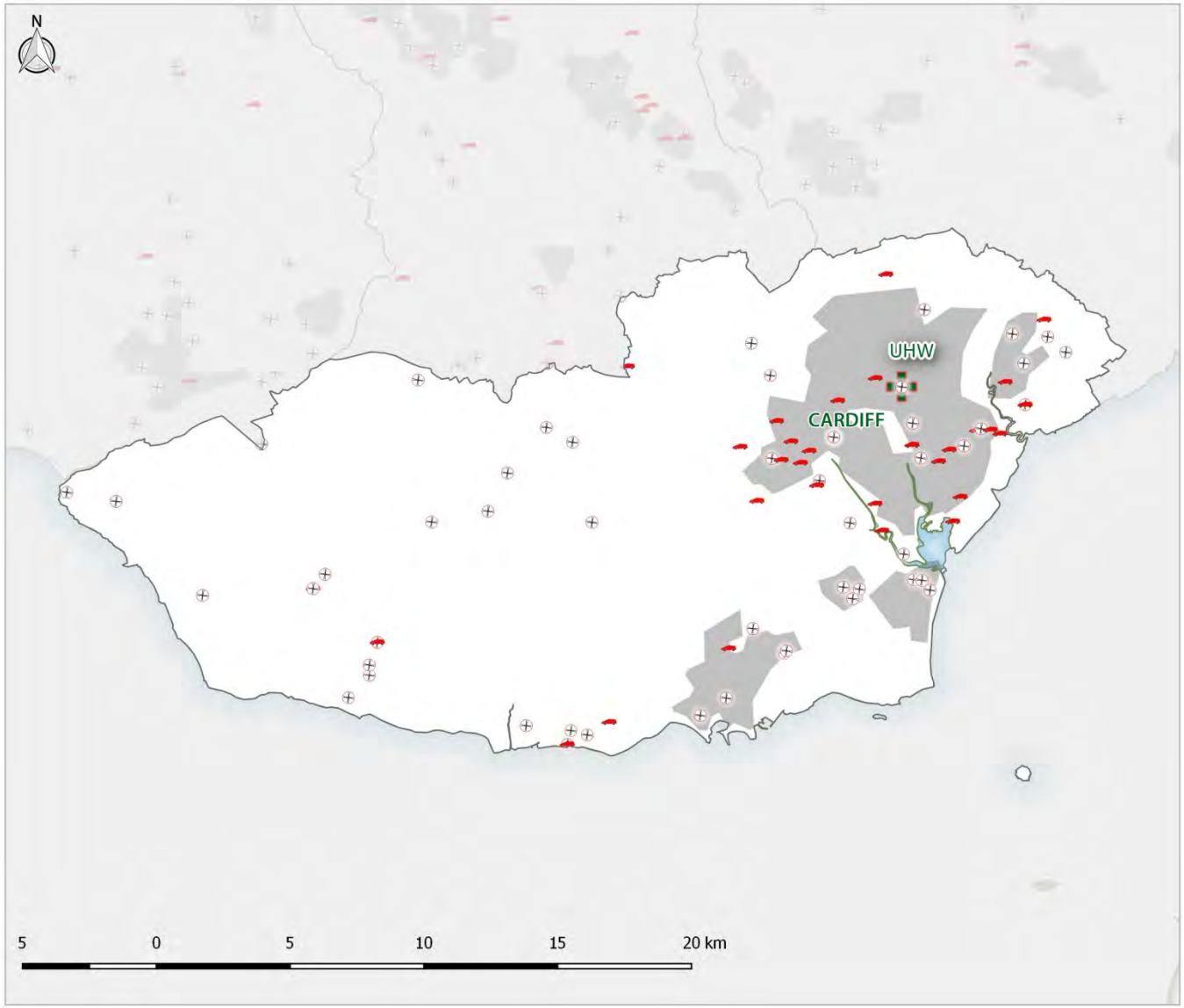


Figure 8 Cardiff and Vale hospital activity by patient group and Health Board of incident



Cardiff and Vale University Health Board EMRTS Incidents Attended - 15/16

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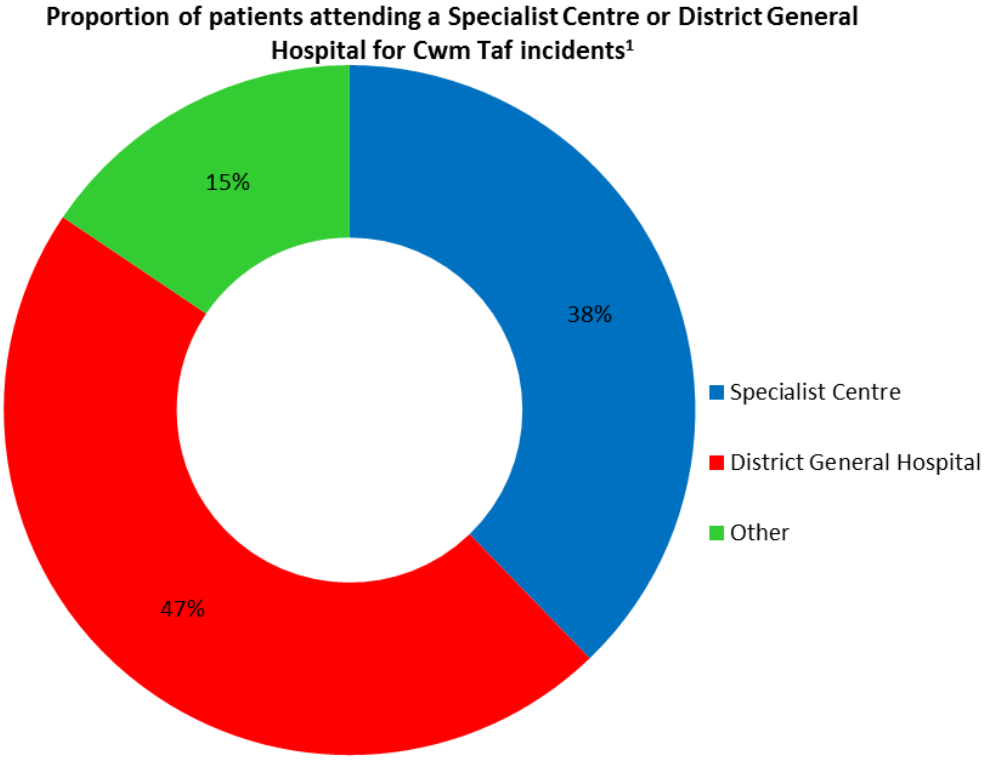
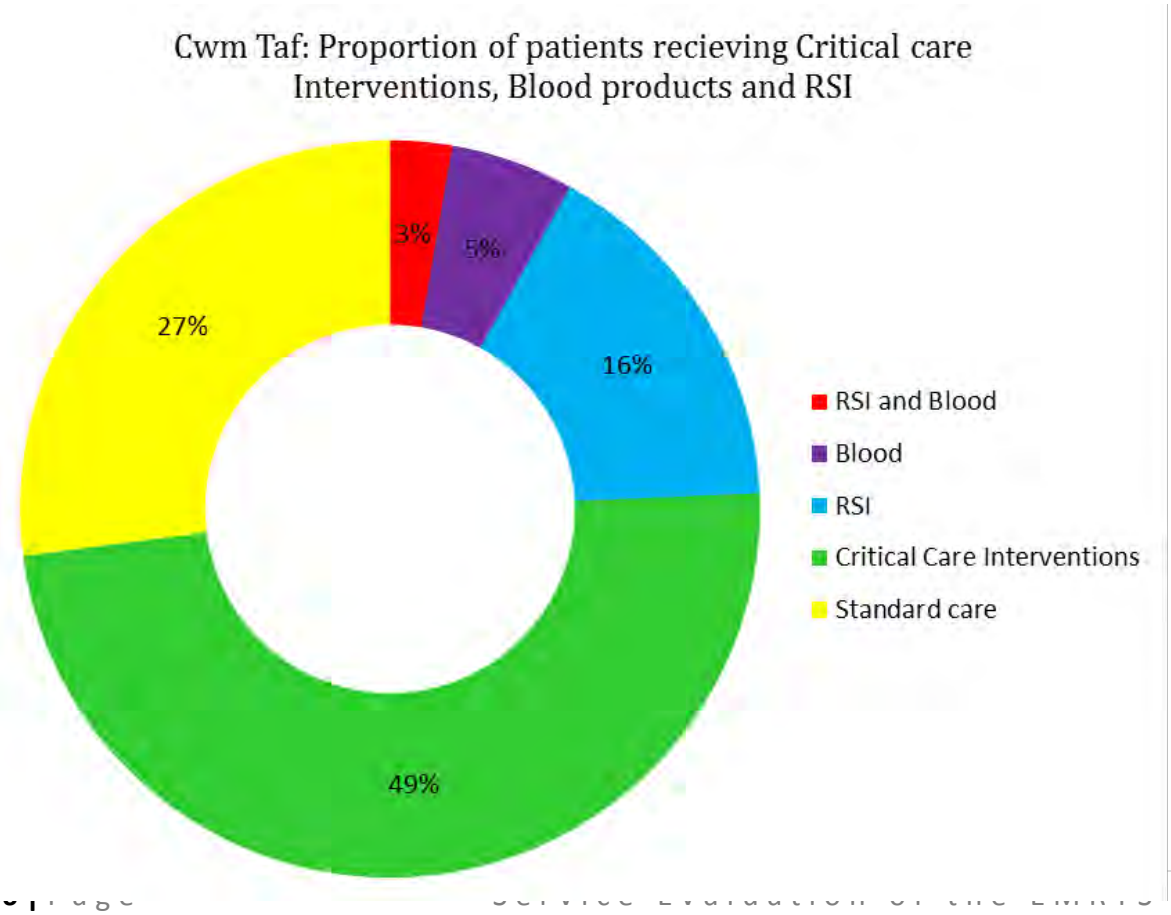
Cwm Taf



[1]100% of other group have a stop code for died at scene, other or alternative pathway



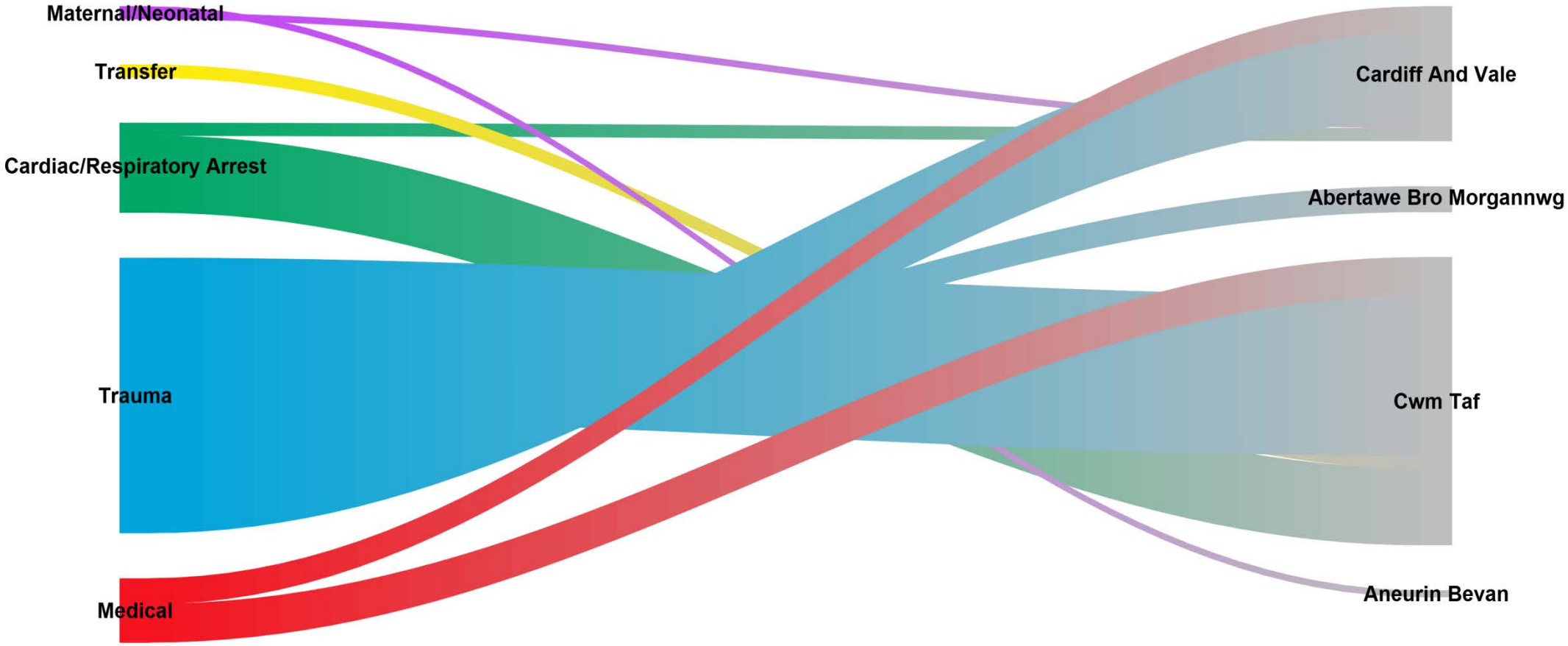
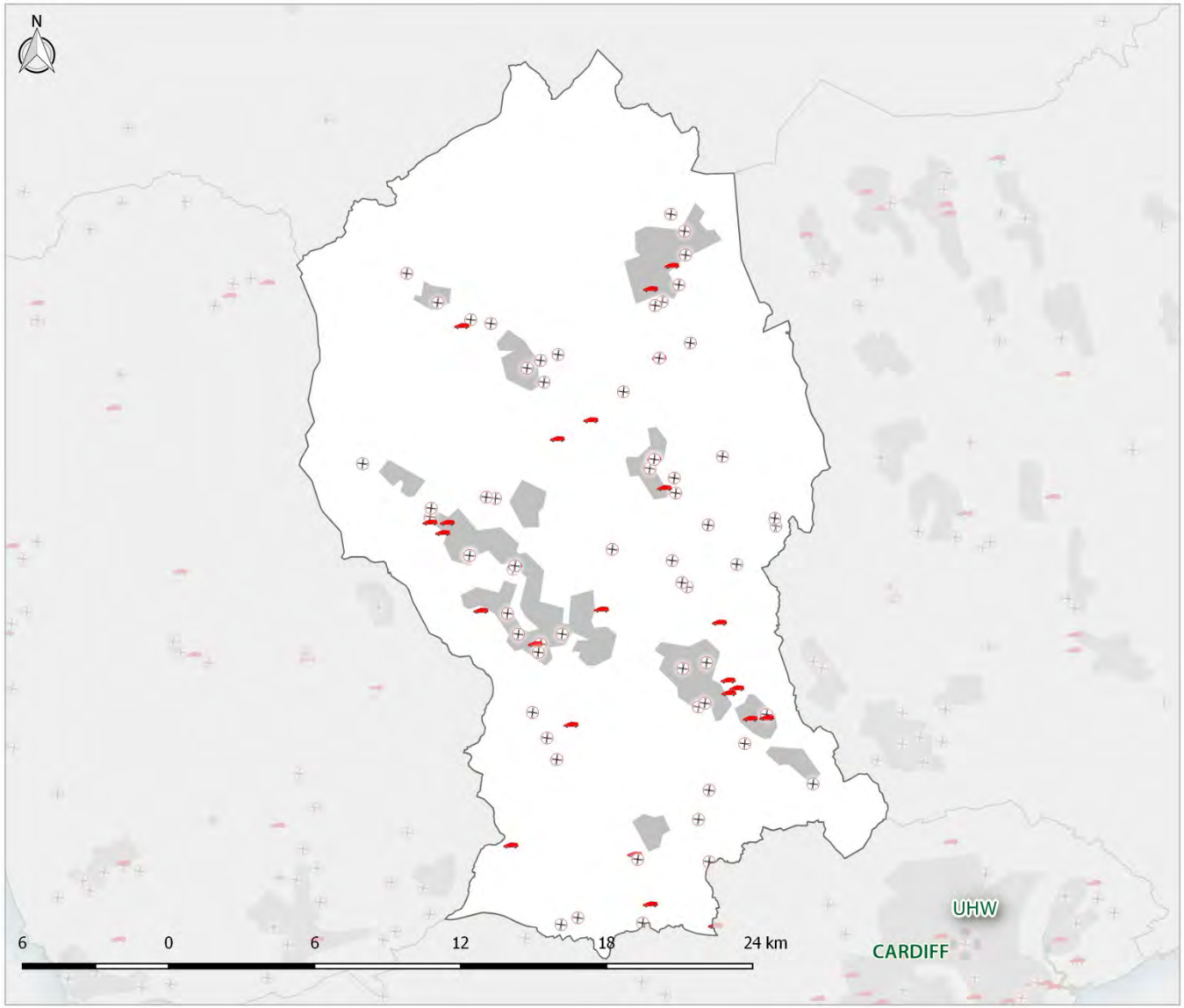


Figure 9 Cwm Taf Health board incident data by patient group and Health board of hospital destination

Figure 10 Cwm Taf hospital activity by patient group and Health Board of incident



Cwm Taf University Health Board EMRTS Incidents Attended - 15/16

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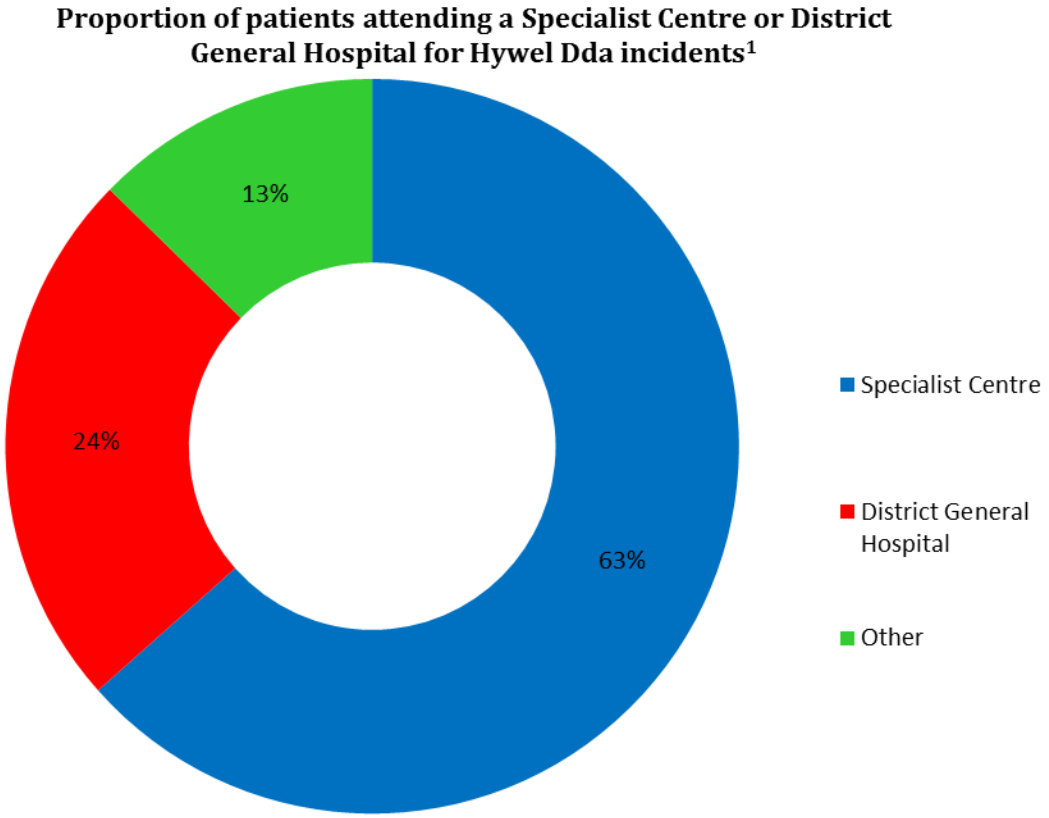
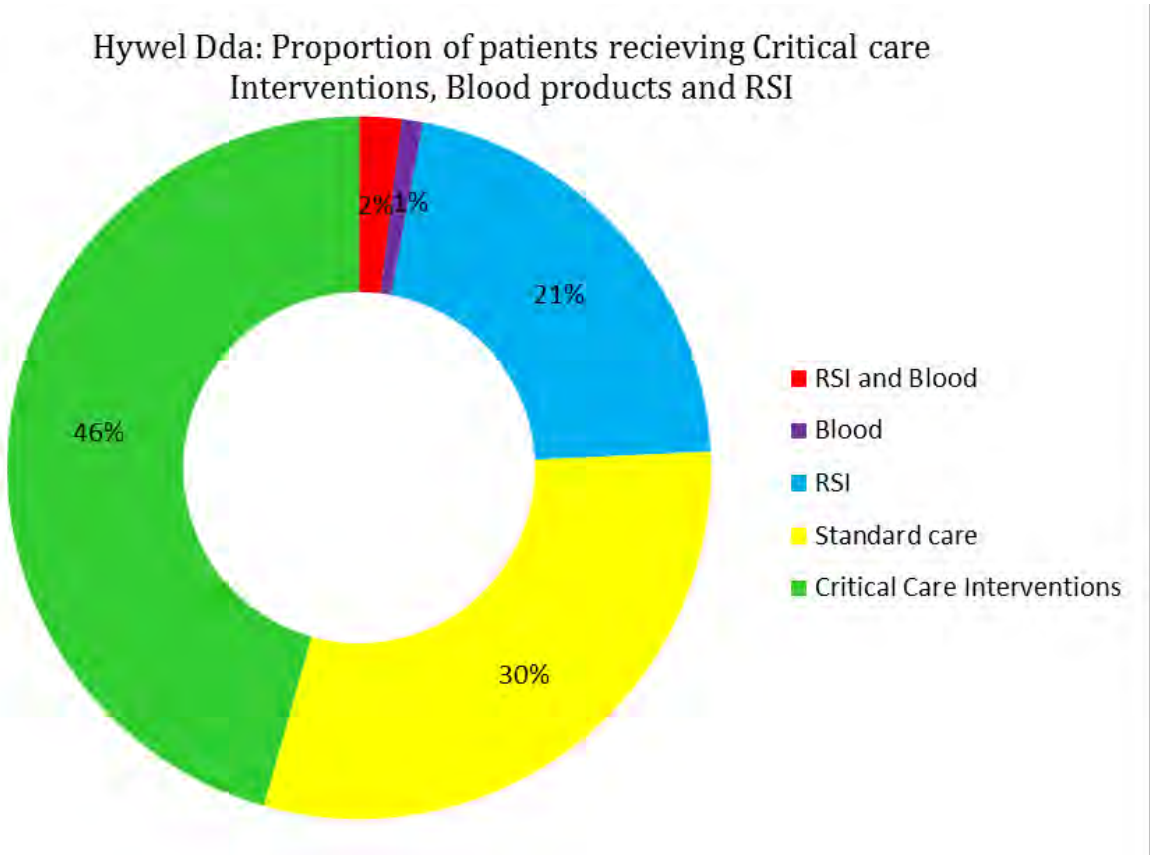
Hywel Dda



[1]76.5% of other group have a stop code for died at scene, other or alternative pathway



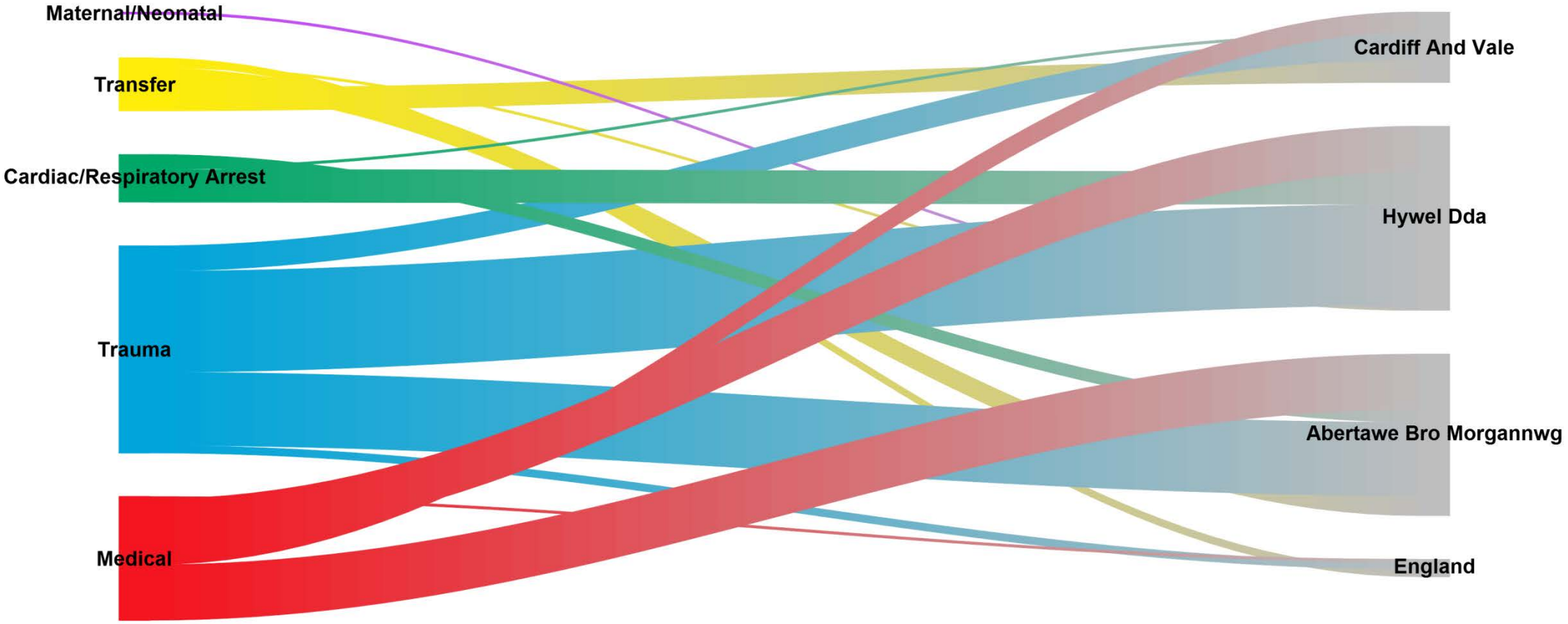


Figure 11 Hywel Dda Health board incident data by patient group and Health board of hospital destination

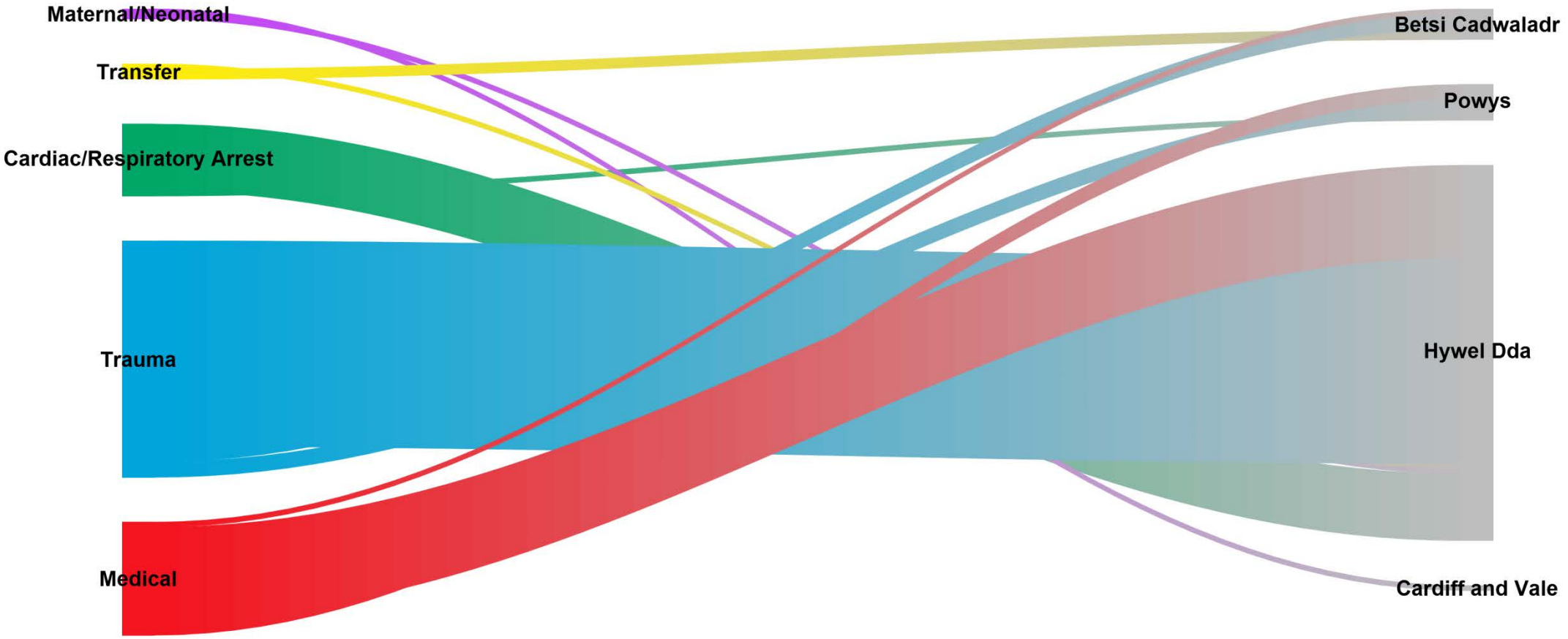
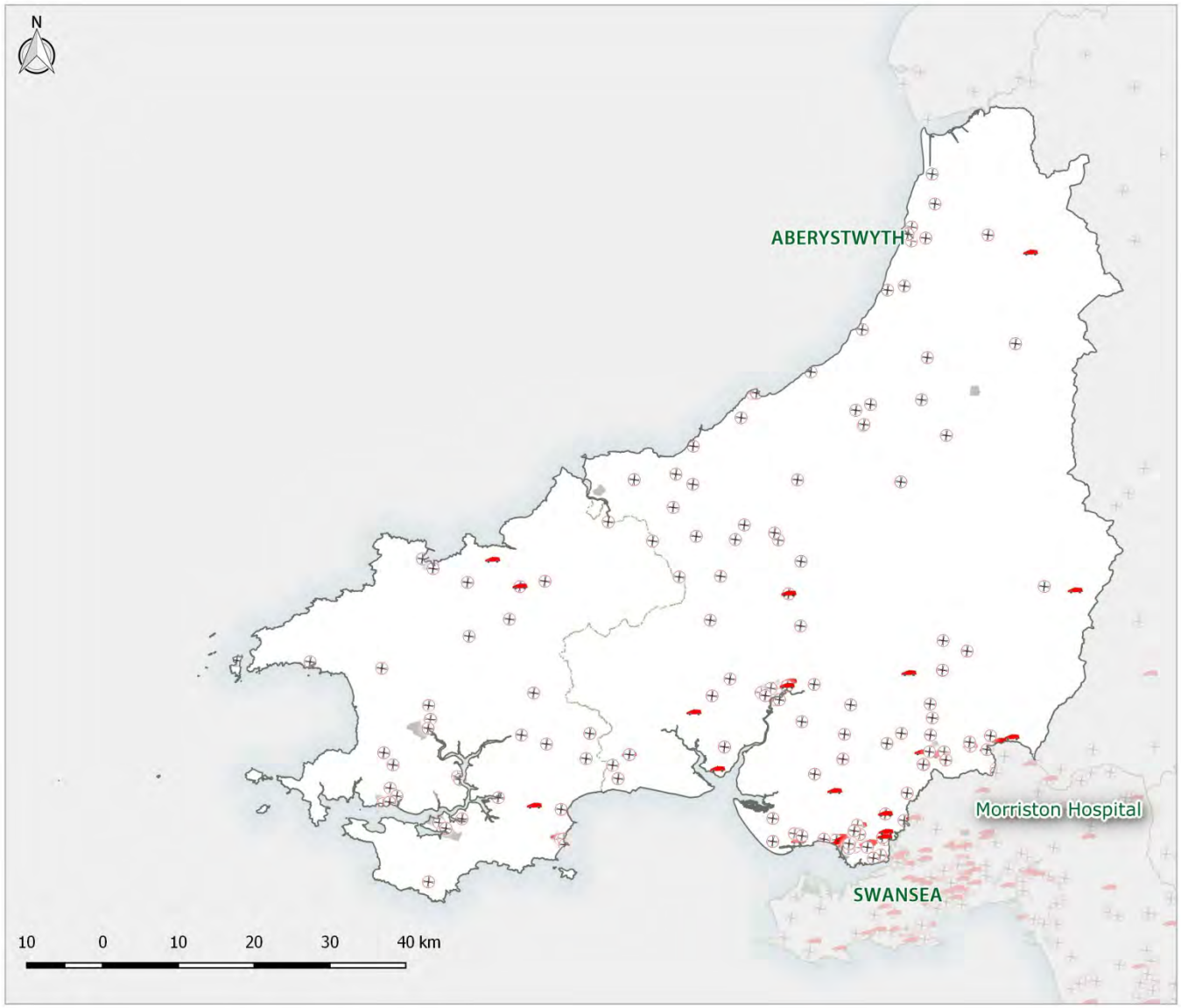


Figure 12 Hywel Dda hospital activity by patient group and Health Board of incident



Hywel Dda University Health Board EMRTS Incidents Attended - 15/16

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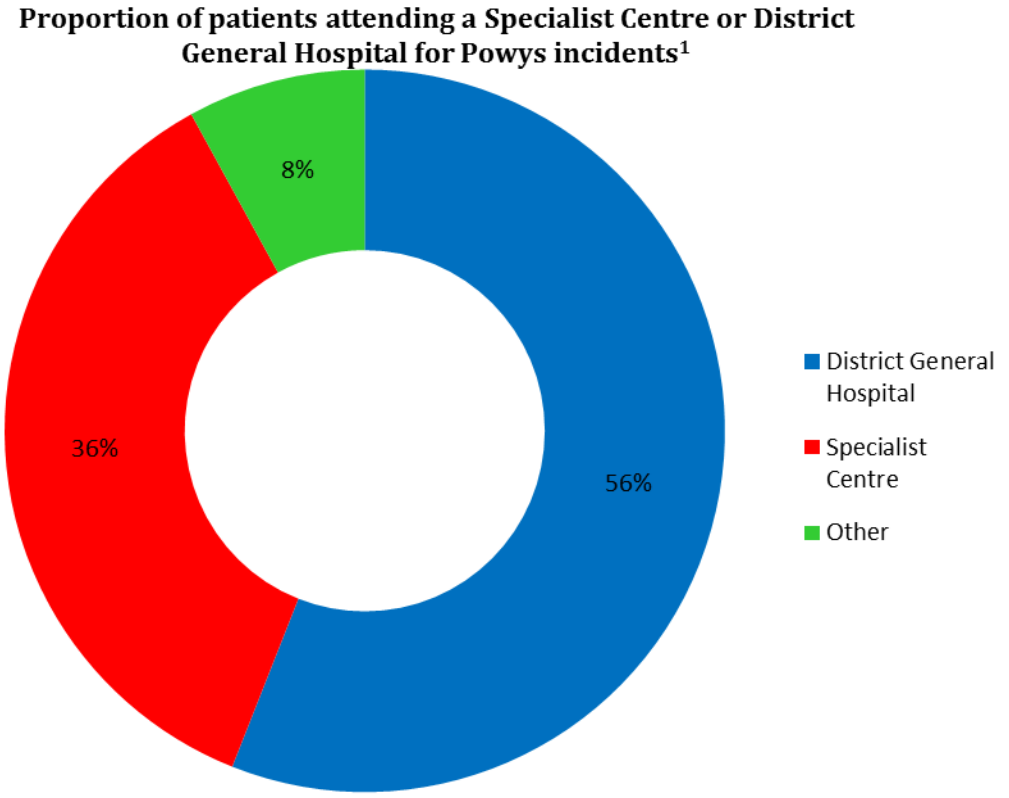
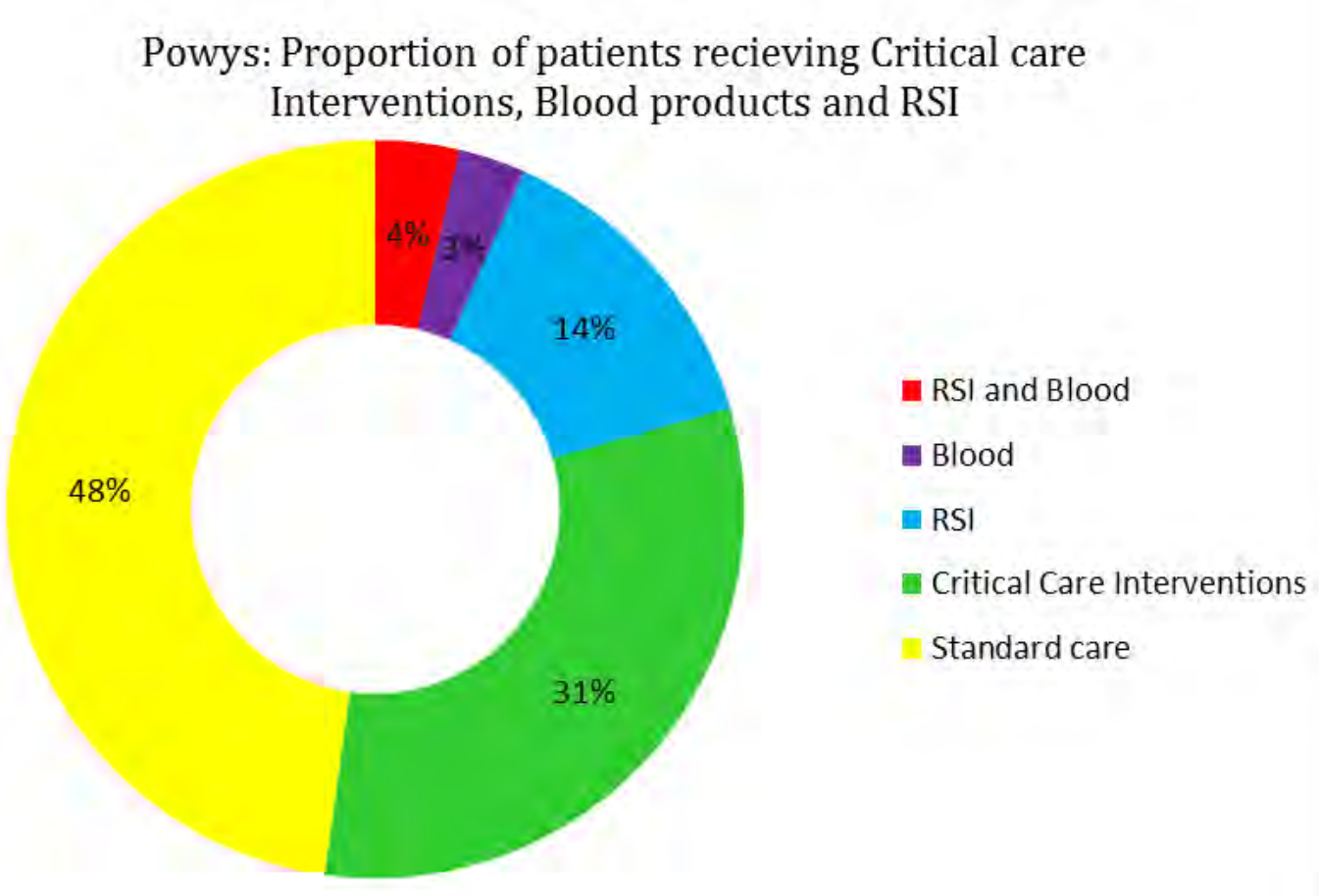
Powys



[1]63.6% of other group have a stop code for died at scene, other or alternative pathway



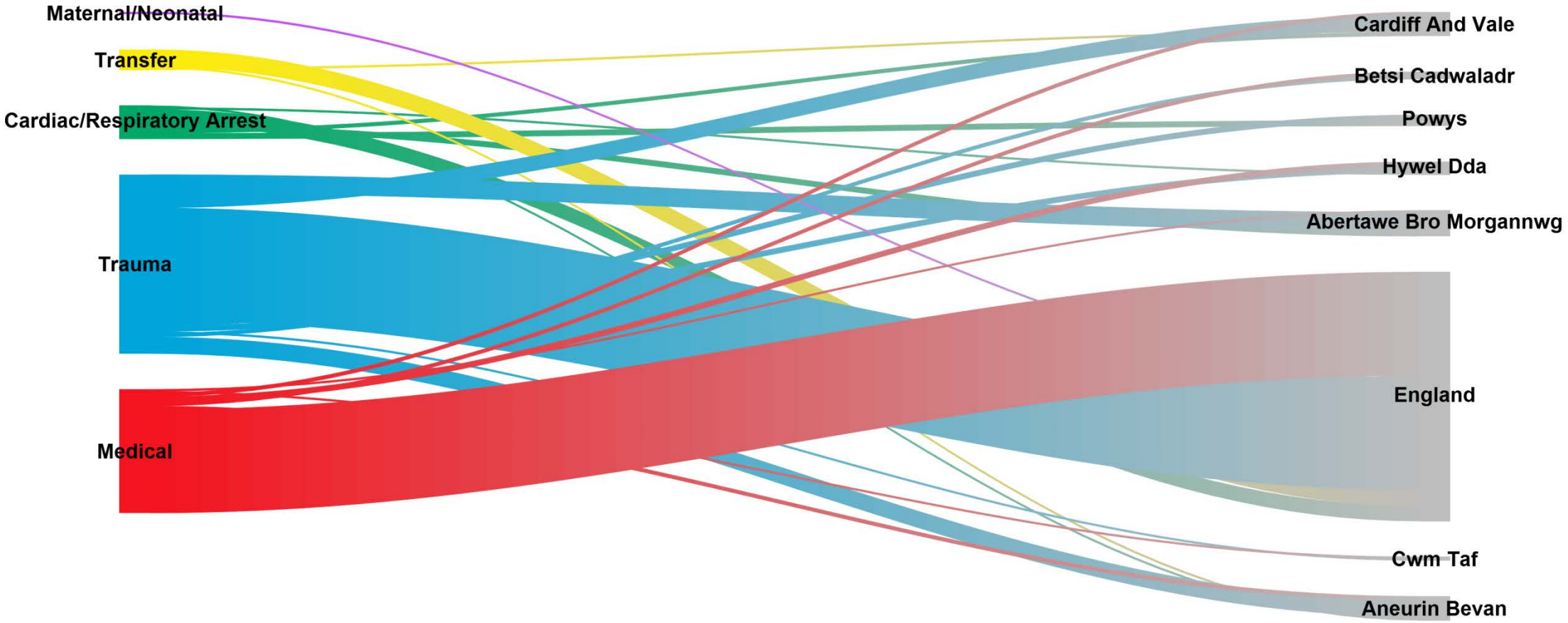
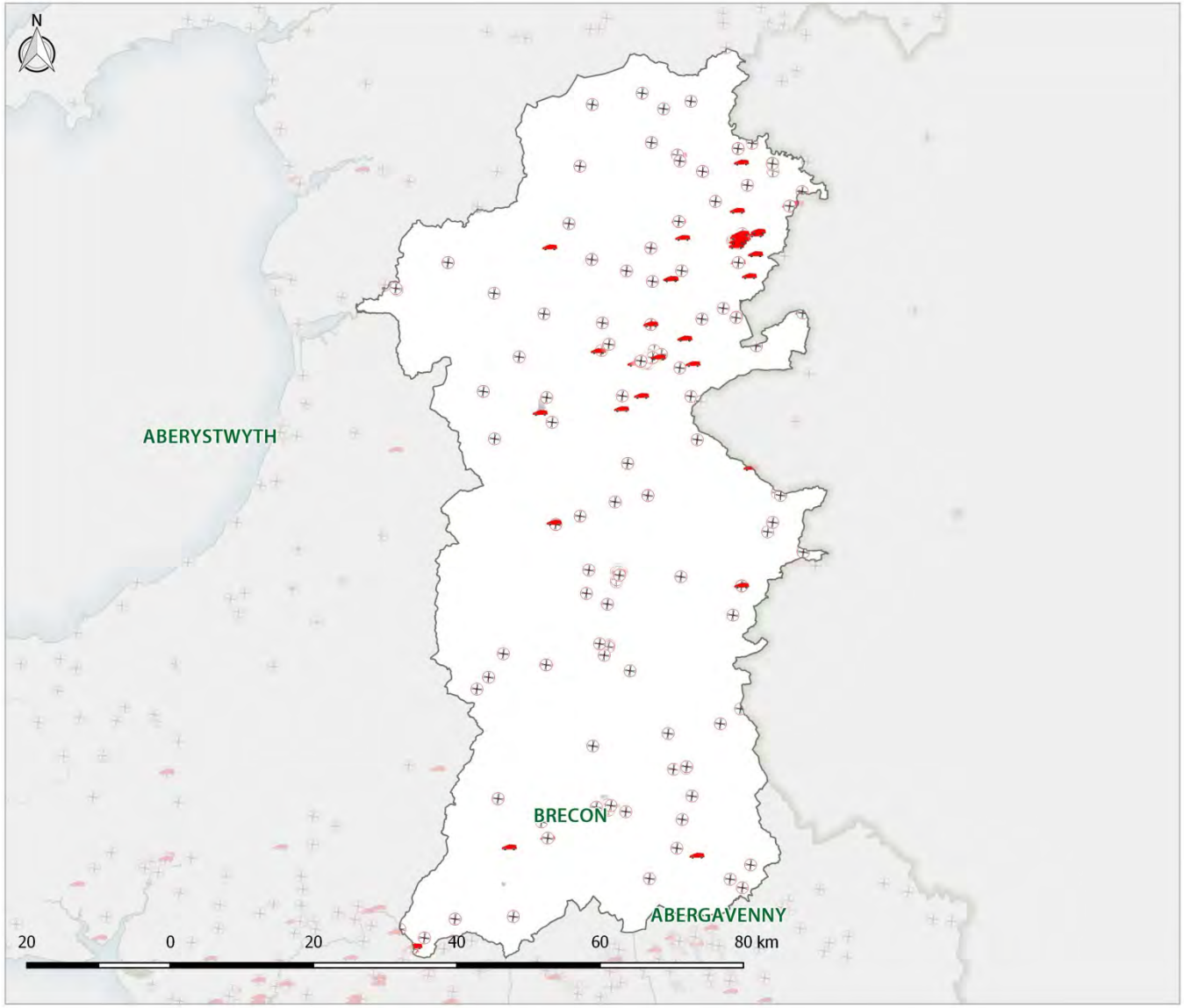


Figure 13 Welsh Health board incident data by patient group and Health board Powys



Powys Teaching Health Board EMRTS Incidents Attended - 15/16

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England as a reciveing hospital group

Figure 14 EMRTS activity Health Board incidents to English hospitals by patient group, (27-04-2015 – 26-04-2016)

All Health Boards

2 - Timeliness of access to specialist care for all patient groups

Time from incident to arrival at hospital(in minutes) to District General Hospitals or Major Trauma Centres by Health Board incident, mission type and Response Vehicle Type

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
Powys	Primary	Air	Mean:	115.2	111.3	109.8	129.5
			Median:	118	122	113	125
			Quintile (IQR)	99-128(29)	93-124(31)	100.5-117.5(17)	111-136(25)
Powys	Secondary	Air	Mean:	125.4	NA	NA	NA
			Median	123			
			Quintile (IQR)	105-140(35)			
Powys	Primary	Car	Mean:	125.4	NA	NA	NA
			Median:	110			
			Quintile (IQR)	99-126(27)			

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
Powys	Secondary	Car	Mean:	NA	NA	na	
			Median:				
			Quintile (IQR)				
Abertawe Bro Morgannwg	Primary	Air	Mean:	NA	88.1	108.3	NA
			Median:		86	101	
			Quintile (IQR)		67-99(32)	94-116(22)	
Abertawe Bro Morgannwg	Secondary	Air	Mean:	NA	NA	113.8	NA
			Median			104.5	
			Quintile			95-108.75(13.	

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			(IQR)			75)	
Abertawe Bro Morgannwg	Primary	Car	Mean:	NA	82.3	97.2	NA
			Median:		80	96	
			Quintile (IQR)		69-97(28)	94-104(10)	
Abertawe Bro Morgannwg	Secondary	Car	Mean:	NA	NA	109	NA
			Median:			109	
			Quintile (IQR)			98-120(22)	
Hywel Dda	Primary	Air	Mean:	125.7	120.2	146.7	156
			Median:	127	112	139	156
			Quintile	110.5-139	101.5-	122.5-	145-

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			(IQR)	(28.5)	129(27.5)	179.5(57)	167(22)
Hywel Dda	Secondary	Air	Mean:	NA	117.8	177.25	NA
			Median		107	152.5	
			Quintile (IQR)		101-129(28)	141-228.25(87.25)	
Hywel Dda	Primary	Car	Mean:	94	NA	154.3	NA
			Median:	94		143	
			Quintile (IQR)	77-111(34)		137.5-165.5(28)	
Hywel Dda	Secondary	Car	Mean:	N/A	NA	NA	NA
			Median:				

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			Quintile (IQR)				
Betsi Cadwaladr	Primary	Air	Mean:	106.9	123	NA	126.6
			Median:	102.5	123		124
			Quintile (IQR)	84.5-123 (38.5)	121-125(4)		101-147(46)
Betsi Cadwaladr	Secondary	Air	Mean:	157.4	NA	NA	163.1
			Median	147			172
			Quintile (IQR)	145-174(29)			141-196.5(55.5)
Betsi Cadwaladr	Primary	Car	Mean:	NA	NA	NA	NA

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			Median:				
			Quintile				
			(IQR)				
Betsi Cadwaladr	Secondary	Car	Mean:	NA	NA	NA	NA
			Median:				
			Quintile				
			(IQR)				
Cwm Taf	Primary	Air	Mean:	88	109	98	NA
			Median:	64	113.5	96	
			Quintile	55.5-109(53.5)	100.75-121.75(21)	83-112(29)	
			(IQR)				
Cwm Taf	Seconda	Air	Mean:	NA	NA	NA	NA

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
	ry						
			Median				
			Quintile				
			(IQR)				
Cwm Taf	Primary	Car	Mean:	NA	N.A	NA	NA
			Median:				
			Quintile				
			(IQR)				
Cwm Taf	Secondary	Car	Mean:	NA	NA	NA	NA
			Median:				
			Quintile				
			(IQR)				

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
Aneurin Bevan	Primary	Air	Mean:	86.7	97.5	95.3	NA
			Median:	80	98	94	
			Quintile (IQR)	72.5-97.5(25)	89.5-106(16.5)	78.5-109(30.5)	
Aneurin Bevan	Secondary	Air	Mean:	NA	NA	81.7	NA
			Median			64	
			Quintile (IQR)			52-102.5(50.5)	
Aneurin Bevan	Primary	Car	Mean:	NA	NA	NA	NA
			Median:				
			Quintile				

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			(IQR)				
Aneurin Bevan	Secondary	Car	Mean: Median: Quintile (IQR)	NA	NA	NA	NA
Cardiff and Vale	Primary	Air	Mean: Median: Quintile (IQR)	NA	NA	91.8 79 73-108.25(35.25)	NA
Cardiff and Vale	Secondary	Air	Mean:	NA	NA	NA	NA

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
			Median Quintile (IQR)				
Cardiff and Vale	Primary	Car	Mean: Median: Quintile (IQR)	NA	NA	81.7 91 72.5-95.5(23)	NA
Cardiff and Vale	Secondary	Car	Mean: Median: Quintile (IQR)	NA	NA	NA	NA

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
Wales	Primary	Air	Mean:	111.3	109	110.9	128.4
			Median:	115	109	108	127.5
			Quintile (IQR)	87-128(41)	86-127(41)	93.5-121.5(28)	104.75-147.75(43)
Wales	Secondary	Air	Mean:	133.3	117.9	142.9	163.1
			Median	134	107	136.5	172
			Quintile (IQR)	105-147(42)	101-129(28)	98.75-183(84.25)	141-196.5(55.5)
Wales	Primary	Car	Mean:	114.5	84.7	107.5	NA
			Median:	106	80.5	100	
			Quintile (IQR)	88-126(38)	67.5-98.5(31)	94-127(33)	

Region (location of incident)	Mission Type	Response Vehicle Type	Time measurement	District General Hospital (minutes)	Morriston Hospital (minutes)	University Hospital of Wales (minutes)	University Hospitals North Midlands (minutes)
Wales	Secondary	Car	Mean:	148	NA	139	NA
			Median:	117		131	
			Quintile (IQR)	79.5-201(121.5)		109-165(56)	

EMRTS dataset missing 55.6% of arrival at hospital timestamps despite having hospital locations – NA: missing data or very small numbers
1Please refer to appendix x for Major Trauma Centre

Time from incident to arrival at scene for patients receiving blood products and primary missions.

Health Board of incident	Response Vehicle Type	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	26	26	25-27(2)
Cwm Taf	Car			
Abertawe Bro Morgannwg	Air	26.25	23	20-29.25(9.25)
Abertawe Bro Morgannwg	Car			
Aneurin Bevan	Air	34.5	34.5	34.25-34.75(0.5)
Aneurin Bevan	Car			
Cardiff and Vale	Air	25.75	20.5	20-25.25(5.25
Cardiff and Vale	Car			
Powys	Air	38.1	30	29.5-33.5(4)
Powys	Car			
Betsi Cadwaladr	Air	39.1	35.5	22.75-52.75(30)
Betsi Cadwaladr	Car			
Hywel Dda	Air	33	39	27-42(15)
Hywel Dda	Car			
Wales	Air	33.2	29	22.5-38.5(16)
Wales	Car	65.3	48	41.5-80.5(39)

Time from incident to arrival at scene for patients receiving a critical care intervention and primary missions

Health Board of incident	Response Vehicle Type	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	36.3	29	25-37.25(12.25)
Cwm Taf	Car	36.3	37	28.5-44.75(16.25)
Abertawe Bro Morgannwg	Air	24.8	21	16-28(12)
Abertawe Bro Morgannwg	Car	29.8	21	13-34(21)
Aneurin Bevan	Air	33.9	31.5	27.25-36.5(9.25)
Aneurin Bevan	Car	55	48	47.25-66.75(19.5)
Cardiff and Vale	Air	31.7	29	23.50-37(13.5)
Cardiff and Vale	Car	38	35	25.75-47.25(21.5)
Powys	Air	41.8	38	29-50(21)
Powys	Car	36.9	36	18.75-50.25(31.5)
Betsi Cadwaladr	Air	42	42	27-56(29)
Betsi Cadwaladr	Car			
Hywel Dda	Air	45.6	38	14-53(29)
Hywel Dda	Car	52.25	38.5	38.5-62(42)
Wales	Air	37.7	32	24-44.25(20.25)
Wales	Car	37.2	30.5	17-46.5(29.5)

Time from incident to arrival at scene for patients receiving RSI and primary missions.

Health Board of incident	Response Vehicle Type	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	25.7	24.5	24-25.7(1.75)
Cwm Taf	Car			
Abertawe Bro Morgannwg	Air	25.5	26	18-32(14)
Abertawe Bro Morgannwg	Car	24.25	24.5	11.75-35(23.25)
Aneurin Bevan	Air	29.4	31	28-32(4)
Aneurin Bevan	Car			
Cardiff and Vale	Air	28.75	28.5	20.75-36.5(15.75)
Cardiff and Vale	Car			
Powys	Air	32.85	32	25.75-39.25(13.5)
Powys	Car	27.25	23.5	5.25-45.5(40.25)
Betsi Cadwaladr	Air	46.1	48.5	26.5-58.75(32.25)
Betsi Cadwaladr	Car			
Hywel Dda	Air	48.8	35	29-55(26)
Hywel Dda	Car	62.8	47	45-86(41)
Wales	Air	37.2	32	24-43(19)
Wales	Car	34.9	35	12-44(32)

Time from incident to arrival at scene for all patients and primary missions.

Health Board of incident	Response Vehicle Type	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	35.6	29	25-35.75(10.75)
Cwm Taf	Car	33.3	30	25-44.5(19.5)
Abertawe Bro Morgannwg	Air	26.5	22	16-35(19)
Abertawe Bro Morgannwg	Car	24.7	18	12.25-31.5(19)
Aneurin Bevan	Air	35.7	32.5	28-41.75(13.75)
Aneurin Bevan	Car	43.3	47	24-49(25)
Cardiff and Vale	Air	31.3	30	23-38(15)
Cardiff and Vale	Car	29.6	32	17-39.5(22.5)
Powys	Air	45.2	40	29-59(30)
Powys	Car	30.6	24	15-39.75(24.75)
Betsi Cadwaladr	Air	44.3	43.5	27.75-56.25(28.5)
Betsi Cadwaladr	Car			
Hywel Dda	Air	47.5	40	25-61.5(36.5)
Hywel Dda	Car	50.3	38.5	22.5-52.25(29.75)
Wales	Air	40.1	35	24-52(28)
Wales	Car	30.7	22	15-39.5(24.5)

Paediatrics: Time from incident to arrival at scene for all patients aged between 0 and 17 and primary missions.

Region	Response Vehicle Type	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	25.1	27.5	19.75-29.25(9.5)
Cwm Taf	Car			
Abertawe Bro Morgannwg	Air	27.9	23	16-27(11)
Abertawe Bro Morgannwg	Car	24.3	20	15.25-27.75(12.5)
Aneurin Bevan	Air	35	28	27-45(18)
Aneurin Bevan	Car	30	24	20-37(17)
Cardiff and Vale	Air	26.3	24.5	16.25-35.75(19.5)
Cardiff and Vale	Car			
Powys	Air	39.8	34	21-43.75(22.75)
Powys	Car	31.1	38	20-40(20)
Betsi Cadwaladr	Air	46	56	31-58(27)
Betsi Cadwaladr	Car			
Hywel Dda	Air	36.6	33	25-44(19)
Hywel Dda	Car			
Wales	Air	35.1	30	21-43.5(22.5)
Wales	Car	28.1	22	16-38(22)

Time from incident to arrival at scene for all incident and primary missions.

Region	Response Vehicle Type	Nature of Incident	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Cwm Taf	Air	Trauma	39.9	29	25.75-40.75(15)
		Medical	35.8	35	31.25-38.75(7.5)
		Cardiac/ Respiratory Arrest	28.6	25	22.5-36.5(14)
Cwm Taf	Car	Trauma	35.1	31.5	27.25-46(18.75)
		Medical	45.3	44	34-56(22)
		Cardiac/ Respiratory Arrest	28.4	23	22-30(8)
Abertawe Bro Morgannwg	Air	Trauma	26.4	19.5	15.75-28.75(13)
		Medical	33.7	30	19.5-43.5(24)
		Cardiac/ Respiratory Arrest	19.5	18.5	15-23.25(8.25)
Abertawe Bro Morgannwg	Car	Trauma	24.2	16	10.5-29(18.5)
		Medical	32.5	27	14.75-39.75(25)
		Cardiac/ Respiratory Arrest	22.9	16.5	12.25-33.5(21.25)
Aneurin Bevan	Air	Trauma	37.7	35	29.25-44.75(15.5)
		Medical	34.3	30	27.25-

Region	Response Vehicle Type	Nature of Incident	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
					39.25(12)
		Cardiac/ Respiratory Arrest	29.5	29	25-34.5(9.5)
Aneurin Bevan	Car	Trauma	37.6	35	22-48(26)
		Medical	29.5	29.5	21.5-37.5(16)
		Cardiac/ Respiratory Arrest	N/A		
Cardiff and Vale	Air	Trauma	32	30.5	21-38(17)
		Medical	50.7	39	33-62.5(29.5)
		Cardiac/ Respiratory Arrest	28.6	27	23-28(5)
Cardiff and Vale	Car	Trauma	27.6	25	16-36(20)
		Medical	29	10	8.5-40(31.5)
		Cardiac/ Respiratory Arrest	17.75	18	7.75-28(20.25)
Powys	Air	Trauma	39.6	34	23-56(33)
		Medical	53.8	54.5	39.75-64.25(24.5)
		Cardiac/ Respiratory Arrest	31.8	29	21.5-37.75(16.25)
Powys	Car	Trauma	32.7	22	14-42(28)
		Medical	43.3	40	22-52.5(30.5)
		Cardiac/ Respiratory	17.6	10.5	8.75-25(16.25)

Region	Response Vehicle Type	Nature of Incident	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
		Arrest			
Betsi Cadwaladr	Air	Trauma	41.6	41	27-53.5(26.5)
		Medical	54.5	55.5	40.75-71(30.25)
		Cardiac/ Respiratory Arrest	28.3	27	19.5-37.5(18)
Betsi Cadwaladr	Car	Trauma	58.25	51	46.75-62.5(15.75)
		Medical	43.8	40	22-52.5(30.5)
		Cardiac/ Respiratory Arrest	22	22	17.5-26.5(9)
Hywel Dda	Air	Trauma	38.2	32	23-43(20)
		Medical	63	64	46.5-73.5(27)
		Cardiac/ Respiratory Arrest	32	28.5	19-43(14)
Hywel Dda	Car	Trauma	43.5	45	16-50(34)
		Medical	51.7	33.5	30.5-77.75(47.25)
		Cardiac/ Respiratory Arrest	29.25	25	20.25-33.75(13.25)
Wales	Air	Trauma	36.7	32	22-42(22)
		Medical	51.1	49	34-65(31)
		Cardiac/ Respiratory Arrest	28.2	25	19-34(15)

Region	Response Vehicle Type	Nature of Incident	Mean time to scene (minutes)	Median time to scene (minutes)	Quintile(IQR) time to scene (minutes)
Wales	Car	Trauma	31.4	24	14-43(29)
		Medical	38.1	31.5	16.5-48(31.5)
		Cardiac/ Respiratory Arrest	22.7	18	11-31(20)

Time from arrival at scene to EMRTS left scene for all incident and primary missions.

Region	Response Vehicle Type	Nature of Incident	Mean time on scene (minutes)	Median time on scene (minutes)	Quintile(IQR) time on scene (minutes)
Cwm Taf	Air	Trauma	46.1	47	28.75-56.75(28)
		Medical	39	37.5	18.75-57.75(39)
		Cardiac/ Respiratory Arrest	47.1	43.5	38.5-58(19.5)
Cwm Taf	Car	Trauma	58.6	40.5	34-78.5(44.5)
		Medical	33.3	31	17.5-48(30.5)
		Cardiac/ Respiratory Arrest	30.6	18	16-26(10)
Abertawe Bro Morgannwg	Air	Trauma	46.2	42	27-61(34)
		Medical	56.8	55	33.5-73(39.5)
		Cardiac/ Respiratory Arrest	62.3	52	34.25-85.5(51.25)
Abertawe Bro Morgannwg	Car	Trauma	24.2	16	10.5-29(18.5)
		Medical	31.2	25	17.5-40.5(23)
		Cardiac/ Respiratory Arrest	50.9	42	35.25-61(25.75)
Aneurin Bevan	Air	Trauma	54.2	41	32-73.5(41.5)
		Medical	56.5	52	35-61.75(26.75)
		Cardiac/ Respiratory Arrest	43.1	36	27.75-41.25(13.5)

Region	Response Vehicle Type	Nature of Incident	Mean time on scene (minutes)	Median time on scene (minutes)	Quintile(IQR) time on scene (minutes)
Aneurin Bevan	Car	Trauma	38.5	25	18-60(42)
		Medical	37.75	20.5	15-43.25(28.25)
		Cardiac/ Respiratory Arrest	NA		
Cardiff and Vale	Air	Trauma	59.8	61	27-83(56)
		Medical	62.7	65	50-76.5(26.5)
		Cardiac/ Respiratory Arrest	47.9	35	27-70(43)
Cardiff and Vale	Car	Trauma	35.5	20	6-56(50)
		Medical	38.3	46	26.5-54(27.5)
		Cardiac/ Respiratory Arrest	43.25	34.5	17.5-60.25(42.75)
Powys	Air	Trauma	50.7	50	37-60(23)
		Medical	41.4	37	26-51.25(25.25)
		Cardiac/ Respiratory Arrest	49.4	45	34.75-60.5(25.75)
Powys	Car	Trauma	58.7	48	28-64(36)
		Medical	42.6	27	15-52(37)
		Cardiac/ Respiratory Arrest	58.75	38.5	32.5-72(39.5)
Betsi Cadwaladr	Air	Trauma	51.75	50	35-64(29)
		Medical	40.25	38.5	25-

Region	Response Vehicle Type	Nature of Incident	Mean time on scene (minutes)	Median time on scene (minutes)	Quintile(IQR) time on scene (minutes)
					48.75(23.75)
		Cardiac/ Respiratory Arrest	28.3	27	19.5-37.5(18)
Betsi Cadwaladr	Car	Trauma	40	36.5	34.75-41.75(7)
		Medical	NA		
		Cardiac/ Respiratory Arrest			
Hywel Dda	Air	Trauma	55.7	52	34.75-63.25(28.5)
		Medical	56.8	59	31-82.5(51.5)
		Cardiac/ Respiratory Arrest	53.2	51.5	35-63.75(28.75)
Hywel Dda	Car	Trauma	53.1	31	16-87(71)
		Medical	51.7	33.5	30.5-77.75(47.25)
		Cardiac/ Respiratory Arrest	67.5	65	31.75-100.75(69)
Wales	Air	Trauma	51.6	47.5	32.75-64(31.25)
		Medical	46.7	40	28-56(28)
		Cardiac/ Respiratory Arrest	52.2	44	32.25-62.25(30)
Wales	Car	Trauma	42.5	34	15.75-57.75(42)

Region	Response Vehicle Type	Nature of Incident	Mean time on scene (minutes)	Median time on scene (minutes)	Quintile(IQR) time on scene (minutes)
		Medical	38.3	30	16-56(40)
		Cardiac/ Respiratory Arrest	49.9	39	28-66(38)

NA: missing data or very small numbers

Time from incident to arrival at hospital for all incident and primary missions.

Region	Response Vehicle Type	Nature of Incident	Mean total time (minutes)	Median total time (minutes)	Quintile(IQR) total time (minutes
Cwm Taf	Air	Trauma	103.4	102.5	81-11.5(38.5)
		Medical	93	93	86-100(14)
		Cardiac/ Respiratory Arrest	72.5	72.5	59.75-85.25(25.5)
Cwm Taf	Car	Trauma	NA		
		Medical	NA		
		Cardiac/ Respiratory Arrest	NA		
Abertawe Bro Morgannwg	Air	Trauma	94.3	92	78.5-108(29.5)
		Medical	113.6	119	101-122(21)
		Cardiac/ Respiratory Arrest	72.5	76	57.5-91(33.5)
Abertawe Bro Morgannwg	Car	Trauma	92.9	94	71-114.5(43.5)
		Medical	91	95.5	88.75-97.75(9)
		Cardiac/ Respiratory Arrest	76.25	74.5	61.75-86.5(24.75)
Aneurin Bevan	Air	Trauma	99.1	99.5	82-109(27)
		Medical	97.2	104	94-109(15)
		Cardiac/ Respiratory Arrest	68.7	76	63-78(15)

Region	Response Vehicle Type	Nature of Incident	Mean total time (minutes)	Median total time (minutes)	Quintile(IQR) total time (minutes
Aneurin Bevan	Car	Trauma	149	149	148-150(2)
		Medical	NA		
		Cardiac/ Respiratory Arrest	NA		
Cardiff and Vale	Air	Trauma	83.6	76	72-82(10)
		Medical	NA		
		Cardiac/ Respiratory Arrest	NA		
Cardiff and Vale	Car	Trauma	81.7	91	72.5-95.5(23)
		Medical	NA	NA	NA
		Cardiac/ Respiratory Arrest	NA		
Powys	Air	Trauma	118.8	116	102.5-130.5(28)
		Medical	116	117.5	102.5-130.25(27.5)
		Cardiac/ Respiratory Arrest	105.1	119	97-121(24)
Powys	Car	Trauma	133.7	120	98-145.5(47.5)
		Medical	102.3	102	95-109.5(14.5)
		Cardiac/ Respiratory Arrest	86	86	79.5-92.5(13)
Betsi Cadwaladr	Air	Trauma	120.6	116	101-143(42)

Region	Response Vehicle Type	Nature of Incident	Mean total time (minutes)	Median total time (minutes)	Quintile(IQR) total time (minutes
		Medical	117	106	91-150(59)
		Cardiac/ Respiratory Arrest	NA		
Betsi Cadwaladr	Car	Trauma	NA		
		Medical	NA		
		Cardiac/ Respiratory Arrest	NA		
Hywel Dda	Air	Trauma	117.3	113	100-127(27)
		Medical	141.8	129	122.25-158.25(36)
		Cardiac/ Respiratory Arrest	127.75	127	122-132.75(10.75)
Hywel Dda	Car	Trauma	NA		
		Medical	126.7	132	96-160(64)
		Cardiac/ Respiratory Arrest	NA		
Wales	Air	Trauma	112.3	109	91.75-127(32.25)
		Medical	122	120.5	101.75-138.25(36.5)
		Cardiac/ Respiratory Arrest	94.4	98	73-120.5(47.5)
Wales	Car	Trauma	104.8	100	80-126(46)
		Medical	101.4	96	79-110(31)

Region	Response Vehicle Type	Nature of Incident	Mean total time (minutes)	Median total time (minutes)	Quintile(IQR) total time (minutes
		Cardiac/ Respiratory Arrest	78.2	76.5	64.5-93.5(29)

NA: missing data or very small numbers

D.Functional outcome questionnaires

Both EQ5D and GOSE have been incorporated into a bespoke web interface. The questions posed are included here as an example of the content.

Health Questionnaire

English version for the UK

Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

I have no problems in walking about ❑
I have slight problems in walking about ❑
I have moderate problems in walking about ❑
I have severe problems in walking about ❑
I am unable to walk about ❑

SELF-CARE

I have no problems washing or dressing myself ❑
I have slight problems washing or dressing myself ❑
I have moderate problems washing or dressing myself ❑
I have severe problems washing or dressing myself ❑
I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

I have no problems doing my usual activities ❑
I have slight problems doing my usual activities ❑
I have moderate problems doing my usual activities ❑
I have severe problems doing my usual activities ❑
I am unable to do my usual activities ❑

PAIN / DISCOMFORT

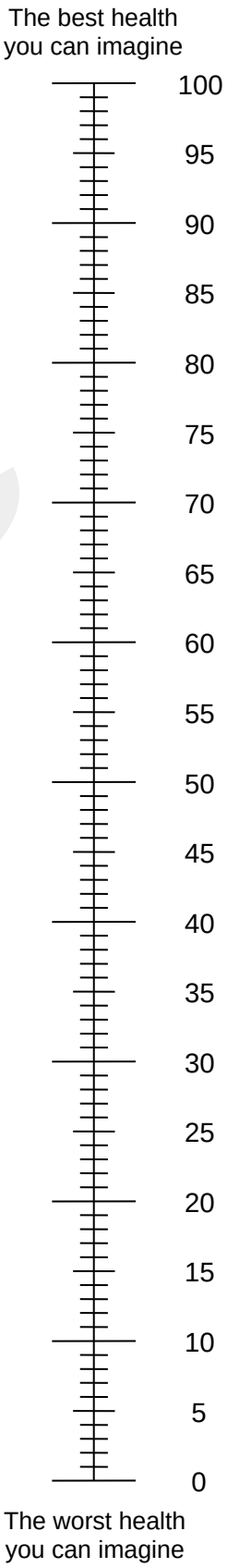
I have no pain or discomfort ❑
I have slight pain or discomfort ❑
I have moderate pain or discomfort ❑
I have severe pain or discomfort ❑
I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION

I am not anxious or depressed ❑
I am slightly anxious or depressed ❑
I am moderately anxious or depressed ❑
I am severely anxious or depressed ❑
I am extremely anxious or depressed ❑

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the <u>best</u> health you can imagine.
  0 means the <u>worst</u> health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
- Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐



POST DISCHARGE
STRUCTURED INTERVIEW FOR GOSE

Respondent: ☐ 0 = Patient alone 1 = Relative/friend/caretaker alone 2 = Patient plus relative/friend/caretaker

Conciousness:

1. Is the head-injured person able to obey simple commands or say any words?

◯ Yes ◯ No (VS)

Note: anyone who shows the ability to obey even simple commands or utter any word or communicate specifically in any other way is no longer considered to be in vegetative state. Eye movements are not reliable evidence of meaningful responsiveness. Corroborate with nursing staff and/or other caretakers. Confirmation of VS requires full assessment.

Independence at home:

2a. Is the assistance of another person at home essential every day for some activities of daily living?

◯ Yes ◯ No (VS) **If no: go to 3**

Note: for a NO answer they should be able to look after themselves at home for 24 hours if necessary, though they need not actually look after themselves. Independence includes the ability to plan for and carry out the following activities: getting washed, putting on clean clothes without prompting, preparing food for themselves, dealing with callers and handling minor domestic crises. The person should be able to carry out activities without needing prompting or reminding and should be capable of being left alone overnight.

2b. Do they need frequent help of someone to be around at home most of the time?

◯ Yes (lower SD) ◯ No (upper SD)

Note: for a NO answer they should be able to look after themselves at home up to eight hours during the day if necessary, though they need not actually look after themselves

2c. Was the patient independent at home before the injury?

◯ Yes ◯ No

Independence outside home:

3a. Are they able to shop without assistance?

◯ Yes ◯ No (upper SD)

Note: this includes being able to plan what to buy, take care of money themselves and behave appropriately in public. They need not normally shop, but must be able to do so.

3b. Were they able to shop without assistance before?

◯ Yes ◯ No

4a. Are they able to travel locally without assistance?

◯ Yes ◯ No (upper SD)

Note: they may drive or use public transport to get around. Ability to use a taxi is sufficient, provided the person can phone for it themselves and instruct the driver.

4b. Were they able to travel locally without assistance before the injury?

◯ Yes ◯ No

Work:

5a. Are they currently able to work (or look after others at home) to their previous capacity?

◯ Yes **If yes, go to 6** ◯ No

5b. How restricted are they?

a. Reduced work capacity? ◯ a. (Upper MD)

b. Able to work only in a sheltered workshop or non-competitive job or currently unable to work? ◯ b. (Lower MD)

5c. Does the level of restriction represent a change in respect to the pre-trauma situation?

◯ Yes ◯ No

Social and Leisure activities:

6a. Are they able to resume regular social and leisure activities outside home?

◯ Yes **If yes, go to 7** ◯ No

Note: they need not have resumed all their previous leisure activities, but should not be prevented by physical or mental impairment. If they have stopped the majority of activities because of loss of interest or motivation, then this is also considered a disability.

6b. What is the extent of restriction on their social and leisure activities?

a. Participate a bit less: at least half as often as before injury ◯ a. (Lower GR)

b. Participate much less: less than half as often ◯ b. (Upper MD)

c. Unable to participate: rarely, if ever, take part ◯ c. (Lower MD)

6c. Does the extent of restriction in regular social and leisure activities outside home represent a change in respect or pre-trauma

◯ Yes ◯ No

Family and friendships:

7a. Has there been family or friendship disruption due to psychological problems?

◯ Yes ◯ No **If no, go to 8**

Note: typical post-traumatic personality changes are: quick temper, irritability, anxiety, insensitivity to others, mood swings, depression and unreasonable or childish behaviour.

7b. What has been the extent of disruption or strain?

a. Occasional - less than weekly ◯ a. (Lower GR)

b. Frequent - once a week or more, but not tolerable ◯ b. (Upper MD)

c. Constant - daily and intolerable ◯ c. (Lower MD)

7c. Does the level of disruption or strain represent a change in respect to pre-trauma situation?

◯ Yes ◯ No

Note: if there were some problems before injury, but these have become markedly worse since the injury then answer yes to question

Return to normal life:

8a. Are there any other current problems relating to the injury which affect daily life?

◯ Yes (Lower GR) ◯ No (Upper GR)

Note: other typical problems reported after head injury: headaches, dizziness, sensitivity to noise or light, slowness, memory failures and concentration problems.

8b. If similar problems were present before the injury, have these become markedly worse?

◯ Yes ◯ No

9. What is the most important factor in outcome?

◯ a. Effects of head injury

◯ b. Effects of illness or injury to another part of the body

◯ c. A mixture of these

Note: extended GOS grades are shown beside responses on the CRF. The overall rating is based on the lowest outcome category indicated.
Areas in which there has been no change with respect to the pre-trauma situation are ignored when the overall rating is made

E. SAIL Matching

ALF status code explanation

F. Value	Meaning
1	NHS Number passes check digit test
2	NHS Number derived through external linkage, i.e. CRN match on PEDW
4	Surname, First Name, Post Code, Date of Birth and Gender Code match exactly to AR
35	Fuzzy Matching probability >= 0.5 & < 0.9
39	Surname, Post Code, Date of Birth and Gender Code match exactly to AR, First Name matches on Lexicon (known variants) or Fuzzy Matching probability >= 0.9
99	No match or Fuzzy Matching probability < 0.5

G.Dataset Descriptions

Dataset	Description
EMRTS	The EMRTS schema is comprised of three datasets: EMRTS_ALF containing the unique anonymised linking field (ALFs), week of birth, gender and person address aggregated at the Lower Super Output Area(LSOA) level; EMRTS_Operation containing both clinical incident information and non-clinical vehicle travel times
WAST (non GIS)	EMRTS_Destination contains the hospitals EMRTS conveyed to and time of arrival at hospital. Individuals can be linked to their health data in the below datasets held within the SAIL gateway at Swansea University.
Critical Care Network (CCN)	The CCN schema is comprised of four dataset: a separate ALF dataset; CCN_Clinical containing patients' clinical observations; CCN_Non_Clinical containing staff information involved in transferring patients and CCN_transfer containing the hospital transfer operational information.
TARN	The TARN schema is comprised of two dataset: a separate ALF dataset and a clinical dataset providing information on trauma hospital admissions who are Welsh residents or patients treated in Welsh units and whose incident occurred in Wales. Data includes injury type, injury

	severity scores; number and type of operations; times to theatre and time to CT/head CT
ICNARC	The ICNARC dataset contains patient clinical observations, treatments and procedures as well as duration and level of care received from English critical care units.
PEDW	PEDW contains information on all inpatient stay at NHS Wales hospitals. Welsh residents treated in English units are also included. This schema includes the duration of stay, admission type and status, reason for admission through ICD10 coding and discharge type and status. Further information: http://www.datadictionary.wales.nhs.uk/
Critical Care	The critical care dataset provides information on critical care received at NHS Wales hospitals. This includes information on bed level, length of critical care stay and organ support required. In addition it contains calculated physiological scores. Further information: http://www.datadictionary.wales.nhs.uk/
EDDS	The Emergency Department dataset contains data on patients attending NHS Wales Emergency Departments. This includes Emergency Department arrival

	timestamps, attendance aetiology as well as specific injury variables for injury causality. Further information: http://www.datadictionary.wales.nhs.uk/
GP	The GP datasets provides information from 76% of GP surgeries in Wales. The datasets contains information on patient registration, date of GP event and Read codes used to describe GP events.
Outpatient	The outpatient dataset contains information on outpatient appointments at NHS Wales hospitals such as date of attendance, consultant specialty and origin of referral. Further information: http://www.datadictionary.wales.nhs.uk/
WDS	The WDS contains information on Welsh residents such as week of birth, date of death, gender and residential address aggregated to LSOA level.
ONS Mortality	The office of National Statistics death dataset contains information on death circumstances such as the date or death and underlying causes of death.

Break down of patient groups by nature of incident

Patient group	Nature of Incident
Cardiac Arrest	Cardiac/Respiratory Arrest
Trauma	Animal bites/attacks Assault/Sexual assault Burns(scalds)/Explosion Traumatic injuries, specific Traffic/transportation accidents Stab/Gunshot/Penetrating trauma Drowning(near)/diving/scuba Electrocution/lightening Falls Haemorrhage/laceration Major incident
Maternal/Neonatal	Maternal/Neonatal
Transfer	Transfer Healthcare professional
Medical	Allergies(reactions)/envenomation Breathing problems Carbon monoxide/inhalation/hazchem Chest pain Choking Convulsion/fitting Overdose/poisoning(ingestion) Psych/abnormal behaviour/suicide Sick person-specific diagnosis Stroke-CVA Unconscious/fainting(near)

Break down of EMRTS stop code

EMRTS stop code groups	Stop codes
EMRTS	Patient treated by EMRTS, no reason to stop treatment/not attend incident
Died on scene	ROLE Policy Implemented Police dealing Patient deteriorated
Alternative pathway	Patient treated at scene Own transport after ambulance arrival Referred to other healthcare professional Referred to GP out of hours Referred to GP Referred to epilepsy pathway Referred to specialist practise
Other	Patient refused treatment after ambulance arrival Fire service dealing Information call only
Remove[1]	Duplicate Call Passed to another ambulance control Cancelled pre-arrival No patient found on scene Hoax/malicious

[1]Data grouped under remove were removed from analysis

Hospitals that EMRTS conveyed to and hospital classification

Hospital	Hospital group
Princess Of Wales Bridgend	District General Hospital
Southmead Hospital Bristol	Specialist Centre
Prince Philip Hospital Llanelli	District General Hospital
West Wales General Hospital	District General Hospital
Withybush Hospital Haverfordwest	District General Hospital
Hereford County Hospital	District General Hospital
Nevill Hall Hosp Abergavenny	District General Hospital
Victoria Memorial Welshpool	Minor Injury Unit
Birmingham Childrens Hospital	Specialist Centre
Heartlands Hospital Birmingham	Specialist Centre
Princess Royal Hospital Telford	District General Hospital
Royal Shrewsbury Hospital	District General Hospital
Worcestershire Royal Hospital	District General Hospital
Bronglais Gen Hospital Aberystwyth	District General Hospital
Cardiothoracic Centre Broadgreen	Specialist Centre
North Stafford Royal Infirmary	Specialist Centre
Singleton Hospital Swansea	District General Hospital
Ysbyty Gwynedd Hospital Bangor	District General Hospital
Whiston Hospital Prescot	Specialist Centre
Childrens Hospital Wales Cardiff	Specialist Centre
Welshpool Medical Centre	Minor Injury Unit
Dolgellau Hospital	Minor Injury Unit
Queen Elizabeth Hosptial Birmingham	Specialist Centre
Royal Gwent Hospital Newport	District General Hospital
University Hospital Of Wales	Specialist Centre
Walton Centre Fazackerley	Specialist Centre
Hospital To Be Confirmed	
Llandrindod Wells War Mem Hospital	Minor Injury Unit
Maelor General Hospital Wrecsam	District General Hospital
Derriford Hospital Plymouth	Specialist Centre

Alderhey Hospital Liverpool	Specialist Centre
Countess Of Chester Hospital	District General Hospital
Morriston Hospital Swansea	Specialist Centre
New Cross Hospital Wolverhampton	District General Hospital for trauma Specialist Centre for cardiac
Royal Glamorgan Hospital Pontyclun	District General Hospital
Univversity North Staff City Hospital	Specialist Centre
Ysbyty Cwm Cynon	Minor Injury Unit
Glan Clwyd Hospital Bodelwyddan	Specialist Centre for cardiac during 9am and 5pm
Prince Charles Hospital Merthyr	District General Hospital

Hospitals from dataset classified as major trauma centres for the purpose of analysis. [1]

- Morriston Hospital
- University Hospital Of Wales
- Cardiothoracic Centre Broadgreen, Whiston Hospital Prescot, Walton Centre Fazackerley, Alderhey Hospital, grouped as Liverpool
- Heartlands Hospital Birmingham, Queen Elizabeth Hospital, Birmingham Children's Hospital, grouped as Birmingham
- North Stafford Royal Infirmary, University North Staffordshire City Hospital, group as University North Midlands

[1] *N.B. at the time of writing there are no designated Major Trauma Centres in Wales, pending the formation of the South Wales Trauma Network. In North Wales, District hospitals are designated as Trauma Units, and form part of the North Wales and North West Midlands Trauma Network.*

TARN data

EMRTS 1st export

Dates: 1st January 2012 - 31st December 2015

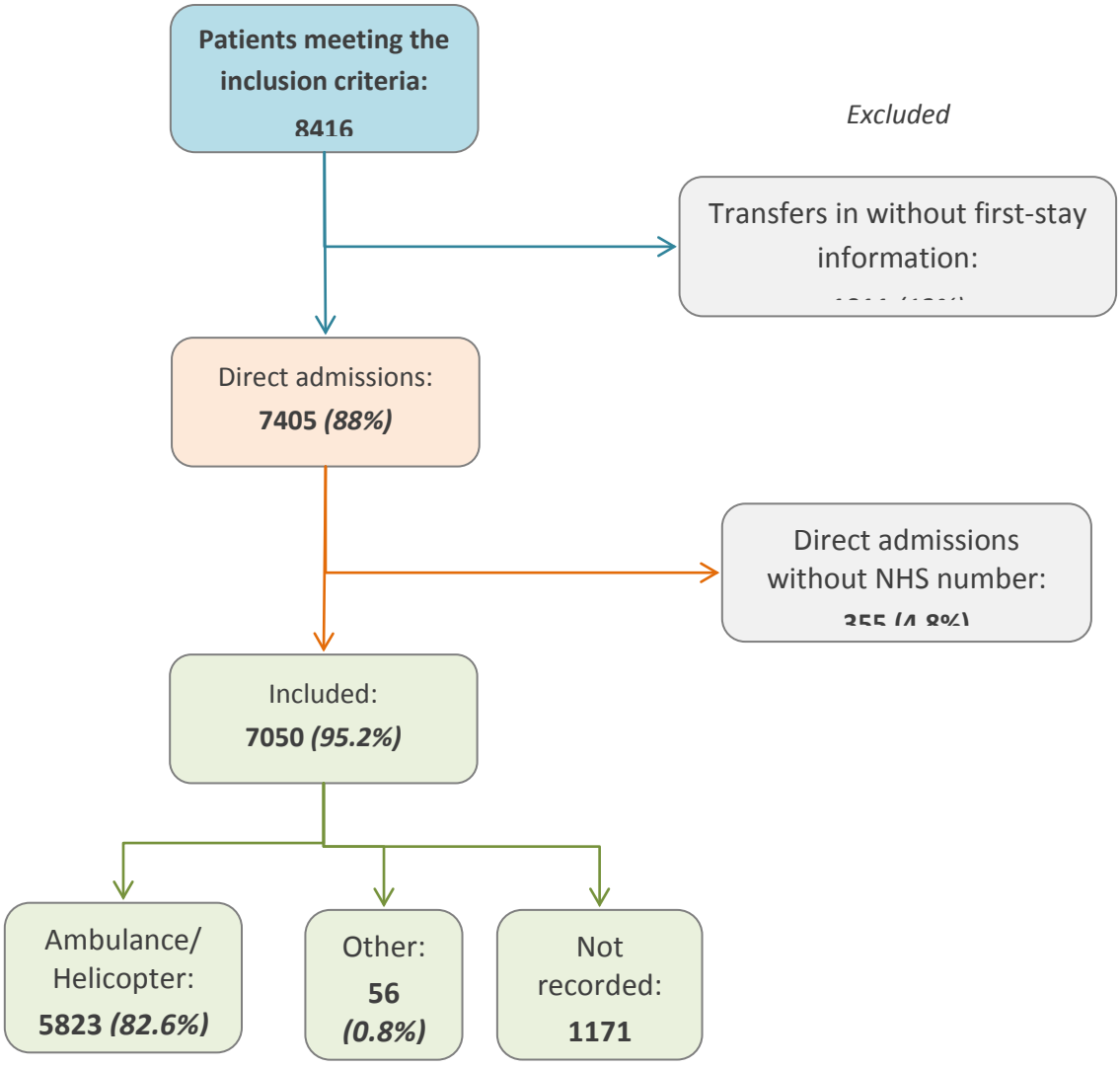
Inclusion criteria:

Patients that:

- were treated in Welsh units or
- were Welsh residents
- their incident occurred in Wales

* Welsh postcodes:

CF, LD, LL, NP, SA, SY



Critical care network dataset analysis

Summary table of initial exploration (next page)

ccn

H. Workshop Presentations

Evaluation Workshop

June 2016

Have your say

Plan for the Day

- Evaluation Overview
- EMRTS update
- Workshops
  - Presentations
  - Group discussions
  - Feedback

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Evaluation

- Measurable Benefits Register
  - Equity
  - Health Gain
  - Clinical & Skills Sustainability
- Swansea University
- Stakeholder Engagement

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Evaluation

- Quantitative/ Qualitative
- 1 & 3 Year Cycle
- SAIL Data Linkages
  - TARN
  - ICNARC
  - EDDS/ GP/ CCMDS/ WDS/ HES
- WAST Datasets

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SERVICE UPDATE

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Mission Statement

"To provide advanced decision-making and critical care for life or limb-threatening emergencies that require transfer for time-critical specialist treatment at an appropriate facility"

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Timeframes

2014
- Strategic Outline Programme
- Approved September

2014
- Business Justification Cases
- Approved December

2015
- Go Live
- 27th April

£1.895 Million Capital
£2.868 Million Revenue

A Recap – The Service

08:00 – 20:00 Daily

Clinical service model:
- Pre-hospital critical care (all age groups)
- Time critical adult/paediatric retrieval
- Maternal/neonatal care
- Major incident response

Supported by:
- Air Support Desk
- Top Cover Consultant

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Where are we?

- Service specification
  - Clinical
  - Workforce
  - Operational

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What's Outstanding?

- Car conveyance
- Helipads
- Incubator

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Year 1
27th April 2015 - 27th April 2016

- Takings via ASD= 1917
- Attendances (patients) = 1285
- 3.8 patients per day
- 72% Helicopter response
- 13:00 peak time

- Male 69%
- Female 31%
- Age range 0-97
- Median age 47
- 16% paediatric (under 17)

Category	
TRAFFIC/TRANSPORTATION ACCIDENTS	29%
CARDIAC/RESPIRATORY ARREST	16%
Trauma- Other	13%
FALLS	12%
TRANSFER/ Health Professional admissions	8%
UNCONSCIOUS/ Fitting	8%
CHEST PAIN	6%
Medical- Other	3%
BREATHING PROBLEMS	2%
BURNS(SCALDS)/EXPLOSION	1%
STROKE - CVA	1%
Maternity/ Neonatal	1%

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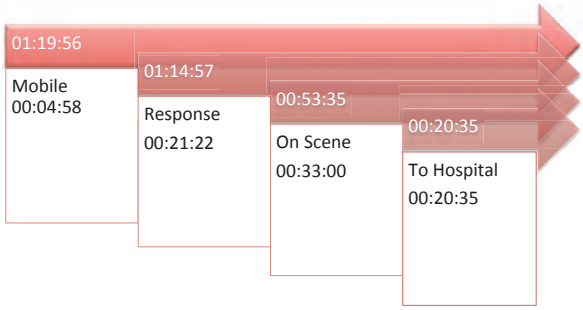
Median Timings (HH:MM:SS)



On Scene

- 55% Trauma
- 45% Medical
- 150 Emergency Anaesthetics
- 47 Blood product transfusions

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What?

- 1183 Primary Missions
- 102 Inter-hospital Transfers/ Health care professional admissions

EVALUATION- MEASURABLE BENEFITS

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Measurable Benefits

- Equity
- Health Gain
- Clinical and Skills sustainability

Measurable Benefits

EQUITY

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Equity

– Access to specialist care not available at patients nearest acute hospital
– Timeliness of access to specialist care for all patient groups

Mapping

- WAST Dataset
- EMRTS Dataset
  – 2014/2015
- 300,000 records relating to ambulance responses

- Swansea University
- Dr Richard Fry

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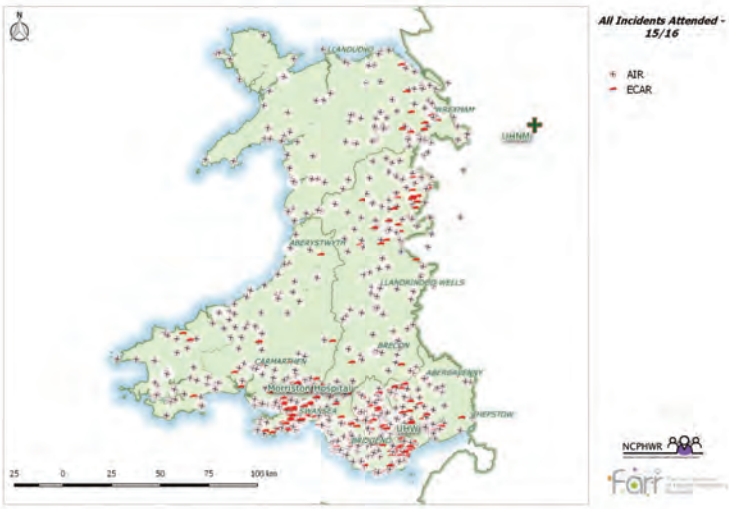

Critical Care Interventions

- Consultant decision-making
- Emergency anaesthesia
- Intraosseous (IO) access
- Advanced drugs (outside JRCALC)
- Use of epistats and bite blocks
- Surgical airway
- Central venous access
- Use of vasopressors/inotropes
- Pelvic splintage
- Procedural sedation
- Sedation and paralysis
- Advanced warming techniques (neonates)
- Limb splintage
- Finger thoracostomy
- Administration of blood products
- Dedicated pressure dressings
- LUCAS 2 external compression device
- Post cardiac arrest care bundle
- Resuscitative thoracotomy
- Acute reversal of anticoagulation
- Tourniquets and haemostatic agents
- IV antibiotics in neonates

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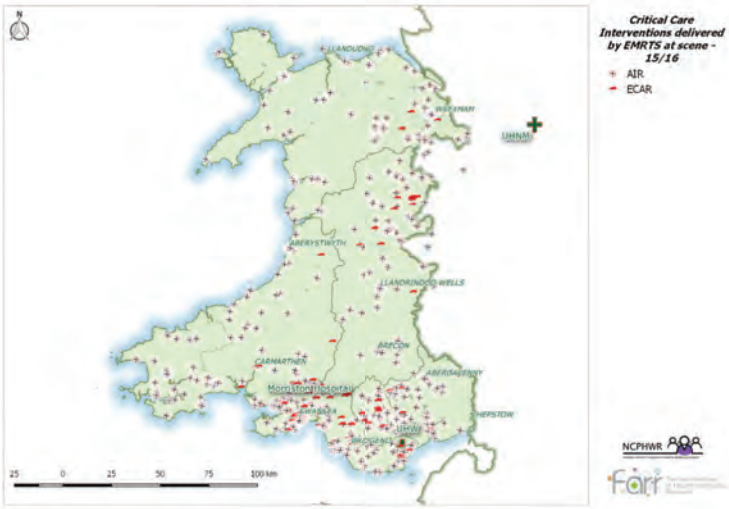

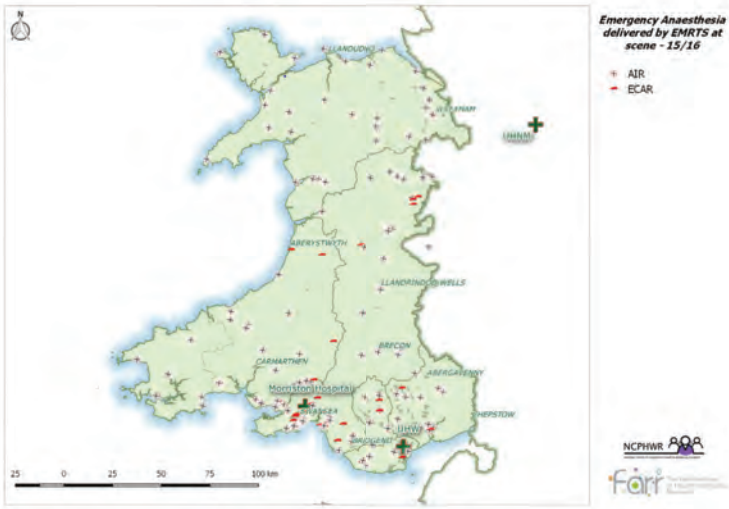

Cardiac Arrest/ Post ROSC

At scene within 60 minutes from 999

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Medical

Within 60 minutes of call

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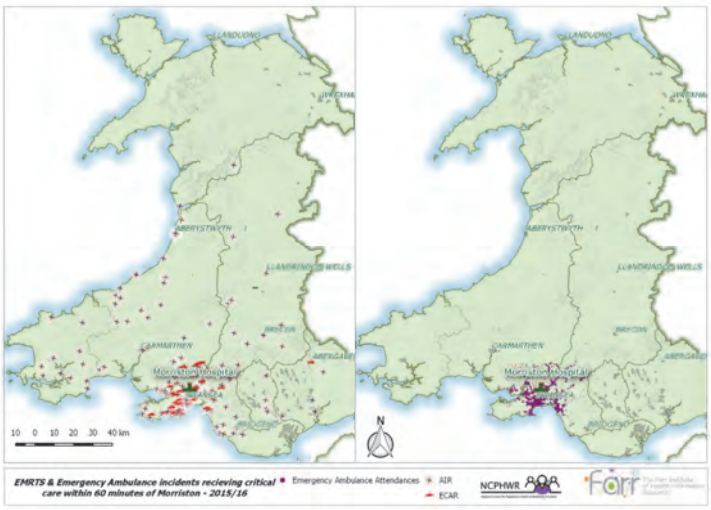

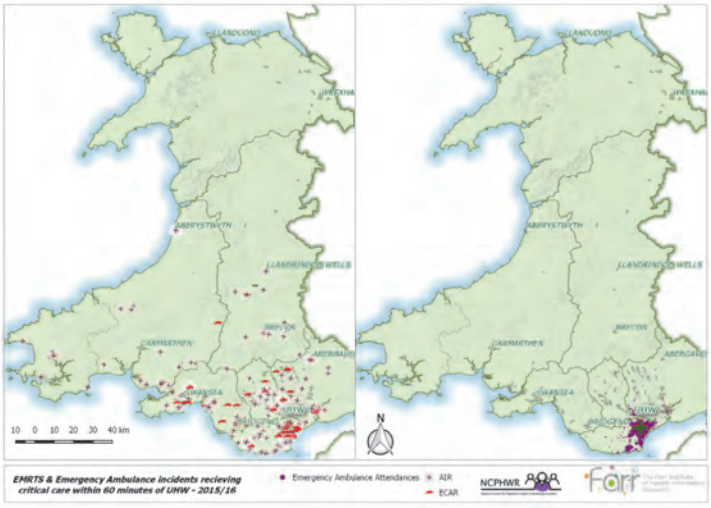

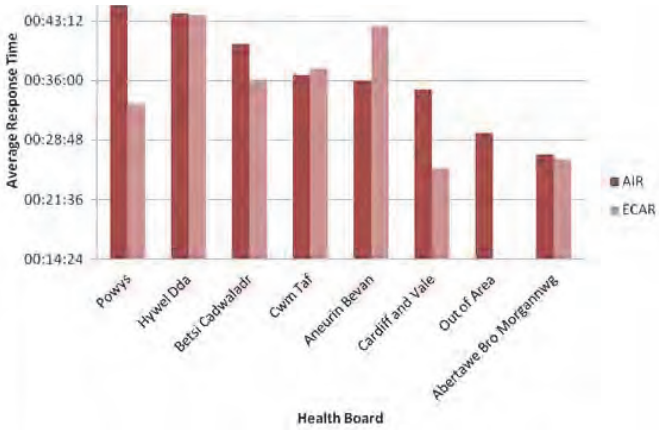

Equity

Discussion

- Do you feel that the Service provides equity of care to:
  - Urban areas
  - Rural areas
- Consider NW and out of operational hours

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Measurable Benefits

HEALTH GAIN

Health Gain

- Mortality
- Morbidity
- Unexpected survivors
- Length of Intensive care and hospital stays
- Down stream benefits
- **Perception of Health Gain**

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Critical Care Interventions - 50%

- Consultant decision-making
- Emergency anaesthesia
- Intraosseous (IO) access
- Advanced drugs (outside paramedic practice)
- Use of epistats and bite blocks
- Surgical airway
- Central venous access
- Use of vasopressors/inotropes
- Pelvic splintage
- Procedural sedation
- Sedation and paralysis
- Advanced warming techniques (neonates)
- Limb splintage
- Finger thoracostomy
- Administration of blood products
- Dedicated pressure dressings
- LUCAS 2 external compression device
- Post cardiac arrest care bundle
- Resuscitative thoracotomy
- Acute reversal of anticoagulation
- Tourniquets and haemostatic agents
- IV antibiotics in neonates

Interventions

- Critical care – 50%
- Emergency Anaesthesia 12%
- Blood and Blood products 3.7%

PRODUCT USED	TOTAL QUANTITY
Packed Red Blood Cells	96 units
'LyoPlas'	82 units
Fibrinogen Concentrate	7g
Prothrombin Complex Concentrate	10,500IU (5 uses)

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Operation Vampire – Results So Far

INDICATION FOR USE	TOTAL
Traumatic cardiac arrest (Penetrating)	1
Traumatic cardiac arrest (Blunt)	15
Critical hypovolaemia (Penetrating)	3
Critical hypovolaemia (Blunt)	22
GI bleed	1
Anticoagulation reversal	5

Survived to arrival in hospital	**70% (33/47)**
Died on scene	**30% (14/47)**

The Farr Institute of Health Informatics Research
Swansea University Prifysgol Abertawe
SAIL DATABANK

PATIENT FLOWS

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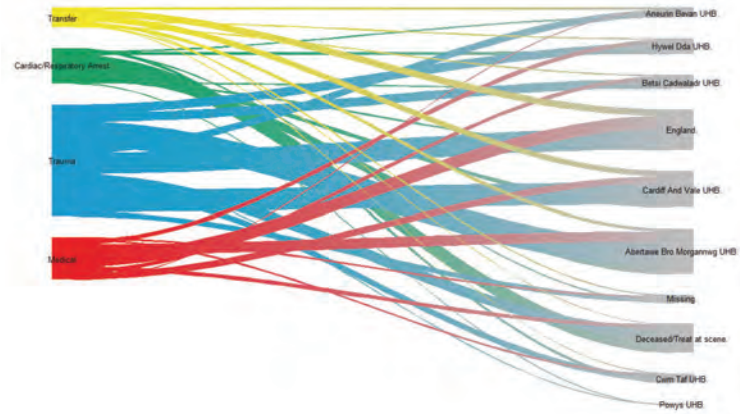
Incident location to definitive care location, by health board.

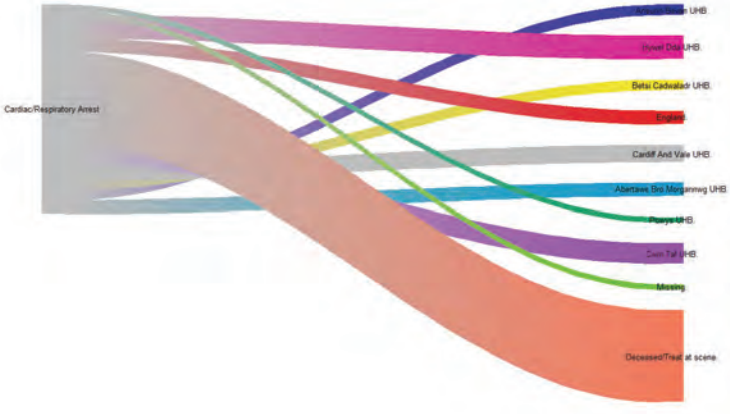
Incident group to definitive care, by hospital.

Incident group to definitive care, by health board.



NON ABMU or C&V cardiac/respiratory arrest incidents by destination

NON ABMU or C&V cardiac/respiratory arrest incidents by destination



CASE STUDIES

179 Cases

Primary Incidents

- Access times
- Avoidance of a secondary transfer

Secondary Incidents

- Timeliness of transfer to specialist Centre
- Avoids depleting local hospital resources

Location: Llandudno
Male, 30's
Cyclist, collided with a wall

Unconscious at scene
Head Injury

Broken skull, ribs and a bleed on the brain

- Emergency anaesthesia delivered at the scene
- Arrived in Stoke within 3 hours of 999 call
- Secondary transfer avoided
- Discharged to local hospital at 15 days

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Emergency Medical Retrieval & Transfer Service
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Location: A494 near Bala
Male in 50's
Motorcyclist

Right chest injury and severe haemorrhage from partially amputated right lower leg

- Emergency anaesthesia
- Tourniquet
- Haemostatic dressing, pelvic binder
- Right thoracostomy

- Hypotensive and lost radial pulse *en route*

- Given 2U's PRBC and 2 bottles 'LyoPlas'
- Air transfer to Royal Stoke University Hospital

OUTCOME

- Improvement in blood pressure, and blood gasses
- Required 6U PRBC and 6U FFP in theatre
- Had AE amputation and ex fixation followed by definitive repair
- Full neurological recovery

- Rapid access to critical care and onward transfer
- Avoidance of Secondary transfer

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Location: North Wales
Male, 10
Car passenger

Multiple casualty incident
Head injury

- Emergency anaesthesia
- Controlled ventilation
- Neuroprotective measures

- Flown to Alderhay for specialist trauma care

OUTCOME

- Discharged home and doing well
- Favorable neurological outcome

- Timeliness of access to care
- Change in journey

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Transfer

20's, Male, fallen from moving vehicle
Taken to Bangor – early hours

Head injury in need of neurosurgical care

Intubated and ventilated, accepted for transfer to UHNM

- Received consultant level care
- Neuroprotective measures
- 40 minutes transfer
- Underwent neurosurgical intervention
- Base of skull fracture
- Bilateral subdural hematomas
- Discharged to specialist rehab
- Avoidance depletion of local resources
- Senior level of care
- Rapid air transport (vs 2 hour road transfer)

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247 Cases

Primary Incidents

- Access times
- Avoidance of a secondary transfer

Secondary Incidents

- Timeliness of transfer to specialist Centre
- Avoids depleting local hospital resources

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Location: Minor Injury Unit

Male, presented with chest pain

Suffered cardiac arrest in unit

- Full Advanced Life Support
- Use of external compression device
- Advanced diagnostics including ECHO

OUTCOME

Unable to restore circulation

Consultant level decision making in remote healthcare facilities " a mobile intensive care unit"

- Timeliness of access to care
- Avoidance of hospital transfer
- Ability to facilitate critical care and onward transfer in the event of a return of spontaneous circulation

Location: Llanidloes

Male in 50's

Waste site operative Crushed by industrial digger bucket

Bilateral lower limb fractures and catastrophic haemorrhage

Traumatic cardiac arrest

- 4x Tourniquets
- Pelvic binder
- Intubation
- Thoracostomies
- 4 Units Blood
- 4 Units Lyoplas

- Return of spontaneous circulation
- Flown, and then road transfer to UHNM

OUTCOME

- Ongoing tranfusion in hospital
- Bilateral above knee amputations
- Full neurological recovery
- "Unexpected Survivor"
- Timeliness of access to care
- Change in journey

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Additional benefits observed

- RVP of local ambulance crews at airbase
  - Ability to fly during hours of darkness to tertiary centres
  - Early assessment by consultant team
  - Ability to provide advanced interventions and onward transfer
- Mobile resuscitation and intensive care team

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225 Cases

- Double Transfer at 18:30
- 2x intracerebral bleeds
- UHW
- 2x helicopters to Haverfordwest HLS

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111 Cases

- Usk
- Collision with tree down side of valley
- Unconscious, low blood pressure
- Blood and Lyoplas transfusion
- Anaesthesia
- Surgery to chest
- Flown to UHW
- Her story.....

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SARAH'S STORY

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GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Caerdydd a'r Fro
Cardiff and Vale University Health Board

87 Cases

- Young competition trampoliner
- Open fracture of ankle
- Limb threatening
- Extremely painful
- Procedural sedation given
- Reduction of fracture
- Prevention of limb loss
- Taken to hospital for definitive treatment

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GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Cwm Taf University Health Board

89 cases

- 11 year old boy
- Mountain Ash
- Walking to school
- Hit and run by motorcycle
- Unconscious
- Anaesthesia at scene
- Rapid transfer to UHW for specialist care
- Multiple bleeds on brain
- Now in rehabilitation

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GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Cwm Taf University Health Board

Neonatal Case

- Treorchy
- Home Birth - premature
- Team flown within 30 minutes of call
- Neonatal life support given
- Bypass of local hospitals to definitive care

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GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Abertawe Bro Morgannwg University Health Board

289 cases

- Young Lady in Morriston Hospital
- Heart attack
- Cardiogenic shock
- Specialist aortic balloon pump
- Team flown to hospital from Welshpool
- Road transfer to Birmingham for surgery

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Sonali, 47 years old

Crushed by a car at low speed

Significant left sided chest injury

Emergency anaesthesia

Thoracostomy

Road transfer from Porthcawl to Morriston

Deteriorated en-route

- Given emergency blood and plasma transfusion en-route
- Improved blood pressure
- Mutiple rib fractures, haemopneumothorax
- ICU/ Fixation of ribs
- Full recovery
- Returned to work @ 12 weeks

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Sonali

Health Gain

Discussion

- Do you feel EMRTS provides enhanced health gain?
- Pre hospital
- Transfers
- Neonatal/ Maternity
- Areas to cut back on?
- Areas to expand on?
- Feedback

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CLINICAL AND SKILLS SUSTAINABILITY

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Clinical and Skills Sustainability

- Increased consultant appointments especially in emergency medicine, anaesthesia, critical care
- Increased educational interventions to doctors/ paramedics / nurse practitioners / midwifes
- Increasingly providing support to colleagues across ambulance and health boards

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Workforce

- Critical Care Practitioners
  - 90 applicants
  - 12 posts filled
  - 2x Nursing background
  - 30% from outside of Wales
    - CTL
    - Educational lead
    - ASD

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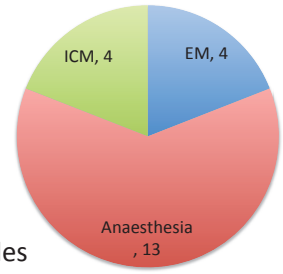
Workforce

- Consultant
  - 35 applicants
  - 19 posts filled initially
  - 21 in post currently
  - 2 new EM consultants to Wales
  - 2+ sessions per week



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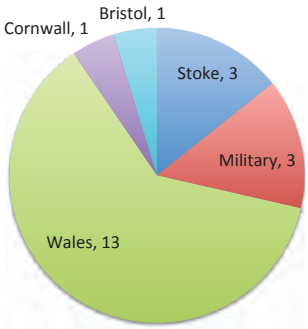
Consultant Base Hospital



Consultant/ Medical Workforce

- Hosting PHEM Trainees x2
- Observer shifts - future workforce
- HB adverts/ joint jobs
- Sustainability

NHS Jobs

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Training

- 2 week accelerated training programme
- 50+ simulated moulages
- Comprehensive sign off process
  - 2 days advanced neonatal training and placement
  - Welsh Blood Service training
  - Competency packs / 360 feedback
  - Supervised shifts
- Resilience training

ENGAGEMENT

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Engagement

- Day-to-Day on scene / next day follow-up calls
- Open Monthly Governance Days
- Training
- 95+ recorded events
- Ongoing events

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Engagement

- Local
  - WAST
  - Health Boards
  - Emergency services
    - Search and Rescue
    - Police
    - Fire

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International Audience

Discussion and Feedback

Clinical and Skills Sustainability

- Now?
- The future?
- Areas to expand on?

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SUMMARY AND CLOSE

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