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# **Technology Enhanced Learning in Emergency Medicine**

**2018**

**Simon David Carley**

**A thesis submitted in partial fulfilment of the requirements of the Manchester  
Metropolitan University for the degree of Doctor of Philosophy by Published Work  
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**Faculty of Health, Psychology and Social Care**

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**Manchester Metropolitan University**

# **Technology enhanced learning in emergency medicine**

**Prof. Simon Carley**

**MB. ChB, DipIMC (RCS Ed), Dip Med Ed, MPhil, MD, FFAEM, FHEA,  
FAcadMEd, FRCM**

Consultant in Emergency Medicine, Manchester Foundation Trust.

Associate Dean, Health Education England (North West).

Visiting Professor, Manchester Metropolitan University.

Education Associate, General Medical Council

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### 1.3 Abstract

Education is integral to the practice and delivery of Emergency Medicine in the UK. The staffing structures, the complexity of the workload and the need to deliver a service 24-hours a day require a high-quality learning environment.

This thesis describes my work in using web-based technologies to enhance the learning experience of emergency medicine trainees and consultants. It describes three overlapping themes of innovation.

Theme 1 describes the development of the BestBets approach to evidence-based medicine in emergency care. The papers and websites presented describe how the principles of evidence-based medicine were adapted, developed and published to provide a practical and pragmatic approach suitable for the acute care environment.

Theme 2 describes how Virtual Learning Environments provided a solution to the challenges of teaching and learning with a chronologically and geographically distributed workforce.

Theme 3 describes how I have used the latest social media technologies to enhance learning on a global scale. It describes how local learning can be shared amongst a diverse range of learners using social media tools. This theme charts how my projects on the St. Emlyn's platform have advocated for the Free Open Access Medical Education movement. It also describes how I have created a symbiotic relationship between modern and traditional publishing mechanisms to promote the academic outputs of local and international publishing collaborations.

In this thesis I describe the narrative of educational development alongside and in some cases in the mutual support of technological innovation. I reflect on the strengths and weaknesses of the learning narrative and also on the methodological approach to the analysis of the three main themes.

Central to my work is how I have developed my skills to now lead the social media projects for the St.Emlyn's group and in the establishment of my recognition as a leader in the area of technologically enhanced emergency medical education.



## 1.4 Acknowledgements

This thesis would not have been possible without the support and advice of a number of colleagues, family members and friends. I am also extremely grateful for the academic and pastoral support I have gained through engagement with colleagues across the world in the evolving online community of medical education. I would particularly like to thank the following people:

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## 1.5 Chapter 1. Introduction

### 1.6 Layout of this thesis

This PhD by publication is a route 2 submission which differs from my previous submissions for higher degrees. It is a review and critique of my work in the field of medical education over the last 20 years. It charts how technology has influenced, and in many cases enhanced, the experience of medical education for clinicians primarily training and working in emergency medicine. Where the work impacts on other allied specialties such as critical care, anaesthesia, acute medicine, paediatrics and prehospital care I have highlighted this. The themes discussed in this thesis are viewed from an emergency medicine perspective since that is my own, but these themes have a clear synergy with implications for allied specialties and professions.

I chose to produce this work to not only describe and consolidate my learning journey but also to contextualize my more recent research and activity in the use of social media for medical education. This more recent work illustrates how I have maintained an interest in technological enhanced learning over many years and describes how I continue to innovate in this area. The most recent projects using #FOAMed and Social Media based learning represent the current cutting edge of emergency medicine education at the time of writing, just as the prior projects in BestBets and Virtual Learning Environments were cutting edge topics in their time. This thesis will explain how new technologies evolve and adapt in tandem with the educational culture and practice of the time.

The structure of a PhD thesis by publication is perhaps less well established than the traditional PhD and as such I have taken advice from colleagues at Manchester Metropolitan University (MMU) in developing a structure that reflects the narrative nature of the work.

The introduction follows a familiar theme of setting the scene and describing the background to the peculiarities of education in emergency medicine, challenged as it is by chronology and geography. Chapter 2 presents the key

publications and narratives that encompass the major part of this thesis. I have chosen to critique each element separately initially, but then bring these together in an overall critique of technology enhanced learning in emergency medicine before drawing final conclusions and discussing the next steps in research and education.

Since much of my work has been conducted at the interface of emerging technologies the traditional model of paper publication has not always been the best, the most appropriate, or even a possible method of knowledge dissemination. As a result, the publications and artefacts in this thesis are varied in their presentation, format and accessibility. I have incorporated multi-media and technologically enhanced elements into the thesis such as links to websites, blogs, podcasts and presentations. In a thesis that advocates the use of technologically enhanced education it seems natural and appropriate to demonstrate the integration of the old and new technologies together. An experience which typifies the lived experience of modern learners and educators.

#### **1.6.1 Reference formatting.**

I have chosen to present the thesis with references in the Vancouver style as opposed to the Harvard referencing which is recommended in the university regulations. The decision to reference in this style is in order to reflect the form of referencing used in the artefacts presented. All the articles presented in this thesis are published in journals that use the Vancouver style. As these articles are reproduced in their entirety within the thesis it is appropriate for the referencing style to remain consistent throughout.

#### **1.6.2 A note on declaration of authorship**

This thesis requires the production of documents to outline the relative contributions of multi-author papers. Multi-author papers are more common in medicine than in other academic disciplines. All of the papers presented are typical of medical publications in that none are sole authorship. There is a range of author numbers from 2 to 12 authors.

The publications produced as artefacts in this thesis are truly multi-authored with varying contributions from co-authors and collaborators. For those published in peer reviewed journals then all such papers have met the ICJME criteria for authorship as part of the submission process for journals(1,2). For artefacts such as websites, blogs and podcasts then I have applied the principles outlined below.

The assessment of authorship asked in the PhD submission is different to that typically required of a journal submission and it does not naturally fit with non-peer reviewed journal submissions. The RDPUB forms ask for a percentage contribution figure which is a challenging and arguably reductionist approach. The global assessment of percentage contribution presents challenges to multi-author papers and projects as described here.

Percentage contributions are difficult to accurately determine owing to the complex nature of medical studies from conception through to publication. The many elements will all have differential contributions (for example one individual may be heavily involved in data analysis, but they may have a much lesser role in drafting the final publication).

Similarly, the assessment of contribution to each individual element of contribution is in itself arbitrary as there is, for example, no agreed determinant of percentage of time spent reviewing an article prior to submission.

Although it would be possible to attribute scores to each author and each element of contribution to the project, perhaps as a matrix of contribution percentage (a subjective assessment) against different elements of each project (which is again subjective) to produce a percentage score, it would arguably be meaningless in that it would simply be an amalgamation of estimates.

I have spent some time in discussion with academics at MMU and elsewhere with regard to how to divide and attribute the amount of work for each artefact provided. This is an incredibly challenging question, which, for the reasons described above would provide a number that I could not legitimately defend as accurate or precise.

After discussion with academics at MMU I have allocated authorship as follows.

1. In cases where small numbers of authors exist, and where they have all been substantially involved in all elements of the paper/artifact from conception through to publication I have simply divided the total percentage contribution by the number of authors. This almost certainly under-estimates my overall contribution, but it is pragmatic and reflects the fact that every paper required contributions from the listed authors.
2. In papers where I have taken a substantial lead in development and writing I have attributed a higher value in agreement with co-authors (e.g. most recent paper in Postgraduate Medical Journal(3)).
3. In artifacts where the prime reason for inclusion is the development of the process I have attributed contributions to those who have led the design, development and editorship of the projects (e.g. Authorship of the St. Emlyn's blog(4)).

The order of authorship in the presented papers has limited association with the relative contribution of those named. In general, the first and last authors are regarded as the most important authors on a paper, but in the early days of my academic career the approach was to list authors in descending order of leadership. I have taken this into account when attributing contributions in the manner described in points 1-3 above.

Not all authors are signatories to the authorship forms in this thesis. Recent guidance from the Head of Faculty Research Degrees has clarified this matter. The guidance states that where there are 3 or 4 co-authors at least two signatories are needed, and where there are 5 or more co-authors at least 3 signatories are required. I have fulfilled these criteria for all the artefacts presented in this thesis.

Gaining clarity and organising the receipt of assessments and the RDPUB forms has been a challenging but worthwhile enterprise. I am confident that the statements provided in this thesis recognise my contributions to the various projects and demonstrate my continued involvement in technology enhanced education in emergency medicine over a sustained period of time.

## 1.7 Chapter 2: Emergency Medicine

Emergency medicine is a specialty characterised by the need to provide timely assessment and care to patients across a broad range of presentations and pathologies. Emergency physicians are primarily based in emergency departments that function 24 hours a day, and on every day of the year.

Emergency Medicine is still considered a relatively young specialty. In the UK the specialty of emergency medicine emerged out of the casualty departments attached to hospitals. These were small departments that were often annexes to the main part of the hospital. They were typically staffed by junior staff from the medical and surgical specialties (5). The care was variable, and in many cases sub optimal, with little senior oversight and no accredited specialists. Early departments focused on the care of patients with traumatic injury as opposed to medical problems (6). Typically this occurred in departments adjacent to or within hospitals (7), but occasionally in dedicated hospitals, notably the Birmingham Accident Hospital which might be considered a precursor of a modern trauma centre (8).

In the UK the first consultant in what would now be recognised as an emergency department was Maurice Ellis who was appointed in Leeds in 1952 (6,9,10). The work of the casualty departments at that time can be imagined by examining contemporaneously published texts such as the Casualty Officers' Handbook published by Maurice Ellis (11). In this, and in other texts of the time, the work of the ED can be seen to primarily surgical and traumatic. This is in contrast to the modern emergency department where a much greater component of the workload is medical, paediatric and other associated specialities.

The need for a comprehensive over-hall of emergency services and the requirement to develop a role for specialists was increasingly recognized in through the 1950s and 1960s culminating in the publication of the Platt report in 1962 (12,13). The Platt report outlined a reconfiguration of departments, training and supervision to improve the care of patients presenting with medical and surgical emergencies. It placed a responsibility on the NHS to

provide adequate services to the people of the UK and arguably secured the future of emergency medicine services in the UK up until the present day.

The specialty of what is now known as emergency medicine was formed as a professional organization in 1967 with the first meeting of the Casualty Surgeons Association (CSA) at BMA house (10). This was an important step in that it identified and recognised a group of specialists with an interest in emergencies. Up until that time departments were staffed primarily by rotational or itinerant staff who did not have the structures or support to develop themselves or the speciality in a co-ordinated manner. The CSA brought together a small group of self-declared specialists who formed the nucleus of knowledge and support that has subsequently developed into the speciality we see in the UK today.

The name emergency medicine was adopted in 1999 when it changed from 'Accident and Emergency' to simply 'Emergency Medicine' to bring the terminology in line with the rest of the world and to reflect the increasing role in assessing and treating all emergencies and not those resulting from accidental injury (14,15).

The College of Emergency Medicine was established in 2006, with a Royal Charter being awarded in 2008 and then finally the permission to be use the title Royal College of Emergency Medicine in 2015.

A similar story took place internationally. Broadly speaking the US, Australia, Canada and the UK were early adopters of emergency medicine(16). In the US the American College of Emergency Physicians was established in 1969 and the speciality was officially recognised by the American Medical Association in 1972. Emergency Medicine is now well established in the US with a much greater proportion of accredited specialists in practice but it is similarly regarded as a relatively young speciality in many countries (17-20). In many lower and middle income countries emergency medicine is yet to establish itself as a recognised or resourced speciality (21).



### 1.7.1 The relationships and position of Emergency in modern healthcare economies.

In 2017 the Royal College of Emergency Medicine, the lead organization for the speciality in the UK celebrated its 50<sup>th</sup> Anniversary with a series of events and publications (5). After 50 years, the establishment of a college and the award of a Royal Charter the speciality appears to be well established, but this apparent permanence must be compared against other more established and well-connected specialities. For example, in the year that that RCEM celebrated its 50<sup>th</sup> anniversary the Royal College of Physicians celebrated their 500<sup>th</sup> year anniversary (22). This difference in perceived permanence and influence still affects the political, clinical and financial relationships of the college, and it also influences the standing of the speciality in day to day working practice. For many emergency physicians the concerns about recognition as a distinct speciality are a real and lived experience (14). In education this can manifest itself through the dismissal of expertise gained in the emergency department at the expense of culture and practice suggested by more well established specialities (15).

Examples abound of inter-speciality differences which reflect the hierarchical nature of clinical practice. In EM the most obvious and arguably the best researched is that of who should deliver anaesthetic skills in the emergency department. Long running debates and publications have argued for and against the acquisition and maintenance of airway skills by emergency physicians (23-28). From an evidence-based perspective there appears to be good evidence that trained emergency physicians can deliver advanced airway management, but despite the evidence the debates continue. These debates, which are increasingly conducted through social media platforms, rarely centre around patient care but are arguably underpinned by custom, practice, protectionism and professional pride on all sides. Educationally these issues are important. Without a long heritage and established evidence base for emergency medicine the speciality has had to find ways to create its own knowledge and to disseminate this from a position of authority. For many years the speciality derived its evidence from practice by acquiring relevant aspects of other specialities curricula. It is only recently, arguably in the last 20 years, with the development of research programmes and specialist

publications, that the speciality has begun to create and maintain its own evidential base for practice. This evolution has been a significant challenge for clinicians and educators and continues to be so.

The role of education within emergency medicine education is especially important owing to the current staffing structures within the UK. Within our health economies much of the work in emergency departments is delivered by relatively junior doctors (22,23) with consultant cover typically being absent and unavailable for direct clinical care for significant periods of time, especially during periods of time outside of the typical 9-5 working week (29). It then follows that the mechanism by which accredited emergency medicine specialists can deliver care must be through the more junior non-specialist workforce. In order for that to be safe and effective then the mechanism to deliver this must be through educating them in how to work in the emergency department. Such pyramidal structures of staffing seniority have always existed in emergency medicine and whilst they are currently improving with the expansion in consultant numbers in the UK (30), the demand on departments has similarly increased such that the pyramidal nature (small numbers of accredited emergency medicine specialists atop larger groups of junior doctors and allied health professionals) has continued. This has led to concerns and plans to secure a workforce that increasingly is perceived to have recruitment and retention difficulties (31-34). The stresses of emergency medicine training are not unique to the UK (35-37), with, for example, emergency medicine topping the league of specialities experiencing burnout in the US(38). Arguably the stress and burn out rates may reflect the pyramidal staffing structures and high workloads in emergency medicine, which whilst not unique to the speciality, they are arguably worse as compared to other UK specialities. This was highlighted in a report by the General Medical Council (GMC) looking specifically at pressures in emergency medicine and their impact on training in the UK (39). I was a member of the GMC team that wrote this report.

In many UK departments the majority of patients will be seen, assessed and discharged/assessed by doctors in their first 5 years of training, often with no

previous emergency medicine experience and frequently out of hours without direct consultant supervision. This junior workforce is required to deliver care across every hour and every day of the year. Thus the challenge of educating a workforce which is chronologically and geographically disrupted has proved extremely difficult(40) with work pressures affecting the amount of perceived teaching time junior doctors receive (41,42). Much interaction and teaching occurs in the clinical setting through the discussion of clinical cases in a one to one(43) or in semi-formal board round (44) (or more commonly as part of handover) events. This is increasingly a challenge in a high activity environment (41-43). The traditional idea of teaching taking place with the model of a weekly face-to-face tutorial for all clinicians is simply impossible in a modern day emergency medicine service (45).

The question of what to teach is similarly challenging. Emergency medicine is a diverse specialty that requires clinicians to be able to initially assess and manage any condition that may present to the emergency department. It is simply impossible to present and acquire all the knowledge required to practice EM in a short period of time, especially as it is expected that junior doctors will start seeing patients in the ED within 1-2 days of starting their training in that speciality. Whilst they will bring transferrable skills from past posts it is extremely challenging to provide adequate training before new starters are expected to work competently. The need to rapidly induce clinicians into practice is not unique to emergency medicine, but it is compounded by the 24-hour nature of the speciality and the fixed rotation dates that typify UK junior doctor training (46). The effect of these constraints on the timing and delivery of teaching requires teaching for the most junior clinicians to be initially targeted on common and high-risk presentations. For more senior trainees and consultant clinicians the challenge is to develop and maintain them as future experts in the speciality.

Expertise in the speciality of emergency medicine may be difficult to define precisely, but as a proxy, the completion of specialist exams and the award of the Fellowship of the Royal College of Emergency Medicine is a widely held standard. In the UK this requires a minimum of 8 years postgraduate training

to complete a certificate of completion of training (CCT) or equivalent(47). These standards can then permit the clinician to take on a substantive role as consultant in emergency medicine.

All these factors, notably the time to train, rotations, supervision and workforce mean that education is an essential component of ensuring patient safety in emergency departments. For the foreseeable future patients in UK emergency departments will be seen, assessed and discharged by non-specialist junior doctors. It is therefore essential that education strategies and techniques exist that can circumvent these challenges if patients are to receive high quality care. However, as I describe in more detail later in this thesis, the 24/7 nature of emergency medicine also makes the practice of teaching and learning especially difficult. It is virtually impossible to organise large face to face educational meetings whilst also running a service that never sleeps.

Finally, there are the challenges of keeping up to date and at the cutting edge of a specialty as broad as emergency medicine. It is widely accepted that the time taken for high quality research being available in print to its delivery at the bedside is staggeringly prolonged. The time lag is referred to as the knowledge translation gap and is reported in time scales of 'years'(48,49), this lost years represent significant lost opportunities for the improvement and enhancement of patient care and outcomes.

### **1.7.2 The challenge of delivering effective education in Emergency Medicine**

All clinicians must learn and spend time keeping up to date with new knowledge, skills and innovations relevant to their practice. In emergency medicine there are a number of challenges to delivering this.

1. Shift working and Rotations
2. Breadth of Subject
3. Rare but life-saving events

4. The balance between assessment driven learning and the real world/hidden curriculum of medicine.

### **1.7.3 Shift working and rotations**

Shift working patterns and the introduction of strict requirements for rest and recovery (50-52) make the delivery of face to face education extremely challenging. This is especially the case in those specialties that cannot reduce demand to facilitate education such as emergency medicine. As a 24-hour specialty there is little or no opportunity to stop clinical activity in order to teach and train. Thus is it typically the case that fewer than half of trainees will be able to attend fixed face to face teaching sessions (40). Alternative methods for the creation, dissemination and assessment of trainees are therefore attractive to educators. This problem is not unique to emergency medicine, nor to other professions as societies and cultures move away from a traditional working week pattern. This has driven technological developments such as online learning platforms to develop widely across most academic institutions over the last 10-20 years (53-55). However, the constant nature of emergency medicine work, the increase in emergency department attendances and complexity combined with the requirement for departments to maintain performance against the 4-hour standard(56) means that teaching sessions are especially difficult to deliver in a traditional group format.

### **1.7.4 Breadth of subject**

The breadth of the emergency medicine curriculum is also a challenge. The nature of emergency medicine, where patients choose to present to the ED without prior filtering for the notion of 'suitability' means that the emergency clinician must be able to assess a very broad range of presentations and pathologies. In the UK the Royal College of Emergency Medicine Curriculum (57,58) provides the structure for the emergency medicine curriculum. This document reveals the challenges of delivering training across such a broad range of topics and in particular in delivering a balance between the very common, but relatively benign presentations to the ED, together with the rare

but life threatening conditions such as thoracotomy, peri-mortem C-section (53,54), or complex cardiac arrest scenarios (59).

#### **1.7.5 Rare but life saving events**

A major challenge for emergency clinicians is the acquisition of competence for such rare procedures (60). Maintaining those skills and further refining them to levels of ability beyond competence expertise to mastery and excellence are further challenges for the specialty (61).

#### **1.7.6 The balance between assessment driven learning and the real world/hidden curriculum of medicine.**

##### **1.7.6.1 Assessment**

Emergency medicine is not unique in developing training programs that prioritise the accumulation and demonstration of knowledge in order to progress through the various academic hurdles in the form of professional exams (62). Whilst there are clear reasons why this occurs, in that some form of assessment is required to chart progress, the unintended consequence is the focus on teaching that which can be examined, the so called 'assessment drives learning' effect (63-65). Emergency medicine is not unique in this regard. The practicalities of 'what' can be examined means that there are always aspects of professional practice that exist outside of the examinations process. The effect of assessment driven curricula and exams means that trainees may not be adequately exposed to or, have the opportunity to explore all aspects of clinical practice. Typically, areas such as interpersonal interaction, challenging or complex cases that develop over time and philosophical discussions around the scope, applicability and suitability of intervention are recognized as experiences in emergency medicine education. These do not typically feature in all examination processes, although long cases exams, OSCEs and Viva-Voce processes may permit some insight. However, these factors are infrequently tested in a real clinical environment.

### **1.7.6.2 Hidden curricula in emergency medicine**

If we are to take a more holistic approach to the development of the expert emergency clinician, then facilitating teaching and learning in those areas not covered by formalised curricula and examinations has face validity. Those areas of practice that are outside of the formalised curricula, but are similarly important to the development of expertise (66,67) are often referred to as the hidden curriculum (66,67). The hidden curriculum was first described in the medical literature by Hafferty in 1998 as a way of exploring the full scope of what students and trainees learn as opposed to what they are formally taught (68) (though the term dates back to the 1960s) It recognises that the learning environment encompasses far more than simply what is formally taught in lectures, workshops, or even what is explicitly laid out in the curriculum. The experience of the learner is affected by various elements around the environment such as the culture, policies, evaluation methods and language used (68). The learner thus gains from the stated and offered curriculum, the informal curriculum of interactions between students and learners (usually ad hoc and highly personal) and the hidden curriculum of organisational structure and culture.

In emergency medicine the hidden curriculum is highly influential to the learning experience. For example, the issue of wait times in emergency medicine is a constant stress on the emergency care system and has been implicated as a leading cause of work related stress for emergency physicians. Attitudes to wait times and emergency department flow can create a culture that changes the way doctors think and feel about their work and the patients they treat. This was explored in an ethnographic study by Webster in the US demonstrating how these factors change the behaviours and learning environment through a focus on flow and efficiency rather than patient care. These pressures led to changes in the way that was not conducive to caring and patient orientated care (66,69), which is at odds with what we try to achieve in medical education. These hidden aspects of the curriculum link closely to the professional behaviours that we hope to instil in learners, and yet that is a challenge if they do not, by definition, form part of the explicit curriculum. Typically, the modelling of behaviours, values, behaviours and

attitudes takes place in the workplace within personal interactions and thus influencing these from a broader educator perspective is difficult. Online learning and in particular the observation of social learning through new social media platforms may offer the chance to influence hidden curricula learning through a broader exposure to and interaction with other clinicians discussing such matters in a public space. This of course comes at a risk as there is no certainty that the observation or engagement in online learning will result in positive reinforcement and behaviours. Social platforms have the ability to promote negative as well as positive values about staff, patients, specialities and health economies. Indeed, this is a significant concern regarding the use of social media and other technology enhanced learning by clinicians (70-72). The hidden curriculum is sometimes referred to in derogatory terms when it is felt to compromise clinical care and empathy, but it is much wider than that in that it describes how clinicians orientate and learn to function within the emergency care environment (73). David Sokol writing in the BMJ from an ethics perspective has questioned whether the revealing of doctor's thoughts and emotions may in fact be harmful to the profession and patients by openly revealing the uncertainty and difficulties inherent in the profession (74), though that argument could be counterbalanced by the opportunity to share and discuss positive experiences. What is clear is that online interactions may have the ability to influence the hidden curriculum (75,76).

In summary the hidden curricula are an important aspect of the learning experience in emergency medicine. New technologies, especially those with the ability to share interpersonal attitudes and beliefs may offer mechanisms to influence this important aspect of learning.

#### ***1.7.6.3 What to change and when to believe?***

It is tempting to believe that change in emergency medicine takes place in a timely and safe manner as new evidence emerges around patient care and treatment. Sadly, this is not the case with multiple studies demonstrating that the pace of change in clinical practice lags behind the publication of high quality evidence (77-79). There are of course many reasons why it may take



time to change clinical practice. Pathman's pipeline is an oft quoted representation of why evidence fails to reach the patient (visually represented in figure 1), and some of these, notably those that involve the distribution of technologies and other costs will inevitably lead to delays in knowledge translation.

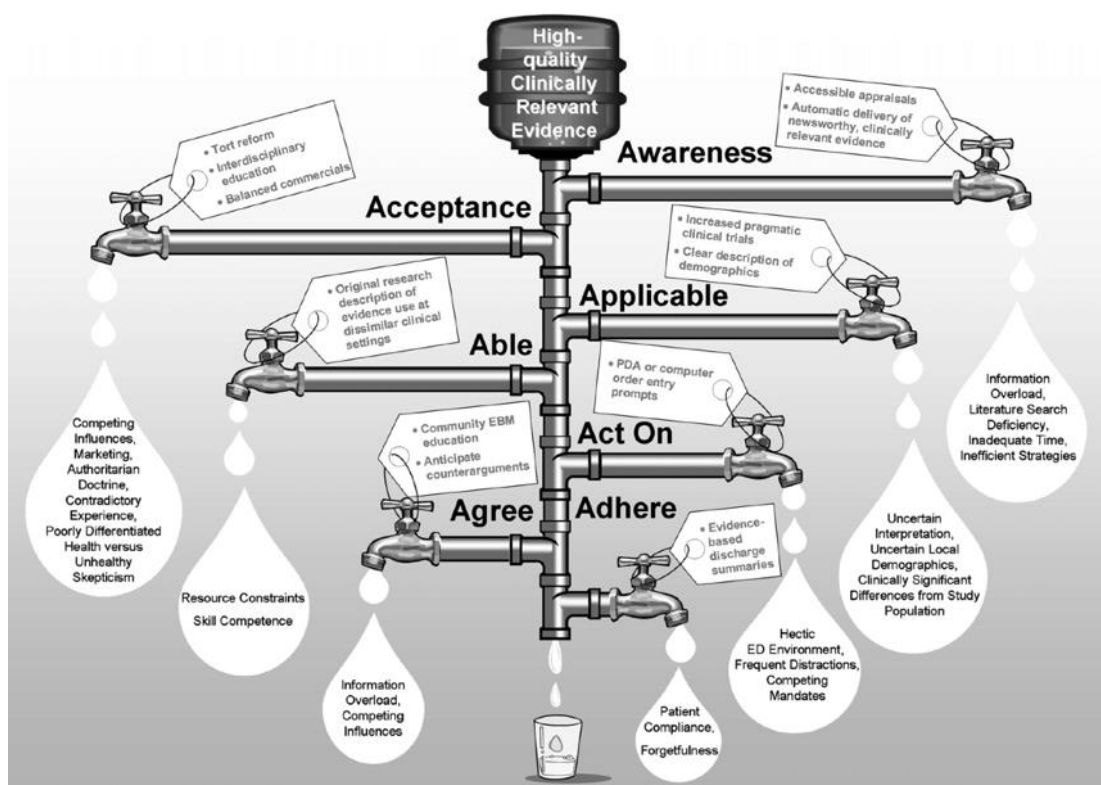


Figure 1 Pathman's Pipeline(80)

Pathman (81) described the need for clinicians to be aware of, to agree with, to adopt and then to adhere to new guidelines or information and that along that pathway change can leak out at any point (82). Similarly, the disconnect between evidence and practice was described very well back in 1996 in an influential ACP Journal club paper (83) which again describes the problems of moving from simple awareness through to action at the bedside with significant drop off from research through awareness, to understanding and finally to action (see Figure 2). From an emergency medicine perspective this means that simply providing information will be unlikely to result in a change of practice for our patients and that more effort needs to be expended in challenging the speed of adoption into clinical practice.

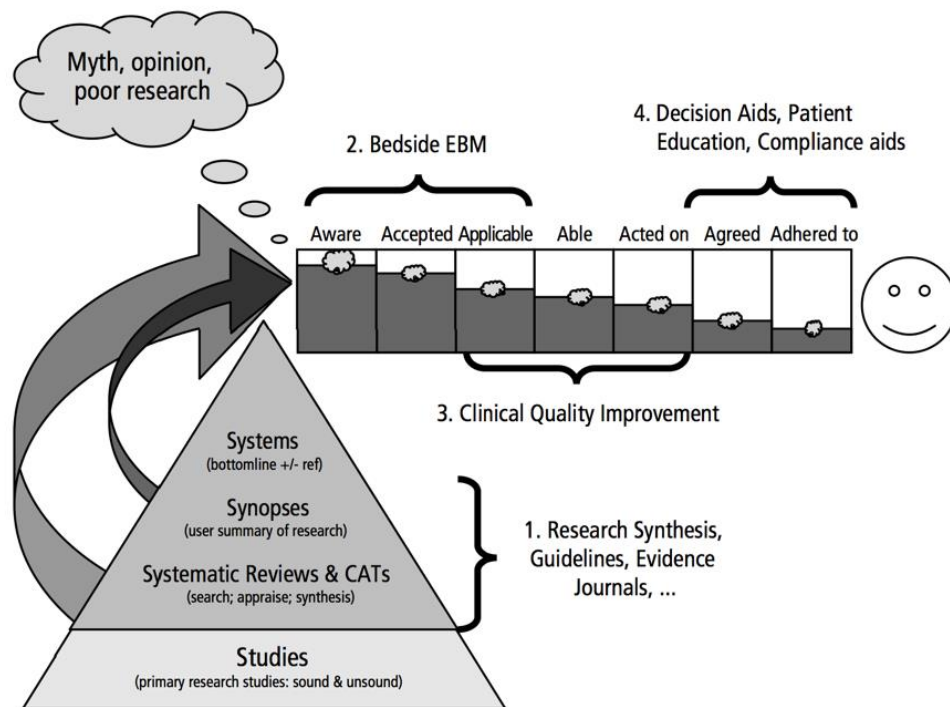


Figure 2 Evidence to practice from Glasziou 2005(83)

How to achieve this is clearly a challenge for the emergency medicine educator. Whilst much effort has been expended in developing better research methods rather less effort has been focused on knowledge translation into practice (80). It is therefore incumbent on educators to help develop the cognitive and practical skills within the knowledge translation framework if we are to develop high quality emergency physicians of the future, perhaps with a focus on developing these in junior doctors so as to influence future changes in healthcare development (80).

It is currently unclear what works in terms of knowledge translation in emergency medicine. There is little evidence available to guide the educator, but what is apparent from the theories proposed is that it is the beliefs of the clinician that significantly influence the speed and effectiveness of adoption of new evidence. Belief is a poorly understood aspect of evidence-based medicine as it is oft assumed that if evidence is presented in an accessible format then it will be adopted. This is a topic I addressed in a conference presentation at 'SMACCG Gold' in 2014 (and subsequently repeated at other conferences) exploring the difficulties and challenges in evidence adoption

within emergency medicine and critical care. The talk can be accessed on the Intensive Care Network website (84).

#### ***1.7.6.4 Curriculum scope in emergency medicine***

The question of what curricula and exams should focus on is also challenging. Topics that are common or where there are high risks involved are clearly more important than the benign and rare. However, determining what should and should not be included in curricula is complex. Some of my early work in the development and understanding of curricula in medicine looked to determine those components of the College of Emergency Medicine exams in anatomy that had true clinical relevance (85). This used an expert Delphi technique to score and attribute values to basic science topics and their relevance to the clinical practice of emergency medicine. Delphi techniques are used to garner 'expertise' in a semi structured fashion and are particularly useful when there is no defined correct answer, but where the collected opinion of a group of experts is likely to be better than just following current practice or by deciding within a small group subject to power differentials and disproportionate influence. I have used Delphi techniques in a variety of settings where expert opinion is sought from a group of professionally and geographically diverse experts, notably in my work around the preparation and response to major incident management (86-92). The decision to use Delphi techniques to set curriculum priorities for emergency medicine was based on the importance of engaging with a broad range of experts from both clinical practice and academic anatomy in order to link the teaching process to the final aim of developing clinicians with the required knowledge to treat patients. That project promoted the idea, and inputted into the college curriculum, that the development of expertise is linked both to what is important and also to what is commonly encountered in the practice of the specialty. Our initial study focused on a particular aspect of practice, that of upper limb anatomy using a broad panel of experts. This study showed how a Delphi technique could be used to prioritise curricula content towards clinical utility and application. As a proof of concept paper it was influential as following on from the project in upper limb anatomy the Delphi process was taken further, by co-authors, to develop other aspects of the emergency

medicine curriculum in pharmacology (86), anatomy (87) and emergency medicine core content (88).

### **1.7.7 Education in the age of social interaction, technology and the internet.**

This thesis charts my research through several ages of technological innovation. The choice to collate the artefacts in this thesis in chronological order is intended to chart the learning journey from early uses of the Internet in support of the BestBets projects, through to the more technologically dependent aspects of teaching through the use of virtual learning environments and more recently social media.

In order to place this thesis in context it is important to consider how we as a society and as a clinical workforce interact with technology. Past technologies and projects are inevitably viewed from a modern-day perspective with a degree of clarity that is unachievable for more recent and current projects. This does affect the way in which the critical appraisals and assessment of the artefacts is viewed. For example, the impact of BestBets as viewed at the present time (2018) is well established and clear. In contrast the later work on social media enabled learning is still in development and thus the impact and longevity of that work is more difficult to determine.

Technology is increasingly pervasive in our daily lives. The academic and social media commentator and author Julian Stodd has described the concept of us increasingly learning and interacting in what he describes as *the social age* (89). The social age is characterized less by the emergence of new technologies but rather the ways in which we interact with them, the sociology and the psychology that underpins our interactions rather than the digital architecture of the hardware or software itself. Education has always involved interaction between tutors and learners and between learners themselves and thus the utilization and engagement with social tools to facilitate this is nothing new. However, the widespread use of social media, the internet and mobile communications by clinicians has allowed the

development of methods to enhance or change learning through the use of online social interaction with an ease and accessibility that we have never previously experienced (90). Clinicians, patients, relatives and the public at large all access health information via the internet with health information being one of the most common reasons for searching the internet (91).

Online education is used across many educational institutions through the use of virtual learning environments like Moodle (92) or Blackboard (93). However, most educational institutions using online learning do so using courses that are closed to public access. The obvious reason for this is so that they then control access to the materials around a business model relationship between students and institutions. More recently social media education is demonstrating a potential to undermine traditional models, especially through movements such as #FOAMed where open access is highly valued.

Online learning lends itself well to the dispersed emergency medicine workforce. Closed systems offer advantages to learners and educators who are rightly concerned about safety and confidentiality. Closed systems permit control by tutors over what, how and when learners interact with online content. It models a traditional view of education where the tutors dictate the pace and scope of practice. This has clear advantages in focusing learning around a curriculum but may not reflect the needs of learners with complex and advanced learning needs (94). Postgraduate medical education for example requires a blend of learning directly related to curricula in the pursuit of career advancement and postgraduate examinations but also requires clinicians to continually reflect and learn on practice in the workplace (95-97).

The disadvantage of closed systems is also clear. Learning can only take place amongst those who are registered and permitted access to the system. This complicates and restricts the reach of any educational interventions to those within the system. Whilst this clearly meets a business model for education it has questionable ethical and moral issues when knowledge is

withheld from learners who might improve patient care as a result of consuming and acting on that knowledge.

In contrast social media platforms allow engagement across a much broader range of learners and teachers (98,99). They are not restricted by time, geography or permissions and thus can engage with a much wider audience (100).

The 2012 IFEM conference was one of the first to embrace social media as an integral part of the meeting (101). Following discussions with leaders in online education in Dublin we were inspired to design and publish the first St. Emlyn's blog on the 1<sup>st</sup> July 2012. This coincided with the creation of the Free Open Access Medical Education (#FOAMed) movement by Mike Cadogan from the Life in the Fast Lane website (102). The initial blog posts and content on St. Emlyn's were supported and promoted by other #FOAMed sites at the time, notably Life in the Fast Lane (102) and EMCRIT (103).

Since that time the number and range of #FOAMed sites has increased (98,104) perhaps reflecting an increasing interest and engagement with social media based learning resources (105). Emergency medicine, critical care and prehospital care appear to have a greater engagement with #FOAMed resources perhaps reflecting the broader scope of practice amongst a chronologically and geographically distributed workforce. In the US (106) and Canada (107) engagement rates amongst trainees in emergency medicine approach near ubiquity with most trainees utilizing resources on a weekly basis. Trainers too have increasing levels of engagement and utilization of #FOAMed resources reflected by increasing numbers of trainers interacting in #FOAMed spaces such as twitter. These increasing levels of engagement and utilization have been reflected in an accompanying academic interest in the growth, reach and development of #FOAMed (106-120).

The nature of education is that it must always reflect and work with the environment and culture of the time and circumstance if it is to be effective. This thesis has been written at a time where developments in emergency

medicine education are being influenced by the technologies associated with the social age. It is in that context that the comments, critiques and history of the artefacts are presented.

#### ***1.7.7.1 Change management in the modern age***

In section 1.7.6.3 I discussed the complexities in changing behavior amongst emergency clinicians and how that is linked to the belief systems of individuals and organisations. Changing practice is a significant challenge across all healthcare economies, but evidence for evidence based strategies to effect change are limited(121).

Despite this, the use of technology to support change has been strongly advocated in UK practice. The internet offers the ability for large amounts of information to be readily accessible to clinicians, initially through computers, but now increasingly through the use of apps and mobile devices. It is tempting to think that by simply improving access to information then as a result change in practice will inevitably take place. However, there is little evidence to support this as evidenced by continued evidence of knowledge translation gaps from 2003 (78) to 2014 (84) (albeit in different health economies).

Online databases such as NICE, Cochrane, SIGN and other organization websites are clearly opportunities to improve access to information to clinicians, but the effectiveness of these in creating change in behaviours that translate to changes in patient care are relatively unproven. Similarly the BestBets (122) website described in this thesis may also be considered in the same group of knowledge repositories. Whilst these and many other websites improve the opportunity to change they are no guarantee of such change taking place (77).

In a 2004 article Seow outlines the difficulties of change management within the complex and chaotic environment of the ED (123). Although focused on organizational change it is clear from that review that simply having knowledge or a good idea is not enough to meaningfully and sustainably

influence a change in practice within an ED setting. Communication with staff, encouragement, power and influence can create either inertia or momentum to practice. Whether the adoption of new technologies and platforms to improve access to information is unknown.

Currently there are a number of Emergency Medicine based projects seeking to examine whether technological enhanced communication through the use of online resources can improve the translation of evidence to patients. Ken Milne, lead author of the SGEM (Skeptic's Guide to Emergency Medicine) (124) is working with the Canadian Journal of Emergency Medicine and Academic Emergency Medicine to examine whether highlighting interesting and practical papers through social media can influence practice and in particular whether it might reduce the knowledge translation gap through the 'Hot off the Press' series of blogs, podcasts and articles (125-127) (128).

In recent years UK emergency medicine has focused on Quality Improvement methodologies to implement and sustain change in practice. This is recognized by the requirement for all trainees in emergency medicine to complete a Quality Improvement Project (QIP) as part of their final professional examinations (129,130). Such projects are now featuring in other health economies such as Canada (131-133), Australia (134) and many others.

Whilst these might appear to be distinct from simply providing access to knowledge and new information, this is clearly not the case. All QIP processes work on the basis of finding and then delivering the best available evidence with which to enact and sustain change in clinical practice. Thus, the acquisition of the best available evidence will typically follow similar techniques of evidence finding and summarization as demonstrated in projects such as BestBets, indeed as an examiner for the Royal College of Emergency Medicine it is clear that a similar structure is typically used. Similarly, all QIPs require staff and or systems to change what they do. In order to achieve this then some form of educational intervention is necessary to facilitate change. Therefore, there is scope to improve change



management through the use of technology enhanced learning with regard to change management and quality improvement strategies. This is especially the case when dealing with a geographically and chronologically distributed workforce such as that which typically staffs emergency departments and who subsequently find it difficult to attend face to face teaching session.

#### ***1.7.7.2 Case study on multi-format learning in the social age of education.***

Technology permits the engagement with, and the dissemination of knowledge through a variety of co-created platforms. This is a strategy that I have adopted alongside the construction of social media learning platforms and blogs.

For example as a conference presenter I am acutely aware of the difficulties of effectively transmitting factual information using the traditional lecture format where the knowledge translation is lost through the lack of active learning in the traditional format of a presentation (135). Despite this lectures and conference presentations are a popular and oft-requested format to share and enhance learning. How then can we enhance the traditional model of lecturing to enhance learning? In the modern age this challenge may be met by increasingly using a multi-platform approach to education as described below.

A case study would be the way in which a topic such as 'In-situ simulation' can be enhanced through multi-platform engagement and delivery. This is a topic that was inspired through discussions on twitter where the work that we had done locally was shared and disseminated globally. In turn this led to invitations to present at conferences on the subject of simulation. In-situ simulation describes a process of using simulated patients (usually mannequins) to run a mock emergency in the learner's normal place of work (136). In contrast much simulation is done in simulation centres away from

the workplace. There are advantages and disadvantages to both approaches which are oft debated at conferences, workshops and in publication, it therefore makes an interesting, emerging and current topic in emergency medicine and acute care education (137).

Invitations to speak at conferences are welcome but they present challenges in getting the key messages of a presentation across to an audience of between of 50-500 people (typical numbers in non-plenary EM conference session). It is also difficult to try and embed the core messages in a presentation such that the learners will remember the content after the presentation has finished. This has been a problem with the lecture format for many years. The lack of clarity and subsequent recall of core messages can be partly mitigated by handouts, but this is not always feasible or financially viable to deliver. In this case the presentation on in-situ simulation was designed in conjunction with a multi-platform approach. This required the co-creation of four separate media to carry the same themes in widely accessible formats.

1. The presentation itself delivered for the young emergency physicians group at the EuSEM conference in Vienna attended by approximately 100 people (138).
2. The St. Emlyn's Podcast on in situ simulation (139) downloaded by 2844 people (up to 26/1/18)
3. The St. Emlyn's Blog post on Simulation in situ (140) 3657 downloads (up to 26/1/18)
4. The traditional journal publication on in-situ simulation (141) with 682 downloads from EMJ site (up to 26/1/18)

These different modalities are all independently valid as reusable learning objects, and are also mutually supportive. Those present at the meeting may be inspired or challenged by a conference presentation can be directed to

additional resources on line to deliver a much greater depth of content. Those engaging the topic through written media on the blog may then choose to view and engage in the audio/visual media at a conference or seminar. Learners can thus access the same content through a variety of different media that all contribute to the overall topic, but which all have strengths and weaknesses in accessibility, with no one media capable of delivering the entirety of the learning experience. It is interesting to note that the podcast and blog far exceed the engagement statistics as compared to traditional models of knowledge dissemination (lectures and journal presentations).

Additionally any or all of the media can be used in a flipped classroom model of education whereby learners are invited to review the open access content in advance of a face to face learning session such that the benefits of face to face teaching, namely discussion and interaction are maximized in the time available (142-145).

This case study demonstrates a new approach to academic publishing and education. Each of the communication modalities described have strengths and weaknesses in reaching different audiences and for levels of engagement. However, by interconnecting and mutually supporting each other the core messages are shared in an accessible and mutually supportive way. The end result is an amplification of the academic and educational potential of the learning materials. This has only been achieved through the recent development of social media technologies and represents a novel and creative output of my social media projects as described later in this thesis.

### 1.7.8 Aims of the thesis

This thesis aims to present a narrative that describes how technology and the needs of learners in emergency medicine have interacted to enhance the quality, reach and effectiveness of education.

The thesis describes how pedagogy and technology can work in a symbiotic fashion with technology driving enhancements in educational opportunity. It reflects how the increasingly challenging requirements of postgraduate education can be mitigated and the learning experience enhanced through the adoption, design and construction of educationally useful technologies.

The specific aims of this thesis are.

- To provide an understanding of the complexities of education in emergency medicine and related specialties.
- Explore and critique the projects and work that I have contributed to over 20 years of education in emergency medicine and related specialties.
- To explore and critique the use of online learning strategies to enhance the learning experience for a chronologically dispersed junior workforce.
- To explain how medical educators can use social media technologies to enhance medical education.
- To explore and critique the rise of Free Open Medical Education as a strategy to enhance emergency medical education.
- To explore and critique how traditional and innovative strategies in medical education might influence the reach and effectiveness of knowledge translation strategies.

## 1.8 Chapter 3: Publications, narratives and critical appraisals

*This section details my publications relevant to this thesis. Each paper is accompanied by a narrative describing the rationale and relevance of the paper in the context, it's influence at the time of publication/development, and in the evolution of technology enhanced learning in emergency medicine.*

*An RDPUB form is provided for each paper.*

The overarching theme of this thesis is the use of technologies to enhance and develop medical education most notably in emergency and critical care medicine.

This overarching theme is divided into 3 sub themes containing a range of academic artefacts that illustrate a career where my clinical work has paralleled a long-standing academic interest in medical education, with a focus on medical education and in particular the use of novel technologies to enhance medical education in emergency care.

Although each of the sub-themes have a significant element of crossover and mutual development, for the purposes of this presentation I have divided the artefacts for this study into three overlapping phases of innovation and study.

1. The Best Evidence Topic Reports (BestBets)
2. The use of Virtual Learning Environments (VLEs)
3. The use of Social Media (#SoMe) and Free Open Access Medical Education (#FOAMed)

This section details my publications relevant to this thesis. A short narrative describing the rationale and relevance of the paper accompanies each paper.

An RDPUB form is provided for each paper, including statements providing a clear indication of my contribution to each publication.

### **1.8.1 Theme 1: BestBets**

### **1.8.1.1 Narrative: The need for Evidence based medicine in Emergency Care**

In the late 1990's my work at Manchester Royal Infirmary and in my completion of an MPhil in Clinical Epidemiology and Biostatistics in 1992 led me to understand the importance of evidence-based medicine in practice, and most notably the difficulties in the translation of that evidence into clinical practice. There is ample evidence for the difficulties of translating evidence into practice (78,146), a concept that has become known as the Knowledge Translation (KT) gap (49). Clinicians struggle to know the evidence for their current practice and also to find, assess and summarise evidence into a form that can be used in clinical practice.

In Oxford, David Sackett and colleagues recognised the difficulties in translating evidence to the bedside and with colleagues from a clinical epidemiological background developed clinician orientated methods such Critical Appraised Topics (CATs). Sackett and colleagues (in Canada and Oxford) developed these and many other concepts and methods to deliver *evidence-based medicine* (EBM) in the 90's. These were however primarily orientated towards the practice of internal/general medicine (114,147-153). Although they clearly advanced EBM internationally some of the methods described were not directly transferrable to the emergency medicine environment. For example, the CAT system was based on finding a single high-quality paper to answer a particular question. When we tried to apply this format in to the practice of emergency medicine in the 1990s it was rarely possible to confine a clinical problem to a single study and for many questions there were no high-quality papers at all to answer our questions. It was clear that EBM in relation to EM would require a broader base of evidence. This required a methodology that could assess a number of different types of paper within the same format. This led to the adaptation of the CATs method into the BestBets system (154) which is more closely aligned to emergency and acute care practice.



### 1.8.1.2 What are BestBets?

BestBets is an abbreviated form of *Best Evidence Topic Reports* sometimes abbreviated to simply BETs.

The BETs system was set up at Manchester Royal Infirmary in 1996.

As with all systems the precise construction of a BET has changed over time. For example, early BETs focused on just one bibliographic database (typically the OVID interface to Medline) whereas it is now normal practice to search across a range of databases. Similarly, the search strategies and knowledge of evidence-based medicine and information technology have influenced the quality and scope of searches. The BETs have been very successful with over 3000 registered questions and over 300 publications (122).

A broad range of clinicians contributes to BestBets from around the world and from a variety of specialities and professions.

BET stands for Best Evidence Topic and the terms are interchangeable. The BET is designed as a systematic approach to answering real world clinical problems. It is an agreed and explicit series of steps and techniques to allow working clinicians to answer the important questions in their own clinical practice. The initial methods have evolved the methods over the years to identify a standard set of techniques to find clinical answers to clinical problems.

#### 1.8.1.2.1 What is a BET and what is it not.

BETs use a systematic approach that is reproducible and explicit to answer real world clinical problems from the perspective of a clinical practitioner (154). The system is based on evidence-based principles of defining questions, searching and assessing the literature, summarising the facts, and then formulating a clinical bottom line to aid decision making (155).

BETs are not narrative reviews. Authors should not arbitrarily select papers that support a particular viewpoint, nor should they pick and choose which

papers to use in order to support prior viewpoints. The BETs author, using the BETs system can and should present all the evidence found in such a way that the reader could understand the process by how the clinical bottom line and summary are achieved.

BETs are designed for the working clinician and therefore do not normally search the "grey literature" as is the case in formal systematic reviews. Whilst it would be an ideal for every clinical problem to be answered by a wide-ranging systematic review and meta-analysis (if appropriate), this is not, and probably never will be the case. BETs offer the reader and researcher a pragmatic systematic review for clinical practice. Where systematic reviews do exist, we can incorporate these into the BETs model.

By using a common format for publication BETs authors and the BestBets team have answered thousands of real world clinical problems. The standard format for reporting has allowed the development of a repository on the web and in the paper publication of BETs in a number of international journals.

These are short reviews linked to clinical practice. characterized by the following elements (156). These are described in more detail below.

- 1. A recognisable clinical scenario:** BETs are designed to be used by working clinicians and as such they should be grounded in the lived experience of the clinician. All BETs should start with a brief clinical description that contains enough detail for the reader to understand why the author chose the question and why they subsequently formulated a three-part question.
- 2. A focused and answerable three-part question:** The BETs system uses the three-part question (3PQ) model to define an answerable question. These are focused questions that directly relate to the clinical scenario. There are unsurprisingly three components to the 3PQ. Patient group, Intervention or defining question, Relevant outcomes. This model is sometimes described in four parts as a PICO (Patient, Intervention, Comparison, Outcome), which contains the same

elements. Both the 3PQ and PICO models are widely used as a tool for evidence based medicine practice (157).

- 3. An explicit search strategy:** The three-part question is used to refine and define the search strategy. The three parts of the question are used to define separate aspects of the search strategy; these are then combined to identify relevant papers to the three-part question. These papers are then reviewed for quality and applicability.
  
- 4. A checklist approach to critical appraisal:** A structured method to critical appraisal using the BestBets checklists. Initially checklists from Sackett's book on clinical epidemiology (155) were used. However, although this is an excellent book it is long and beyond the requirements of most BestBets authors. We therefore moved to using the Crombie (158) checklists which are far more accessible. However, these checklists did not cover the range of papers encountered on BET topics, this resulted in the BestBets group developing their own range of checklists to cover a broader range of paper types. These are available online at the BestBets website (122).
  
- 5. A conclusion that links directly to the 3PQ:** Finally, the BET authors are tasked with answering the original three-part question in light of the evidence found. If, as can be the case, there is insufficient evidence to be certain then this is declared within the concluding statement.

The BestBets project led to the development of the BestBets website (159), the design and delivery of critical appraisal courses and invitations to talk on evidence based medicine at emergency medicine conferences.

Selected BestBets are published in the Emergency Medicine Journal (160), Trauma (161), International Journal of Surgery (162) and Interactive Cardiovascular and Thoracic Surgery (163). BestBets formed the original concept behind the long running Archimedes series of evidence-based

reviews in Archives of disease in childhood (164,165). More recently it has been adopted in the Veterinary world as BestVETS (166).

To date the BestBets website (<http://www.bestbets.org> ) contains just under 3000 questions and reviews. Over 400 BestBets have now been published in print in the journals listed above.

The additional editorials (154), papers (156,161,166,167), updates (159) and reviews of related activities such as journal clubs (168,169) has contributed to a broad development of evidence based practice within UK and International emergency medicine.

Examples of the editorial comments from BestBets as published in the EMJ are shown below, together with an example of a BestBet published from colleagues in Plymouth.

Figure 3 Example of BestBets authorship in Emergency Medicine Journal

## Towards evidence based emergency medicine: Best BETs from the Manchester Royal Infirmary



Edited by Simon D Carley

Best Evidence Topic reports (BETs) summarise the evidence pertaining to particular clinical questions. They are not systematic reviews, but rather contain the best (highest level) evidence that can be practically obtained by busy practicing clinicians. The search strategies used to find the best evidence are reported in detail in order to allow clinicians to update searches whenever necessary. Each BET is based on a clinical scenario and ends with a clinical bottom line which indicates, in the light of the evidence found, what the reporting clinician would do if faced with the same scenario again.

The BETs published below were first reported at the Critical Appraisal Journal Club at the Manchester Royal Infirmary<sup>1</sup> or placed on the BestBETs website. Each BET has been constructed in the four stages that have been described elsewhere.<sup>2</sup> The BETs shown here together with those published previously and those currently under construction can be seen at <http://www.bestbets.org>.<sup>3</sup> Three BETs are included in this issue of the journal.

	Title
1	Targeted blood pressure management in the hyperacute and acute stages following spontaneous intracerebral haemorrhage
2	Core stability vs conventional exercise for treating non-specific low back pain.
3	Advantages of ultrasound-assisted lumbar puncture: new evidences

1 Carley SD, Mackway-Jones K, Jones A, *et al*. Moving towards evidence based emergency medicine: use of a structured critical appraisal journal club. *J Accid Emerg Med* 1998;15:220–2.

2 Mackway-Jones K, Carley SD, Morton RJ, *et al*. The best evidence topic report: a modified CAT for summarising the available evidence in emergency medicine. *J Accid Emerg Med* 1998;15:222–6.

3 Mackway-Jones K, Carley SD. [bestbets.org](http://www.bestbets.org): odds on favourite for evidence in emergency medicine reaches the worldwide web. *J Accid Emerg Med* 2000;17:235–6.

# Towards evidence based emergency medicine: Best BETs from the Manchester Royal Infirmary



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## BET 1: TARGETED BLOOD PRESSURE MANAGEMENT IN THE HYPERACUTE AND ACUTE STAGES FOLLOWING SPONTANEOUS INTRACEREBRAL HAEMORRHAGE

**Authors:** Kapil Mohan Rajwani, Azlisham Mohd Nor

**Institution:** Derriford Hospital, Plymouth, UK

### ABSTRACT

A short cut review was carried out to establish whether targeted blood pressure management in the hyperacute and acute stages following spontaneous intracerebral haemorrhage. 275 papers were found of which 6 presented the best evidence to answer the clinical question. The author, date and country of publication, patient group studied, study type, relevant outcomes, results and study weaknesses of these best papers are tabulated. The clinical bottom line is the current evidence suggests in patients with hypertension following spontaneous intracerebral haemorrhage, intensive lowering of SBP to a target of less than 140mmHg in the hyperacute and acute stages is safe and may improve functional recovery.

### CLINICAL SCENARIO

A 62-year-old woman is brought to the ED with sudden onset left-sided hemiplegia. CT scan of her head shows an acute right basal thalamic intracerebral haemorrhage (ICH). Her BP in the ED is 195/100. You wonder whether you should treat this patient's hypertension in the ED.

### THREE PART QUESTION

In (patients with spontaneous intracerebral haemorrhage) does (targeted BP management in the hyperacute and acute stages) improve (functional neurological outcomes)?

### SEARCH STRATEGY

Evidence was searched using Medline and Embase via Ovid interface.

Ovid MEDLINE(R) (1940 to week 4 June 2015): The following terms were searched:

1. exp Cerebral Hemorrhage/
2. ((cereb\* or brain or stroke or intracereb\* or intracran\*) adj5 h?emor-rhag\*).mp.

3. 1 or 2
  4. ("blood pressure" or hypertens\* or BP or antihypertens\*) adj5 (lower\* or manage\* or treat\* or reduc\* or target\* or therapy\*).mp.
  5. (treatment\* or neurolog\* or function\*) adj5 (measure\* or outcome\*).mp.
  6. Treatment Outcome/
  7. 5 or 6
  8. 3 and 4 and 7
- EMBASE (1947–Present): The following terms were searched:
1. exp brain hemorrhage/
  2. ((cereb\* or brain or stroke or intracereb\* or intracran\*) adj5 h?emor-rhag\*).mp.
  3. 1 or 2
  4. (blood pressure or hypertens\* or BP or antihypertens\*) adj5 (lower\* or manage\* or treat\* or reduc\* or target\* or therapy\*).mp.
  5. (treatment\* or neurolog\* or function\*) adj5 (measure\* or outcome\*).mp.
  6. treatment outcome/
  7. 5 or 6
  8. 3 and 4 and 7

9. limit 8 to (english language and yr='2011–2015')

Reference lists of all relevant papers were searched for secondary references. The search was current as of 30 June 2015.

### SEARCH OUTCOME

The literature search yielded 275 results on Medline and 243 results on Embase. The titles and abstracts of these papers were scanned and 37 relevant papers were identified. Of these, six papers answered the three part question, were of sufficient quality and represent the best evidence. These are summarised in table 1.

### COMMENT(S)

Acute ICH is responsible for 9–27% of all strokes globally,<sup>7</sup> with an estimated more than one million people affected each year, many of whom either die or are left with severe neurological disability.<sup>8</sup> There are no proven therapeutic interventions for ICH and haematoma expansion in the acute stages is a key factor associated with

Table 1 Relevant papers

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
INTERACT (pilot trial), Anderson et al, 2008, <sup>1</sup> Australia	404 patients who presented within 6 h of spontaneous ICH onset and had a SBP between 150 mm Hg and 220 mm Hg were randomly assigned to either: intensive BP-lowering treatment; target SBP <140 mm Hg to achieve within 1 h of randomisation and maintain for 7 days (n=203) OR Standard/AHA guideline recommended treatment; target SBP <180 mm Hg (n=201)	Multicentre, prospective, randomised, pilot trial, 44 centres in 3 countries (Australia, China, South Korea) enrolled patients. Level IIb evidence	The main clinical end point was death or dependency (mRS 3–5) at 90 days For safety analysis, the primary outcome was death from any cause and the secondary outcomes were early neurological deterioration (drop in GCS by ≥2 points or a gain of ≥4 points in the NIHSS from baseline to 72 h) Primary outcome: Neurological deterioration defined as an increase of ≥2 points in NIHSS from baseline to 48 h Secondary outcome: Favourable outcome, at 90 days, defined as mRS ≤2	At 90 days, there was no significant difference in death or dependency between the groups (95 patients had an outcome of death or dependency in the intensive-treatment group and 100 patients in the guideline-treatment group; p=0.81) Intensive lowering of BP had no significant excess adverse effect on death or on any of the clinical scales	Study not powered to assess difference in functional neurological outcomes. Assignment of interventions was open (unblinded). Therefore participants and clinicians knew whether the treatment was intensive or guideline-recommended management. The risk of performance bias is unclear. Antihypertensive agents not standardised across centres, and this may have had an effect on outcomes
Koch et al, 2008, <sup>2</sup> USA	42 patients who presented within 8 h of spontaneous ICH onset and with a MAP >110 mm Hg were randomly assigned to either: Standard/AHA guideline recommended BP treatment; target MAP 110–130 mm Hg (n=21) OR Aggressive BP treatment; target MAP <110 mm Hg (n=21)	Prospective, randomised controlled trial. Level IIb evidence	Primary outcome: Neurological deterioration defined as an increase of ≥2 points in NIHSS from baseline to 48 h Secondary outcome: Favourable outcome, at 90 days, defined as mRS ≤2	No significant differences in neurological deterioration at 48 h between the groups. Clinical deterioration occurred in 2 patients in the aggressive treatment arm and 1 patient in the standard group (p=0.55) 18 patients had a favourable outcome at 90 days (10 in the standard therapy group vs 8 in the aggressive therapy group; p=0.43). At 90 days, 6 patients had died, 3 in each group (p=1.00)	Single centre. Primarily designed to test safety of BP reduction. No power calculation reported. Small sample size. Antihypertensive agents for BP management not standardised
INTERACT2, Anderson et al, 2013, <sup>3</sup> Australia	2839 patients who presented within 6 h of spontaneous ICH onset and had a SBP between 150 mm Hg and 220 mm Hg were randomly assigned to either: intensive BP-lowering treatment; target SBP <140 mm Hg to achieve within 1 h of randomisation and maintain for 7 days (n=1403) OR Standard/AHA guideline recommended treatment; target SBP <180 mm Hg (n=1436)	Multicentre, prospective, randomised, clinical trial, 144 centres in 21 countries enrolled patients. Level IIb evidence	Primary outcome: death or major disability (mRS 3–5) at 90 days was defined as a poor outcome Secondary outcomes: Physical function across all 7 levels of the mRS Five dimensions of health-related quality of life (mobility, self care, usual activities, pain or discomfort, and anxiety or depression), as assessed with the EQ-5D questionnaire	At 90 days, there was no significant difference in poor outcomes between the groups (719 (52%) patients in the intensive-treatment group vs 785 (55.6%) in the standard-treatment group had a poor outcome; p=0.06). Patients in the intensive BP-lowering group had a significantly better functional recovery. Ordinal analysis of the mRS showed a significant favourable shift in the distribution of scores with intensive BP-lowering treatment (pooled OR for shift to higher mRS 0.87; 95% CI 0.77 to 1.00; p=0.04) At 90 days, patients in the intensive treatment group reported fewer problems and had significantly better overall health-related quality of life as per the EQ-5D questionnaire (mean score 0.60 vs 0.55; p=0.002)	Assignment of interventions was open (unblinded). Therefore participants and clinicians knew whether the treatment was intensive or guideline-recommended management. The initiation of treatment was significantly quicker in the intensive treatment group. This may have been due to the differences in the management strategies for the two groups. The risk of performance bias is unclear. BP management protocols were based on local availability of agents. Therefore antihypertensive agents were not standardised and this may have had an effect on outcomes. Only a third of patients in the intensive treatment group achieved the target SBP level within 1 hour (half achieved the target by 6 h)
ICH ADAPT, Butcher et al, 2013, <sup>4</sup> Canada	75 patients who presented within 24 h of spontaneous ICH onset with a SBP >150 mm Hg were randomly assigned to either: intensive BP lowering; target SBP <150 mm Hg to achieve within 1 h of randomisation (n=39) OR Standard treatment; target SBP <180 mm Hg (n=36). 2 h after randomisation patients underwent a CT brain scan and perfusion scan	Multicentre, prospective, randomised clinical trial. Level IIb evidence	Primary outcome: Difference in relative CBF within the perihematomal region between the two treatment groups Secondary outcomes: Mortality at 30 days and functional scores (mRS, Barthel Index) at 90 days post randomisation	There was no significant difference in relative CBF within the perihematomal region between the two groups (p=0.19). Shows cerebral ischaemia is not precipitated by rapid BP reductions in patients with acute ICH Clinical end points such as mortality and functional scores were not significantly different between the groups. 30-day mortality in the intensive-treatment group was 7 vs 4 in the standard-treatment group (p=0.40). 90-day median mRS was 2.5 in the intensive group vs 4 in the standard group (p=0.65). Median Barthel Index score was 95 in both groups (p=0.31)	Patients were enrolled within 24 h of ICH onset, this is a larger time window compared with other studies. As a result, the median time to randomisation was 7.4 h which is later than other studies. Study not powered to assess difference in functional neurological outcomes. Assignment of interventions was open (unblinded). Therefore participants and clinicians knew whether the treatment was intensive or guideline-recommended management. The risk of performance bias is unclear

Continued

Table 1 Continued

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
SAMURICH, Sakamoto <i>et al.</i> 2013, <sup>7</sup> Japan	211 patients who presented within 3 h of spontaneous ICH onset with >180 mm Hg were given IV nicardipine for 24 h; target SBP <160 mm Hg (range 120–160 mm Hg)	Prospective, multicentre, observational study. Level IIc evidence	Neurological deterioration (decrease of ≥2 points in mRS) at 72 h Unfavourable outcome, defined as mRS 4–6 at 3 months or patients who underwent surgical intervention for ICH	Neurological deterioration was observed in 17 (8%) patients with different SBP targets. The number of patients in the different SBP interval groups were not balanced (eg, 27 patients had a mean SBP >145 compared with 59 with a mean SBP of 135–140)	Observational study; did not compare groups with different SBP targets. The number of patients in the different SBP interval groups were not balanced (eg, 27 patients had a mean SBP >145 compared with 59 with a mean SBP of 135–140)
Tsongalis <i>et al.</i> 2014, <sup>6</sup> Multinational	Meta-analysis of RCTs; 4 studies met the inclusion criteria, 3315 patients who presented acutely (within 24 h) with spontaneous ICH and hypertension (SBP >150 mm Hg or MAP >110 mm Hg) were randomly assigned to either: intensive BP-lowering treatment or Standard/AHA guideline recommended treatment. Aim to assess the safety and efficacy of intensive BP reduction	Systematic review and meta-analysis of RCTs. Studies included: ICH ADAPT, INTERACT 1, INTERACT 2, Koch <i>et al.</i> <sup>8</sup> Level 1a evidence	Safety: Mortality rates 3 months after randomisation Efficacy: Unfavourable outcome was defined as death or dependency (mRS >2) at 3 months	Mortality rates were similar between patients randomised to intensive BP-lowering treatment and those receiving standard guideline recommended BP-lowering treatment (OR 1.01, 95% CI 0.83 to 1.22; p=0.914). Authors concluded, intensive lowering of BP in acute-onset ICH is safe Intensive BP-lowering treatment was associated with lower rates of death or dependency at 3 months (OR 0.87, 95% CI 0.76 to 1.01; p=0.062). However the difference between the groups was not statistically significant	All RCTs included had open-label protocols (assignment of interventions was unblinded). This was probably unavoidable. The risk of performance bias cannot be ruled out. 84% of the overall patients and pooled data was from 1 study (INTERACT 2)

AHA, American Heart Association; CBF, cerebral blood flow; EQ-5D, European Quality of Life-5 Dimensions; ICH, intracerebral haemorrhage; IV, intravenous; MAP, mean arterial pressure; mRS, modified Rankin scale; NIHSS, National Institute of Health Stroke Scale; RCT, randomised controlled trial; SBP, systolic BP.

poorer neurological outcomes.<sup>4 9 10</sup> Haematoma expansion occurs in about a third of patients with ICH and BP is often elevated in these patients which is thought to contribute to haematoma growth.<sup>10 11</sup> Targeted BP lowering in the acute stages has been shown to limit haematoma growth but is controversial as many have debated the early elevations of BP are an adaptive response to maintain perfusion to an ischaemic penumbra surrounding the haematoma.<sup>10 12</sup> The question is whether intensive BP lowering following acute spontaneous ICH is safe and improves functional neurological outcomes. The ICH ADAPT trial<sup>3</sup> established intensive lowering of BP to a target systolic BP (SBP) <150 mm Hg following acute ICH was safe and did not reduce perihematoma cerebral blood flow. Functional outcome scores were not significantly different between patients treated with intensive BP lowering and those given standard treatment (target SBP <180 mm Hg). The multicentre pilot randomised controlled trial (RCT), INTERACT1, involving 404 patients with ICH found intensive BP lowering in the hyperacute stage (within 6 h) to a target SBP <140 mm Hg was safe and did not increase rates of early neurological deterioration, mortality or dependency at 3 months compared with patients treated with a target SBP <180 mm Hg. In an observational study by Sakamoto *et al.*, 211 patients who presented within 3 h of spontaneous ICH onset and hypertension (SBP >180 mm Hg) received intravenous nicardipine for 24 h to maintain a SBP target of <160 mm Hg. The best 3-month functional outcomes were seen in patients who had a mean SBP <130 mm Hg in the first 24 h following acute ICH. INTERACT 2, involving 2839 patients, is the largest RCT evaluating the effect of intensive BP lowering on functional outcomes. In patients who presented within 6 h of ICH onset and hypertension (SBP between 150 mm Hg and 220 mm Hg), intensive lowering of BP (target SBP <140 mm Hg) did not significantly improve rates of death or major disability at 90 days. On a key secondary outcome, ordinal analysis of modified Rankin scale (mRS) scores showed a significant favourable shift in the distribution of scores in those patients treated with intensive BP lowering. Patients in the intensive treatment group also reported better overall health-related quality of life. However, overall the clinical benefits of intensive BP lowering are modest, the number of patients needed to treat to prevent one poor outcome, defined as death or major



## Best evidence topic reports

disability (mRS 3–5), was 28. There was also no clear relationship between outcome and the time from onset of ICH to commencing treatment.

### Clinical bottom line

Overall, the current evidence suggests in patients with hypertension (SBP between 150 mm Hg and 220 mm Hg) following spontaneous intracerebral haemorrhage, intensive lowering of SBP to a target of less than 140 mmHg in the hyperacute and acute stages is safe and may improve functional recovery.

### LEVEL OF EVIDENCE

Level 1—Recent well done systematic review was considered or a study of high quality is available.

### REFERENCES

- 1 Anderson CS, Huang Y, Wang JG, et al. Intensive Blood Pressure Reduction in Acute Cerebral Haemorrhage Trial (INTERACT): a randomised pilot trial. *Lancet Neurol* 2008;7:391–9.
- 2 Koch S, Romano JG, Forteza AM, et al. Rapid blood pressure reduction in acute intracerebral hemorrhage: feasibility and safety. *Neurocrit Care* 2008;8:316–21.
- 3 Anderson CS, Heeley E, Huang Y, et al. Rapid blood-pressure lowering in patients with acute intracerebral hemorrhage. *N Engl J Med* 2013;368:2355–65.
- 4 Butcher KS, Jeerakathil T, Hill M, et al. The intracerebral hemorrhage acutely decreasing arterial pressure trial. *Stroke* 2013;44:620–6.
- 5 Sakamoto Y, Koga M, Yamagami H, et al. Systolic blood pressure after intravenous antihypertensive treatment and clinical outcomes in hyperacute intracerebral hemorrhage: the stroke acute management with urgent risk-factor assessment and improvement-intracerebral hemorrhage study. *Stroke* 2013;44:1846–51.
- 6 Tsigoulis G, Katsanos AH, Butcher KS, et al. Intensive blood pressure reduction in acute intracerebral hemorrhage: a meta-analysis. *Neurology* 2014;83:1532–9.
- 7 Steiner T, Al-Shahi Salman R, Beer R, et al. European Stroke Organisation (ESO) guidelines for the management of spontaneous intracerebral haemorrhage. *Int J Stroke* 2014;9:840–55.
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- 9 Zhang Y, Reilly KH, Tong W, et al. Blood pressure and clinical outcome among patients with acute stroke in inner Mongolia, China. *J Hypertens* 2008;26:1446–52.
- 10 Xi G, Hua Y, Keep RF. Blood pressure lowering in acute perihematomal brain edema after intracerebral haemorrhage. *Stroke* 2014;45:1241–2.
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- 12 Frontera JA. Blood pressure in intracerebral hemorrhage—how low should we go? *N Engl J Med* 2013;368:2426–7.

*Emerg Med J* 2016;33:159–162.  
doi:10.1136/emered-2016-205681.1

### ***1.8.1.3 Artifacts linked to BestBets Projects.***

#### 1.8.1.3.1 Artifact 1: Development of BestBets (journal paper).

**Carley SD**, Mackway-Jones K, Jones A, Morton RJ, Dollery W, Maurice S, et al. Moving towards evidence-based emergency medicine: use of a structured critical appraisal journal club. *J Accid Emerg Med.* 1998 Jul;15(4):220–2 (170)

Link to paper: <http://emj.bmj.com/content/15/4/220>

Citations as of 4/12/17

Downloads from EMJ site 1589

Google Scholar: 83 citations.

Web of Science: 89 citations.



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
CONTRIBUTION TO PUBLICATIONS**

This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.

1. The Candidate		
First Name(s):	Simon	Preferred Title: Dr
Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
Personal e-mail address:	carleys@me.com	Student ID Number: 17090583
2. Title of PhD Proposal		
Technology enhanced learning in emergency medicine		
3. Title of Research Output		
S D Carley, K Mackway-Jones, A Jones, R J Morton, W Dollery, S Maurice, L Niklaus, S Donnan: Moving towards evidence based emergency medicine: Use of a structured critical appraisal journal club. Journal of accident & emergency medicine 08/1998; 15(4). DOI:10.1136/emj.15.4.220		
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)		
25% for this paper. All contributed		
5. Co author(s):		
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.		
Name	Signature	Current e-mail address
Sue Maurice		hansolo@doctors.org.uk
Wendy Dollery		wdollery@abdn.ac.uk
6. Statement by Director of Studies/Advisor		
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.		
Signature:		Date: 20/12/17
	(Director of Studies/Advisor)	
7. Signature of Faculty Research Degrees Administrator		
Signature:		Date:
	(Faculty Research Degrees Administrator)	



## PhD BY PUBLISHED WORK (ROUTE 1/2): CONTRIBUTION TO PUBLICATIONS

This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.

### 1. The Candidate

First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583

### 2. Title of PhD Proposal

Technology enhanced learning in emergency medicine

### 3. Title of Research Output

Carley SD, Mackway-Jones K, Jones A, Morton RJ, Dollery W, Maurice S, et al. Moving towards evidence based emergency medicine: use of a structured critical appraisal journal club. J Accid Emerg Med. 1998 Jul;15(4):220-2

### 4. Candidate's contribution to the research output

(State nature and approximate percentage contribution of each author)

All contributed to development and design of the project and paper. 25% for this paper

### 5. Co author(s):

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

Name	Signature	Current e-mail address
Rosemary Morton		rosemary.morton@cmft.nhs.uk
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk

### 6. Statement by Director of Studies/Advisor

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature:

(Director of Studies/Advisor)

Date: 20/12/17

### 7. Signature of Faculty Research Degrees Administrator

Signature:

(Faculty Research Degrees Administrator)

Date:

## BEST EVIDENCE IN EMERGENCY MEDICINE

## Moving towards evidence based emergency medicine: use of a structured critical appraisal journal club

S D Carley, K Mackway-Jones, A Jones, R J Morton, W Dollery, S Maurice, L Niklaus, S Donnan

Keeping up to date with new research and clinical developments is one of the major challenges in postgraduate education.<sup>1</sup> In a broadly based specialty such as emergency medicine this is particularly difficult as relevant articles may be published in a wide spectrum of journals. Estimates of reading times among clinicians have shown that it is impossible for an active clinician to keep up to date by reading journals on an individual basis.<sup>2</sup>

There has been increasing interest about how the principles of evidence based medicine can be introduced into clinical practice and, in common with other specialists, practitioners of emergency medicine are struggling with this problem. Emergency medicine is a relatively new specialty with unique features—in particular single patient episodes, short patient consultations, no ward rounds, a wide scope of practice, a limited research base (especially for more minor complaints), and large numbers of junior doctors led (but rarely directly supervised) by a small number of more senior colleagues. These particular factors mean that many of the established methods for introducing evidence based medicine (which were developed in a different and less pressured context) are unsuitable for use in an emergency department.

In an attempt to overcome some of these problems an evidence based emergency medicine journal club was set up at the Manchester Royal Infirmary in 1997. This had the triple aims shown in box 1.

### Box 1

- Teaching critical appraisal techniques
- Keeping abreast of developments
- Introducing the principles of evidence based medicine into practice

This paper outlines the methods by which the aims were achieved and explores how the findings of an evidence based journal club (the evidence for the practice of emergency medicine) can be disseminated into clinical practice.

### The journal club

The journal club meets weekly for approximately one hour. It is held within the emergency department and is open to all medical and nursing staff. The authors represent the initial core members of the club which is now open to clinicians from other departments and hospitals. The aims of the club have been achieved as follows:

#### TEACHING CRITICAL APPRAISAL OF THE LITERATURE

A key component to practising evidence based medicine is the ability to interpret the literature.<sup>3</sup> This ability to critically appraise papers is a key skill for practising emergency physicians and is now a component of the final fellowship in emergency medicine in the UK.<sup>4</sup> To achieve a basic competence in this skill a series of workshops were constructed based around the critical appraisal text by Crombie.<sup>5</sup> This was chosen for its brevity and its use of checklists.

The workshop programme is outlined in table 1. Each session was led by a nominated member of the group with the assistance of one of the senior physicians experienced in critical appraisal.

The series of tutorials were designed to cover the standard types of paper published in journals.<sup>6</sup> From week 4 to week 9 papers relevant to emergency medicine that utilised the particular methodology under discussion were selected in advance. These papers, which are listed in table 2, were distributed to all group members one week before the workshop so as to allow appraisal before the meeting. In this way the group were able to develop and exercise critical appraisal skills across a range of paper types and standards.

Table 1 Programme of evidence based workshops

Week	Topic
1	Introduction to evidence based medicine
2	Introduction to critical appraisal
3	Identifying the research method
3	Interpreting the results
4	Introduction to the checklists
4	Standard appraisal questions
5	Appraising surveys
6	Appraising cohort studies
7	Appraising clinical trials
8	Appraising case-control studies
9	Appraising review papers

Department of  
Emergency Medicine,  
Manchester Royal  
Infirmary, Oxford  
Road, Manchester  
M13 9WL  
S D Carley  
K Mackway-Jones  
A Jones  
R J Morton  
W Dollery  
S Maurice  
L Niklaus

Department of Public  
Health and  
Epidemiology,  
University of  
Manchester,  
Manchester  
S Donnan

Correspondence to:  
Simon Carley (e-mail:  
s.carley@btinternet.com).

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16 April 1998

Table 2 Papers used in the critical appraisal workshops

Surveys	Are British hospitals ready for the next major incident? Analysis of hospital major incident plans <sup>8</sup>
	Skull fractures in children: a population study <sup>9</sup>
Cohort studies	Does out-of-hospital EMS time affect trauma survival? <sup>10</sup>
	Natural evolution of the late whiplash syndrome outside the medicolegal context <sup>11</sup>
Clinical trials	Regional anaesthesia preferable for Colles' fracture? <sup>12</sup>
	Randomised trial of intravenous salbutamol in early management of acute severe asthma in children <sup>13</sup>
Case-control studies	Case-control study of stroke and the quality of hypertension in north west England <sup>14</sup>
	A population based case-control study of agricultural injuries in children <sup>15</sup>
Review papers	Hypertension soft tissue injuries of the cervical spine—a review <sup>16</sup>
	Acute neck sprain: "whiplash" reappraisal <sup>17</sup>

Table 3 Frequency of journal review

Journal	Reviews per year
Academic Emergency Medicine	3
Accident and Emergency Nursing	1
American Journal of Emergency Medicine	3
Annals of Emergency Medicine	6
Archives of Disease in Childhood	2
British Medical Journal	6
Emergency Nurse	1
European Journal of Emergency Medicine	1
Injury	2
Injury Prevention	1
Journal of Accident and Emergency Medicine	3
Journal of Emergency Nursing	1
Journal of Trauma	3
Lancet	6
New England Journal of Medicine	6
Pre-hospital Immediate Care	1
Resuscitation	3

Although the Manchester Royal Infirmary group chose to use the small Crombie book, other books are also available and could be used in a similar way to help develop critical appraisal skills.<sup>6,7</sup>

#### KEEPING ABREAST OF CURRENT DEVELOPMENTS IN EMERGENCY MEDICINE

There are a large number of journals that could contain useful papers for the practising emergency physicians, yet it would be impossible for any one individual to scan, read, and appraise all of them.

Many journal clubs attempt to highlight interesting or relevant papers as a mechanism for changing practice. However, this is often done in an unstructured and haphazard fashion. In order to ensure that important articles were not missed and that time was not wasted on reading irrelevant or poor quality articles a structured approach was taken. A list of 17 peer reviewed journals that were both relevant to the practice of emergency medicine and available for study was formulated. Each journal was assigned a number of times to be reviewed per year (the review rate reflecting both the number of issues in a year and the estimated chances of quality emergency medicine papers appearing). The list of journals and their review rates are shown in table 3.

Table 4 Strength of evidence

A	There is good evidence to support the use of the procedure
B	There is fair evidence to support the use of the procedure
C	There is poor evidence to support the use of the procedure
D	There is fair evidence to support the rejection of the procedure
E	There is good evidence to support the rejection of the procedure

Only the best, most relevant, or interesting articles from the journal of the week are presented to the other members of the journal club. As was the case during the initial workshops papers are made available one week in advance and are appraised using the checklists from the critical appraisal guide.<sup>5-7</sup> Papers are rated using the categorisation of evidence shown in table 4.<sup>18</sup> Compelling evidence from high quality papers is integrated into departmental policy.

This structured approach ensures that important papers are not overlooked by individual members of the journal club. In total 49 sessions per year are allocated to particular journals. Since two papers are reviewed each week at least 98 papers are critically appraised by the group per year.

On several occasions no high quality papers have been found after the review of the journal. In this case lower quality papers are reviewed and study design improvements are discussed. This process educates the group in research design as well as in critical appraisal. Furthermore potential research topics have been highlighted in this way.

#### INTRODUCING EVIDENCE BASED MEDICINE INTO PRACTICE "MAKING BETS"

It could be argued that evidence based practice can be introduced into emergency medicine merely by scanning and appraising journals as outlined above; it is certainly the case that some changes in practice have come about in this way. However this process of learning is not an accurate reflection of clinical practice since it is patients not journal articles that present to the emergency department. Clinical practice is based around making decisions on real patients, and it is essential that evidence based medicine reflects this. Thus evidence that pertains to questions that arise during clinical encounters should also be addressed. As described elsewhere in this journal<sup>19</sup> we have modified the critically appraised topic technique for use in emergency medicine. The reports generated, called best evidence topic reports (BETs), are used to introduce and change clinical practice within the emergency department.

Topics for BETs are selected by the group and each week one member of the group presents a report.

#### Discussion

Structured journal clubs are not new to emergency medicine<sup>20-22</sup> but we believe that this is the first report of a journal club being used to implement evidence based practice in an emergency department. Many emergency departments and training rotations in the UK participate in journals clubs of some kind. Experience has shown these to be unstructured and rather haphazard affairs that do little to establish the practice of evidence based medicine. With evidence based medicine becoming an ever more important aspect of training and clinical practice we advocate the structure described here to other emergency medicine journal clubs.

No formal assessment of group satisfaction was undertaken before and after the

development of the journal club. Anecdotally we found that participants did not feel that their reading time had significantly increased. However, their reading time was more focused, critical, and across a much wider range of journals. Overall the members of the group consider the journal club to be a success, and an effective use of the limited amount of time available for private study in a busy emergency department.

We have not assessed the impact of the journal club on clinical practice and patient care within the department as no data was collected prior to the development of the journal club system. Anecdotally lessons learned from BETs and structured journal scans have been implemented within the department.

Emergency medicine has close links with a large number of other specialties. It is important that evidence used in the emergency department is shared with in hospital specialties and on call teams. We believe that the construction and dissemination of the BETs can aid this interspecialty liaison and improve clinical practice.

### Conclusion

Traditional methods of instituting evidence based medicine are not applicable to the emergency department setting. A structured journal club was designed to teach critical appraisal, keep abreast of developments in the field of emergency medicine, and institute evidence based medicine in this setting.

A proactive approach to evidence based medicine is necessary in emergency medicine. The use of a journal club to critically appraise journals relevant to emergency medicine and to construct and disseminate BETs, is one mechanism by which this can be achieved.

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#### 1.8.1.3.2 Artifact 2: The Best Evidence Topic origins.

Mackway-Jones K, Carley SD, Morton RJ, Donnan S. The best evidence topic report: a modified CAT for summarising the available evidence in emergency medicine. [J Accid Emerg Med](#). 1998 Jul; 15(4): 222–226.

Link to paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1343127/>

Citations as of

Google Scholar: 98 citations

Web of Science: 96 citations



Research and Knowledge Exchange  
Graduate School  
Form RDPUB (ROUTE 1 AND 2)



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate			
First Name(s):	Simon	Preferred Title: Dr	
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
Mackway Jones K, Carley SD, Morton RJ, Donnan S. The best evidence topic report: a modified CAT for summarising the available evidence in emergency medicine. J Accid Emerg Med. 1998 Jul;15(4):222-6			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
All contributed to development and design of the project and paper. 25% for this paper			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk	
Rosemary Morton		rosemary.morton@cmft.nhs.uk	
Stuart Donnan		stuart@donnan.eu	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:			Date: 20/11/11
		(Director of Studies/Advisor)	
7. Signature of Faculty Research Degrees Administrator			
Signature:			Date:
		(Faculty Research Degrees Administrator)	

# The best evidence topic report: a modified CAT for summarising the available evidence in emergency medicine

Department of  
Emergency Medicine,  
Manchester Royal  
Infirmary, Oxford  
Road, Manchester  
M13 9WL  
K Mackway-Jones  
S D Carley  
R J Morton

Department of Public  
Health and  
Epidemiology,  
University of  
Manchester,  
Manchester  
S Donnan

Correspondence to:  
Kevin Mackway-Jones  
(e-mail: kmackway@  
fs1.mci.man.ac.uk).

Accepted for publication  
16 April 1998

K Mackway-Jones, S D Carley, R J Morton, S Donnan

In order to achieve the optimal care for patients in the emergency department it is essential that their management is based upon the best available evidence. While the concept of evidence based medicine is widely accepted across many hospital and community specialties, emergency medicine has lagged behind in formalising the approach to evidence based practice.

One commonly used approach is that of the critically appraised topic (CAT).<sup>1,2</sup> This was designed to be a one page summary of the evidence related to a particular clinical question. This established method would appear to be a

reasonable starting point for developing a clinically based approach to examining the evidence in emergency medicine. Unfortunately problems have been identified. CATs work best when based on papers that stand up to rigorous critical appraisal. In emergency medicine the evidence that does exist is frequently not of high quality, and consequently the critical appraisal process would tend to discard many papers because of either methodological flaws or poor design. The experience of the critical appraisal journal club<sup>3</sup> was that an absolute requirement for high quality evidence meant

that large numbers of clinical questions in emergency medicine could not be answered at all. It became apparent during the searches that evidence of lower quality was available, and that this could be assimilated to give the best available answer at the present time.

This realisation that it was necessary to use the best available evidence led to the development of the best evidence topic report (BET) discussed below.

### Design

BETs are constructed in four stages, based on the principles underlying all evidence based medicine. These stages are summarised in box 1 and are discussed below.

#### Box 1

- Asking the right question
- Searching for the evidence
- Appraising the evidence
- Summarising the evidence

#### ASKING THE RIGHT QUESTIONS

If a BET is to have real meaning to practising clinicians it is important that each topic selected is rooted in the practice of emergency medicine. In order to ensure that this is the case a clinical scenario is developed to illustrate the topic of interest. This scenario will be familiar to the person preparing the report, and will represent a real clinical problem in emergency medicine.

In order to ensure that the question is well defined and answerable a three part question is prepared from the clinical scenario. This process is well described as a tool for evidence based medicine.<sup>2-4</sup> The three part question has the structure shown in box 2.

#### Box 2

- Patient characteristic
- Intervention(s) or defining question
- Relevant outcome(s)

It is vitally important to define the three part question well as this helps ensure that an appropriate search strategy can be formulated. An example of a general question of interest and a derived three part question are shown in box 3.

#### Box 3

##### General question

Is a haematoma block the best way to reduce a Colles' fracture?

##### Derived three part question

In [elderly patients with a Colles' fracture]

Is [a haematoma block better than a Bier's block]

At [reducing pain during manipulation and decreasing the need for remanipulation]

Table 1 Maximally sensitive randomised controlled trial filter

1	Randomised controlled trial.pt.
2	Controlled clinical trial.pt.
3	Randomised controlled trials.sh.
4	Random allocation.sh.
5	Double-blind method.sh.
6	Single-blind method.sh.
7	or/1-6
8	Animal.sh not human.sh.
9	7 not 8
10	Clinical trial.pt.
11	Exp clinical trials
12	(clin\$ adj25 trial\$).ti.ab.
13	((single or double or treble or triple) adj25 (blind\$ or mas\$)).ti.ab.
14	Placebos.sh.
15	Placebo\$.ti.ab.
16	Random\$.ti.ab.
17	Research design.sh.
18	or/10-17
19	18 not 8
20	19 not 9
21	Comparative study.sh.
22	Exp evaluation studies/
23	Follow up studies.sh.
24	Prospective studies.sh.
25	(control\$ or prospectiv\$ or volunteer\$).ti.ab.
26	or/21-25
27	26 not 8
28	26 not (9 or 20)
29	9 or 20 or 28

#### SEARCHING FOR EVIDENCE

In order to ensure that as much evidence as possible is included in the BET, it is essential that search strategies are sound and explicit. Two sources are explored in the construction of a BET. First the Medline database is searched using a strategy constructed as outlined below. Secondly the Best Evidence CD-ROM<sup>5</sup> can be searched to see if there are any relevant systematic reviews.

##### Medline

There are three parts to the Medline search. First it is necessary to use search terms to produce a subset of the Medline database that contains all the papers relevant to the subject defined by the three part question. Second evidence based or methodological filters are applied if appropriate. Finally the titles and abstracts of the "hits" are scanned to see which papers are actually relevant to the question posed. Techniques for searching the Medline database have been reviewed recently.<sup>6</sup>

##### The subject search

In order to achieve the aims of the BET (finding and summarising the best evidence) it is important that the subject search has a high sensitivity (that is it has a high likelihood of retrieving all relevant items) so that important evidence is not overlooked. It may be necessary to use a number of different search strategies (that is use different search terms and combinations of terms) as well as using search terms that cover a slightly broader question. Greater sensitivity is achieved by using a combination of free text and text words together with medical subject headings (MeSH). A particularly useful feature enabling increased search sensitivity is the explosion command; this maps an individual MeSH term on to other related MeSH terms. Since some 50% of the articles

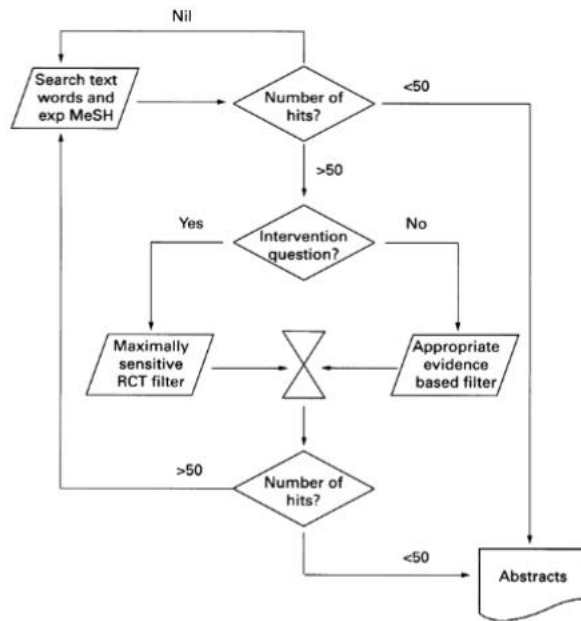


Figure 1 Overall search strategy for BETs (exp = explode; MeSH = medical subject headings; RCT = randomised controlled trial).

on Medline are misclassified by subject heading, this ability to search for related terms is invaluable.

If the highly sensitive search yields too many "hits" to be manageable, then it may be necessary to increase the specificity (the proportion of documents which are relevant) by refining the search. In general techniques for increasing specificity are the opposite of those for increasing sensitivity. Thus the question needs to be better defined and more specific terms need to be used in free text. Other techniques for increasing specificity include combining terms using the boolean operator *and* to combine different aspects of the question, and use of the Medline LIMIT command to set various general limits of the search such as language, species, or publication type.

As has been mentioned above the proper construction of a three part question holds the key to the search. A properly constructed question will allow a sensitive search to be carried out in a particular area of interest, so that all relevant papers relating to that area can be gathered and appraised.

Table 2 Type and strength of evidence

I	Strong evidence from at least one published systematic review of multiple well designed randomised controlled trials
II	Strong evidence from at least one published properly designed randomised controlled trial of appropriate size and in an appropriate clinical setting
III	Evidence from published well designed trials without randomisation, single group pre-post, cohort, time series, or matched case-control studies
IV	Evidence from well designed non-experimental studies from more than one centre or research group
V	Opinions of respected authorities, based on clinical evidence, descriptive studies, or reports of expert consensus committees

#### Applying filters

If a properly sensitive search carried out in a relevant area still yields a large number of hits then filters can be used. These are search strategies that have been designed to perform particular tasks such as finding randomised controlled trials or research overviews. A number of these are available in the public domain and have been published<sup>6</sup> or can be found at appropriate web sites.<sup>7</sup>

The vast majority of questions of interest to emergency physicians at the present time (and therefore those most likely to appear as BETs) involve either treatments (interventions) or diagnosis. An appropriate filter for intervention studies in the context of BETs is a maximally sensitive randomised controlled trial filter; one such is shown in table 1.<sup>6</sup>

Diagnostic questions require a different approach since randomised controlled trials are not in general an appropriate method of investigation. In such cases an appropriate diagnostic evidence based medicine filter can be used. Diagnostic evidence filters and other evidence based filters appropriate to different types of questions (such as epidemiological or aetiological ones) are available from the Centre for Evidence Based Medicine and other appropriate sources.<sup>7</sup>

Making the searches explicit meant that they can easily be repeated to update the BET at a later date.

#### Scanning titles and abstracts

Once the subject search has been completed and any necessary filters have been applied a number of papers will fulfil the search criteria. There is no guarantee that these will all be relevant to the question posed and a final scan of titles and, if there is any doubt, abstracts will be necessary. Ideally a maximum of 50 papers will be left for scanning in this way, but on some occasions more than this number will remain despite increasing the specificity of the search. It is better to have a higher number of papers to scan than to miss relevant papers by over refining the search.

At the end of the scanning process a number of papers will be discarded as "irrelevant to the question". All the other papers remaining will need to be critically appraised. This process is described below.

The overall search strategy used in the construction of a BET is summarised in fig 1.

#### APPRAISING THE EVIDENCE

Evidence based medicine is not about dismissing all evidence that has not been gained by randomised trials and meta-analyses.<sup>8</sup> Some types of question are not best answered by these approaches and appropriate evidence needs to be found for these. Furthermore for many questions in emergency medicine there is no appropriate research that stands up to rigorous critical appraisal. BETs are designed to find the best evidence that exists to answer a particular question. If high level evidence does exist then the question posed can be answered with some certainty. If high level evidence does not exist then best evidence available can be

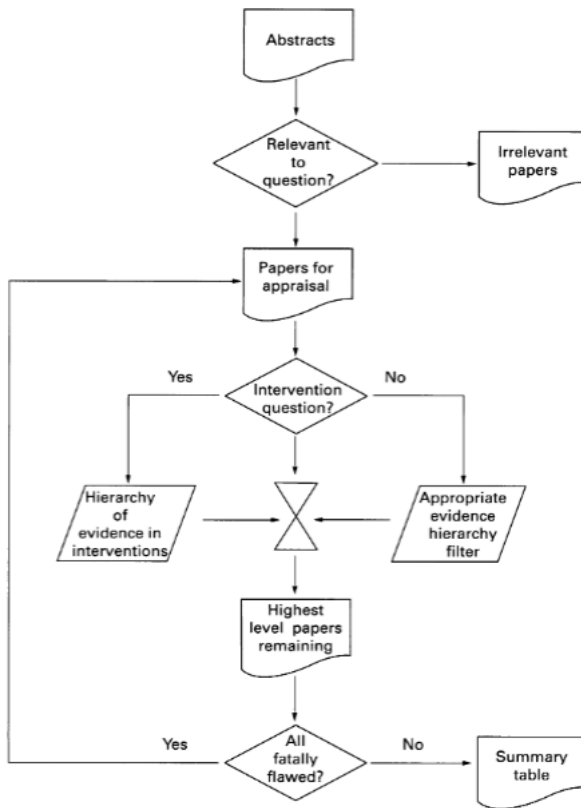


Figure 2 Critical appraisal strategy.

summarised, and the failure to find good evidence can be used as a springboard for appropriate research.

The first critical appraisal filter to be applied to papers that are found by the search is methodological. The question underlying the methodological filter is: "what is the appropriate design of research to answer this question?", and, if more than one approach is

possible the second question is: "what is the relative merit of each of the possible methods?" In the case of questions concerning interventions the hierarchy of evidence shown in table 2 is generally accepted<sup>7</sup> and is used in constructing BETs. Although other hierarchies have been proposed<sup>8</sup> the concepts underlying them all are the same.

The highest available level of evidence is used to construct the BET—thus level I evidence will be used if it exists; if there is no level I evidence then level II will be sought and so on.

Once papers containing the highest level of evidence available have been identified, they are critically appraised. The critical appraisal methods used are standard and have been published in a number of places.<sup>9 10 11</sup> Key questions include methodological and analytical soundness.

After critical appraisal a paper may be found to be so flawed as to be unusable and will thus be discarded as of "insufficient quality for inclusion". If a paper is not fatally flawed or if, despite being flawed, it represents the best evidence that is available it will be included in the BET. Comments about study weaknesses will be included in the last column of the table summarising the evidence.

The overall strategy for critical appraisal used in the construction of the BET is summarised in fig 2.

SUMMARISING THE EVIDENCE

In order to keep a record of appraised topics a summary of the evidence is made in the form of a BET. The first of these BETs appear in this month's journal. The reports follow a standardised format.<sup>12</sup> This includes the title, the clinical scenario, the derived three part question, the detailed search strategy, and the results of the search. The number of "hits" is followed by the number of papers which were not relevant to the question and the number which were of insufficient quality for inclusion (after critical appraisal). Those papers which are included in the BET are reported in table format. The table includes the author, date, and country of the research, the patients groups the study type (and the level of evidence), the outcomes that were investigated,

Table 3 Template for a BET

<b>Title</b>					
Report by:					
Search checked by:					
<i>Clinical scenario</i>					
<i>Three part question</i>					
<i>Search strategy</i>					
<i>Search outcome</i>					
<i>Author, date, and country</i>	<i>Patient group</i>	<i>Study type (level of evidence)</i>	<i>Outcomes</i>	<i>Key results</i>	<i>Study weaknesses</i>
<hr/>					
<i>Comment</i>					
<i>Clinical bottom line</i>					
<i>References</i>					

the key results for each outcome and the study weaknesses that were identified. A further analysis of the results of the best papers may be given if the results allow this. Free text comment about the search and its outcome is then given, followed by the clinical bottom line (the answer to the original question). The references of the relevant papers are given in full.

The template for the BET is shown in table 3.

Each BET is attributed to a main author and also a subsidiary author who is responsible for checking the search strategy and outcome.

#### NEGATIVE BET REPORTS

It is foreseen that a significant number of topics will fail to produce any evidence to answer the clinical question posed. These "negative" BETs are indicative of areas for further research, and a list of the questions for which no answer at all can be found should be circulated alongside "positive" reports.

#### Discussion

BETs are an attempt to formalise evidence based practice in the emergency department. Their very name indicates the uncertain nature of much of the "evidence" in this area. The hope is that by basing BETs on real problems in emergency medicine, real questions will be answered with the best evidence available. This process is essential as real questions about patient care arise on a daily basis in the emergency department, yet there is rarely time to search for evidence at the time of a patient presentation. It is therefore essential to be proactive in the approach to evidence based practice. Emergency medicine is still a relatively young specialty and there is a paucity of high quality evidence for many aspects of practice, BETs will therefore not be confined to questions regarding new or novel practices and will examine the evidence for well established practices as well.

The BET does have its weaknesses. While it reports the best available evidence obtained

through literature searching on Medline and other information resources, it does not examine unpublished literature in the way that systematic reviews do. It is unlikely that systematic reviews will become available for many of the more minor complaints that present to the emergency department for some time. Even if they did, as the BETs will show, it is unlikely that much of the evidence would pass the methodological filters used in systematic reviews.

BETs contain the best evidence that can be practically obtained by busy practising clinicians and should be used to inform best practice. They can be disseminated around members of journal clubs, training schemes, and can be published in peer reviewed journals or web sites. It is hoped that BETs will demonstrate both the strengths and the weaknesses of the evidence base on which the practice of emergency medicine is based.

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- 5 Best evidence CD-ROM. London: BMJ Publishing Group, 1997.
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- 9 Stevens A, Raftery J, eds. US task force on preventative health care. *Health care needs assessment: the epidemiologically based needs assessment reviews*. Second series. Abingdon: Radcliffe Medical Press, 1997.
- 10 Crombie IK. *The pocket guide to critical appraisal*. London: BMJ Publishing Group, 1996.
- 11 Greenhalgh T. *How to read a paper: the basics of evidence based medicine*. London: BMJ Publishing Group, 1997.
- 12 Mackway-Jones K, ed. Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary. *J Accid Emerg Med* 1998;15:227-30.

#### 1.8.1.3.3 Artifact 3: Growth and impact of BestBets (journal paper).

Mackway-Jones K, Carley S. bestbets.org: odds on favourite for evidence in emergency medicine reaches the World Wide Web. J Accid Emerg Med. BMJ Group; 2000 Jul;17(4):235–6 (154)

Link to paper: <http://emj.bmj.com/content/17/4/235.2>

Citations as of

Google Scholar: 60 citations

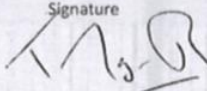
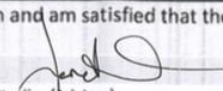
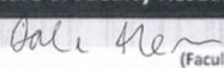
Web of Science: 66 citations

Research and Knowledge Exchange  
Graduate School  
Form RDPUB (ROUTE 1 AND 2)



**PHD BY PUBLISHED WORK (ROUTE 1/2):  
CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate			
First Name(s):	Simon	Preferred Title: Dr	
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
Mackway-Jones K, Carley SD. BestBets website. www.bestbets.org			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
All contributed to development and design of the project and paper. 50% for this project			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Kevin Mackway-Jones		kevin.mackway-jones@mmu.ac.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date: 20/12/17	
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			



## bestbets.org: Odds on favourite for evidence in emergency medicine reaches the world wide web

This edition sees the second anniversary of the first publication of best evidence topic reports (BETs) from Manchester Royal Infirmary,<sup>1</sup> the publication of the first ever "guest" BETs and the launch of the bestbets web site.

The BETs were designed in 1997 as a method for appraising real clinical questions using published evidence.<sup>2</sup> The BETs were never meant to be systematic reviews. They are a method of evidence retrieval, evaluation and collation easily achievable by busy emergency physicians. Although originally used to influence practice locally, publication in the *JAEEM* has disseminated the information to a much wider audience. The BETs were based on the critically appraised topics (CATs) developed by Sackett *et al.*<sup>3,4</sup> CATs usually use one or two high qual-

ity papers to answer a specific question; this approach has been adopted in other emergency medicine journals.<sup>5</sup> The BETs extend the model by including lower quality evidence where no high quality evidence exists as the practising clinician needs to know "what evidence is available?" rather than just "are there any high quality papers on the subject?"

This need for inclusion of lower ranking evidence is particularly marked in emergency medicine where the subject matter is vast and the research base is frequently poor. Patients still need to be treated and judgments must be made on whatever evidence is available. The BETs system makes the information explicit (whatever its level) so that decisions can be informed ones. An interesting side effect of the critical analysis of the research base has been a realisation of just how frequently established practice is based on little to nothing. This has led to questioning of current practice and the gestation of many research projects.

Other centres and individuals have shown a great deal of interest in producing their own BETs. This sounds a simple thing to organise but actually presents problems in terms of both quality assurance and duplication of effort (over 200 BETs are currently registered as complete or in progress and only 61 have been published so far). The Best BETs web site at <http://www.bestbets.org> has been developed to facilitate the process of BET production and publication by allowing anyone to register BET topics online. BETs should be registered as three part questions, and, once registered, topics will be held for six months. This time should be ample for completion of the BET. By registering and developing BETs through the web site we hope to encourage and help in the publication of "guest" BETs alongside those from the Manchester Royal Infirmary. The first of these "guest" BETs appear in this edition.

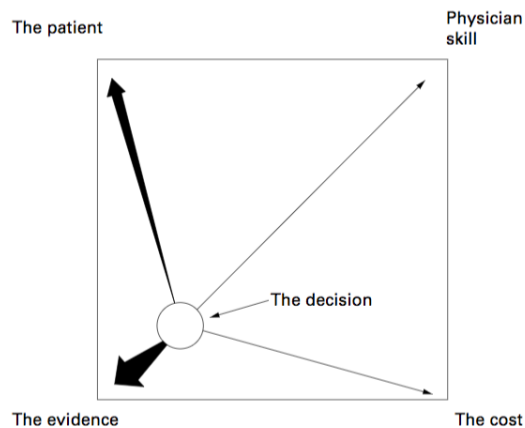


Figure 1 Factors affecting the clinical decision.

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New evidence is always appearing and BETs can only be as up to date as the date on which the search was last executed. The search strategies have always been an explicit part of the BETs so as to allow others to check and update the evidence. The web site offers an opportunity to continuously update BETs and it is intended that this will be done at a minimum of six monthly intervals.

Local and national interest in the BETs has suggested that they are widely read. However, determining if they result in a change in practice is difficult. This will be the acid test in determining whether all the effort has been worthwhile and further work on this question is currently in progress.

In clinical practice decisions regarding individual patient care are rarely made purely on the basis of the evidence, however good it might be. Doctors treat patients not papers, have limited budgets and differing skill levels. What is actually done will depend upon the relative weightings of all these factors as shown in figure 1.

Defining the evidence is an essential step in allowing clinical decisions to be made rationally. Ultimately, it is

hoped that the BETs will address most of the important issues in our practice, producing the evidence for what we do. The list of unanswered questions is clearly enormous and if the desire to define the evidence on which we base our practice is to succeed, many people will need to be involved in answering them.

We look forward to hearing from you.

KEVIN MACKWAY-JONES  
SIMON CARLEY

Department of Emergency Medicine, Manchester Royal Infirmary

- 1 Carley SD, Mackway-Jones K, Jones A, *et al.* Moving towards evidence based emergency medicine: use of a structured critical appraisal journal club. *J Accid Emerg Med* 1998;15:220-2.
- 2 Mackway-Jones K, Carley SD, Morton RJ, *et al.* The best evidence topic report: a modified CAT for summarising the available evidence in emergency medicine. *J Accid Emerg Med* 1998;15:222-6.
- 3 <http://cebmr2.ox.ac.uk/docs/cats/catabout.html>
- 4 Sackett DL, Richardson WS, Rosenberg W, *et al.* *Evidence-based medicine. How to practice and teach EBM.* New York: Churchill Livingstone, 1997.
- 5 Wyer P. The critically appraised topic: closing the evidence-transfer gap. *Ann Emerg Med* 1997;30:639-40.

#### 1.8.1.3.4 Artifact 4: Online website and BestBets library (website)

The BestBets website(122)

Link to website: <http://www.bestbets.org>

Citations as of 1/3/18

BestBets submitted on line 2996

Research and Knowledge Exchange  
 Graduate School  
 Form RDPUB (ROUTE 1 AND 2)



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
 CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

**1. The Candidate**

First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583

**2. Title of PhD Proposal**

Technology enhanced learning in emergency medicine

**3. Title of Research Output**

Mackway-Jones K, Carley SD. BestBets website. www.bestbets.org

**4. Candidate's contribution to the research output**

(State nature and approximate percentage contribution of each author)

All contributed to development and design of the project and paper. 50% for this project

**5. Co author(s):**

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

Name	Signature	Current e-mail address
Kevin Mackway-Jones		kevin.mackway-jones@mmu.ac.uk

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature:		Date:	20/12/17
	(Director of Studies/Advisor)		

**7. Signature of Faculty Research Degrees Administrator**

Signature:		Date:	
	(Faculty Research Degrees Administrator)		



## About

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- [People](#)
- [Database Introduction](#)
- [Participation](#)

## Databases

## Background

## Teaching

## News

## Resources

## Contact



Physicians need rapid access to the best current evidence on a wide range of clinical topics. But where to find it? Textbooks are frequently out-of-date, and we don't have the time to perform literature reviews while the patient is waiting.

BETs were developed in the Emergency Department of Manchester Royal Infirmary, UK, to provide rapid evidence-based answers to real-life clinical questions, using a systematic approach to reviewing the literature. BETs take into account the shortcomings of much current evidence, allowing physicians to make the best of what there is. Although BETs initially had an emergency medicine focus, there are a significant number of BETs covering cardiothoracics, nursing, primary care and paediatrics.

Tell your colleagues about this site - it could save your department a lot of time!



Why not write a BET of your own, and have it published here, for the benefit of patients everywhere? We're keen to receive Best Evidence Topic reviews from colleagues all over the world. Use the submission form in the database section, for you to register your intention to write a BET. We'll add your topic to the database, and the world will await your completed review!

A more advanced feature is now available on the BestBETs website - appraisal tool checklists are available for use online or downloading as an aid to the critical appraisal process. We strongly encourage BET authors to submit their critical appraisals of papers in the BET table along with their BET. Visitors to the site can now view critical appraisals independently or link directly from the BET table wherever appears. Further details of BestBETs new features can be found on the 'Site & EBM news' page in the News section.

If you have any comments about BETs or the website, please feel free to contact us.

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#### ***1.8.1.4 Critical Appraisal: Development, assessment and progression of the BestBets method and database.***

##### **1.8.1.4.1 Further developments beyond Emergency Medicine**

The BestBets project was originally designed to meet the needs of the local emergency medicine community and then the wider emergency medicine community at in the UK and globally. From a methodological perspective there is no rational reason why the process should or could be limited to emergency medicine and this has been shown through the adoption of the technique in other specialities.

The potential for using similar methodologies beyond emergency medicine was recognized initially by the paediatric community and the BestBets process led to the development of the Archimedes projects in the Annals of Paediatrics and Child Health (164,165,171). Although Archimedes permits a more in-depth commentary the concept, practice, process and structure of the evidence-based summaries in paediatrics is the same as the original BestBets project. Archimedes summaries are also published on the BestBets website.

Joel Dunning trained in the emergency department at Manchester Royal Infirmary before embarking on a career as a cardiothoracic surgeon. He took the BestBets methodology to the Interactive Cardiovascular and Thoracic Surgery journal (163). These are dual published in that journal and on the BestBets website.

The International Journal of Surgery began publishing BestBets in 2011(162,172). A focus on defining and expanding the evidence based in surgery is the aim (173), with high citation and download statistics reported (173).

The Veterinary Review journal in collaboration with the Centre for Evidence Based Veterinary Medicine (174) have published over 60 Bets to improve the

use of EBM in veterinary medicine (166,175) across the range of large and small animal work (176,177).

Most recently the journal Trauma has adopted the BestBets system to describe the evidence base for major trauma care in the UK (161).

#### 1.8.1.4.2 Critique

BestBets has clearly been extremely successful in terms of reach, diversity and longevity. The range and quantity of material developed, with further publication in a broad church of journals reflects a project that has had a significant academic impact both in the revealing of evidence, but also in the promotion of an understanding of how evidence can be applied in practice. However, as with many academic innovations it has not been without harsh criticism. For example a BestBets published in 2005 regarding prehospital intubation (178) led to published concerns about rationale, editorial control and data interpretation (179-182). Similarly in 2004 the inclusion of BestBets as serious evidence reviews was questioned by UK colleagues (183,184). The position was defended both by the BestBets team (185), editors (186) and others (187). More recently an audit of BestBets methodology in the International Journal of Surgery identified some methodological concerns around adherence to structural compliance but also recommended increasing the visibility and scope of submissions, thus delivering a positive review of BestBets in surgical specialties (172). The development of short evidence summaries in paediatrics received similar criticism to those in emergency medicine, with comparable rebuttals from the editor (188).

Such concerns reflect a healthy debate about the process of BestBets and the use of evidence in clinical practice. Despite these occasional concerns raised in print and at conferences the system continues to train clinicians in critical appraisal skills and forms a repository of useful and interesting questions and answers in emergency medicine. Questions are still submitted, answered and published. Both the website and print publications are continuing to be active in 2018.

#### 1.8.1.4.3 Personal contribution to the BestBets project

I have been involved in the project from the very beginning. The initial ideas around the development of CATs in emergency medicine began as a result of my completion of an MPhil in Clinical Epidemiology and Biostatistics. The course work for that course used Sackett's book on Clinical Epidemiology (155) and it was this that started the project that subsequently developed into the BestBets system. Working initially with colleagues at Manchester and subsequently in other print and electronic media. I co-developed the original strategies, the critical appraisal checklists, the design and look of the website and subsequent improvements over time. I have encouraged and supported hundreds of BET authors in their ideas and in the construction of their BETs. I have edited many BETs for both online and paper publication. As an associate editor of the Emergency Medicine Journal for over 10 years, I have worked with my editor colleagues and with the publication teams to deliver the publication of BETs in the journal. BestBets published in the EMJ are fully indexed on Medline as *review* articles.

#### ***1.8.1.5 How have these artifacts related to BestBets and evidence-based medicine contributed to the development of Emergency Medical Education?***

The fact that the BestBets system has been widely cited, presented and adopted by groups across the globe is a testament to its impact. In addition the subsequent adoption of the BestBets methodologies to be published in a broad range of journals, in emergency medicine (154), paediatrics (164,165,171), cardiac surgery (163), veterinary medicine(166), surgery(162,172) and trauma care(161). The authorship of BestBets has not been confined to the medical profession with many BestBets being published by nursing and allied health professionals. BestBets have been published by all levels of seniority in medicine from medical students through to full time academic scientists. Geographically BestBets have been published from a range of countries across the globe.

The BestBets methodology has also been used as the underpinning evidence collation and assessment method of evidence for guideline development. The GEMNET(189) (Guidelines in Emergency Medicine Network) guidance from the Royal College of Emergency Medicine used the BestBets methodology to develop guidance across a range of emergency medicine conditions including thrombo-prophylaxis and drug toxicity (190,191).

More recently the BestBets methodology was used to assess and prioritise questions posed by a multi-professional patient: clinician partnership as part of the James Lind alliance. The James Lind Alliance sets research priorities as an independent body to the National Institute of Healthcare Research (NIHR) (192). The James Lind Alliance is highly influential in determining future research priorities from major funding bodies such as the NIHR and the integration of BestBets into this process reflects how they are valued beyond the initial research group. The BestBets method was chosen as a screening process for clinical questions posed by the public, patients and clinicians in order to identify those areas where definitive answers did not already exist. This typifies the pragmatic, time efficient and practical utility of the BestBets process. I was asked to be committee member for this project and subsequently an author on the final report and paper(193-197). This project also demonstrates how BestBets continue to offer a practical, pragmatic and robust method for rapid evidence-based practice.

#### 1.8.1.5.1 Conclusions

The BestBets project was designed at a time when evidence-based medicine was first developing in the UK. The particular challenges of working in a 24/7 system such as emergency medicine necessitated a method of evidence searching, collation and dissemination using an internet-based platform.

It has provided a pragmatic tool for all emergency medicine clinicians to practice evidence-based medicine. The use of online databases, internet information and submission processes clearly demonstrates how technological innovation, in this case through the use of online database and



search engines, can be used to promote and disseminate a core principle of emergency medicine practice. In this case the dissemination and promotion of evidence-based practice.

The success of the BestBets process is clearly demonstrated by its widespread adoption and development by other groups outside of the original emergency medicine group.

## **1.8.2 Theme 2: Virtual learning environments**

### *1.8.2.1 Narrative: Why Virtual Learning Environments developed in Emergency Medicine.*

The chronologically and distributed workforce in emergency care presents clear difficulties for the educator(45). Traditional models of face-to-face teaching are clearly impossible to achieve for all in a specialty where the workflow cannot simply stop and where the complexities of shift work and the associated work pattern restrictions limit the opportunities for face-to-face interactions(45).

A consequence of this is that clinicians in emergency specialties struggle to attend face to face teaching sessions(45,198,199). This is of particular concern within the UK model of emergency care where much of the workforce consists of junior doctors who may have little or no prior exposure to the specialty. Additionally, the working patterns of senior doctors does not mirror that of junior doctors and thus it is common for junior doctors to work without direct clinician supervision within a few days of starting in a specialty where the risks of error are high. Traditionally this has been a tremendous challenge to ensure safe working practice and arguably it has led to significant clinical risks and harms.

Our experience in Manchester led to an understanding that trainees cannot attend face to face teaching with sufficient regularity to ensure safe education and working. It was clear that an alternative approach, one that permitted education to take place irrespective of time and location was required. This led to the decision to move some components of the emergency medicine teaching program onto an online platform.

The original decisions to use the Moodle platform was therefore primarily based on the pragmatic rationale to try and improve the opportunities for engaging with learners. Virtual Learning environments allow tutors to engage with learners in an asynchronous fashion providing increased flexibility, cost-effectiveness and improved resource utilization(200). It may also address the preferences of the millennial generation(200,201).

VLEs are also capable of providing data on learner progress and achievement (e.g. through online submissions, quizzes or assignments). The paper presented here on developing a virtual learning course for those Foundation year 2 (F2) doctors new to emergency medicine describes the construction and increase in engagement by using this online system(198). The project continues to the present day and is still used in Manchester to track trainee progress in their orientation and first steps in emergency medicine. It has been used in a variety of other hospitals as an induction system for junior doctors, either as a formalised blended learning program (as it is in Manchester) or as an adjunct to more traditional models of learning. The foundation induction course has been updated on a number of occasions and in its present format it is open access to anyone who self-registers on the St. Emlyn's Moodle site(202,203) and is based around the use of reusable learning objects from #FOAMed (Free Open Access Medical Education(98)) resources.

Following the establishment of a course designed to train the most junior doctors in emergency medicine (those on their first placement), further work led to the development of more advanced courses in Paediatric emergency medicine(204) and advanced emergency medicine training(40).

These papers demonstrate how initial progress in transferring training from a face to face to approach to a blended learning approach led to further developments in engaging more senior learners within a more complex pedagogy of learning needs. This again demonstrates the flexibility and agility of online systems to adapt and change to different learner groups and in response to changing requirements for education. These lessons learned are in constant evolution and subsequently led into the design and delivery of education using social media platforms in an increasingly social age of learning(205).

The Moodle Website: <http://classroom.stemlyns.org.uk> has had over 16000 registered users since inception and continues to provide courses in emergency medicine, critical care and emergency paediatrics. The Moodle

site has also been used to develop local learning within the journal club based at Manchester Royal Infirmary(168). This journal club has been used as a model for learning in other centres advocating positive incident reporting and case discussions through asynchronous communication (the awesome and amazing message boards(206)). The design, supervision and methods of the journal club have been shared widely through social media and conference presentations (168-170).

### ***1.8.2.2 Artifacts linked to Virtual Learning Environment projects.***

#### 1.8.2.2.1 Artifact 5: Developing and evaluating virtual learning environments in emergency medicine (40)

Mackway-Jones K, Carley SD, Kilroy D. Advanced training in emergency medicine: a pedagogical journey from didactic teachers to virtual problems. Emerg Med J. 2007 Oct; 24(10): 696–698.

Paper link: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2658434/>

Google Scholar: 10 citations

Web of Science: 5 citations

Altmetrics: score: not available

Mendeley readers: not available

Blogged: not available

Downloaded from EMJ site: 350 times.

Research and Knowledge Exchange  
Graduate School  
Form RDPUB (ROUTE 1 AND 2)



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate	
First Name(s):	Simon <span style="float: right;">Preferred Title: Dr</span>
Surname:	Carley
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk <span style="float: right;">Contact Number: 07986264331</span>
Personal e-mail address:	carleys@me.com <span style="float: right;">Student ID Number: 17090583</span>
2. Title of PhD Proposal	
Technology enhanced learning in emergency medicine	
3. Title of Research Output	
Mackway-Jones K, Carley S, Kilroy D, St Emlyn's Development Team. Advanced training in emergency medicine: a pedagogical journey from didactic teachers to virtual problems. Emerg Med J. BMJ Publishing Group Ltd and the British Association for Accident & Emergency Medicine; 2007 Oct;24(10):696-8.	
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)	
Development of the St.Emlyn's education program, construction of learning materials, delivery of education programs, design and publication of paper. I estimate my contribution to this project to be 40% of the total content related to the development and publication.	
5. Co author(s):	
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.	
Name	Signature <span style="float: right;">Current e-mail address</span>
Kevin Mackway-Jones	<span style="float: right;">kevin.mackway-jones@cmft.nhs.uk</span>
Darren Kilroy	<span style="float: right;">darren.kilroy@nhs.net</span>
6. Statement by Director of Studies/Advisor	
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.	
Signature:	<span style="float: right;">Date: 20/12/17</span>
(Director of Studies/Advisor)	
7. Signature of Faculty Research Degrees Administrator	
Signature:	<span style="float: right;">Date:</span>
(Faculty Research Degrees Administrator)	

Research and Knowledge Exchange  
 Graduate School  
 Form RDPUB (ROUTE 1 AND 2)



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
 CONTRIBUTION TO PUBLICATIONS**

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**1. The Candidate**

First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583

**2. Title of PhD Proposal**

Technology enhanced learning in emergency medicine

**3. Title of Research Output:**

Mackway-Jones K, Carley S, Kilroy D, St Emlyn's Development Team. Advanced training in emergency medicine: a pedagogical journey from didactic teachers to virtual problems. Emerg Med J. BMJ Publishing Group Ltd and the British Association for Accident & Emergency Medicine; 2007 Oct;24(10):696-8.

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(State nature and approximate percentage contribution of each author)

Development of the St.Emlyn's education program, construction of learning materials, delivery of education programs, design and publication of paper. I estimate my contribution to this project to be 40% of the total content related to the development and publication.

**5. Co author(s):**

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

Name	Signature	Current e-mail address
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk
Darren Kilroy		darren.kilroy@nhs.net

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature: Date: 2/2/17  
 (Director of Studies/Advisor)

**7. Signature of Faculty Research Degrees Administrator**

Signature: Date: \_\_\_\_\_  
 (Faculty Research Degrees Administrator)



## ORIGINAL ARTICLE

## Advanced training in emergency medicine: a pedagogical journey from didactic teachers to virtual problems

Kevin Mackway-Jones, Simon Carley, Darren Kilroy, on behalf of the St Emlyn's Development Team

*Emerg Med J* 2007;24:696–698. doi: 10.1136/emj.2006.043885

See end of article for authors' affiliations

Correspondence to:  
Professor Kevin Mackway-Jones, Emergency Department, Manchester Royal Infirmary, Oxford Road, Manchester, M13 9WL, UK; kevin.mackway-jones@manchester.ac.uk

Accepted 26 June 2007

**Background:** As trainee numbers and the geographical spread of training departments have increased, the model of weekly face-to-face teaching has come under strain because of long travel times. This has been compounded by a reduction in the total number of hours worked by trainees. Furthermore the traditional teacher centred educational programme has been challenged as unfit for purpose on grounds of both content and style.

**Objective:** This article describes two shifts in the delivery of the programme. The first involved migration from a didactic delivery to a problem-based model; the second a gradual shift to the internet culminating in implementation of a web based virtual learning environment.

**Conclusion:** The principles outlined in this paper are widely applicable and will be of interest to all clinical educators within the specialty, both within the UK and overseas.

There is increasing emphasis on the need to quality assure medical teaching both by delivering content defined by national curricula and also by providing evidence that this teaching has occurred and been effective. This is challenging in any setting, but particularly in specialties like emergency medicine in the UK where regional cohorts of specialty higher trainees work shift patterns and are dispersed to hospitals over a wide geographical area.

The North West emergency medicine specialty training programme (Specialty Training in Emergency Medicine—STEM) has been preparing trainees to pass the specialty exit exam since the onset of specialist registrar training and was initially very successful. However, in recent years, with increased trainee numbers and consequent greater geographical spread, the model of weekly face-to-face teaching sessions has come under strain because of long travel times. This has been compounded both by a reduction in the total number of hours worked by trainees and also by the need to ensure that shift rotas comply with the requirements of the European Working Time Directive (EWTD). Furthermore the traditional teacher centred educational programme was challenged as unfit for purpose by the trainees who felt that both content and style were suboptimal.

From an educational perspective we have also seen a shift away from behaviourist models of learning towards social and constructivist learning pedagogies. However, the geographical and chronological dispersal of trainees has often meant that it is difficult to develop learning networks to support such a change. Indeed, it could be argued that changes to working practice have suggested a need for independent and individual learning whereas educational theory has increasingly expounded the adoption of a more constructive and collaborative approach that requires intellectual and social interaction between learners. From a pedagogical perspective we are advocates of a blended approach to learning, picking the right pedagogy for the task required. However, in practice, the reality of emergency medicine practice—that of discussion, constant development, rapidly shifting knowledge base together with a high degree of necessary interpersonal discussion and debate—means that we have developed as social and constructivist tutors.<sup>1</sup> This means that we place great emphasis in assisting individual and groups of learners to educate themselves and

others and to allow them to develop their own thoughts and solutions. Online learning offers a variety of approaches,<sup>2</sup> but we believe that group interaction and social learning are essential for effective emergency physician education and development.

This article describes two shifts in the delivery of the programme: the first involved migration from a didactic delivery to a problem based model; the second a gradual shift to the internet culminating in implementation of a web based virtual learning environment (VLE).

## WHY PROBLEM BASED LEARNING?

Problem based learning (PBL) supports the key elements of adult learning. PBL has been extensively debated elsewhere.<sup>3–5</sup> The seven step Maastricht method of PBL used in Manchester<sup>6</sup> requires the same group to open and close a case. This allows the learners to both identify problems and then answer them as a team.

PBL is widely employed in UK medical schools and has attracted increasing interest at postgraduate level as it allows a senior group of clinicians (the trainees themselves) to take control of the specific educational content of each session while the course designers retain overall control by specifying the content of the cases for discussion. This promotes professional team working within the groups and allows them to focus and develop their own ideas and solutions.

## DESIGNING AND DELIVERING A PBL COURSE

Initial core content for the North West PBL programme was developed around a series of meetings between trainees and trainers that took place before the publication of the original FFAEM curriculum. Content was generated and refined with the aim of creating a succinct series of learning modules which best reflected common and/or important clinical scenarios and problems in everyday practice.

These discussions resulted in the design of six distinct clinical modules as shown below:

**Abbreviations:** EWTD, European Working Time Directive; FCEM, Fellowship of the College of Emergency Medicine; FFAEM, Fellowship of the Faculty of Accident and Emergency Medicine; PBL, problem based learning; STEM, Specialty Training in Emergency Medicine; VLE, virtual learning environment

www.emjonline.com

Figure 1 Screenshot of a PBL Moodle session on St Emlyn's.

- Advanced management of acute medical emergencies 1
- Advanced management of paediatric emergencies
- Advanced management of trauma emergencies
- Advanced management of surgical emergencies
- Advanced management of acute medical emergencies 2
- Advanced management of psychosocial emergencies.

With the publication of the FFAEM (now FCEM) curriculum,<sup>7</sup> content was reviewed to establish mapping to national learning requirements and to benchmark STEM's quality assurance.

The six 12-session modules run over a 3 year cycle. Each session contains one or two cases for discussion. The cases are designed to guide students to consider both clinical and managerial aspects of emergency medicine practice in accordance with good PBL case design.<sup>8</sup>

Based upon the geographical spread of the region, three subregional learning groups were established, each following an identical programme track such that trainees from across the North West are each at the same stage in the STEM cycle. These groups meet biweekly throughout the year and each PBL session lasts 2 h.

#### WHY MOVE TO THE WEB?

Initially cases were written and distributed on paper. Soon the distribution was by email, but the fundamental method of sending cases to each of the trainers and trainees was unchanged. As could be expected, significant numbers of participants forgot their papers or left significant parts behind, and this could detract from the delivery of the sessions. It was realised that a website would allow equity of access throughout the region and would also allow the inclusion of higher definition supporting materials such as x rays, videos and sound files. The website ([www.stemlyns.org.uk](http://www.stemlyns.org.uk)) was funded through the National Health Service Modernisation Agency and is still, to our knowledge, the only hospital built with government money, on time and within budget.

Despite the improvement in access that resulted from a move to the web-based case repository, the trainees' work patterns continued to be a barrier to universally effective PBL, or indeed any learning modality that demands physical presence for all.

Such problems are not limited to emergency medicine. The majority of the analysis, classification and formulation steps in the Maastricht model take place in face to face sessions. Members of the group unable to attend face to face sessions were therefore unable to fully take part. In effect this meant that only a minority of trainees were able to participate and therefore benefit from the discussions in a face to face manner.

In an attempt to facilitate fuller trainee interactivity and remove the barriers inherent in the original St Emlyn's model, we migrated the PBL course into an open source course management system, Moodle, in 2006. VLE systems such as Moodle offer a wide range of information and activity types. The requirements to facilitate PBL are limited and easy to set up, and comprise the tools needed to facilitate asynchronous communication, content delivery, internal and external web links and feedback modules. This is shown in fig 1.

The VLE allows everyone to benefit from teaching even if unable to attend a face to face meeting. Learning outcomes can be developed in the meetings or online, and reporting can be delivered via the discussion boards to allow all members to benefit from the work of the group. This allows even those who were not present to take part. Passive learners can observe the construction and dialogue and still gain and learn from the case based discussions. In this way all members can collaborate and construct solutions to the problems posed by the PBL group. In addition, the course tutors can see the activity of the group, take part in the discussion as a co-learner, and facilitate if required. The tacit educational benefits for VLE tutors are significant in themselves.

Our current model has sub-regionally based trainee groups who meet both face-to-face and virtually. A tutor is still allocated to facilitate each of the face to face sessions but there is relatively little interaction between tutors and trainees online. The variability of a need for virtual tutor interaction on a day by day basis arguably reflects the seniority of the trainees, their inherent motivation for learning and their familiarity with PBL teaching. Other online PBL courses aimed at students have required a much greater tutor presence,<sup>9</sup> with a greater need of facilitation than in traditional PBL, but we have not found this to be necessary. While much of the e-PBL system is self supporting, a team of two consultants oversee the virtual environment for each module.

## THE FUTURE

The courses are currently aimed at specialist registrar training, but will migrate without modification into ST 4–6 training under Modernising Medical Careers in 2007.<sup>10</sup> The precise year at which a trainee joins the programme is not materially relevant since all trainees remain in the teaching groups for at least 3 years and will therefore complete each module at some point before the end of training.

VLEs are only one element of a comprehensive educational approach and have well-recognised limitations.<sup>11</sup> Care must be taken to address other aspects of education that cannot be delivered via the web. For example, practical skills, history taking, attitudes and interpersonal relationships are best taught at the bedside with a skilled tutor.

We have recently augmented the established VLE package with a series of competency-based skills which are learnt and taught in small group format alongside the cognitive (knowledge based) course elements.

Trainees acquire skills confidence based upon the established “four stage” approach to psychomotor learning. Subregional meetings allow hands on practice based upon standardised competency documents which are made available to trainees in advance of each session. Within each session, a designated skill, drawn from the skills bank, is chosen for practice.

The guides are in a downloadable format, are mapped to the OSCE requirements of the FCEM diploma, and can therefore be used as a written record and revision aid by trainees in preparation for speciality examinations. It is vital to remember that e-learning is simply an additional tool for emergency medicine education, it cannot and should not entirely replace other media.<sup>12</sup>

Although the focus of the PBL courses is the education of the trainees, the information sought, appraised and disseminated online by them is just as valuable to the trainers. A further advantage to the VLE facilitation is that this information can be easily shared, and that all trainers can be made aware of the core STEM training and the individual skills that are the core of emergency medicine practice.

## SUMMARY

Our experience in developing and delivering a VLE PBL course for senior trainees in emergency medicine strongly supports the idea that VLE is a necessary core element of effective medical

education in the emergency department. Furthermore, the VLE can be used as a focus for skills training in a blended<sup>12</sup> approach to professional education.

If you want to know more then please contact us by email or letter. You can also visit one of the links below where you will be able to see demonstrations of the courses and learning.

- Moodle: <http://www.moodle.org>
- StEmlyns virtual hospital: <http://www.stemlyns.org.uk>

Most courses on the StEmlyns site require a password to enter, but you can view the “Getting to know Moodle” course and the demo course, which will illustrate key features of the system.

## Authors' affiliations

**Kevin Mackway-Jones, Simon Carley**, Emergency Department, Manchester Royal Infirmary, Manchester, UK

**Darren Kilroy**, Emergency Department, Stepping Hill Hospital, Stockport, UK

Competing interest: None declared.

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## Emergency Care Specialist Library

Please visit the Emergency Care Specialist Library [www.library.nhs.uk/emergency](http://www.library.nhs.uk/emergency) via the EMU home page.

This is a valuable resource containing a library of guidelines, Cochrane reviews, systematic reviews and management briefings relevant to emergency care.

#### 1.8.2.2.2 Artifact 6: Developing a virtual learning course in emergency medicine for F2 doctors (198)

Developing a virtual learning course in emergency medicine for F2 doctors.

Carley S, Mackway-Jones K. Developing a virtual learning course in emergency medicine for F2 doctors. *Emerg Med J*. BMJ Publishing Group Ltd and the British Association for Accident & Emergency Medicine; 2007 Aug;24(8):525–8.

Paper link: <http://emj.bmj.com/content/24/8/525.short>

Google Scholar: 30 citations

Web of Science: 11 citations

Altmetrics: score: 6

Mendeley readers: 23

Blogged:1

Downloaded from EMJ website: 445 times.



Altmetrics score.



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate		
First Name(s):	Simon	Preferred Title: Dr
Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
Personal e-mail address:	carleys@me.com	Student ID Number: 17090583
2. Title of PhD Proposal		
Technology enhanced learning in emergency medicine		
3. Title of Research Output		
Carley S, Mackway-Jones K. Developing a virtual learning course in emergency medicine for F2 doctors. Emerg Med J. BMJ Publishing Group Ltd and the British Association for Accident & Emergency Medicine; 2007 Aug;24(8):525-8		
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)		
All contributed to development and design of the project and paper. 50% for this paper		
5. Co author(s):		
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.		
Name	Signature	Current e-mail address
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk
6. Statement by Director of Studies/Advisor		
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.		
Signature:		Date: 20/12/17
(Director of Studies/Advisor)		
7. Signature of Faculty Research Degrees Administrator		
Signature:		Date:
(Faculty Research Degrees Administrator)		

## ORIGINAL ARTICLE

# Developing a virtual learning course in emergency medicine for F2 doctors

Simon Carley, Kevin Mackway-Jones

See end of article for authors' affiliations

*Emerg Med J* 2007;24:525-528. doi: 10.1136/emj.2006.042937

Correspondence to:  
Simon Carley, Emergency  
Department, Manchester  
Royal Infirmary, Oxford  
Road, Manchester M13  
9WL, UK; simon.carley@  
mmc.nhs.uk

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Changes in the regulation of junior doctors' hours and in the design of medical career pathways have rendered the traditional weekly tutorial ineffective for teaching the core knowledge of emergency medicine. In this paper, the inception of a virtual learning environment and the development of an online course for F2 doctors in our emergency department are described. The course, delivered in the open source Moodle virtual learning environment, allows us to reliably deliver educational content to all our juniors regardless of shift patterns. It provides insight into the effectiveness of that education, and records the students' activities and achievements to a level far beyond that achievable through traditional teaching methods.

Recent changes in postgraduate medical training have presented many challenges to emergency departments.<sup>1</sup> There is now a greater emphasis on the need to define that the teaching is delivered against national criteria and to provide documentary evidence that this teaching has occurred. This is a challenge in itself, but is further compounded by changes in working hours,<sup>2</sup> the unremitting 24-h pressures of emergency care and the modernisation of medical careers.<sup>3</sup>

Like many emergency departments, we have prided ourselves on delivering a high-quality teaching programme for many years. However, it has become apparent that the degree of engagement of our junior doctors with the teaching programme has decreased. In 2005, attendance at teaching had fallen to approximately 30% of eligible doctors per week. In large part, this was due to shift patterns, holidays and study leave, and on occasion to the business of the department during teaching times. Our juniors failed, therefore, to access 70% of our well-designed, well-taught, teaching programme, thus rendering it ineffective. The teachers were disheartened by this clear failing and they themselves became less committed. A new and radical approach was required.

We surmise that similar problems exist in other emergency departments in the UK and elsewhere. We describe the selection, design and implementation of a web-based virtual learning environment designed to deal with the problems of access to, supervision of and documentation of learning among junior emergency department doctors.

## WHY A VIRTUAL LEARNING SYSTEM?

A virtual learning environment (VLE) allows students to access and interact with teaching materials irrespective of time or place.<sup>4</sup> It requires access to the internet; this is more flexible than traditional methods, as students can engage from a variety of locations including home. Such flexibility allows students to interact with the teaching materials regardless of what shift they are on, and (to some extent) at a time that suits them.

In the past, we have tried to select the most "important" areas of teaching and to deliver them in the initial weeks of any course. Inevitably, however good the topic selection, the juniors come across patients whose conditions are covered later. There is no way they can bring the teaching forward. In contrast with this, VLEs allow access to all the teaching materials all the time and, although the course may be arranged in traditional weekly

topics, open access means that the juniors can look at materials early if they have a particular learning need.

## SELECTION OF VLE SYSTEMS

The VLE system is essentially the software that enables the course directors to organise and deliver the educational content online. A number of VLE systems are available. In the academic community, the most commonly used systems are WebCT and Blackboard (which have recently merged) and Moodle (<http://www.moodle.org>). A detailed description of the available software is beyond the scope of this article. It is sufficient to say that all systems have pros and cons, some features are available only in particular systems, but all can deliver basic content to the web and all have a solid academic background. We selected Moodle primarily because it is open source, is widely used in the academic community (including large organisations, such as the Open University) and is free to download and use (fig 1). The features of Moodle can be seen at <http://www.moodle.org>. Alternatively, you can access the "Getting to know Moodle" course at <http://classroom.stemlyns.org.uk> for a hands-on trip into our virtual classroom.

## KEY FEATURES OF VLE SYSTEMS

VLE systems can function in a variety of ways, but are essentially course management systems that allow the tutors to guide students through teaching material. Perhaps the most important difference between a VLE and a simple departmental website is the way in which interaction is a feature.<sup>4</sup> Material can be delivered in a variety of ways.

### Information delivery

Clearly, one purpose of the system is to deliver "content" to the students. The great temptation is to simply transfer documents and presentations on to the web, and expect the students to work through them. Such "brain dumping" is likely to be ineffective—effective web-based learning requires a different way of setting out materials. This can be achieved in a number of different ways:

- Original content can be created online by the tutors. This is time consuming and largely unnecessary. There is little to be gained from writing a textbook of emergency medicine

Abbreviation: VLE, virtual learning environment

[www.emjonline.com](http://www.emjonline.com)



Figure 1 Screenshot of Moodle courses on St Emlyn's.

online, as many exist already. However, it may be necessary to create content at a local level to describe local guidelines and policies.

- Documents can be uploaded to the web server as separate files linked to the main teaching page. This is useful for documents such as departmental guidelines and policies.
- Content can be delivered as links to other websites. This is especially useful as it avoids the need to reproduce information that is already in the public domain. Students can be directed to a website that contains relevant information. This is especially useful when the content may change on a regular basis—examples include links to the Health Protection Agency or World Health Organization for the most current material about infectious diseases. A variety of clinical cases are also needed. We source these from the St Emlyn's virtual hospital (<http://www.stemlyn.org>). This is our free-to-access virtual hospital with a wide range of virtual patients that can be used for teaching purposes.
- Multimedia files can be added to the VLE (pictures, video, sound). These are useful if practical procedures need to be shown or if the content, such as interactive anatomy pages, need to be displayed. In fact, any content that is available on the web can be linked out from the site.

#### Activities

A concern with all web-based learning is determining how students are interacting with the material. Simply placing content on the web means nothing unless the interactivity that occurs in face-to-face teaching can be reproduced. It is important to design the online activities with the aim of guiding trainees to a deep approach to the learning material. This can be achieved through activities such as case-based discussions and interactive lessons. Typical VLE system features that allow this include:

- **Discussion:** This can be asynchronous (the bulletin board or forum) or synchronous (the chat room).<sup>3</sup> We predominantly use asynchronous communication, as the advantages of such a system (access at the time of the student's choosing) are a

principle reason for adopting the VLE. We also use a chat room once a week to allow students to contact their tutors. Discussion<sup>4</sup> is a powerful tool, and we use this to facilitate a reflective approach to learning. Typically, a group is asked to discuss a clinical case and to use their peers and tutor to identify learning needs and subsequently to answer them.

- **Lessons:** It is possible to create online lessons for students that work as a series of interactive pages. Each page is separated by a question that students must answer to progress to the next page. Feedback can be given for correct or incorrect answers. These are especially useful for topics such as *x* ray interpretation or the assessment of laboratory results.
- **Quizzes:** Quizzes can be used to allow students to assess the validity of their own learning. For instance, a brief quiz can be placed after a reading assignment to allow the student to judge whether they have assimilated and understood the content in context. Such quizzes can be set up to allow students to have multiple attempts (and can also be designed to shuffle questions and answers to ensure that any improvement reflects better understanding rather than better test taking).

#### Assessment

In traditional teaching methods such as tutorials, there is an emphasis on delivering information, but usually no measure of whether the information has been assimilated or understood. Although it is possible to observe clinical practice while working, it is rare that we see enough of a trainee to determine how much knowledge has been gained. VLEs offer a number of ways to assess students.

- **Lessons:** A structured lesson in the VLE can be set up to keep a score as each item of information is tackled and questioned. These are usually used as running scores for the students (to see how they are getting on), but may also be of value to the tutors in identifying strengths and weaknesses in knowledge.

- **Quizzes:** These can be set using a variety of question types. As noted above, they can be used as a formative tool by students to see how they are progressing, or by tutors as summative assessments at the end of a topic or course.
- **Assignments:** Most VLEs allow a drop-box function where students can upload projects for grading. These may be short web-based submissions or a file upload that is especially useful for longer pieces of work (eg, submitting an audit project).

### Monitoring

Monitoring student activity is a key feature of VLEs and is incredibly valuable. The degree of information available is substantial and allows the tutors a real insight into the activities and success of the students on the course. Information available includes:

- Time and duration of access.
- Exact (page-by-page) reports of what items were accessed, how often and for how long (eg, how long a lesson took to complete).
- Marks from any quiz, lesson or other activity. The number of attempts, which questions were correct/incorrect, etc.
- Individual posts to forums/discussions/chats, etc.
- Internet protocol address of computer.

This information can be fed back to the students' individual educational supervisors allowing them to determine if they are engaged with the teaching and also to identify gaps or strengths in knowledge. This information can also be used to inform individual learning plans.

### PRACTICAL IMPLEMENTATION

A number of practical points need to be considered if you are to adopt a VLE.

#### Equipment and information technology

A certain degree of knowledge in information technology is required to upload and manage the VLE software. You must have access to a server and have sufficient storage to manage the program and subsequent content. There are costs inherent in this, although it may be possible in some trusts to reduce these by using the hospital's information technology department. The students and tutors require access to a computer, and although it is rare for junior doctors not to have their own computers, this cannot be assumed; thus, access within the hospital and department is essential.

#### Training the trainers

Having established the chosen system, it is the responsibility of the tutors to develop and upload content. Although this seems relatively straightforward, we thought that they would benefit from appropriate training and sent our tutors to a 2-day course on course design (How to Moodle),<sup>7</sup> which rapidly brought the team up to speed. We believe that this saved a great deal of time in the long term.

The time required to design, write and upload any course is considerable and should not be underestimated. Our experience suggests that it takes 10–20 times as long as the lesson length—thus, a 1–2 h lesson might take two working days to prepare. However, any time spent is a good investment as, once online, the material can be used repeatedly for subsequent cohorts of doctors on the same course. There is no reason at all why foundation schools or emergency medicine schools locally or nationally cannot use the same online material, and if this happens then eventual time savings will be even more worthwhile.

#### Time for trainees

It is essential that trainees are given an allocated time in which to access the teaching material. We have allocated "VLE" time on the junior doctors rota; this involves them leaving the shop floor to access the VLE during their shift. In this way, we ensure that they have specific, paid time to engage with the teaching and that we do not rely on them doing the work elsewhere. This also means that there is a clear requirement for them to engage with the material and no real excuse not to complete the activities on time. The service benefits of not having all the junior doctors on duty leave the department at the same time are obvious.

#### Running the course

We allocate two consultants per cohort of doctors to oversee the virtual learning of that cohort. These VLE tutors are responsible for marking assignments (online), moderating asynchronous forums and running the weekly synchronous student support chat room. In addition to the VLE tutors, each student has their own individual educational supervisor. Cohorts of trainees are divided into discrete groups on the VLE (reflecting the time they start in the department), thus allowing multiple independent groups to be working on the same course at the same time.

#### Course management

The VLE allows control over when and how the students interact with the material. It is possible to hide elements from students (although we do not advocate this) and drip feed content. It is also possible to allow all information to be available, but to set a program that forces students to engage with a particular topic in a given time period. This is the approach we have taken, and our students are directed to a particular weekly topic. During that week, they are expected to complete the activities specific to that particular topic.

#### INTEGRATION WITH OTHER TEACHING MODALITIES

VLEs are not a complete panacea to teaching, and care must be taken to consider other aspects of education that cannot be delivered via the web. For example, practical skills, history taking, attitudes and interpersonal relationships are best taught at the bedside with a skilled tutor. However, we believe that such activities are facilitated by the VLE, as face-to-face education time can then be focused on activities that truly require personal interaction. As is the case for all foundation trainees, our junior doctors are also engaged in case-based discussion, practical skill-competency assessments and 360° appraisals. They also undertake audits and have a full programme of face-to-face induction both to the department and to the skills they will require in the specialty. We do not, however, provide any further group-based face-to-face training once induction is finished for this group.

#### MEASURING AGAINST F2 COMPETENCIES

The VLE system has allowed us to map F2 competencies against the teaching programme. This allows our students to obtain evidence of satisfactory completion of the knowledge associated with those competencies.

Students who engage with the online learning, provide online feedback and who complete 80% of online activities are awarded a certificate at the end of their attachment for inclusion in their personal development portfolio.

#### SUMMARY

The changes in medical career structure and working hours mean that traditional methods of weekly face-to-face tutorials



are unworkable and do not deliver adequate levels of training to staff. Radical changes in curriculum delivery are required if we are to satisfy these demands. Our experience in developing and delivering a VLE course for F2 doctors has convinced us that it is the future of medical education in the emergency department. If you want to know more, feel free to visit one of the following links:

- Moodle: <http://www.moodle.org>
- St Emlyns virtual hospital: <http://www.stemlyns.org.uk>
- St Emlyns Moodle classroom: <http://classroom.stemlyns.org.uk>

Most courses on the St Emlyns site require a password to enter, but you can view the "Getting to know Moodle" course which will illustrate key features of the system.

#### Authors' affiliations

**Simon Carley, Kevin Mackway-Jones**, Emergency Department, Manchester Royal Infirmary, Manchester, UK

Competing interests: None declared.

#### REFERENCES

- 1 National Health Service. Modernising Medical Careers. [MMC website] 2006. <http://www.mmc.nhs.uk/pages/home> (accessed 1 May 2006).
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#### Webcast: International Forum on Quality and Safety in Health Care

Plenary sessions at this year's International Forum on Quality and Safety in Health Care were filmed and broadcast live over the internet. The sessions are still available to view free, on demand and at your own convenience at <http://barcelona.bmj.com>. Each session is accompanied by a panel discussion.

The webcast includes the following, in either English or Spanish translation:

- **Donald M Berwick**: Can health care ever be safe?
- **Richard Smith**: What the quality movement can learn from other social movements
- **Lucian Leape and Linda Kenney**: When things go wrong: communicating about adverse events
- **John Prooi and Harry Molendijk**: Partnering for patient safety

### 1.8.2.3 Artifact 7: Blended learning in paediatric emergency medicine.

Link <https://www.ncbi.nlm.nih.gov/pubmed/22415016>

Spedding R, Jenner R, Potier K, Mackway-Jones K, Carley S. [Blended learning in paediatric emergency medicine: preliminary analysis of a virtual learning environment](#). Eur J Emerg Med. 2013 Apr;20(2):98-102. doi: 10.1097/MEJ.0b013e3283514cdf.

Google Scholar: 14

Web of Science: citations 7

Altmetrics: score: 1

Mendeley readers: 6

Altmetrics score



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Form RDPUB (ROUTE 1 AND 2)



## PHD BY PUBLISHED WORK (ROUTE 1/2): CONTRIBUTION TO PUBLICATIONS

This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.

1. The Candidate			
First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
Spedding R, Jenner R, Potier K, Mackway-Jones K, Carley S. Blended learning in paediatric emergency medicine: preliminary analysis of a virtual learning environment. Eur J Emerg Med. 2013 Apr;20(2):98-102			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
Spedding - analysis as Med Student 20%, Jenner, Potier, Mackway-Jones, Carley 20% each as supervisors and designers/delivery of teaching program			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk	
Ruth Spedding		ruthspedding@hotmail.com	
Katherine Potier		Katherine.Potier@cmft.nhs.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date:	28/12/17
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			



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1. The Candidate			
First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
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4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
Spedding - analysis as Med Student 20%, Jenner, Potier, Mackway-Jones, Carley 20% each as supervisors and designers/delivery of teaching program			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk	
Ruth Spedding		ruthspedding@hotmail.com	
Katherine Potier		Katherine.Potier@cmft.nhs.uk	
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Signature:		Date: 20/12/17	
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			

Research and Knowledge Exchange  
 Graduate School  
 Form RDPUB (ROUTE 1 AND 2)



**PHD BY PUBLISHED WORK (ROUTE 1/2):  
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Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
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Spedding - analysis as Med Student 20%, Jenner, Potier, Mackway-Jones, Carley 20% each as supervisors and designers/delivery of teaching program			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk	
Ruth Spedding		ruthspedding@hotmail.com	
Katherine Potier		Katherine.Potier@cmft.nhs.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date: 20/12/17	
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			

## Blended learning in paediatric emergency medicine: preliminary analysis of a virtual learning environment

Ruth Spedding<sup>a</sup>, Rachel Jenner<sup>b</sup>, Katherine Potier<sup>b</sup>, Kevin Mackway-Jones<sup>c</sup> and Simon Carley<sup>c</sup>

**Objectives** Paediatric emergency medicine (PEM) currently faces many competing educational challenges. Recent changes to the working patterns have made the delivery of effective teaching to trainees extremely difficult. We developed a virtual learning environment, on the basis of socioconstructivist principles, which allows learning to take place regardless of time or location. The aim was to evaluate the effectiveness of a blended e-learning approach for PEM training.

**Methods** We evaluated the experiences of ST3 trainees in PEM using a multimodal approach. We classified and analysed message board discussions over a 6-month period to look for evidence of practice change and learning. We conducted semistructured qualitative interviews with trainees approximately 5 months after they completed the course.

**Results** Trainees embraced the virtual learning environment and had positive experiences of the blended approach to learning. Socioconstructivist learning did take place through the use of message boards on the virtual

learning environment. Despite their initial unfamiliarity with the online learning system, the participants found it easy to access and use. The participants found the learning relevant and there was an overlap between shop floor learning and the online content. Clinical discussion was often led by trainees on the forums and these were described as enjoyable and informative.

**Conclusion** A blended approach to e-learning in basic PEM is effective and enjoyable to trainees. *European Journal of Emergency Medicine* 20:98–102 © 2013 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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**Keywords:** education, e-learning, Emergency Medicine, Paediatrics

<sup>a</sup>Manchester Medical School, <sup>b</sup>Royal Manchester Children's Hospital and <sup>c</sup>Manchester Metropolitan University, Manchester, UK

Correspondence to Professor Simon Carley, MD, c/o Emergency Department, Manchester Royal Infirmary, Oxford Road, Manchester M13 9WL, UK  
Tel: +44 161 276 5731; fax: +44 161 276 8538;  
e-mail: Simon.carley@cmft.nhs.uk

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### Introduction

In the UK, trainees in emergency medicine must complete a 6-month paediatric emergency medicine (PEM) rotation during their first 3 years of speciality training. During this time, they must acquire the skills and knowledge required to manage paediatric patients in the emergency setting [1]. PEM currently faces many competing educational challenges. Recent changes to working patterns as a result of modernizing medical careers [2], the European working time directive and the increasing use of shift patterns have made the delivery of effective teaching to junior staff difficult [3]. In addition, there is an increasing necessity for trainers and learners to document what, when and how they are learning.

Our group has previously encountered and solved similar problems for training at foundation [4] and senior trainee [5] levels using a blended learning approach using a virtual learning environment (VLE). Those courses adopt specific learning strategies: the foundation project is fairly didactic, whereas the senior trainee courses are based on a problem-based learning model.

Neither was considered ideal for learners at the core speciality training level and a new course has been developed for this specific learning group. Before the VLE training comprised weekly tutorials that were poorly attended by trainees.

The basic PEM course has 22 teaching blocks, each representing a week of training. Each teaching block is set out in a similar way and contains various different components to maximize the effectiveness of the teaching. Table 1 shows an educational week in the training programme. Specific to this course, there is also a weekly case for discussion that is facilitated online but supported through face-to-face teaching. The course was designed using socioconstructivist principles [6] and is written using the Moodle platform [7]. The online forums facilitate this by enabling trainees and trainers to communicate and discuss each case with each other. It also encouraged trainees to discuss interesting cases that they had dealt with.

The aim of this study was to evaluate the effectiveness of a blended e-learning approach for PEM training.

### Methods

We used a multimodal approach in this project, using quantitative and qualitative methodologies focusing on

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the experiences of a single cohort of trainees from the academic year 2008–2009. The cohort comprised eight junior doctors attached to the paediatric emergency department at the middle-grade level. This represented all middle-grade doctors working in the department at that time. In addition, eight consultants had access to the online learning environment. Four consultants were actively engaged in the online learning; the other four were not directly tutoring on the course.

Ethical guidance was sought from the research ethics committee. In the opinion of the committee, this study was a service evaluation project and they advised us that formal ethical approval would not be required.

#### Analysis of message board communication

Discussion board posts were categorized using a taxonomy based on the message board evaluation tool developed by Sackville and Sherratt [8].

The taxonomy divides message board communication into:

- (1) *Statement*: a view expressed. A 'closed' statement. Not inviting response or comparison. A position statement.
- (2) *Limited response*: refers back to an earlier posting, but only in a limited way. May be encouragement – for example, 'yes I agree'.
- (3) *Questioning response*: opens up the topic. Expands on the ideas, makes comparisons.
- (4) *Dialogue*: building on ideas, taking them further, introducing new interpretation, joint problem-solving, disagreements and disputes.

In addition, we categorized each post using the criteria in Table 2.

**Table 1** An educational week in basic paediatric emergency medicine training

Case-based discussion	Discussions facilitated online and supported with shop floor teaching. Cases from the emergency department are posted and discussed by trainers and trainees using an online forum
Skill of the week	The curriculum for paediatric emergency medicine contains a range of practical skills. These are divided across the 6-month attachment, with trainees reviewing one a week for 6 months
Didactic material	Each week, a topic theme (e.g. meningitis) links to articles and websites that complement the learning material and facilitate debate on paediatric topics. Links to external organizations plus local policies are used to generate debate both online and within the workplace

**Table 2** Classification system used to define message board posts

Four classification systems used in analysis	
1. Respondent	Student or teacher
2. Type	Clinical – e.g. case discussions OR social – e.g. group night out OR admin – e.g. protocol change
3. Sackett taxonomy	Questioning response OR statement OR limited response OR dialogue

#### Qualitative methods

We conducted semistructured interviews with learners to ensure a deep understanding of their experiences. The interview was used to allow trainees to discuss the issues in Table 3. Additional issues raised by trainees were also recorded. Interviews were conducted separately with the lead researcher.

All interviews were digitally recorded and the data were analysed using a qualitative data analysis package. The interview questions are shown in Appendix 1, Supplemental digital content 1, <http://links.lww.com/EJEM/A15>.

The thematic analysis was conducted by a single researcher (R.S.) with supervision and clarification from a consultant (S.C.). Themes were identified when the same topic or statement was raised by multiple participants and/or when themes appeared in several different sections of the interview. The transcripts were re-examined multiple times until no new themes arose. We used Nvivo [9] to classify and record supporting evidence for each of the themes and subthemes.

#### Results

##### Forum analysis

There were 323 posts on the forums, with 58% of these being from teachers and 42% from students. Students ranged in their engagement with individuals, posting between 2 and 32% of posts on the message boards. Three individuals accounted for 80% of the posts (Fig. 1).

Figure 2 shows the percentage of posts in each category. The most common type of post was a questioning response (37%) and the least common type was a limited response (8%).

##### Semistructured interviews

We identified seven recurrent themes in the analysis of the semistructured interviews.

- (1) Participants described the novelty of the system and this method of learning. Although participants were familiar with the use of computers and the Internet, they had not used this kind of learning in the past.

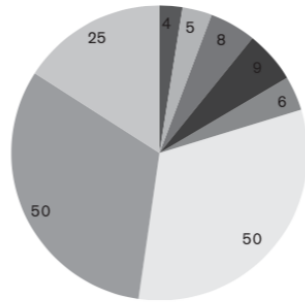
'I've never experienced it before, it's the first time I've ever used it in my training or professional career'.

'In terms of usability, it's not completely foreign to me but I've never used it in the context of work related material'.

**Table 3** Topics covered in semistructured interviews

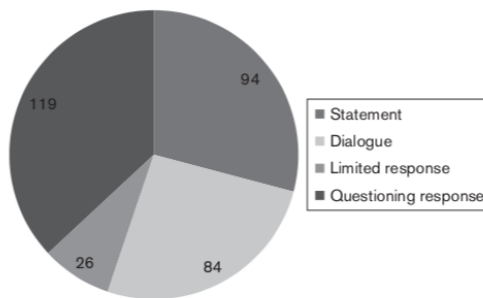
1. Trainee experience of online learning (past and present)
2. Accessibility and technology issues
3. Usefulness of didactic content, forum discussions and other areas of learning in the paediatric emergency medicine post
4. Would trainees use this technology/method in the future
5. What, how and when did they learn during their placement. What was the influence of the virtual learning environment in this
6. Other issues they might raise

Fig. 1



Postings by participants from the 155 posts made by trainees.

Fig. 2



Types of message board post.

(2) Participants commented on their ability to interact with the system in a positive way, using the system during formal times, opportunistically in relation to clinical time and while outside the workplace (e.g. at home):

'I have accessed it in work time as an aid to management and to refresh memory on certain aspects of care, but then generally, in terms of going through the material, I have done it more at home'.

'I would access it at home, in the evenings'.

'It's quite easy to use, it is user friendly'.

(3) The forums enhanced learning by providing an opportunity to discuss interesting cases. Postings on interesting cases uploaded by trainees, particularly if unusual or atypical, were highly valued.

'I think we all posted interesting cases that we'd seen and I think we all learnt from it'.

'Yes, although generally we have a lot of discussion between ourselves on the shop floor rather than the forum, but the forum would be for everyone'.

'A difficult clinical problem and someone had a new perspective or someone more senior to you who had more experience giving you their insight into the problem'.

'Unusual stuff: if you're lucky enough to see the patient then brilliant, but in A&E you may not see rare stuff very often and if you're not on the shift at that time, you may miss it. The forum gives you an opportunity to be able to talk through those cases'.

'An interesting case, pitched at the right level for me. If it's not at the right level, I might not have the confidence to chip in'.

(4) We found evidence of learning and practice change from forum discussions that subsequently led to change in patient care.

'An impacted food bolus in a child which someone suggested the use of fizzy drinks. I'd never thought of it before but I've tried it since and it's worked'.

'The ketamine information (changed my practice)'.

'Children with bendy arms and reducing them. I used to think you'd always leave to the orthopods. It was interesting to see you can reduce them...'

(5) Trainees stated that they would use this type of learning in the future as tutors and participants.

'Yes, certainly. Computers and technologies are there to be used. Having the backbone and structure that trainees can refer to at an easy point of access and then having further face-to-face teaching, that will be the norm'.

'Definitely yes. One of the best ways to disseminate information and share knowledge is the Internet. With time people will become more Internet savvy and it will become more accessible. You can dispense a lot more information via the Web than with hard copies or real life situations. There are a huge number of advantages, so yes – no question about it'.

(6) The participants identified a number of limitations of the system on the basis of their own and others' engagement, which varied over the 6-month attachment.

'I could have been more interactive. It is what you make of it: you get out what you put in'.

'I did learn from it. It was sporadic: when activity was up and going I felt that I learnt a lot because it was related to a specific case and so your interest span was heightened during that period but otherwise there were long periods where I didn't learn a lot. I think it's a reflection of how active the group was'.



## Discussion

This study shows evidence that VLE learning took place, that active participation occurred on the message boards and that both constructive and social learning took place. There was evidence to show that online learning took place in conjunction with workplace learning and that on many occasions this was symbiotic, with subject learning taking place between and across any perceived boundaries. Online learning influenced shop floor learning, and discussions from the shop floor would often be posted on the forums. This demonstrates that the blended learning approach was effective at combining the online learning with the more traditional methods of face-to-face teaching.

The forum analysis showed that trainees actively participated in the forums and would often drive the learning content with real clinical cases. Participants stated that the most enjoyable posts were the cases that they had uploaded themselves, although learning took place regardless of who originally posted cases. Participants stated that their learning focused on things that interested them in the end of course questionnaire. This was supported by the qualitative analysis, which showed that the forums enhanced the participants' knowledge and complemented the written content. Some trainees were more enthusiastic to contribute to the forums than others. We were interested in determining whether there was a relationship between the number of posts by a trainee and their perceived benefit of the learning programme. The forum analysis showed that there were three particularly active trainees on the forum, who altogether contributed to 80% of the posts; however, the participant who contributed the most did not find that the online learning suited them, and conversely, two participants who contributed to less than 8% of posts combined stated that they learnt well from the online system. This suggests that we cannot equate visible activity on the forums to engagement or learning by trainees. Not participating in the message boards might be the equivalent of sitting quietly at the back of a face-to-face teaching session. For tutors this presents difficulties as it is difficult to identify such passive engagement in an online environment.

Using a single cohort has been a strength in this research as it has allowed an in-depth analysis of a community of practice [10]. However, our single-course study limits the generalizability of the results. A study by Sackville and Sherratt [8] demonstrated that within learning sets on the same course, there were different levels of activity on discussion boards, with some groups identified as 'active' discussion sets and other groups identified as 'passive' discussion sets [8]. However, we believe this cohort to be broadly representative of past and current cohorts. The trainees finished the course 5 months before the interviews took place, which will have led to some recall bias.

A strength of this study is the learner-centred approach; Sharpe *et al.* [11] reviewed a number of studies conducted

since 2000. They found that there were many studies investigating the perspective of the practitioner and course design but there was a severe lack of studies that focused on the learner voice [3]. In our study, although the forum analysis involved analysing posts from both trainees and tutors, the semistructured interviews were only conducted with trainees. The focus is therefore on the learners, and while we believe that trainers also benefited through participation, we have not specifically investigated such learning in this study.

There are a number of other studies that have attempted to compare e-learning with the more traditional methods of teaching [12,13]. Although a direct comparison is difficult, it is clear from these studies that some learners find e-learning useful and enjoyable, whereas others learners less so, supporting the findings from this study. A more recent review of e-learning experiences in postgraduate medical learning [12] stresses the importance of case studies, flexibility, peer discussion, support and knowledge validation. In our programme, all but the last is integrated into the online teaching package online, with support in some areas, such as knowledge validation, through clinical learning. The participants in this study enjoyed the course, found it useful and unanimously said that they would use this form of learning again. Although concerns have been raised in emergency medicine about the appropriateness of e-learning in the delivery of the curriculum [14], we believe that our findings support its effectiveness in a blended learning programme.

### Study limitations

The focus on a single small cohort in one hospital is a limitation to the generalizability of the findings. This is a common characteristic of qualitative case studies. Our findings may not be applicable to other health economies where access to online materials may be more difficult.

### Conclusion

We have found that a blended approach to learning in ST3 PEM training is effective and enjoyable to trainees. Trainee involvement is important to the effective engagement and learning of the group.

### Practice points

- (1) Learning can be enhanced by the use of a local VLE for specialities We are trainees work variable shifts.
- (2) Forum discussions reflect and enhance learning that takes place during clinical shifts.
- (3) Trainees in PEM are capable and enthusiastic about sharing learning through the use of online forums.
- (4) The amount of participation in online discussion does not always indicate that the trainee values such discussions. Nonparticipatory members of online discussion groups do value and learn even if they do not post online.

### Acknowledgements

Ruth Spedding is a final-year medical student at Manchester University with an interest in medical education. Ruth designed, executed and prepared the manuscript; Rachel Jenner and Katherine Potier are consultants in PEM. They designed the blended learning course content, supervised the trainees and helped prepare the manuscript; Kevin Mackway-Jones and Simon Carley are Professors of Emergency Medicine in Manchester. They designed the overall learning strategy of the course and helped develop the content. They also supervised trainees on the course; Ruth Spedding and Simon Carley designed, executed and prepared the manuscript.

### Conflicts of interest

There are no conflicts of interest.

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### Appendix

#### Table A1

**Table A1 The basic interview questions. In each interview, the participants were asked to give examples and diverge on certain issues as they arose**

1. As you know we have used a different method of teaching during your paediatric attachment. We are really interested to know how it works from the trainee's perspective and although we do want to ask you some specific questions about the system we would like to start off by asking you tell us a little bit about your experiences of using the Moodle-based teaching system?
2. Obviously, you will have had lots of experience of different teaching methods in the past, as trainer and trainee I imagine. How did this system compare with other teaching and learning programmes that you have experienced?
3. The course leaders have suggested that one of the reasons for setting this type of course up was that it would be easier for trainees to access. Did you find this was the case?
4. One of the concerns with using technology is that it will not 'work' for everyone. How did you find your interaction with the technology?
5. The course leaders have designed the course with two aspects, the written content and the forums. I have had a look at the forums and it's really interesting from my perspective to see that there was quite a lot of activity on them. I am interested to know what you felt about the forum discussions?
6. In the not too distant future, it is quite likely that you will end up running teaching programmes yourself. Would you use this kind of system?
7. Thanks very much for your time, it is really appreciated. Do you have any final comments that you would like to make?

1.8.2.3.1 Artifact 8: Website. St. Emlyn's Moodle classroom (202)

Link <http://classroom.stemlyns.org.uk/>

In last 8 years. Dec 09-Dec17

Registered users: 16,377

Site visits: 1,401,116

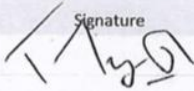
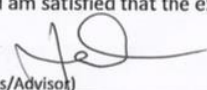
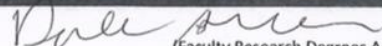
Average visits per month 14,444

Research and Knowledge Exchange  
 Graduate School  
 Form **RDPUB (ROUTE 1 AND 2)**



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
 CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate		
First Name(s):	Simon	Preferred Title: Dr
Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
Personal e-mail address:	carleys@me.com	Student ID Number: 17090583
2. Title of PhD Proposal		
Technology enhanced learning in emergency medicine		
3. Title of Research Output		
Carley S, Mackway-Jones K. <a href="http://classroom.stemlyns.org.uk">http://classroom.stemlyns.org.uk</a> The Moodle classroom used for St.Emlyn's courses.		
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)		
All contributed to development and design of the project and paper. 50% for this paper		
5. Co author(s):		
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.		
Name	Signature	Current e-mail address
Kevin Mackway-Jones		kevin.mackway-jones@cmft.nhs.uk
6. Statement by Director of Studies/Advisor		
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.		
Signature:		Date: 20/12/17
(Director of Studies/Advisor)		
7. Signature of Faculty Research Degrees Administrator		
Signature:		Date:
(Faculty Research Degrees Administrator)		



ANNOUNCEMENTS Welcome to the new look site.....

Course categories

Welcome to the St Emlyn's online classroom

- ▶ Emergency Medicine School (4) ▼ Collapse all
- ▶ MMU MSc in Emergency Medicine
- ▶ MRI ED (12)
- ▶ Foundation School (5)
- ▶ Critical Care School (12)
- ▶ School of Paediatric Anaesthesia (4)
- ▶ BestBETs (1)
- ▶ Resus training (5)
- ▶ PICU (4)

**St Emlyn's Blog**

Dan does part of State of the Art #CSSOA2017. St.Emlyn's

Tough Times in the Emergency Department. St.Emlyn's

JC: Subarachnoid Haemorrhage, Decision Rules & Overtesting Headaches

HIV screening in the ED. When, who and why. St.Emlyn's

Risk, probability and decisions in Emergency Medicine. St.Emlyn's

Source site...

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**Online users**

(last 10 minutes)

Simon Carley

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**Calendar**

#### ***1.8.2.4 Critical Appraisal of virtual learning environments.***

##### **1.8.2.4.1 The Moodle platform selection and design principles.**

The online system of virtual learning environment used in these projects is the Moodle platform(207). Moodle is one of many platforms available for the delivery of online learning environments. In this case it was chosen because of its widespread use across academic institutions worldwide thus demonstrating that it is stable and well managed. A final and arguably most important factor was that Moodle is available as open source software.

The initial Moodle projects were aimed to support new postgraduate starters in emergency medicine (Foundation doctors) and as such the initial courses were tutor defined with a didactic approach to content and format. Beyond foundation doctors the emergency department has a range of trainees from different backgrounds and at different stages of their learning and career development. For higher grades of learner a system such as Moodle can provide a different pedagogical approach, one that is less didactic and more problem based with constructivist principles(208). The ability to deliver different pedagogical approaches within the same environment was another strength of the Moodle system. This differential allowed the development of courses tailored in both content and learning style to the appropriate level of trainee.

The concept of blended learning was embraced in all courses aimed at emergency clinicians (57,155). Blended learning strategies recognise that a VLE cannot deliver all the educational requirements of the learners. In a practical speciality like emergency medicine it is neither wise nor desirable to exclusively teach and learn online. Practical skills, interpersonal skills and organizational skills are examples of core topics in the curriculum that are best taught and assessed in the clinical environment. VLE's in a blended learning environment are designed to run alongside the clinical experience, informal bedside teaching, regional teaching (which is typically face to face) and other educational experiences such as courses and conferences. Trainees continue to have parallel teaching and assessments in addition to

the VLE based topics. It is interesting to note that until 2012 online learning was not permitted as an appropriate instructional method in US residency programs(209).

#### 1.8.2.4.2 Critical Appraisal of courses aimed at F2 doctors

The 2006 paper in this thesis examined the design, delivery and outcome of a course aimed at foundation year 2 doctors in a single emergency department (Manchester Royal Infirmary)(198). Foundation year 2 doctors are typically in their first placement in emergency medicine and thus require a course that delivers a level of knowledge and skills that are applicable to a junior doctor in the emergency department. In this regard the training should be focused on the core principles of emergency medicine together with the core knowledge required to manage common conditions in the emergency department (e.g. Chest Pain).

The course was designed around educational principles of learning and reflection. Each week the doctors were assigned to a topic (e.g. chest pain), which encompassed a brief introduction, followed by links to other resources, followed by a reflective piece that was marked by their clinical tutor.

The original courses also included forums for the discussion of interesting cases.

Although forums and assignments are designed to increase the active participation in the online learning programs the design of a junior level courses inevitably focuses on core areas of practice(210) and thus has a didactic tendency. The knowledge content is chosen, designed and then delivered by the senior educators according to a predetermined curriculum, in this case based around recommendation for teaching programs from (at that time) the Faculty of Emergency Medicine(58) (now the Royal College of Emergency Medicine) and other regulatory bodies such as the General Medical Council(211).

At the time when the Moodle based courses were being designed in Manchester there was a widespread national debate on the most effective methods to teach and train the most junior doctors in the emergency department setting. In this regard the drivers for the development of the virtual learning environments was not unique. However, most participants in the debate were focused on adaptations of traditional teaching methods as opposed to a radical change to an online learning platform (212).

Contemporaneously to the development of the virtual learning environments on the Moodle platform there was a change in the approach to training in the UK as a result of the MMC (Modernising Medical Careers) program in 2005 (213,214). This new approach to postgraduate medical training encompassed a recognition that a greater degree of self-learning, reflective practice and analysis was required in order to develop future doctors (215). The adoption of reflective assignments, discussion boards and case based reusable learning objects on Moodle enabled this development of learning practice as these elements were built into the Moodle courses.

Similarly, there were other pressures on emergency department training that influenced the decision to go to an online-based system for trainees. The foundation program (the foundation program takes doctors for the first two years after leaving medical school) changed to include proposals to increase the number of trainees experiencing emergency medicine as part of their basic training programs. This expansion of junior posts took place without a significant expansion in middle grade or senior posts (which could not practically happen in advance of the proposals). This further increased the imbalance between junior and senior clinicians in the emergency department with clear concerns raised about the ability for the specialty to effectively train as a result (216).

The adoption of a virtual learning environment to teach part of the induction and core training programs is clearly attractive as it may reduce the burden of education on the remaining senior clinicians. In addition, the access to content online can be staggered as it is accessible by learners irrespective of



geographical or chronological boundaries. This also permits a larger number of trainees to be taught by a smaller group of tutors. This creates time and resource benefits for trainers and departmental resource.

In extreme forms this principle is the same as that which underpins the concept of MOOCs (Massive Open Online Courses(217)) designed to reach large numbers of participants. However, in the Moodle based courses designed as part of the St. Emlyn's project, the degree of expansion is limited by the requirement for the tutors to assess and respond to assignments on a weekly basis.

The content of the courses at junior level is largely defined by the tutors and thus these courses are arguably more aligned to an online version of a traditional pedagogical model of teaching(54). Arguably this is a valid criticism of the courses aimed at the most junior of doctors. The driving force for the development of the courses was that of convenience and access for the trainers and the trainees. In doing so we were able to develop forums, more reflective assignments and the ability to use resources from a wide range of online sites, but these were not the primary aims in moving online. The papers presented in this thesis would have benefited from a better description of these additional opportunities and an analysis of them from the trainer and trainee perspective. In subsequent artefacts in this thesis (34,165) and in further studies we were able to demonstrate how trainees engaged with the courses to a limited degree. Further work in this area, to understand how learners translate their learning into clinical practice would be valuable.

A significant advantage of web-based courses is the ability to update and adapt in an agile way in response to feedback from trainers and trainees. When the courses were originally designed and the first analysis conducted(198) this type of teaching and training was unusual in emergency medicine, but the actual content of the courses changed frequently. For example, if a new chest pain protocol was introduced into the emergency department the online courses could be adapted to reflect this. Similarly, if problems were identified regarding certain groups of patients in the ED or in

their management then teaching could be introduced into the online courses as a result. This agility is important in order to support patient safety in the complex environment of the emergency department.

The experience of the Manchester group in teaching junior emergency doctors using online systems was sought at conference proceedings and regional and national meetings. This arguably led to further developments in emergency medicine learning in other settings and at national level with the development of the Royal College of Emergency Medicine's 'enlightenme' project, a web-based project to deliver online training for UK emergency physicians. The enlightenme project was subsequently absorbed into the RCEM learning projects based on social media platforms that exist today (218).

As a journal article the publication was largely descriptive in nature and lacked detailed information on the engagement of learners or learning outcomes. This is not uncommon in educational papers within general journals where the novelty in publication is around the innovation itself as opposed to the effectiveness of that innovation. The download, sharing and citation data suggests that the information in the paper was used and valued, but in retrospect this paper would have benefited from a deeper analysis of the learner experience and the achievement of learning outcomes.

#### 1.8.2.4.3 Critical Appraisal of courses for advanced trainees in emergency medicine

In contrast to courses aimed at junior doctors more senior trainees benefit from a less didactic approach to teaching. As trainees gain more comfortable with more content there is a need to move from behaviourist approaches to education and learning to one of constructivism and socio-constructivism(219).

The second paper presented in this section describes the rationale for the move from a didactic model of learning into one that recognized the need to

engage trainees in higher levels of learning in keeping with the aims of Modernising Medical Careers(214) and changes in emergency medicine curricula(58). A key aspect of the development of more senior courses was the move to problem based learning (PBL)(220). PBL in healthcare is now well established across a range of undergraduate and postgraduate courses, but at the time the Moodle courses developed it was not widely accepted as a teaching modality and was not commonly used in the online format. In Manchester we were fortunate in that an early advocate of PBL at undergraduate level in the UK was Manchester University(221). The emergency department had run PBL groups for students over many years and were familiar with the strengths and weaknesses of the process. Although the initial experience was at undergraduate level there was the belief that the PBL approach may be a more powerful learning tool with more senior learners. Senior learners are more likely to construct new knowledge on the basis of past experience and exposure to clinical practice encourages a more constructionist approach to learning(208,222). It was a deliberate choice to embrace constructionist principles into the case-based, problem-based learning modules for courses aimed at more senior clinicians.

The initial creation of a problem based learning based around the curriculum led to a more complex pedagogical approach with the aim of pushing learners into higher levels of learning as described by Bloom(223). Cases were designed according to PBL principles to cover the scope and practice of emergency medicine in the UK(224).

The process of teaching using a constructivist problem-based learning approach was criticised by some trainers and trainees, as it did not align to the examination process in as obvious way as other regions in the UK. Teaching for senior postgraduate doctors in the UK is organized at regional level. In the North West this represented approximately 40 doctors. The choice of how regional training takes place (on average once per week) is led by the head of the emergency medicine school, which at the time was my co-author on this paper (KMJ). In other regions of the country different approaches aligned regional teaching days to the assessment process, for

example in running mock exams and sticking to didactic lectures to cover the published curriculum(58). In reality, there was little evidence from exam success rates that any particular approach conferred any benefit on pass rates as these vary widely across the country irrespective of teaching styles(225). However, assessment modalities are a strong driver for how clinicians perceive the quality of their teaching programs. In the North West some clinicians felt that an exam focused training program was more likely to lead to success. In contrast the PBL teaching was not so obviously aligned to the assessment process. This is despite the fact that the PBL cases were designed to cover the entirety of the curriculum, with learning outcomes linked to the curriculum. However, the nature of PBL is such that learner groups may not immediately link their conversations, tasks and presentations in the same way that a didactic approach delivers. In essence this means that PBL based courses may lack the clarity of linkage between activity and curriculum in the same way that didactic based courses do.

Designed in 2006 the online PBL package ran until 2017 when a new head of school in Manchester choose an alternative way to manage regional teaching. The new approach is based around the final exit exam in emergency medicine and focuses on a more didactic approach to knowledge as led by the assessment process. The old adage that assessment drives learning has come to pass. My personal belief is that this is a retrospective step in educational design.

#### 1.8.2.4.4 Critical Appraisal of paper on the Blended Learning Approach to Paediatric Emergency Medicine

Having designed, developed and delivered the Virtual Learning Environments on the Moodle platforms there was an initial enthusiasm about the reach and engagement with the course. Local assessments of engagement demonstrated an increase in the accessibility of learning materials to doctors at foundation level. However, although the ability to access learning materials was easy to demonstrate it did not reveal whether learners valued the content and whether they found it effective in their clinical practice.

To investigate this further I worked with a University of Manchester Medical Student who was seconded to the emergency department for 12 weeks as part of her research module. I designed and supervised the study aimed at exploring how middle grade doctors valued the learning opportunities.

The multimodal approach in this paper was designed to reflect the multimodal, or blended, approach to education in paediatric emergency medicine. We were interested in finding out how virtual learning platforms integrated into the rest of the educational experience from the learner's perspective.

The message board analysis based on the work of Sherrat and Sackville(226) was effective at a time when classification systems for message board analysis were in their infancy, but in retrospect there are better ways of approaching this question, for example by linking posts to Bloom's Hierarchy(223).

The qualitative interviews using a semi-structured approach worked well in exploring the views of a small number of participants and led to interesting learning outcomes.

Firstly, as a proponent of online learning I was intrigued of the lack of a clear link between the quantity of activity on social media and the perceived benefits of it. This reinforced the belief that we cannot equate the silent learner in online learning being the one who learns the least. Silence in cyberspace may appear to be very quiet as it is impossible for the participants to see who is reading or listening.

Secondly, the notion of a virtual learning environment supporting and nurturing a community of practice(227) within the ED supported an aim in bringing chronologically and in some cases geographically distributed learners together.

Finally, the study demonstrated, from the learner's perspective, a greater level of engagement and a willingness to use online learning alongside traditional teaching methods, thus demonstrating the effectiveness of a blended approach to learning.

It was important to test the experience from a learner's perspective and the use of a medical student who was previously unrelated to the project as a lead author and interviewer on this study was important. This separation of course designer and evaluator is important in order to try and obtain truthful and open answers from participants. However, it is likely that there would have been some influence and potential bias as the learner's studies will have known that the lead author was invested in the content and the outcomes. This is a significant problem in many educational studies where the assessor is often closely related to the designer and director of the content itself. Ideally, it would have been beneficial to have an independent evaluation of this course and others. However, this was an effective assessment and investigation of a single course from the learner's perspective using a mixed methods approach. Whether the results can be extrapolated to other courses and other settings is uncertain, but within this platform and within this group of educators it was important information to help develop future courses.

#### ***1.8.2.5 How have these artifacts related to Virtual Learning***

##### ***Environments contributed to the development of Emergency Medical Education?***

The virtual learning environments originally developed as a response to the challenges of balancing service and training in a 24-hour specialty such as emergency medicine. Our paper on developing an F2 course clearly demonstrates how this improved the access, and by implication the effectiveness of education in emergency medicine for junior trainees in adult(198) and paediatric emergency medicine(204). At the time when these projects developed the concept of using blended learning techniques in

emergency medicine was new and had not previously been described in this cohort.

The VLE for higher trainees in emergency medicine in the North West ran as the core regional teaching program for 11 years between 2006 and 2017.

Following the success of local courses the development of the site to further academic courses led to the development of the Masters courses based at Manchester Metropolitan University(228). This was the first Masters course in Emergency Medicine to be developed in the UK(229). More recently the use of virtual learning environments in emergency medicine is now commonplace for a range of emergency presentations(45,209,230-237). In the next section on #FOAMed based learning I describe how VLE's can use new open access resources as reusable learning objects (RLOs) to develop courses in emergency medicine. This move to using a broader range of resources and in particular those available online represents the latest iteration of VLE based learning in emergency medicine (180,209). Although often described as a new idea the origin of such approaches can be seen to derive from the VLE approach to blended teaching and learning.

#### ***1.8.2.6 Case based discussions on St. Emlyn's***

In addition to the course-based programs on St. Emlyn's the Moodle platform also supports a local discussion group for clinicians working in Central Manchester. This is primarily based around a discussion board of anonymized cases used to highlight interesting and excellent practice. The message board was a way of bringing the concept of a board round into a virtual learning environment. Participants are able to discuss clinical cases in a secure environment facilitated by a wider faculty of peers and trainers. This differs from a course-based structure as there is no beginning or end, or direction from the tutors. This is an example of how case-based learning can be enhanced through online facilitation.

The case-based discussions are limited to senior clinicians in the department in order to maintain security and also to 'pitch' the learning at higher level. An example of an a short analysis demonstrating higher levels of learning(223) using this case based learning can be seen in the Appendix. In that preliminary analysis it is clear that learners participation in the message boards leads to higher levels of learning as described by Bloom(223).

#### ***1.8.2.7 Personal Contribution to the Virtual Learning Environments Projects.***

The Virtual learning environments are a collaborative effort between senior educators linked to the Manchester Foundation Trust, Manchester Metropolitan University and Health Education North West (previously known as the North West Deanery). My contributions extend from the beginning of these projects through to the present day.

I have designed and delivered many of the courses on the Moodle website. In addition, I have supported colleagues developing their own courses on the St. Emlyn's platform (e.g. paediatric anaesthesia and paediatric intensive care).

I continue to contribute to local courses and to the case-based discussions.

My role as a lead educator on the MSc in Emergency Medicine at MMU is reliant on the facilitation of courses through the Moodle based MMU platform(228,229).

#### ***1.8.2.8 Conclusion***

The section on Virtual Learning Environments demonstrates how a changing workforce and educational requirements can put pressure on traditional models of teaching. The artefacts presented here demonstrate how technology was used to mitigate the difficulties of working practice change whilst simultaneously developing opportunities for learners to participate in blended approaches to learning. The underpinning of these technological



advances on educational theory and practice is demonstrated by the move to problem-based learning in an online environment.

These projects demonstrate the necessity for emergency medicine educators to be agile in their adoption and delivery of technology enhanced education.

The VLE projects have arguably been highly successful, having been accessed by thousands of learners since the project began in 2006.

### **1.8.3 Theme 3: Social Media and #FOAMed**

### ***1.8.3.1 Narrative. Emergency Medicine education in the social age.***

This thesis has already demonstrated that technology can influence how education is delivered consumed and valued. That impact of technology is ever more invasive in our daily lives. Internet access, both through computers and now almost universally through mobile devices was not apparent when we designed the BestBets and Moodle based learning projects. Since then access to online materials and the tools associated with them has become ubiquitous. In recent years the increase in social media engagement has been a significant trend in society and it is not then surprising that this new technology is influencing how trainers and trainees interact and educate. Social media use is generally increasing across society, with very high levels of use amongst younger people(238). Increased usage of social media continues to increase across all age groups with significant numbers of over 65-year olds accessing social media platforms. Social media is hugely influential and must now be considered a mainstream activity for modern society(239).

Julian Stodd has described the current use of mobile and internet enabled technologies as evidence of a Social Age for societies(89). By this he draws on the concept that we have moved beyond the simple development of new technologies as the sole drivers for change, but rather it is the way in which we use new technologies, interact with them and increasingly use them as societal functions that is having the most significant impact on our lives in the modern age. For example, a new technology development such as the internet allowed the creation and archiving of the BestBets project, but that project did not permit much in the way of interactivity and social discussion. Similarly, with the development of VLEs they started with a didactic approach and then moved towards a more discursive and socio-constructive approach for senior learners as the potential of the VLEs was realized. In the modern age interaction enabled by the use of social media is a dominant influence in society and as result educators are seeking to use this latest innovation in a positive way. The innovation itself is not largely about the hardware technologies though, the main features of a social age are not the same as the ground-breaking innovations of the creation of the internet or the

development of smart phones. Those achievements would be considered part of the technological age (which followed the industrial age). The social age is characterised by our use and interaction with technology as a tool to communicate and share through tools such as Facebook, Google, blogs, podcasts and twitter.

It is the way in which social media platforms change the way groups and individuals communicate that is increasingly a significant influence over our clinical practice and education. The latest developments and incredible rise in the engagement between groups and individuals facilitated through the use of social media platforms is changing the way that we learn and hold values in the world. It is not the technology per se that leads to change, but rather the way in which individuals, groups and organisations use it, or are used by it. The emphasis in modern communication, in value building and in promoting new ideas is democratized through an enhanced social network that is unbounded by geography or chronology. This section explores my journey into the use of platforms aligned to the social age in the pursuit of effective emergency medical education.

Social media is a broad term and includes any program or media that allows peer to peer (or group to group) interactions via digital technologies. The definition of “social media” is broad and constantly evolving. In this context the term social media describes internet-based tools that allow individuals or communities to interact and communicate, to share information, ideas, messages, images, or other content. It enables a collaborative approach for users in both synchronous and asynchronous fashion. In many cases it is used to facilitate collaboration between other users in real time(240).

Social media is also often described as “Web 2.0” or “social networking” (241).

In this thesis I predominantly use the term to reflect those technologies that are used in medical education, most notably blogs, podcasts, online video, conference streaming and discussion groups.

Social media platforms (e.g. twitter, blogs, podcasts) allow engagement across a much broader range of learners and teachers(106-120). They are not restricted by time, geography or permissions and thus can engage with a much wider audience(138).

#FOAMed is aligned to the concept of an open educational resource. These are resources that permit and encourage open sharing, participation and creation of learning resources. Most #FOAMed content is licensed for sharing using the creative commons templates(242).

#### 1.8.3.1.1 The St. Emlyn's development timeline.

Together with other colleagues based in the North West of England I became aware of online and open access websites related to the practice of emergency medicine, such as Life in the Fast Lane(102) and EMCRI(103), in the early 2010s. These sites offered insight into the practice of emergency medicine in other health economies. Colleagues were notably inspired to question their own practice after reading and listening to these resources and thus I too began following them. In early 2012 Professor Richard Body and myself explored the possibility of developing a UK based blog to showcase the practice of emergency medicine here.

Fortuitously, in 2012 the International Federation of Emergency Medicine conference (IFEM) was held in Dublin. This conference included a social media stream designed to showcase the early efforts and achievements of a small group of online emergency physicians. Keynote speakers included Joe Lex and Mike Cadogan founders of 'freeemergencytalks.net'(243) and 'Life in the Fast Lane'(102) respectively. Their sessions were well attended, notably by a younger demographic and more diverse demographic as compared to the rest of the conference, and to other emergency medicine conferences in

general. Mike Cadogan in particular offered his assistance in the creation and early web-hosting of the nascent St. Emlyn's blog. This was a key step for Professor Body and myself as it kick started the process of site development. Following these discussions and with the assistance of Mike Cadogan and others familiar with online medical education we designed and published the first St. Emlyn's blog on the 1<sup>st</sup> July 2012. These initial blog posts and content were supported and promoted by other #FOAMed sites at the time, notably Life in the Fast Lane(102) and EMCRI(103).

The IFEM conference was a turning point in the development of social media enhanced medical education in many ways. Firstly the conference organisers were one of the first groups to embrace social media as an integral part of the meeting(101). They encouraged participants to share and discuss conference experiences outside of the physically present delegates thus increasing the reach and impact of the learning.

Secondly it was in Dublin that the term #FOAMed, standing for Free Open Access Medical Education was coined by Mike Cadogan from the Life in the Fast Lane site(140). Finally, it brought together a group of educators from across the worlds that were interested in developing this style of education in a mutually supportive way. This mutual support led to one of the initial publications around the use of social media in conferences(101).

Since that time the number and range of #FOAMed sites has increased (170) perhaps reflecting an increasing interest and engagement with social media based learning resources(154). Emergency medicine, critical care and pre-hospital care appear to have a greater engagement with #FOAMed resources perhaps reflecting the broader scope of practice amongst a chronologically and geographically distributed workforce.

Data on the impact of #FOAMed based resources is relatively poor, but in the US(122) and Canada(78,146) engagement rates amongst trainees in emergency medicine approach near ubiquity with most trainees utilizing resources on a weekly basis.

Trainers too have increasing levels of engagement and utilization of #FOAMed resources reflected by increasing numbers of trainers interacting in #FOAMed spaces such as twitter. These increasing levels of engagement and utilization have been reflected in an accompanying academic interest in the growth, reach and development of #FOAMed (105,111,112,114,244-249). Data in the UK is currently lacking. An unpublished medical student project conducted in the North West region in 2017 suggests that high levels of engagement and influence exist in the UK, but the response rate was too low to draw firm conclusions or to publish the findings in a peer reviewed journal. In this small survey over 95% of respondents reported using #FOAMed based resources to change practice. The data was presented in poster form at the Emergency Medicine Society of South Africa meeting at Sun City in 2017. A copy of the poster can be found in the Appendix.

#### 1.8.3.1.2 Using #FOAMed and reusable learning objects resources in the workplace.

The movement of educational materials into a freely accessible platform may also permit new ways of teaching in the workplace. In a traditional model of face-to-face teaching the tutor and the trainee meet, a topic is 'taught' by the tutor and then there is time for questions and discussion at the end. This lecture mode of teaching is very common despite the general and long standing consensus that it is frequently a quite poor method of imparting information(250,251).

Placing learning information on the web allows them to be used again and again. Such learning artefacts available in this manner have been referred to as reusable learning objects (or RLOs). Having re-usable learning objects available to everyone means that they can be accessed in advance of any face to face teaching event, and then, when the face to face meeting takes place there is more time for discussion, argument and clarification. This idea that learning takes place prior to a face to face meeting and then informs the following discussion is commonly termed the 'Flipped Classroom Model'(142-

144,252). This has a number of attractions in the emergency medicine workforce with their geographical and chronological dispersal. It is commonly advocated as an adjunct to blended learning strategies(92) where online learning supplements face to face learning and in this case can be traced back to earlier projects on the Moodle platforms(92,198,204). In 2013 we demonstrated on the Moodle platforms how learning is facilitated through discussion and debate, particularly amongst more senior learners who wish to explore the detail, the depth, the strength and the applicability of learning content(204). Indeed, the potential benefit is that in a flipped classroom model of education the learners are encouraged to explore information in a way that is likely to lead them into the higher levels of Bloom's taxonomy(223).

The flipped classroom model using #FOAMed based resources is often advocated amongst #FOAMed enthusiasts but there is little definitive data to support its effectiveness in practice(252), though that largely reflects a lack of evidence rather than evidence demonstrating that it is ineffective. As a technique for teaching in emergency medicine it certainly has face validity. In Manchester I have used this model with medical students rotating through the emergency department. An example of the learning program with links to the #FOAMed based RLOs can be found in the Appendix.

Similarly, the use of #FOAMed based resources are a way to reinforce the opportunistic learning that typifies ED education. Many informal teaching episodes occur in clinical practice. However, there is often little record of the teaching moment and thus learners may forget or misinterpret the learning points. In an effort to reinforce learning and to enhance spaced repetition of learning I created the idea of the #FOAMed prescription(253). This was based on an original idea of educational prescriptions as advocated by Sackett et al. (155,254,255). This demonstrates the link between early projects in evidence-based medicine and BestBets influencing the current work around social media. It demonstrates a consistent theme through the various projects described in this thesis, in this case that of delivering shop floor EBM, and how that theme is delivered and transformed alongside the



technological innovations that appear in the form of web-based technologies and now mobile and social technologies.

#### 1.8.3.1.3 Editorial policies.

The St. Emlyn's timeline itself began in 2012 with the development of the blog led by Richard Body and Simon Carley as lead editors. Over time this has developed into a multi-professional core editorial team of 12 clinicians from the US, UK, and Australia. The editorial team peer reviews and approves all content with final sign off by one of the senior editors (RB or SC) before publication.

The team-based peer review system also acts as a sense check to maintain high professional standards and patient and clinician confidentiality on a platform that is accessible to the public. The editorial team also indexes, disseminates and curates content by linking it to the Royal College of Emergency Medicine curriculum(57).

#### 1.8.3.1.4 Themes

The blog and podcast have a broad remit of topics in order to publish across a range of content relevant to emergency medicine, which is by its nature very broad. Four overarching themes have emerged:

1. Evidence based medicine reviews and critical appraisal
2. Clinical topics
3. Philosophy of emergency medicine
4. Wellbeing

These themes are relevant to everyone who works in emergency medicine and similarly to related specialties such as prehospital care, critical care, acute medicine and paediatrics. The process of peer review and editorial oversight is similar to that described in other emergency medicine blogs (246,256).

#### 1.8.3.1.5 e-Books

In late 2017 it became apparent that blog posts frequently fall into themes, but that these themes are not obvious to visitors to the site as they will be dispersed through the blog timeline. Digital collections of related blogs in the form of e-books is a new venture designed to collate related materials in one downloadable form (257). It is uncertain whether this will engage a different audience, or whether the collation will work educationally. The first book published collated a range of blog posts related to clinical decision making in the emergency department. The second collated a series of blogs on a colleague's experience in working for a helicopter retrieval service in New South Wales. These books are offered in iBook (on the Apple platform) and as ePubs (readable by most other e-book readers). The initial response has been positive with several thousand downloads in the first month of release.

### ***1.8.3.2 Artifacts linked to Social Media projects.***

#### 1.8.3.2.1 Artifact 9 Website: St. Emlyn's Blog

Link <http://www.stemlynsblog.org>(4)

To date on 12/12/2017

Site visits: 1.6 Million

Average visits per day

2012: 276

2013: 361

2014: 713

2015: 922

2016: 1193

2017: 1185

Blog posts published: 600


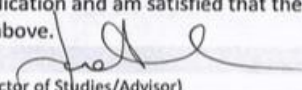

Social Media Index score 10<sup>th</sup> of 156 #FOAMed blog sites listed (113,258).

Research and Knowledge Exchange  
 Graduate School  
 Form RDPUB (ROUTE 1 AND 2)



**PHD BY PUBLISHED WORK (ROUTE 1/2):  
 CONTRIBUTION TO PUBLICATIONS**

*This form is to accompany an application for registration for PhD where the PhD is by Published Work. A separate form should be completed for each publication that is submitted with the proposal and should accompany the RD1 form.*

1. The Candidate			
First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
StEmlyn's - Emergency Medicine #FOAMed. Available from: <a href="http://www.stemlynsblog.org">http://www.stemlynsblog.org</a>			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
All contributed to development and design of the project and paper. 50% for this			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Richard Body		richard.body@manchester.ac.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date:	20/12/17
		(Director of Studies/Advisor)	
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
		(Faculty Research Degrees Administrator)	

### Latest Posts

#### 104 Reflections from Sydney HEMS – the eBook. St.Emlyn's

 Natalie May |  December 19, 2017 |  0 Comments



Firstly, the title of this post is not a typo. When I collated the reflective lessons from my series of Sydney HEMS blog posts I realised there were actually 104, not 101. Apologies for the misleading advertising, but there was...

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#FOAMed, Critical Care, Featured, Healthy Clinicians, Human factors, Paeds, Pain, Prehospital Care, Resus & Crit Care, resuscitation, simulation, The philosophy of EM, Trauma  #FOAMed, ebook, HAP26, iBook, prehospital, prehospital care, retrieval, sydney HEMS

#### JC : Paracetamol, NSAID's or both in MSK trauma. St.Emlyn's

 Gareth Roberts |  December 17, 2017 |  0 Comments

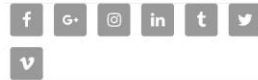


Pain... patients complain about it... A LOT. It's the commonest reason for attending emergency departments across the globe so we should be (and need to be) pretty good at treating it. With that in mind I thought we could look at this...

[READ MORE](#)



#### Social Media Links



1.8.3.2.2 Artifact 10: Website: St. Emlyn's Podcast

Link: Website: <http://www.stemlynspodcast.org> (259)

To date on 12/12/2017

Podcast Downloads: 461,770 in last 24 months.

Episodes: 125

Feed Hits: 3.6 Million

Research and Knowledge Exchange  
 Graduate School  
 Form RDPUB (ROUTE 1 AND 2)



**PhD BY PUBLISHED WORK (ROUTE 1/2):  
 CONTRIBUTION TO PUBLICATIONS**

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1. The Candidate			
First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
Carley S. St.Emlyn's podcast [Internet]. [cited 2017 Feb 22]. Available from: <a href="http://www.stemlynspodcast.org">http://www.stemlynspodcast.org</a>			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
All contributed to development and design of the project and paper. 33% for this paper			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Iain Beardsell		ibeardsell@doctors.org.uk	
Richard Body		richard.body@manchester.ac.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date:	20/12/17
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			

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1. The Candidate			
First Name(s):	Simon	Preferred Title:	Dr
Surname:	Carley		
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
Personal e-mail address:	carleys@me.com	Student ID Number:	17090583
2. Title of PhD Proposal			
Technology enhanced learning in emergency medicine			
3. Title of Research Output			
Carley S. St.Emlyn's podcast [Internet]. [cited 2017 Feb 22]. Available from: <a href="http://www.stemlynspodcast.org">http://www.stemlynspodcast.org</a>			
4. Candidate's contribution to the research output (State nature and approximate percentage contribution of each author)			
All contributed to development and design of the project and paper. 33% for this paper			
5. Co author(s):			
I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.			
Name	Signature	Current e-mail address	
Iain Beardsell		ibeardsell@doctors.org.uk	
Richard Body		richard.body@manchester.ac.uk	
6. Statement by Director of Studies/Advisor			
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.			
Signature:		Date:	20/12/17
(Director of Studies/Advisor)			
7. Signature of Faculty Research Degrees Administrator			
Signature:		Date:	
(Faculty Research Degrees Administrator)			



# The St.Emlyn's virtual hospital podcast

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## November Round up 2017.

December 9, 2017



Our November round up of news from the blog with Simon and Nat.

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## How to use WhatsApp and other group messaging systems in a Major Incident.

December 9, 2017



A quick summary on how you can use group messaging systems in a major incident. A vast improvement on telephone cascades BUT you have to set this up in advance. If you make it up on the day it will be a disaster. Here's the tips and tricks from the Virchester team. You can read more here <http://stemlynsblog.org>



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A podcast on all matters relating to academic emergency medicine from the St.Emlyn's team.

<http://stemlynsblog.org>  
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1.8.3.2.3 Artifact 11: Paper: Quantifying the reach and engagement with social media enabled learning.

Paper: Carley S, Beardsell I, May N, Crowe L, Baombe J, Grayson A, Carden R, Liebig A, Gray A, Fisher R, Horner D, Howard L, Body R. Social media enabled learning in Emergency Medicine: A case study of the Growth, Engagement and Impact of a Free Open Access Medical Education blog. Postgraduate Medical Journal Published Online First: 20 October 2017. doi: 10.1136/postgradmedj-2017-135104. (3)

Paper link: <http://pmj.bmj.com/content/early/2017/10/19/postgradmedj-2017-135104>

NOTE: This paper has not yet appeared in print and so metrics on reach and popularity are not fully available nor indicative of final values.

Google Scholar: Not yet listed

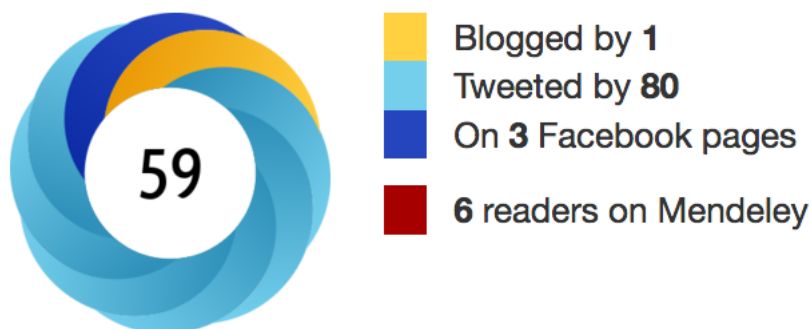
Web of Science: Not yet listed

Altmetrics: score: 59

Mendeley readers: 6

Abstract viewed from PMJ website: 5747 times in first five months of online only publication.

Altmetrics score.

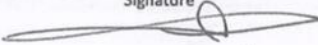
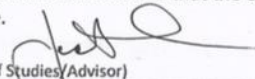
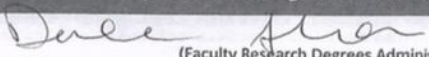


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1. The Candidate		
First Name(s):	Simon	Preferred Title: Dr
Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
Personal e-mail address:	carleys@me.com	Student ID Number: 17090583
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Name	Signature	Current e-mail address
Ross Fisher		ffolliet@googlemail.com
Laura Howard		laurahoward@doctors.org.uk
Dan Horner		danielhorner@nhs.net
6. Statement by Director of Studies/Advisor		
I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.		
Signature:		Date: 20/12/17
(Director of Studies/Advisor)		
7. Signature of Faculty Research Degrees Administrator		
Signature:		Date:
(Faculty Research Degrees Administrator)		

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Name	Signature	Current e-mail address	
Liz Crowe		crowellz@bigpond.net.au	
Janos Baombe		janos.baombe@mft.nhs.uk	
Alan Grayson		dralangrayson@gmail.com	
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**1. The Candidate**

First Name(s): Simon Preferred Title: Dr

Surname: Carley

MMU e-mail address: SIMON.D.CARLEY@stu.mmu.ac.uk Contact Number: 079886264331

Personal e-mail address: carleys@me.com Student ID Number: 17090583

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**5. Co author(s):**

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

Name	Signature	Current e-mail address
Richard Body		richard.body@cmtf.nhs.uk
Iain Beardsell		Iain.Beadsell@nhs.uk
Natalia May		nataliemay@gmail.com

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature: Date: 20/12/17  
 (Director of Studies/Advisor)

**7. Signature of Faculty Research Degrees Administrator**

Signature: Date:  
 (Faculty Research Degrees Administrator)



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First Name(s):	Simon	Preferred Title:	Dr
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MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number:	07986264331
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Name	Signature	Current e-mail address
Richard Body		richard.body@cmft.nhs.uk
Iain Beardsell		Iain.Beadsell@uhs.nhs.uk
Natalie May	Natalie May <small>Digitally signed by Natalie May DN: cn=Natalie May, o=mmu, email=nataliemay@mmu.ac.uk Date: 2017.12.20 14:53 +1100</small>	nataliemmay@gmail.com

**6. Statement by Director of Studies/Advisor**

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Signature:  Date: 20/12/17  
(Director of Studies/Advisor)

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Name	Signature	Current e-mail address
Ross Fisher		ffolliet@googlemail.com
Laura Howard		laurahoward@doctors.org.uk
Dan Horner		danielhorner@nhs.net
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Signature:		Date: 20/12/17
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Name	Signature	Current e-mail address
Liz Crowe		croweliz@bigpond.net.au
Janos Baombe		janos.baombe@mft.nhs.uk
Alan Grayson		dralangrayson@gmail.com

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature: Date: 20/12/17  
(Director of Studies/Advisor)

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Signature: Date: \_\_\_\_\_  
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First Name(s): Simon Preferred Title: Dr

Surname: Carley

MMU e-mail address: SIMON.D.CARLEY@stu.mmu.ac.uk Contact Number: 07986264331

Personal e-mail address: carleys@me.com Student ID Number: 17090583

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**5. Co author(s):**

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

Name	Signature	Current e-mail address
Richard Carden		r.carden@doctors.org.uk
Ashley Liebig		ashleyliebig@icloud.com
Chris Gray		chris.gray@doctors.org.uk

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature: Date: 24/12/17  
 (Director of Studies/Advisor)

**7. Signature of Faculty Research Degrees Administrator**

Signature: Date: \_\_\_\_\_  
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Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
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Surname:	Carley	
MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Contact Number: 07986264331
Personal e-mail address:	carleys@me.com	Student ID Number: 17090583
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Name	Signature	Current e-mail address
Richard Carden		r.carden@doctors.org.uk
Ashley Liebig		ashleyliebig@icloud.com
Chris Gray		chris.gray@doctors.org.uk
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Name	Signature	Current e-mail address
Liz Crowe		croweliz@bigpond.net.au
Janos Baombe		janos.baombe@mt.nhs.uk
Alan Grayson		dralangrayson@gmail.com

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Name	Signature	Current e-mail address
Richard Body		richard.body@cmft.nhs.uk
Iain Beardsell		Iain.Beardsell@uhs.nhs.uk
Natalie May		nataliemay@gmail.com
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MMU e-mail address:	SIMON.D.CARLEY@stu.mmu.ac.uk	Student ID Number:	17090583
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Name	Signature	Current e-mail address
Richard Carden		r.carden@doctors.org.uk
Ashley Liebig		ashleyliebig@icloud.com
Chris Gray		chris.gray@doctors.org.uk

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~~Social-media-~~  
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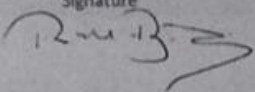
**4. Candidate's contribution to the research output**

(State nature and approximate percentage contribution of each author)

This paper has multiple authors representing the co-creation of the project and content. As lead author I estimate my contribution to be 25% for this project described in this paper

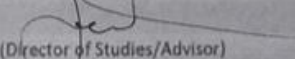
**5. Co author(s):**

I confirm that the contribution indicated above is an accurate assessment of the contribution by the candidate to the research output named in section 3.

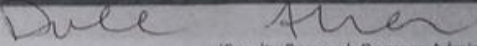
Name	Signature	Current e-mail address
Richard Body		richard.body@cmft.nhs.uk
Iain Beardsell		iain.Beardsell@uhs.nhs.uk
Natalie May		nataliemay@gmail.com

**6. Statement by Director of Studies/Advisor**

I confirm that I have read the above publication and am satisfied that the extent and nature of the candidate's contribution is as indicated in section 4 above.

Signature:  Date: 20/12/13  
(Director of Studies/Advisor)

**7. Signature of Faculty Research Degrees Administrator**

Signature:  Date:  
(Faculty Research Degrees Administrator)

# Social-media-enabled learning in emergency medicine: a case study of the growth, engagement and impact of a free open access medical education blog

Simon Carley,<sup>1</sup> Iain Beardsell,<sup>2</sup> Natalie May,<sup>3</sup> Liz Crowe,<sup>4</sup> Janos Baombe,<sup>1</sup> Alan Grayson,<sup>1</sup> Richard Carden,<sup>5</sup> Ashley Liebig,<sup>6</sup> Chris Gray,<sup>1</sup> Ross Fisher,<sup>7</sup> Daniel Horner,<sup>8</sup> Laura Howard,<sup>1</sup> Richard Body<sup>9</sup>

<sup>1</sup>Emergency Department, Manchester University NHS Foundation Trust, Manchester, UK

<sup>2</sup>Department of Emergency Medicine, University Hospital Southampton, Southampton, UK

<sup>3</sup>Ambulance Service New South Wales Rescue Helicopter Base, New South Wales, Australia

<sup>4</sup>Children's Health Queensland Hospital and Health Service, Lady Cilento Children's Hospital, South Brisbane, Queensland, Australia

<sup>5</sup>Emergency Department, Royal London Hospital, London, UK

<sup>6</sup>STAR Flight, Austin, Texas, USA

<sup>7</sup>Department of Paediatric Surgery, Sheffield Children's NHS Foundation Trust, Sheffield, UK

<sup>8</sup>Emergency Department, Salford Royal NHS Foundation Trust, Salford, UK

<sup>9</sup>Division of Cardiovascular Sciences, University of Manchester, Manchester, UK

## Correspondence to

Professor Simon Carley, Emergency Department, Manchester Royal Infirmary, Manchester M13 9WL, UK; [simon.carley@crfht.nhs.uk](mailto:simon.carley@crfht.nhs.uk)

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## ABSTRACT

**Background** Clinicians are increasingly using social media for professional development and education. In 2012, we developed the St.Emlyn's blog, an open access resource dedicated to providing free education in the field of emergency medicine.

**Objective** To describe the development and growth of this international emergency medicine blog.

**Method** We present a narrative description of the development of St.Emlyn's blog. Data on scope, impact and engagement were extracted from WordPress, Twitter and Google Analytics.

**Results** The St.Emlyn's blog demonstrates a sustained growth in size and user engagement. Since inception in 2012, the site has been viewed over 1.25 million times with a linear year-on-year growth. We have published over 500 blog posts, each of which attracts a mean of 2466 views (range 382–69671). The site has been viewed in nearly every country in the world, although the majority (>75%) of visitors come from the USA, UK and Australia.

**Summary** This case study of an emergency medicine blog quantifies the reach and engagement of social-media-enabled learning in emergency medicine.

## BACKGROUND

We founded the St.Emlyn's blog in June 2012 at the International Conference of Emergency Medicine (ICEM) in Dublin. Our intention was to provide an open access platform that promotes emergency medicine learning through the use of social media. Notably, we aimed to achieve this through the use of blogs and subsequently podcasts, Twitter, Facebook and Instagram means.

This paper describes the history, growth, lessons learnt and user engagement of the decision to take emergency medicine education into the social age.<sup>1</sup>

## METHODS

One of the advantages of developing educational materials online is the ready access to user engagement data. The St.Emlyn's blog is based on the WordPress platform, which provides real-time and trend data on site utilisation. Data are readily available to site owners on the number of users, page views and location of those accessing the site. In

addition, we linked the WordPress to Google Analytics, which provides an even greater depth of information on real-time engagement and trends over time in usage.

Similarly, the number of users on other social media platforms such as Twitter is readily available to users of the services.

We used data available from WordPress, Twitter and Google Analytics to determine the reach and interaction of users with the blog.

We used the online National Health Service Health Research Authority decision tool to determine that this study did not need ethical approval.

## INITIAL DEVELOPMENT

Prior to 2012, our group had embraced online learning as a mechanism to engage with a chronologically and geographically dispersed workforce. We had experience in the use of closed virtual learning environments such as Moodle where learners and educators are able to exchange and learn through asynchronous discussion of clinical cases.<sup>2,3</sup> Online learning lends itself well to the emergency medicine workforce, and closed systems offer advantages to learners and educators who are rightly concerned about safety and confidentiality. The disadvantage of closed systems is also clear: learning can only take place among those who are registered and permitted into the system. This complicates and restricts the reach of any educational interventions to those within the system.

In contrast, social media platforms allow engagement across a much broader range of learners and teachers.<sup>4,5</sup> They are not restricted by time, geography or permissions and thus can engage with a much wider audience.<sup>6</sup>

ICEM in 2012 was one of the first emergency medicine conferences to embrace social media as an integral part of the meeting.<sup>7</sup> Following discussions with leaders in online education in Dublin, we were inspired to design and publish the first blog on 1 July 2012. This coincided with the creation of the Free Open Access Medical Education movement by Mike Cadogan from the Life in the Fast Lane.<sup>8</sup> These initial blog posts and content were supported and promoted by other free, open access medical education ('#FOAMed') sites at the time, notably Life in the Fast Lane<sup>8</sup> and

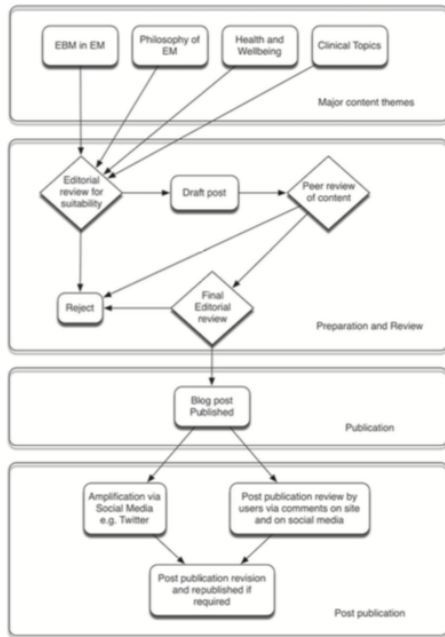
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**Figure 1** Publishing process for blog posts. EBM, evidence-based medicine; EM, emergency medicine.

EMCrit.<sup>9</sup> The blog is based on the WordPress platform and is hosted on a remote server. The editorial team began with two lead editors (RB and SC) and over time has developed a multiprofessional editorial team of 12 clinicians from the

USA, UK and Australia. The editorial team peer reviews and approves all content with final sign off by one of the senior editors before publication.

The team-based peer review system also acts as a sense check to maintain high professional standards and patient and clinician confidentiality on a platform that is accessible to the public. The editorial team also indexes, disseminates and curates content by linking it to the Royal College of Emergency Medicine curriculum.<sup>10</sup>

We focus on publishing content relevant to emergency medicine, which is by its nature very broad. Our approach is to publish on topics 'that would be interesting to UK emergency physicians' across four broad themes.

1. evidence-based medicine reviews and critical appraisal
2. clinical topics
3. philosophy of emergency medicine
4. well-being.

These themes are relevant to everyone who works in emergency medicine and similarly to related specialties such as prehospital care, critical care, acute medicine and paediatrics. The process of peer review and editorial oversight is similar to that described in other emergency medicine blogs.<sup>11 12</sup> The process from themes to postpublication review and revision is shown in [figure 1](#).

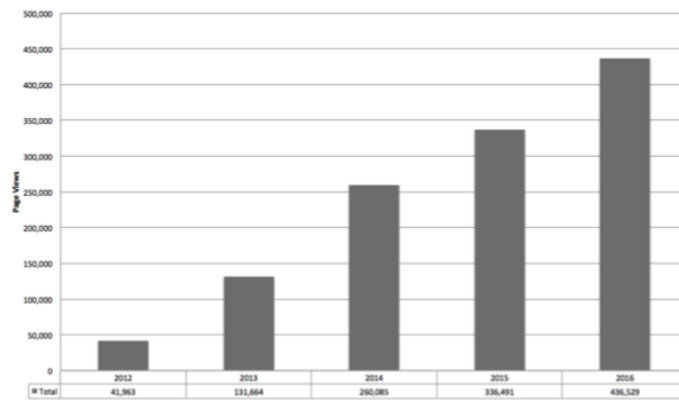
**RESULTS**

From June 2012 to January 2017, the blog has published 510 articles, approved and published 2776 comments and has had pages viewed over 1.25 million times.

[Figure 2](#) shows the linear growth from 2012 to 2016. In the first month of 2017, page views are averaging over 1300 per day, which if sustained predicts over half a million views in 2017.

Data extracted from WordPress and Google Analytics reveal the global reach of a #FOAMed-based blog. Since 2012, visits have been registered from all but a handful of the world's countries.

The distribution of visitors reflects those countries that are primarily English speaking and with high comparative incomes. They are also those health economies that most closely resemble UK practice in emergency care. [Figure 3](#) quantifies this distribution with over 75% of visitors coming from the UK, USA and



**Figure 2** Page views per annum.

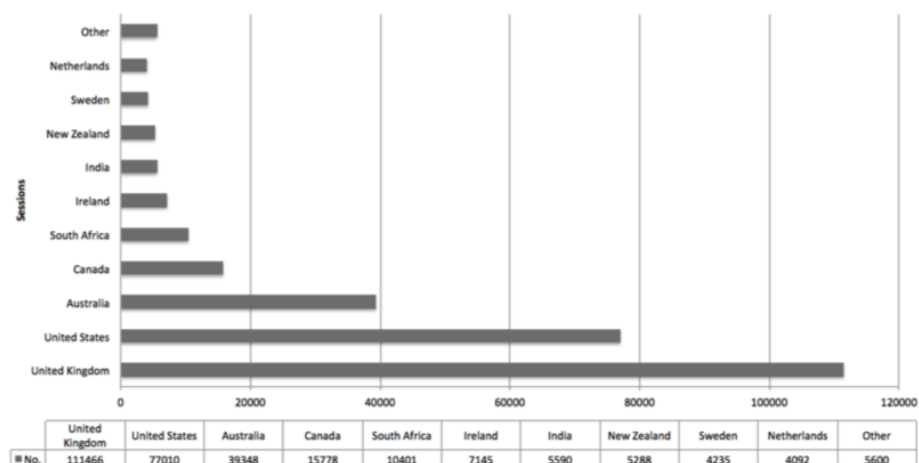


Figure 3 Geographical reach.

**Box 1** Example of early clinical impact of blog post

A post based on the REVERT trial<sup>34,35</sup> led to reports of clinicians using the technique successfully within hours of publication on the blog as communicated by reports on social media. The example given below demonstrates this with clinicians learning about the REVERT technique through the blog and then actioning that knowledge within 12 hours of publication.<sup>36</sup>

Tweet reflecting speed of adoption of new evidence.



Australia. A session represents an individual accessing the site and viewing one or more pages.

These data clearly show that the scope and reach of a #FOAMed blog extends far beyond the immediate face-to-face influence of the authors and thus offers scope to teach and learn with a global audience. Communicating the content to this audience is aided by disseminating new posts through linked Twitter, Facebook and LinkedIn accounts with summary messages and links back to original content. This blend of integrated social media platform publication and dissemination increases the reach of content and takes key selected messages to an even wider audience. For example, in January 2017, the @stemlyns Twitter account achieved 150 000 impressions (ie, delivered to a user's account).

These data demonstrate the reach of a #FOAMed-based blog, but as with many educational interventions, the clinical impact as defined by changes to clinical care is more difficult to demonstrate. This is especially difficult with such a globally dispersed audience. However, anecdotal stories have emerged that demonstrate both the speed and impact of learning through

social media. **Box 1** details the impact of one particular post via various online platforms.

Examples of narratives similar to that above show how knowledge translation through social media can lead to improvements in patient care. However, examples cannot determine the breadth and overall impact of social-media-enabled learning. What is clear is that they do demonstrate the speed at which knowledge can be translated from the primary literature to the bedside through the use of social learning. This is in stark contrast to traditional models of publication where the knowledge translation cycle is measured in years rather than hours.<sup>13,14</sup>

**DISCUSSION**

This case study charts the development of a #FOAMed-based medical education blog. It demonstrates a sustained growth and impact in content and engagement with a worldwide readership. This is the first paper to quantify the reach and impact of an emergency medicine blog as many bloggers are reluctant to reveal their activity data. Previous efforts to rank the impact and size of sites have used publicly available data such as Alexa rankings, Twitter followers and Facebook likes.<sup>15</sup> However, such data, although freely available, contain significant biases, particularly against sites outside of North America. We have previously blogged on the limitations of the Social Media Index (SMi) to recognise the limitations of only having access to public datasets.<sup>16</sup> This paper takes a different approach and uses data ordinarily only available to site publishers. This gives a more accurate and direct reporting of site use and reach.

Our belief is that the St.Emlyn's blog is mid-large in terms of user engagement, as the latest SMi suggests,<sup>17</sup> but without other sites and educators sharing their direct data, it is merely an estimate. We believe that these data will act as a benchmark for other sites and educators. We hope that

## Original Article

by making these data open we will encourage others to share and thus gain a better understanding of #FOAMed resources as a whole.

The data on user engagement show how web-based learning can disseminate content to an extremely large cohort of learners unrestricted by time or geography. The location of users almost certainly reflects the language and systems familiar to the authors. However, the global reach and engagement with lower-income and middle-income countries demonstrates how knowledge can be shared without the need to travel to conferences or to subscribe to journals as the global accessibility of #FOAMed resources is essentially free to the end user.

The data show an increase in size, impact and engagement over time, which probably reflects a sustained growth in #FOAMed-based learning in general.<sup>18 19</sup> Studies in the USA<sup>20</sup> and Canada<sup>21</sup> show that residents in emergency medicine increasingly value and use #FOAMed-based learning. Purdy *et al* demonstrated a near universal engagement with #FOAMed resources among Canadian residents and found evidence that this changed clinical practice.<sup>21</sup> This has raised concerns about the quality of online resources and as to whether knowledge may be disseminated too quickly before it can be tested in practice.<sup>22</sup> Efforts to define quality and impact have sought to counter these concerns through guidelines, process and scoring systems, although none of them are yet to achieve universal acceptance.<sup>15 23 24</sup> These concerns are legitimate, although to date, they appear to be largely theoretical.

Unlike traditional medical publishing, the linked social media sites such as Facebook and Twitter allow users and authors to meet, discuss and improve content in real time. This allows authors and readers to participate in rapid and explicit updates, comments and postpublication review, which can then be incorporated into current and future blogs.<sup>25 26</sup> Recently, traditional journals have recognised this potential and have linked with social media platforms to enhance, debate and review published content. Notably, the *Canadian Journal of Emergency Medicine*<sup>27–29</sup> and *Annals of Emergency Medicine*<sup>30–32</sup> have championed this symbiotic approach to improving the speed of knowledge translation into clinical practice. Thus, the future of medical publishing may increasingly blur the current distinction between traditional publishing and the new disruptive publishing technologies.

## LIMITATIONS

This study relies on the use of statistics obtained from the routinely collected site data. There are limitations with this. Site data may be an imperfect determinant of educational engagement. Merely accessing a site does not mean that the entire content has been read, understood or acted on. Educationally, we are most interested in delivering material that changes practice, and although this can be implied from individual cases and conversations, the overall impact cannot be fully determined using these methods (although the same is true for almost all educational materials).

Data on location are determined by the internet protocol (IP) address of the user and thus can be misinterpreted if the user uses systems to hide their IP address (eg, virtual private networks).

Similarly, although sites now protect against spurious access from automated site viewing programs, it is inevitable that some traffic is not related to clinical learning.

## Main messages

- ▶ Social media technologies are increasingly used by learners to access clinical information.
- ▶ The reach of social media technologies amplifies the reach of educators through digital technologies.
- ▶ Free open access medical education is an emerging ethos amongst emergency medicine and critical care clinicians.

## Current research questions

- ▶ What is the clinical impact of social-media-enhanced education?
- ▶ How will traditional models of publishing engage with independent social-media-enabled learning?
- ▶ Can social-media-enabled learning improve patient outcomes by accelerating published evidence into bedside clinical care?

## FUTURE DIRECTIONS

It is challenging to predict how social-media-enabled learning will develop in the next 5–10 years. What is clear is that new disruptive technologies can lead to significant change in how, where and when learners access educational material. The nature of interaction permitted by social platforms is allowing learners to create their own learning journeys and to construct their own knowledge from easily accessible and internationally created online resources. This has profound implications for educators and learners who must now navigate an educational world where the traditional limitations of data flowing from content creators to users are increasingly being broken down. As clinicians and educators, we have a responsibility to understand and support our teams in navigating this new social age<sup>33</sup> of learning.

## SUMMARY

This case study of an emergency medicine blog is the first to demonstrate the quantitative reach of social-media-enabled learning. We suspect that this case study reflects the growth in social media sites in general and is a clear example of how the modern-day emergency clinician can engage and learn with a global audience.

**Contributors** This paper was initially conceived and written by SC. All authors were subsequently involved in the revision and final approval of the manuscript. All authors were involved in the conception, design, publication, review and analysis of data on the St. Emlyn's site.

**Competing interests** None declared.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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### ***1.8.3.3 Critical Appraisal of Social Media enabled education.***

Education in the digital space of social media is a new phenomenon. The hardware and software technologies required bringing people together through social media sites and the Internet are relatively new inventions.

It seems remarkable that the iPhone became available in the UK as recently as 2007, twitter came online in 2006, WordPress was created in 2003 and apple podcasting through the iTunes store became available in 2005.

Technologies that are now considered mainstream such as Instagram and Snapchat are even more recent (2010 and 2011 respectively). In the current time it seems that technological change is far more rapid than in previous generations. It is therefore highly likely that new services will launch and become popular in the near future with the possibility of influencing medical education. How, when and if that might happen is of course unknown, but recent history would suggest that we will see further change in the next decade and that medical educators will need to be agile in their understanding of these changes if they are to maximise their educational impact.

The artefacts presented in this section demonstrate how educational materials can be presented in an open access format using social media technologies. A significant advantage of digital technologies over traditional print materials is the ability to collect data on user engagement. In traditional print-based education it is possible to track sales and distribution pathways, but to a large part it is not possible to see what happens to information after that point. Many books may be sold but it is always uncertain how many were opened and read. In digital technologies it is possible to track both the range, volume and distribution of educational materials as the Post Graduate Medical Journal (PMJ) paper has shown for the St. Emlyn's blog(3). This gives a better indication of who is reading the material, where they are reading and when they are reading it. However, although anecdotes and case reports are described regarding the impact and use of social media-based learning in practice the true effect is still difficult to determine. It is tempting to believe that individuals who read the blog change practice as a result, it is

very difficult to track data in a way that confirms this in practice. Anecdotal change is a powerful narrative, but as such examples are in themselves given back through social media the possibility of this being erroneously perceived as disproportionality positive as a result of hearing an already engaged population is clear. In essence, the people most likely to be positive about social media enabled learning are those who are active in social media. The effect and impact of blogs and podcasts out with those already engaged is clearly difficult to assess. There is always the risk of preaching to the converted, or speaking into an echo chamber as some critics of #FOAMed and social media have suggested(260,261).

#### 1.8.3.3.1 Medutainment, disruption and the cult of personality.

#FOAMed has also been criticized for venerating personalities over content, with some high profile academic emergency physicians criticizing proponents of #FOAMed in print (262). The concern appears to be that the users of #FOAMed might be persuaded to change practice prematurely or inappropriately as a result of the energy, personality and entertainment values promoted on some social media sites. Although such accusations appear to be unfounded, in that we are unaware of any published evidence of harm to patients as a result of #FOAMed based education, there are legitimate concerns amongst established academics regarding the disruptive potential of #FOAMed(262,263).

In traditional models of learning (before the internet and social media became widespread) and certainly within the timeline of my generation of learners, who are now in positions of being senior educators, the professors, lecturers, consultants and those in positions of authority control what people learn and to a large degree how they access it. If books, local lectures, tutorials and handouts are the prime methods of learning then those in senior positions control what people learn, when they learn it and to a large degree how they learn it. In an Internet enabled world where learners can access content from across the globe without the restrictions of time or geography then such limitations vanish. In the social age senior educators cannot control what

students see and engage with. This is concerning to many who worry about junior clinicians being misled by online content that may be inaccurate or at the very least un-vetted.

As St. Emlyn's is considered to be a high-profile site we have not been immune from such criticism. The article by Peter Cameron in *Emergency Physicians Monthly*(262) drew much attention on twitter and amongst blog authors. He is a highly influential academic and past president of the International Federation of Emergency Medicine. That article and further conversations at conferences led to me contributing to a Pro: Con article in the *Canadian Journal of Emergency Medicine* in 2017(263) , where I presented the opposing view together with Scott Weingart. Scott Weingart runs the EMCRIT Podcast which is the largest #FOAMed based podcast in the world(103).

The rather provocative title of the debate was:

*#SocialMedia – Social media has created emergency medicine celebrities who now influence practice more than published evidence*

Our principle argument is that there is ample evidence that traditional models of knowledge translation don't work well and that disseminating and discussing new knowledge in a public space may improve this(264). As for the accusations that #FOAMed produces celebrities, then that word simply means well known. Being well known is arguably an essential requirement for knowledge translation as without visibility and influence it is not possible to enact change. In contrast the arguments put forward by Peter Cameron focus on the legitimate concerns around precipitous change in medicine as a result of the rapid dissemination of knowledge without careful oversight. It is true that there are many examples of therapies being instituted in medicine in good faith which subsequently turn out to be harmful. The use of Flecainide in the treatment of ventricular dysrhythmias is an on oft quoted but relatively old example(265). More recently the use of starch solutions for the treatment of trauma was first advocated and more recently found to be very harmful in

some patient groups(266-268). Arguably, there is as much harm in the delayed adoption of innovations as there is in the early adoption (as we have seen in the starch in sepsis trials). My belief, that progressions will come from discussion and dissemination amongst a broad base of clinicians and educators is shared by many in the #FOAMed movement(128).

'Pro:Con' articles are challenging to write, as they require the authors to take polarized positions whereas the truth is frequently less black and white. As we develop new technologies and new opportunities to learn then it is all too easy to get caught up on a bandwagon of enthusiasm that might leave some learners behind(263,269). There is a responsibility to engage with those who are not engaged with social media and to ensure that their contributions to the wider field of medical education are not forgotten. Strategies such as guest blogs on websites, or interviews with clinical leaders as podcasts are one method to achieve this blurring of the boundaries between traditional and novel educational techniques.

Although the concerns expressed by Cameron(262,263) and others are legitimate to raise I am relatively unconcerned of their long-term impact on the growth of social media enabled education. We live in an age where connectivity and self-exploration of information is increasingly a norm in education and in clinical practice. Clinicians in hospital no longer need to remember a long list of facts as they now have access to the Internet via mobile devices and can thus look up information in real time. The way that clinicians now use data is different to when my generation trained as medical students. At that time the acquisition, retention and subsequent unassisted recollection of facts was an essential part of the education process. In the modern age, where facts are accessible via the internet, and increasingly that access being facilitated by mobile devices, clinicians no longer need to retain a personal library of memorized facts. An analogy would be that in my original training the expectation was that doctors became repositories of facts and information in the way that a library stores books. In the modern age the library storage function is at least partially outsourced to the internet where there is an almost unlimited capacity for the storage of facts. The skills of the



clinician are in navigating the library index systems and linkages through the use of hyperlinks and search engines etc. In this analogy the modern-day clinician and learner is therefore more akin to the librarian function as opposed to the library function.

Controversies around the role of entertainment influencing content in the digital space are perhaps unsurprising. Blogs and podcasts compete in the same digital space as the entertainment business(270-273). In an increasingly distracted world where various different technologies compete for our attention users are naturally drawn to sites and personalities that not only have useful content, but ones that can also engage with the learner in an entertaining and accessible manner. My article in the Canadian Journal of Emergency Medicine argues that this has arguably always been the case as new technologies emerge and is nothing to be especially concerned about(263). In a lecture at the Royal Society of Medicine celebrating the 50<sup>th</sup> anniversary of emergency medicine in 2017 I quoted three reputable sources that expressed concern about the influence of new technologies on education.

Socrates describing the process of writing, Gessner on the printing press and The Spectator magazine on the use of the telephone.

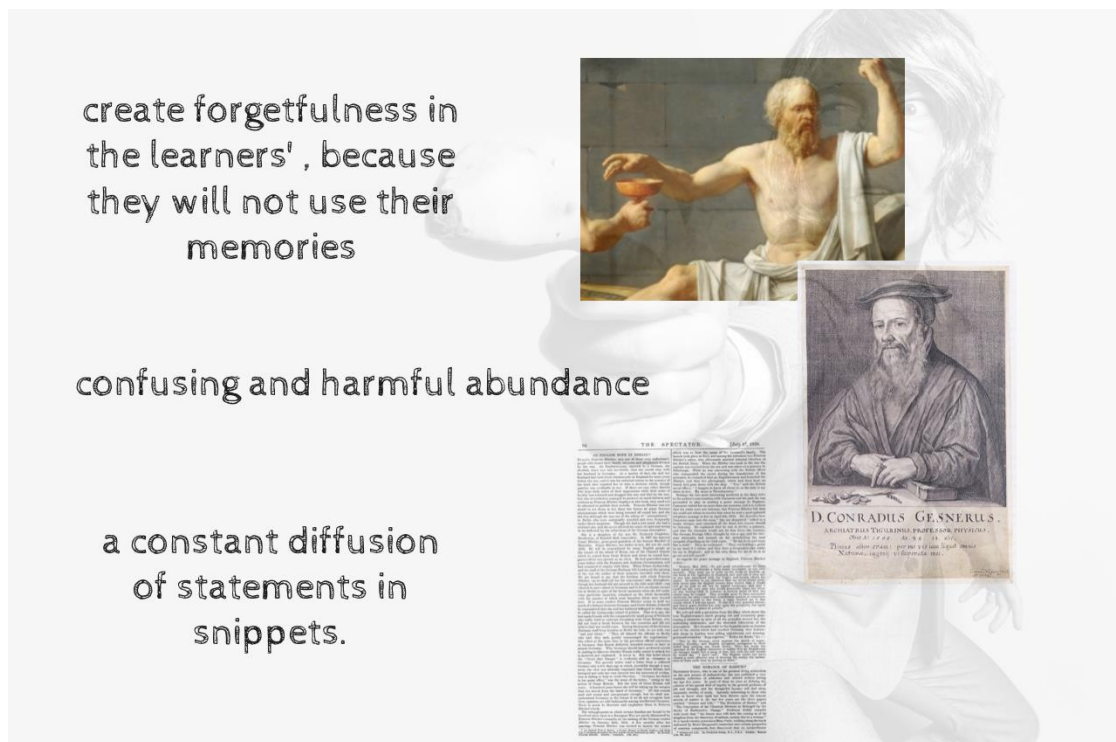


Figure 5 Socrates, Gessner and The Spectator on the adoption of new technologies in education.

Such tensions can be seen in several settings, most notably in the conference field. Those conferences such as SMACC who have heavily invested in the interface between social media and face-to-face conferences suggest an emerging synergy between #FOAMed based content and the conference (274). SMACC releases its content online and for free as #FOAMed content (275).

#### 1.8.3.3.2 Questions of quality in #FOAMed based resources.

The question of how quality control is maintained in an open access publishing environment has been a challenge to many #FOAMed creators. The traditional model of quality control in medicine is the pre-publication peer review process. In essence an author(s) submit a manuscript or artefact to a publishing house that then use a peer review system to establish whether the content is of sufficient quality to be published.

The arguments around pre-publication are well rehearsed and I have no intention into detailing them here. Suffice to say that the pre-publication peer review process has failed to provide a reliable method for assessing quality or

even for detecting fraud and other incorrect content(264,276). Despite this pre-publication peer review persists as a widely acknowledged gold standard in publishing, academic research and grant applications(277). In contrast, online publishing, for example through blogs and podcasts, allows a combination of pre and post publication review. Online publishing typically encourages end user engagement and comments in a highly accessible and, in contrast to traditional publishing, highly visible way. This can be achieved through comment sections on websites and/or through the discussion of #FOAMed on social media platforms such as twitter. Thus, the modern linkage with social media has an agility of reflection, revision and expansion that is unachievable through traditional print methods.

Some social media and #FOAMed sites have formally set out processes to facilitate a combination of both pre and post publication review. The best described of these is probably the AliEM group based in California who have an overt and well described peer review process(278). The St.Emlyn's blog and podcast have a similar explicit approach to peer review and editorial control(3).

Determining the quality of social media educational tools is arguably still in development. Initial attempts focused on the impact of blogs as determined by the reach and readership of blogs by looking at the number of users engaging through twitter, Google plus, Facebook and through web based traffic measurements such as Alexa(113,258). The 'social media index' arguably started the academic assessment of blog quality, but it focused on the size of the sites and their traffic flows. I, amongst others, expressed significant concerns about the validity of an index based on such metrics as size is not a determinant of quality (279). More recently researchers have focused on quality metrics for blogs. The METRIQ score(280,281) seeks to look at process mechanisms that are likely to be associated with higher quality, although they are arguably still proxy measures for quality and impact in terms of clinical change or patient outcome.

Determining what is meant by quality has itself been challenging. Colleagues in North America have used Delphi techniques to determine what quality looks like(115). They derived 13 factors, which predominantly link to credibility (8 factors), and to a lesser extent content (4 factors) and finally design (1 factor). It is interesting to see the most highly valued factor is credibility which is arguably related to traditional academic standing, Similarly a systematic review of blogs and podcasts revealed a similar themes of credibility, content and design(114). Further efforts to define quality and impact have attempted to determine quality through guidelines, process and scoring systems although none of them are yet to achieve universal acceptance (113,256)1(79)(280,282).

The St. Emlyn's blogs and podcasts align closely with the metrics produced from the North American groups. In the social media index assessments (SMi) the blog has regularly appeared in the top 10 blogs worldwide(258)(113) (279). The podcast is not listed as a separate entity on the SMi metric. In the METRIQ and Delphi derived metrics the St.Emlyn's sites closely meets the expected outcomes of a 'quality site'. In part this is because we have added elements to the site in response to quality metrics becoming available. As electronic media is easy to update then when a metric becomes available in a publically accessible way it is relatively easy to change a digital artefact to comply. In the same way that assessment drives learning, as metrics change it is possible and arguably desirable to change the social media sites to comply with the new assessment. This is especially the case with digital artefacts as changes can be made in real time, updated and published within a very short time-frame. Clearly this can become a circular act. If the majority of sites do the same whenever a new metric is produced this leads to a diminution in the discriminatory ability of the index to determine quality.

On the St. Emlyn's blog we demonstrated how this could take place in practice using the 'social media index' as an example (258,279). The social media index uses the number of Facebook likes as a component of the overall quantities assessment of a #FOAMed site. The St. Emlyn's site has a

large number of Facebook likes, but in part this was influenced by the use of paid adverts to increase the number of likes. We targeted adverts to clinicians in primarily Middle Eastern countries and demonstrated a significant increase in the number of likes(279). Whilst this is not the same as buying followers (which is also possible on a number of social media platforms), it did demonstrate that financial incentives could reward sites when measured against metrics such as the social media index which primarily base their scores on popularity and traffic flow. This small experiment was performed in order to support a pro/con debate at the Chicago SMACC conference led by Iain Beardsell, although at the last minute there was a decision to not present this data on stage as we had not had time to explore it with the SMi authors(283). Our conclusion was that the social media index and any other indices that use data such as likes, followers, traffic are susceptible to 'gaming' and thus are unreliable as longitudinal markers of social media quality.

At the time of writing the question of quality remains an elusive metric for social media sites. The current attempts to create a quantifiable measure of quality, largely by North American colleagues, have begun the journey to find reliable metrics but at the current time they are not reliable, valid or reproducible enough in my opinion. Further work in this area will hopefully seek assessments that understand quality with reference to clinical practice and the impact on patients. This is rich area of research which will likely continue for the foreseeable future.

#### 1.8.3.3.3 Scope and practice of emergency medicine in relation to the curriculum.

#FOAMed based resources such as St. Emlyn's have been criticised for not covering the breadth of the emergency medicine curriculum(58). The criticism that #FOAMed disproportionately focuses on that which is interesting and not that which is always important is arguably a valid one(284). Many #FOAMed based sites focus on the interesting, unique, life threatening and unusual aspects of emergency medicine (of which there are many), with less of a

focus on benign, common and what is perceived to be uninteresting conditions.

There are however counter arguments to this criticism, in that common conditions are by definition common, encountered in day-to-day practice and thus offer regularly work based learning opportunities to trainees. In contrast, the rare and/or the life-threatening conditions encountered in practice do not lend themselves to competency acquisition through opportunistic exposure in clinical practice. Thus there is a counter argument that #FOAMed based resource and other opportunities such as conferences and specific training course can offer insights and teaching into topics that require specific attention directly as a result of their rarity in clinical practice(285).

This is not the case with all #FOAMed sites and there have been a number of blogs/podcasts that specifically focus on the more benign and common end of clinical practice (286). Similarly project based around the interpretation of classic EM texts, or where EM texts form a basis for supporting materials also deliver a broader range of clinical topics than those sites that specialize in resuscitation techniques.

#### 1.8.3.3.4 Relationships with traditional publishing

#FOAMed resources have been described as subverting traditional models of publishing(287,288). This is to be expected as the aim of many #FOAMed producers is to disseminate information content for free which disrupts the business model of traditional publishing. The term 'free' is of course misleading as although it is designed to be 'free for the consumer', it is not for the creators. All educational activity has a cost associated with it, that can take the form of hardware costs, software costs, hosting costs and most notably the time taken to create, collate, curate and publish it(289).

#FOAMed has arguably developed at a time when consumers of evidence based medicine have increasingly become frustrated with restricted access, pay-walls and editorial barriers to publication (290). The evolution and

increasing use of guerrilla sites such as SciHub (291,292) where publishing pay-walls are circumvented speaks to a challenge to the traditional oligopoly of publishing houses in medicine and in other sciences(293,294). #FOAMed is arguably part of the subversive process in its challenge to traditional publishing practice.

It has been argued that #FOAMed based publications have content that differs from that typically delivered in traditional media such as journals and textbooks. There is more discussion, appraisal and argument about content alongside conversations about clinical applicability and practicality. The discursive element of #FOAMed where data can be challenged, reviewed and edited through social media platforms, comments sections and other forms of private and public online discussion lend themselves to more open and inclusive approach to knowledge translation and education(295).

Traditional journals, books and conferences clearly do need to charge for access or attendance. Since 2012 and the International Conference of Emergency Medicine in Ireland the distinction has become blurred(101). Traditional print journals were originally sceptical about the impact and longevity of #FOAMed based resources, but in recent years they have begun to embrace and promote their content using the same or similar platforms. Many journals now have associated podcasts and blogs, for example in my role as associate editor for the Emergency Medicine Journal I produce a blog and podcast that promotes the journals content(296). Similar projects exist for many other journals following a realization that learners using social media platforms consume so much content. In some cases, formal relationships have formed between #FOAMed sites that were originally independent, and mainstream journals. The best known example in emergency medicine is the SGEM (Skeptics Guide to Emergency Medicine) podcast linking to the Canadian Journal of Emergency Medicine(125-127) and Academic Emergency Medicine(297,298). There are many examples in other speciality and in general journals.

The future is likely to see more journals engage with social media platforms as a way of disseminating their core content and also in strategies to engage an audience in a wider debate about content and interpretation of published content. Social media allows, even encourages, the potential for post publication review(110) and clarification in a way in which traditional print media cannot.

#### 1.8.3.3.5 Relationships with conferences.

Conferences are increasingly using social media to promote their events. This takes place in advance of the event in the form of advertising but increasingly it is also used as a live feed to engage participants who are not attending in person. The SMACC conferences(275) are arguably the most developed in this regard, with high levels of engagement before, during and after the events(299).

Such engagement is not without concern. Beyond the general concerns expressed about the use of social media for education conferences themselves present particular difficulties when they are summarized and/or shared beyond those physically present. Concerns have been raised about how data is transmitted to others without context and perhaps without permission(300) although the technology is now so ubiquitous that it is difficult to stop delegates sharing what they see and hear (274,301).

Legitimate concerns do exist around protecting pre-publication data and also as to whether the message of the speaker is mistranslated by the audience member. To investigate this, I joined a research team who looked specifically at the use of social media at conferences and in particular at the way in which the speaker's method might be changed through the reflections and amplification of their message through social media. We investigated this at an international conference by analysing tweets about talks and comparing what was tweeted with what the speakers actually intended to say. Broadly, there was agreement, but several speakers expressed concern at the discord or emphasis between what was tweeted and what was said(302). This is



important as it identifies the need for speakers to understand how their intended message might be changed through audience participation in social media. My conclusion from this paper was that speakers and conferences organisers need to participate in related social media conversations as a way of clarifying and amplifying their message. If they do not, then there are risks that their key messages and purpose may be poorly translated or even lost altogether.

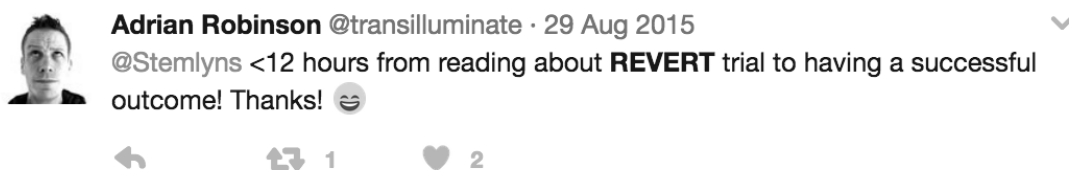
#### 1.8.3.3.6 The use and impact of #FOAMed in practice.

It is often a challenge to determine the impact of an educational intervention. As I demonstrated in our paper on the use of the St. Emlyn's blog website it is relatively straightforward to demonstrate a level of engagement of the emergency medicine community in access to online materials. Indeed, the ability to track the number and habits of readers and listeners is a key innovation in online learning. However, there remains the challenges of determining whether engagement leads to a change in practice as it can be argued that education is only truly effective if it leads to a change in practice, or that it reinforces current practice with greater authority(303).

Determining the impact of #FOAMed based materials is a challenge. Some data exists on the size and utilization of #FOAMed sites, but there is relatively little data on the impact on direct clinical practice (208,222).

Social media feeds contain large numbers of examples of how #FOAMed based resources influence practice. To date these have not been collated in any systematic form, but it is likely that they do represent real change. The example given in the Postgraduate Medical Journal paper describing the evolution of the St. Emlyn's blog (3) showed how a blog post on the REVERT trial(304,305) led to a change of practice directly affecting patient care within 12 hours of publication(306).

Figure 6. Example of a tweet indicating rapid clinical adoption of practice following blog publication.



In terms of formally published data, then that data which does exist is largely based on survey-based studies that ask trainees and trainers about their access and utilization of #FOAMed based learning sites. In 2015, Purdy et al demonstrated that Canadian Emergency Medicine residents had almost universal engagement with #FOAMed based resources and that these were highly valued(107). Interestingly the Canadian study showed that those residents and program directors who utilized #FOAMed resources increased their reading of the primary literature. They also showed that residents were using #FOAMed more than their program directors which suggests that there is a disconnect in learning streams between trainers and trainees.

In 2015 Jeff Riddell and colleagues in the USA found a similar experience with emergency medicine residents having very high rates of #FOAMed use (88.8% monthly). Of note 72.2% of residents stated that podcasts led to a 'somewhat' or 'very much' level of change to clinical practice(106).

In the UK there is no published data. However, in 2017 I assisted a Manchester University Medical Student in surveying the EM trainees and trainers in the North West of England to determine their engagement and use of #FOAMed based learning opportunities. This paper was presented as part of their 4<sup>th</sup> year research project and also as a poster presentation at the 2017 Emergency Medicine Society of South Africa meeting at Sun City, South Africa. A copy of these posters can be seen in the Appendix. Although these were small pilot studies with a view to a wider analysis and exploration of UK EM learning opportunities there is evidence that there are high levels of engagement in the UK in 2017 that are comparable to those found in the US and Canada in 2015.

My personal impression from meeting colleagues at national and regional meetings is that #FOAMed based resources are increasingly influencing clinical learning and practice here in the UK.

#### 1.8.3.3.7 The influence of Social Media on academic progression and dissemination of research findings.

In an age where social media increasingly appears to connect everyone and everything it is not unsurprising that the potential of the media to assist in the development and sharing of academic activities is increasingly recognized. There is now an opportunity for researchers to connect directly with those who might use and in some cases operationalize their activities(110,307).

Social media is increasingly used to disseminate research findings through non-traditional routes and thus to increase citations and impact of the research(308,309). The St. Emlyn's platform has been used in this manner to promote and disseminate research work conducted in Manchester. The table below illustrates examples of how the primary research work of the department of emergency medicine in Manchester is amplified and enhanced through the use of social media resources.

Table 1. Examples of the integration of academic activity with social media activity.

Article	Social Media Post
Evaluation of a 0-Hour/1-Hour Algorithm in the Diagnosis of Myocardial Infarction With High-Sensitivity Cardiac Troponin T (310)	One High Sensitivity Troponin test to rule out myocardial infarction (311)
Body R. Understanding cardiac troponin part 1: avoiding troponinitis. <i>Emerg Med J</i> . July 2017.doi: 10.1136/emered-2017-206812 (312)	Cardiac Troponin: The basics from St. Emlyn's (313)
The Manchester Acute Coronary Syndromes (MACS) decision rule for suspected cardiac chest pain: derivation and external validation (314)	The MACS Rule: Immediate 'rule in' and 'rule out' for suspected cardiac chest pain (315)
The Manchester Acute Coronary Syndromes (MACS) decision rule: validation with a new automated assay for heart-type fatty acid binding protein (316)	The MACS rule: a new user-friendly version (317)
Can emergency physicians 'rule in' and 'rule out' acute myocardial infarction with clinical judgment? (318)	How accurate is clinical judgment for acute coronary syndromes? (319)
Are there too few women presenting at emergency medicine conferences? (320)	JC: Are there too few women speakers at conferences? (321)
An introduction to power and sample size calculations (322)	An introduction to sample size calculations. St. Emlyn's (321)

<p>An emergency medicine research priority setting partnership to establish the top 10 research priorities in emergency medicine (196)</p>	<p>Here's the top 10 (and more) research priorities for emergency medicine. St. Emlyn's (193)</p> <p>James Lind Alliance update. St. Emlyn's (195)</p> <p>The James Lind and the RCEM needs you (and you, and you). St. Emlyn's (194)</p>
<p>Impact brain apnoea - A forgotten cause of cardiovascular collapse in trauma (323)</p>	<p>Impact Brain Apnoea with Gareth Davies from London HEMS. St. Emlyn's (324)</p> <p>JC: Impact Brain Apnoea (325)</p>

These examples of the amplification of core research themes amongst the group (in this case our Troponin and cardiac research programs led by Professor Rick Body) illustrate how conventional research and publishing strategies can be promoted through social media.

Similar examples include work around medical education, and clinical topics in addition to the reincarnation of older studies on topics such as sample size calculation. We have also seen in the introduction how social media platforms can complement and amplify an academic topic through multimodal publication with regard to in situ simulation techniques. (138-140,326).

Within the examples above we can see three different synergistic strategies of the use of social media and research activity.

- In the Troponin research examples social media posts are used to amplify the traditional publishing route. Blog posts are designed to summarise and share the research findings with a larger audience and also to explain the findings in a more accessible way. This may reflect a focus on the main findings but also the ability to discuss in more detail how the findings might be pragmatically implemented in clinical practice.
- In the James Lind Alliance research I used social media as an integral part of the project to attract and recruit emergency clinicians into the project methods. The James Lind process is designed to engage with a wide range of individuals in a public/patient/professional partnership(193). The principle investigators in this project recognized the potential for social media to engage with a wider professional audience and so worked in tandem with the St. Emlyn's team to disseminate information about the project. Social media on the blog and podcast were initially used inform emergency physicians and other clinicians about the project. This was followed up in subsequent posts and podcasts designed to keep them up to date with the project progress and ultimately to disseminate the project findings.
- Finally, some topics begin as posts in the social media space before they subsequently develop into traditional publications. The posts and publications on the topic of impact brain apnoea(323,324) typify this approach. This project began with a blog post and interview with Gareth Davies, lead clinician for London HEMS. That post led to further conversations with other clinicians present at the Chicago SMACC conference(275) and finally to the publication of a historical review and clinical series of cases(323).

Thus, these examples illustrate how traditional publishing academic strategies can amplify and develop with social media support in a synergistic and mutually positive way.

As a disruptive technology social media appears to be changing the way that information flows from traditional print media through to the digitally enabled

and social world we live in today(327). We know that there are significant concerns about the length of time it takes for information to flow from research findings through to the bedside(49,77,78,328), and that delays to new knowledge means that patients may continue to be exposed to treatments that are potentially harmful or ineffective(329). There are clearly opportunities for academia to engage with new dissemination techniques in order to improve the delays that are regularly described in the literature. Although it would be foolish to think that Social Media enabled learning, or any single strategy for that matter(49), will be a panacea for the knowledge translation gap there are clearly opportunities available through faster dissemination with fewer barriers to access.

I have already discussed some of the concerns raised about the precipitant use of social media resources to enact rapid change in clinical practice in an earlier section and will not re-iterate them here, but beyond the concerns around this there is also the question of whether traditional scholars see a value in, or whether they can muster an enthusiasm for dissemination through non-traditional means. Although social media tools permit a broad reach and the ability to use new metrics to assess reach(244) they are not traditionally those that are valued by universities when assessing research impact(330). The best known measures of academic impact are the well-established Journal Impact Factor(331) which measures the impact of an individual publication and the h-index(332) which amalgamates impact data over an individual researchers career.

This traditional model of assessing research impact largely through metrics based on traditional publishing routes may be changing with the advent of metrics such as the Altmetrics(307,333,334) score that does measure the social media impact of journal publications and is one of the metrics I have used in this thesis to demonstrate impact and reach.

Whether busy researchers will see value in dissemination through blogs(335,336), podcasts(337,338), twitter(308,339,340), or video platforms(341,342) as something that is simply good for research, or whether

they are nudged into engagement through the adoption of social media based metrics for research excellence assessment remains to be seen(343). My view is that assessment will drive activity and if research assessment exercises adopt social media-based metrics then we will see a rapid expansion in the utilization and engagement with non-traditional dissemination strategies. If social media activities do not link to promotion and tenure, as is the case in many formal academic settings, then there will be less widespread engagement(344).

In postgraduate education the evidence for a positive impact of social media facilitated education is less clear. Whilst it is relatively easy to determine figures around engagement it is more challenging to clearly identify the impact on education. A recent review of social media enabled education looked at the impact on education, recruitment and professionalism found relatively little definitive evidence to support a positive impact on education(345), although they also point out that the current quality of evidence in this field is poor with only a small number of studies available for analysis and those that do exist are largely confined to junior learners.

#### 1.8.3.3.8 Safety and professionalism with Social Media usage.

Education using social media tools has a clear ability to disseminate knowledge widely, but that dissemination is largely uncontrolled. In a social media space there are few, if any constraints as to where the information may flow. This means that information posted on many social media platforms may be accessed by peers, senior colleagues, junior colleagues, other clinicians, patients and by the general public. This has led to many concerns being raised as to the level of risk that engaging with social media learning may result in(346-354).

In truth the degree of professionalism required when engaging in a social space is the same as that required of other forms of media and this blurring is both a challenge and an important concern to clinicians(355). However, the uncontrolled nature of online communications means that it is possible for confidential data to be released or for opinions that would be considered



unprofessional to reach a wider than intended audience(352,356,357). These concerns are a barrier to participation in online learning and require careful guidance by clinical tutors and national bodies(358). On the one hand it is clearly a learning opportunity to educate using social media tools, but this cannot take place at the expense of personal and professional safety(346,356).

The concerns about the use of social media and the potential for this to lead to accusations of unprofessional behaviour are unlikely to disappear. The role of educators is to inform and guide trainees in the appropriate use of new technologies and to encourage them to recognize how the boundaries of personal and professional practice may collide(358).

#### 1.8.3.3.9 Reflections on the Social Media enabled learning projects.

The initial decision to develop a St.Emlyn's brand, and to engage with blogs, podcasts, twitter, Facebook and other social media platforms was not taken lightly by the initial core group of clinicians. It was arguably done with a degree of reluctance as all such projects inevitably take time and energy away from other elements of professional and personal development.

Strategically the development of the St. Emlyn's group of social media enabled learning platforms has been challenging. It is the nature of modern technology to be agile, diverse and unpredictable. Combined with the requirement to work in an emergency field (that of #FOAMed based education) the ability to define and then stick to a strategic view is challenging and may even be futile. From the start of this project I have regularly met with colleagues from within St. Emlyn's and from other educational groups to review and revise the content, direction, scope and ambition of the project. For example, in 2017 it became clear that the growth of the site, and the amalgamation of groups of blogs and podcasts into themes lent itself to the development of e-books. Two of these have now been published(257).

As with all projects like this the issue of longevity and the loss of enthusiasm that may occur over time are a concern and one that requires careful management. Blogs and podcasts require regular content in order to remain current and useful. Blogs such as St. Emlyn's that contain a large amount of content that aims to keep consumers up to date with new material are especially prone to a lack of regular content. This is one of the many reasons why the team of contributors has expanded over the course of the project from a small group based in Manchester to now over 12 regular contributors combined with several intermittent guest contributions from other authors. On reflection the adoption of new authors, with a particular emphasis on recruiting and nurturing junior colleagues through the support and review of materials by senior authors with a track record in academic publishing has proved successful. This approach has similarly been used by other #FOAMed producers(246) and by journal reviewers familiar with #FOAMed publications (359).

One aspect of the St. Emlyn's projects has been the intentional approach to editorial independence. The project is owned, produced and edited independent of any health or educational structure. This is in keeping with the early producers of #FOAMed as described by Teresa Chan in a controversial blog on the evolution of #FOAMed producers from early idealistic pioneers through to enthusiasts, participants and structuralists (308,309). These four phases were described as analogous to the development of feminism where early altruistic and voluntary support develops into a more structured and inclusive project over time. The blog was controversial in that it appeared to describe a delineation of participants into the 4 distinct phases, whereas in contrast it is suggest that sites and individuals can exist within all 4 phases. From the St. Emlyn's, and my own personal perspective I can see how we have developed through these four phases of #FOAMed engagement(360).

#### ***1.8.3.4 Personal Contribution to the Social Media learning projects.***

Throughout the development of the social media projects I have acted as the lead clinician, editor and strategist within the St. Emlyn's team.

From a financial and technical perspective, I have developed the platforms and funded the online activities of the group.

In terms of the time commitments to the projects then the amount of material produced on the blog and podcast reflects my overall commitment to the projects. Although a large number of individuals have contributed content over 50% of the content has been authored by myself (as of 21/1/18 I have authored 329 of 608 published blogs).

I have also edited and reviewed all blogs and podcasts that go onto the site.

Although the time commitments have not been precisely measured I believe that this amounts to hundreds of hours of commitment to the projects.

For the paper published in the Postgraduate Medical Journal I was the lead author and architect of the paper.

The development of the social media platforms has personally led to multiple opportunities to present and share the work at conferences across the world. I continue to be regularly invited to speak on social media and other aspects of medical education at a wide variety of international, national, regional and local meetings.

The social media platforms have also given me opportunities to collaborate on a number of other research projects related to medical education and technology. Several examples of projects leading to peer reviewed publication that have directly arisen out of collaborations sparked through social media engagement are listed below.

- Does the new Fellowship Examination format ensure a sufficient standard for FACEMs? No Brazil, Carley (63)
- Innovation in the field of medical conference-based education: a new marketplace. Davies, Cheema, Carley (361)
- Top 10 (+1) tips to get started with in situ simulation in emergency and critical care departments. Jesse Spurr, Jonathan Gatward, Nikita Joshi, Simon D Carley (141)
- Are there too few women presenting at emergency medicine conferences? Simon Carley, Richard Carden, Rebecca Riley, Natalie May, Katrin Hruska, Iain Beardsell, Michelle Johnston, Richard Body (320)
- Invited expert on the Academic Life in Emergency Medicine publication on career development through the use of social media engagement (362)
- Co-author on a review paper in Clinical Chemistry as an invited expert on the use of social media for personal and academic progression (363)

These invitations and publications, together with the artefacts presented here are evidence of my continuing contribution to the field of technologically enhanced learning in emergency medicine.

#### ***1.8.3.5 How have these artifacts related to Social Media contributed to the development of Emergency Medical Education?***

As a contributor, creator and advocate of #FOAMed based education it is clear that the St. Emlyn's projects have had a significant impact on the way in which emergency clinicians learn and access clinical information. The data on site traffic, the publications associated with the projects demonstrate this in quantitative terms. The reach and scope of the blog on a geographical scale has demonstrated how social media technologies can engage learners at a distance and how social media permits learners and educators to learn

across health economies by hearing about and understanding how healthcare differs across the globe. This is an important learning tool as a way to encounter different ways of practicing emergency medicine leading to a reflective assessment of one's own practice.

#### ***1.8.3.6 Conclusions***

The social media projects reflect how I have continued to develop novel educational methods alongside the development of new technologies. In this respect it is a continuation of the work done to utilize the Moodle systems of online learning in virtual learning environments.

## 1.9 Chapter 4: Future work.

### 1.9.1 How can the three themes in this thesis progress?

A central theme across the artefacts in this thesis and the suggestions for future work is a pragmatic approach to research methodology. Pragmatic research is typified by comparing or testing interventions designed to improve the organization or delivery of health care(364). Educational evaluations often adopt this methodology as there is a significant overlap between the desire to test and create new knowledge from a positivist research perspective and also the desire to improve quality which is more akin to quality improvement processes. In post graduate medical education the ever changing landscape of health economies, standards, curricula and other external factors dictate the need for an agile, adaptive and pragmatic approach to both the selection of research methods and to the individual design of trials of similar methods.

Pragmatic designs are characterized by an approach that link the choice of the approach directly to the purpose and nature of the research question(365,366). The pragmatic approach encompasses the idea that it is the practical consequences of the project that are a foundational reason for their use(367). Pragmatic research methods are often linked to wider discussions around mixed method approaches and the challenge to traditional positivist approaches to research, many of which we find unsuitable to use within educational research where the question extends beyond describing measurable facts into developing an understanding of how medical education works (or does not). A pragmatic approach where the method chosen is developed as a *'practical and outcome-orientated method of inquiry that is based on action and leads'*(368,369)

The methodological approaches undertaken in the papers presented in this thesis and in the suggestions for future research are pragmatic in their nature. This is both within the narrow definition of a pragmatic approach (what is possible within the constraints of research within the NHS) as well as the more philosophical approach of linking the methodology to the intended utility of the potential outcomes of the chosen research design. The approaches delivered and suggested meet the methodological principles of a rejection of an adherence to one particular research philosophy and a subscription to the

iterative, cyclical approach to research (369,370) that is not wedded to any methodological research paradigm (371) .

A central question in my research and future suggestions for research is the consideration of what is an appropriate outcome measure for technology enhanced medical education. The challenge is to find outcome measures that truly reflect patient outcomes and not simply outcomes for the teachers and learners(372). This is difficult to achieve as the intervention, that of an educative process, is often considered distant to the patient experience and outcome.

There is then a hierarchy of outcomes from an educational intervention that can be measured against Miller's Pyramid of competence(373). Whilst many educational interventions are measured against lower levels of the pyramid, such as knowing something, if we are to truly evaluate the effectiveness of an educational intervention then we must determine whether learners actually put their learning into action. Whilst such studies are possible, they are much more complex to design and analyse, and they have higher associated costs as compared to simple knowledge acquisition studies.

The artefacts presented in this thesis and the suggestions for future work typify a practical and pragmatic approach that encompass a range of methods dictated by both what is possible within resource constraints such as funding and time, and then within those constraints the methods most suitable to deliver an outcome that will be useful to teachers and learners. Thus my philosophical approach to research methodologies is that of the pragmatic researcher. The proposals for the potential future projects adhere to that philosophy in that they select methods appropriate to the question, utility and most importantly outcomes of each of the studies.

#### **1.9.1.1 BestBets**

I will continue to support the BestBets projects through publication in the Emergency Medicine Journal and through the Masters in Emergency



Medicine course at MMU. These projects continue to develop an understanding of the methods of evidence-based medicine and they continue to contribute to the understanding of the breadth and depth of knowledge in the speciality.

#### **1.9.1.2 Virtual Learning Environments**

The Virtual Learning Environments continue to be used for teaching at a variety of different grades and in different specialities. There is further work to be done in understanding how learners utilise these, and especially in how they have not begun to integrate open access materials into online conversations. An exploration of how senior learners and consultants use online message board learning, a pilot of which is described in the appendix, may shed further light on the effectiveness of this sort of educational intervention.

Message board analysis of the content analysis of online discussions amongst trainees in emergency medicine has the potential to explore if learners are changing their beliefs and potentially their practice in emergency medicine. The pilot project conducted together with a medical student was designed to explore whether we could develop a system to allow messages on a case based discussion board to be classified according to Bloom's taxonomy(223). In postgraduate emergency medicine training the aim is to develop higher levels of learning such as analysis, evaluation and creation(58). In a traditional learning environment where information is simply transmitted to learners it can be difficult to understand whether these higher levels of learning are taking place as tests tend to focus on the acquisition of knowledge and/or skills. The social discourse on case-based message boards offers the potential to explore whether higher levels of learning take place.

In the pilot study (described in the appendix) there was evidence that higher learning takes place, but methodologically the trial had not taken into account the need to calibrate the assessors such as to ensure that there was little interobserver variability. This error made the results less robust and not suitable for submission to a peer-reviewed journal at this time.

There is a place for repeating this study based on a larger sample and with a more robust approach to the calibration of assessment, In essence this would involve.

1. A calibration exercise to ensure consistency between assessors when analyzing message board posts.
2. Selection of a period of time during which several different cases are discussed.
3. A content analysis of the posts according to Bloom's hierarchy.
4. A combined quantitative analysis of message board activity and characteristics of participants.

Such a study would give insight into how learners use online discussions to develop their own personal learning and perhaps offer insights into the socio-constructive nature of case-based discussions in medical education using an online format.

From a methodological perspective the choice of using secondary data in this study design is important. The principle research question here relates to how learners learn in the context of the online message boards. A number of approaches are possible ranging from the surveys of the opinions of the participants through to interview-based projects to explore how and what participants learn. Both these approaches produce data which is based on the opinion of the participants, or rather an exploration of what they believe they learn. Such approaches may be useful in exploring beliefs about learning but they are prone to recall bias. In addition such studies typically fail to produce complete responses from all participants, with those that do participate usually being the more engaged and interested in this type of learning (374,375). Non-response bias is a source of concern in survey designs(376,377), particularly when participation is non mandatory(378) and perhaps particularly so in online settings. These factors can additionally bias the findings in favour of the educational intervention. In contrast an assessment of the message board postings themselves focuses on the learning that is shared between the participants and allows an objective assessment of the learning content. However, online assessment of content

may also be biased by focusing on the contributions of those who are actively engaged. As we showed in the paper looking at the Moodle course in paediatrics it is entirely possible for those who contribute the least online to value the learning the most (204).

Methodologically there is an argument to be made for a mixed methods approach to investigating how and if participants learn using an online forum(379). One approach may be in the use of exploratory mixed methods designs which have been used to explore the various different interactions and participatory characteristics in online forums using a sequential mixed methods approach. These approaches typically use smaller groups to explore and topics for further investigation using a qualitative method before proceeding onto quantitative methods using a larger cohort(380,381). These methods develop the inductive results of the focused initial phases (using small groups) to as inputs to the quantitative phases of investigation. The opportunity to explore social media use within a smaller cohort of participants using a qualitative approach such as interviews which then inform a wider survey methodology links to a pragmatic and well-established approach to similarly complex research areas(381,382).

Pragmatically the approach described here to determine message board utilisation is feasible, achievable and will produce valuable data that will answer the research question about if learning occurs at higher levels of Bloom's taxonomy. A further exploratory mixed methods approach could be used to explore how and why the levels of learning develop and are utilise amongst participants.

#### ***1.9.1.3 Social Media in Medical Education***

The social media projects arguably offer the richest source of research projects as it is currently in evolution and not universally accessed by all clinicians. The #FOAMed movement and the use of social media is now well established, but an understanding of how they influence change in practice, whether they are more or less effective than traditional models of education

and an understanding of how the various different platforms integrate with each other is poorly understood.

Given time and funding it would be possible to design and deliver studies that look at various different aspects in the assessment of the impact of social media enabled learning. Examples of such studies are described below in a hierarchical manner according to the ease of delivery.

#### 1.9.1.3.1 Assessment of access and utilisation

Survey study designs can be used to quantify how emergency medicine clinicians use social media for learning. Such a study would be a further development of the similar approach to the exploratory study described in the Appendix, undertaken with Rachel Mansley, a 4<sup>th</sup> year medical student in Manchester.

1. Identify a cohort of emergency clinicians (e.g. doctors in training).
2. Survey them using a survey tool to determine their scope and frequency of social media use – utilising closed questions; but also including open questions(383).The survey would be designed using existing evaluation tools and then piloted in face to face validity testing processes before being released to a wider cohort of emergency clinicians. These techniques are consistent with established evidence and good practice in questionnaire design within healthcare settings(384-387).
3. Closed questions would be analysed using descriptive and interpretive statistics. The precise analysis would be dictated by the data type and distribution(388). Open questions would be analysed using thematic analysis methods(389-392)
4. Both open and closed questions would allow insights into how and whether participants use social media/technological enhanced learning to influence clinical practice.

Such a study would give data on learners perceptions of their use of social media enabled learning, but, as noted above, such studies are prone to bias from recall, expectations, and frequently suffer from a biased return from

those interested in the topic. This would provide anecdotal evidence of change but would only really demonstrate knowledge and not actual practice in the workplace.

From a methodological perspective the use of survey tools (as typified by online surveys utilising services such as SurveyMonkey) are attractive as they are quick, easy to deliver, easy to collect data and typically produce data that is relatively simple to analyse and subsequently present. However, there are significant limitations to the use of surveys to answer questions around the effectiveness of social media in education(383). Response rates are typically low and influenced by an a-priori degree of engagement with social media learning, with those more involved in social media-based training (the salient point of interest in this study) being more likely to respond and engage with the analysis of the intervention(204). Indeed this may be one of the most important factors in surveys(393-395). Similarly, the answers may be based on what participants 'think' they do as opposed to what they actually do in practice(394). This can result in a study which struggles to allow the inference of the results to a wider population. For these reasons, the survey methodology, although attractive from a pragmatic perspective is unlikely to produce definitive data to aid future researchers. However, despite these limitations we should not entirely discount the use of survey methods to determine a baseline of interest and engagement amongst the potential audience for online learning.

The study of social media enabled learning is a relatively new phenomena with little current data available. It is likely that survey methodologies will be used to gain an insight into the current and potential future use of social media enabled learning simply because of the novelty, ease of delivery and potential for publication in a new research field. There is evidence of this being the case through recent publications gaining acceptance in peer-reviewed publications using simple survey methods(106,107).

#### 1.9.1.3.2 Assessment of social media impact

I have argued that the most important aspect of education is a change in clinical practice as a result of educational intervention. However, the determination of educational impact is a complex undertaking, especially in the healthcare environment where the ultimate determination of success and failure of an intervention is arguably determined by patient outcomes; and such outcomes are dependent upon a range of variables that could confound attempts to evaluate the education intervention per se.

The approaches and suggestions above do not attempt to look at changes in behaviour which might ultimately lead to changes in patient outcome. To determine this the methodological approach must use a method that has the ability to examine work-place based practice. Observational approaches are more suited to determining changes in the workplace, most likely from an ethnographic approach(37,396,397). This is an area of research method where I have relatively little experience and such a study would require collaboration with academics skilled in these methods. However, the approach has been used within the healthcare system to look at a variety of topics where the use of information, the role of interprofessional interactions and use of educational materials is reached. This leads me to the belief that the techniques could be used to discover how social media is used in practice and how it interplays with other forms of education(397-399).

#### 1.9.1.3.3 Comparison of information release strategies.

As previously described it is hoped that the dissemination of research through social media will reduce the knowledge translation gap between high quality evidence being available and it reaching clinical practice(110,128,244,327,340). This could be explored by comparing the speed of awareness of new research between articles promoted through social media as compared to those not promoted through social media.

1. Identify new papers suitable for discussion on social media platforms
2. Survey baseline knowledge on current practice amongst a defined group

3. Randomise new papers to promotion vs. no promotion
4. Outcomes based on an assessment of whether knowledge does, or not become acquired and over what period of time this occurs.
  - Comparison of social media metrics e.g. Altmetrics(307), twitter impressions
  - Change in cohorts' knowledge based on subsequent surveys at defined time points.

Such a study would be difficult to deliver but may offer insight into whether new technologies decrease the knowledge translation gap. However, it might offer less insight into whether patient care is influenced and/or improved as a result.

Methodologically this design of study would use the randomised controlled trial approach(400,401) to select and then observe the effect of social media interventions on the quantitative access (through online metrics) and perceived utility (through the survey of potential recipients). This design is common in healthcare with significant advantages in reducing bias and in determining the effect of the intervention(402). The challenges of conducting a randomised controlled trial in education should not be underestimated. There is significant debate regarding the question of whether the randomised controlled trials is the best design for educational interventions and in reality a more pragmatic approach may be adopted(403,404).

#### ***1.9.1.4 Summary of future work***

This section has outlined a number of potential research areas that may be realised in the further pursuit of an evidence base to explore the role of social media and other technologies in emergency medicine learning.

The topics presented here are not exhaustive. Future work may also examine the potential synergy of traditional academic media (e.g. print journals) and innovative online platforms to understand if an emerging synergistic and multi-media approach to education is developing. There are certainly opportunities to examine the interface between traditional formats of

knowledge dissemination and how they have changed and are changing in an increasingly connected and multimedia world. My position as educator, clinician and researcher, working together with colleagues who are subject matter experts in these areas offers the potential for an exciting and innovative future for emergency medicine education.

We also need to be mindful of new platforms coming to market and their potential for enhancing education. Clearly, there are numerous opportunities to investigate these areas in collaboration with other #FOAMed producers and with related specialities such as education. There are a number of current platforms that are just starting to be used as learning tools. Instagram is popular with a younger generation as compared to Twitter and Facebook (Guynn, 2018; Sweney, 2018). There are opportunities to develop learning projects on these newer platforms and of course to look out for future developments as it is highly likely that new online platforms will develop in the next few years.

The studies described link to a pragmatic research philosophy as described at the beginning of this chapter.



## **1.10 Chapter 5: Conclusion of Thesis.**

### **1.10.1 Contribution to technology enhanced medical education.**

This PhD submission together with the associated supporting artefacts demonstrate contributions to medical education over a prolonged period of time. The theme that underpins the artefacts is the use of technologies that encourage interaction between learners and students in order to facilitate better knowledge acquisition.

#### **1.10.1.1 *Narrative summary***

This body of work began with the development of the BestBets process grounded in the evidence based medicine movement of the 1990s(147,154). This led to the further development of online learning management systems designed to reflect the need to educate and engage a geographically and chronologically distributed workforce(40,198). More recently the penetration of social media applications amongst our learning community has allowed me to develop strategies to teach and study how these new technologies can be used to engage and interact with a worldwide audience of learners in the social age. Finally, the culmination of the interests in technologically enhanced education has led to opportunities to present and interact with colleagues across the globe as an international keynote speaker.

#### **1.10.1.2 *Academic enhancement and amplification***

A core aspect of all projects, and especially so of the more recent innovations in social media and #FOAMed has been the integration of evidence-based medicine, research activity and academic publication. All the projects demonstrate how teaching and learning can integrate with research innovation in a symbiotic way. The most recent examples of social media specifically amplifying the research output of clinicians best typifies this. At the time of writing this is arguably the most exciting and rich area for further development of the social media projects.

### **1.10.1.3**      *Contemporaneous determination of innovation*

Through the narratives contained in this thesis I have demonstrated the interaction between emerging technologies, innovation, application and assessment as they impact on emergency medical education. Looking back technologies such as the BestBets website and process are now in widespread use, but at the time they were new and untested approaches to shared education. Similarly, with the adoption of Virtual Learning Environments these were developed as new innovations in emergency medicine. Both of these projects, the technologies and application of which are now mainstream in other disciplines were at the cutting edge of medical education in their time. Innovation and creativity are always judged against the contemporaneous zeitgeist which may be difficult to judge in retrospect. This is especially difficult in the last 20 years as the speed of change and innovation has been rapid and diverse. Thus, the innovative nature of the artefacts presented here should be judged against their impact at the time and not as they present themselves in 2018. In contrast the final artefacts in this thesis describing the impact of social media on education are easier to compare and contrast with what stands as traditional medical education. The social media artefacts demonstrate the challenges of leading a change in the delivery of medical education. It is difficult, exciting, challenging and at times frustrating.

### **1.10.1.4**      *Leadership development*

The artefacts in this thesis also tell a story of educational leadership. All the projects described in this thesis are collaborative. The nature of medical publishing, and the development of projects of this size require a team of enthusiasts to create, deliver and maintain the resources.

I have listed my personal contributions to each group of artefacts at the end of the relevant sections, but those statements do not clearly show the development of my role as collaborator and now leader of technological innovation. The BestBets projects were truly collaborative amongst a team of local emergency physicians seeking to operationalise evidence-based practice in emergency medicine. This was a highly collaborative project. At

the time I was a trainee in emergency medicine with Prof. Mackway-Jones as principle collaborator, overall lead and supervisor in those projects. The VLE projects allowed an increased role in educational leadership as I developed as a course designer and lead for a range of topics. The VLE also allowed me to lead on working with other specialties to develop courses for their trainees (for example the paediatric critical care group). Finally, the Social Media related artefacts show how I have grown and developed resources as a leader in the field.

The leadership journey from collaborator through to a lead innovator in the current world of emergency medicine can be seen through the artefacts presented here.

My current role as a leader in this field is evidenced by the numerous invitations to publish and present on topics related to emergency medicine, evidence-based medicine and social media. These invitations extend beyond emergency medicine and into other fields which demonstrates that the reputation and impact of my work extends beyond my base speciality. Numerous examples can evidence this, a selection of which are shown below.

1. Invitation to participate in an article on social media in Clinical Chemistry (impact factor 8.008). I was invited as a recognized leader in the field (363).
2. Invitation to take part in a debate in the Canadian Journal of Emergency Medicine on the risks of social media based education (263).
3. Presentations and participation at international conferences on the subject of social media and evidence-based medicine (84,287,288,405-407).
4. Invitation to contribute to the 50<sup>th</sup> Anniversary celebratory book published by the Royal College of Emergency Medicine. This was specifically in relation to my work on educational innovation for the specialty (5).

5. Invitation to co-author an article for the 50<sup>th</sup> anniversary of the Emergency Medicine Journal on the use of new technologies in emergency medicine. This invitation recognizes my standing amongst UK emergency physicians as a leader in the field (408).

I believe that the pedagogical journey undertaken in the field of technologically enhanced education in emergency and critical care medicine demonstrates a substantial contribution to the field.

## 1.11 Appendices

### 1.11.1 Appendix 1. Medical Student Project on Social Media use in North West England amongst EM trainees.

These two posters represent work undertaken by Rachel Mansley as a 4<sup>th</sup> year medical student at Manchester University in 2017.

The objective was to determine the use of #FOAMed based materials by trainers and trainees in emergency medicine.


This project was presented to the university as part of Rachel's coursework. In addition, the posters were presented at the EMSSA (Emergency Medicine Society of South Africa) meeting that took place in Sun City during September 2017.

Although the response rate was disappointing and not adequate enough to pursue formal publication the data does demonstrate that there is a significant level of engagement and subsequent clinical activity in relation to online learning and the use of #FOAMed resources.

# A survey of the current use of free open access medical education resources used by UK emergency medicine physicians

Rachel Mansley – Medical student, The University of Manchester, United Kingdom  
Simon Carley – Professor of Emergency Medicine, Manchester, United Kingdom

### What is FOAMed?




Free open access medical education (FOAMed) is a movement to encourage medical educational resources that are free and available for everyone to use. These are mostly in the form of online resources, including blogs, podcasts, videos and social media. The term FOAMed was coined in 2012 by an EM physician, and since then the creation and use of these resources has become more popular.

The aim of this study was to understand how FOAMed is currently being used in the UK, and the impact that these resources have on physicians using them.

### Methods

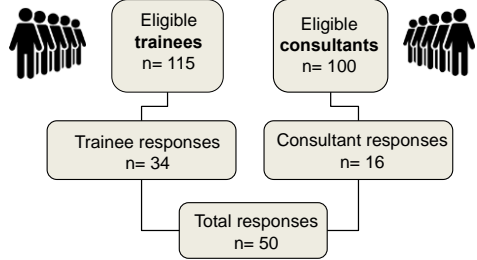
An online questionnaire was created via google forms and emailed to all emergency medicine trainees and selected consultants in one educational deanery in the UK. Questions explored consumption, motivation and impact of FOAMed.

The survey was open for 7 weeks from May-July 2017. Participation was voluntary with no financial incentive. A pilot study was conducted during the creation of the survey.



### Who responded to the survey?

There were 50 responses from an eligible group of 215 potential participants, representing a response rate of 23%.



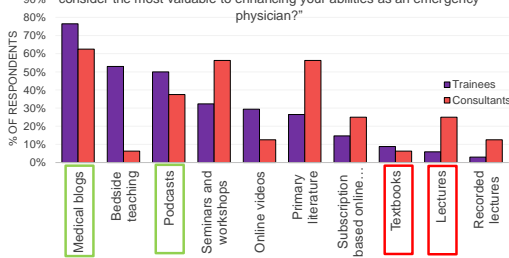
## #FOAMed

Free open access medical education

### What do the survey results tell us?

Both groups considered FOAMed resources (such as blogs and podcasts) very valuable to their education, more so than more traditional resources (such as textbooks and lectures).

“At your current stage of training, which of the following resources do you consider the most valuable to enhancing your abilities as an emergency physician?”



Resource	Trainees (%)	Consultants (%)
Medical blogs	~75	~65
Bedside teaching	~55	~10
Podcasts	~50	~40
Seminars and workshops	~35	~55
Online videos	~30	~15
Primary literature	~25	~55
Subscription based online...	~15	~25
Textbooks	~10	~10
Lectures	~5	~25
Recorded lectures	~5	~15

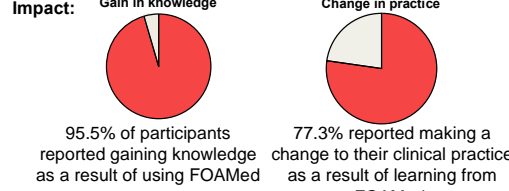
**Consumption:** Most participants used FOAMed resources regularly. Only 3 respondents (6%) had never used FOAMed.

**Motivation:** Participants had multiple reasons for using FOAMed resources, however the most popular for both trainees and consultants were:

- “To keep up with the current literature”
- “To learn EM core content”

Both groups considered it very important that authors of FOAMed content used principles of Evidence Based Medicine.

**Impact:**



Metric	Percentage
Gain in knowledge as a result of using FOAMed resources	95.5%
Change in practice as a result of learning from FOAMed	77.3%

### Conclusions

This study, although not representative of the UK as a whole, suggests EM physicians find FOAMed resources valuable, are using them regularly, and have several motivations for use. Many participants self-reported changing their clinical practice as a result of FOAMed use, suggesting these resources could have a significant impact on emergency medicine education.

### **1.11.2 Appendix 2. Evaluation of learning facilitated by an online discussion board for emergency medicine physicians.**

This project was a pilot study to examine how clinicians use online message boards to learn. The long St. Emlyn's VLE was used to analyse discussions on clinical cases facilitated through an online forum. Posts were analysed according to Bloom's hierarchy.

In this pilot study we learned that there was ample of evidence for higher levels of learning but that the assessment tool lacked inter-observer variability. The intention is to repeat this study following a training/calibration program of the assessment tool.

# Evaluation of learning facilitated by an online discussion board for emergency medicine physicians

Rachel Mansley – *Medical student, The University of Manchester, United Kingdom*  
Simon Carley – *Professor of Emergency Medicine, Manchester, United Kingdom*

### What is an online discussion board?

Medical education can be delivered online in several ways, one of which is through discussion boards (or forums). This method is beneficial to EM trainees due to its asynchronous nature (i.e. being available to many physicians at different locations and times).

**Thread 1: Chest pain**

*John Smith, Monday 1 January 2017, 5.55AM:*  
A patient comes to the ED with chest pain. What are we going to do?

*Jane Brown Monday 1 January 2017, 7.32AM:*  
I would do ... I would also like to know ....

*John Smith, Monday 1 January 2017, 2.05PM:*  
Good idea. Why have you chosen that plan? Is there anything else you would like to know?

The format allows participants to ask and answer clinical questions through a series of online posts, with each thread revolving around a different clinical problem. Thus educators and trainees can interact remotely.

### Methods

The discussion board analysed was that hosted by 'St.Emlyn's virtual classroom', a closed resource for the EM practitioners of one hospital. The content of each post was assigned a level of Bloom's Taxonomy. If there were multiple levels of learning demonstrated in one post, it was coded as the *highest* level achieved. The coded levels were converted to a numerical value. Several reviews were conducted as follows:

6	Create
5	Evaluate
4	Analyse
3	Apply
2	Understand
1	Remember
0	Unclassified

**Review 1:** 5 months of content coded by RM

**Review 2:** coding repeated by RM, blinded to results of Review 1

**Review 3:** SC independently coded a selection of posts. The posts included in this review had been assigned the same level in reviews 1&2

Intra-rater reliability of results of reviews 1& 2 calculated in SPSS.

Inter-rater reliability of results from review 3 and 1&2 calculated in SPSS.

### How can learning be evaluated?

The quality of someone's learning can be analysed from different directions. One way is to consider the depth of learning achieved, as physicians can adopt either a surface or deep approach to their learning. Developing these higher order skills is important to progressing as a clinician. One means of assessing the depth of learning is through the use of the Bloom's Taxonomy framework (below).

**Bloom's Taxonomy**

Deep learning

Surface learning

The taxonomy sets out a hierarchy of learning needs, divided into 6 levels. In order to progress towards the higher levels of learning, you must achieve those below. For example to evaluate a decision you first must be able to remember the information involved (know it), understand (explain it), apply (interpret it), and analyse it (compare/test). The aim of postgraduate education is to encourage learning at the highest levels of the taxonomy. This study aimed to determine whether higher levels of learning can be achieved using online discussion boards.

### Results

**Distribution of levels of learning displayed in all content**

Create	0%
Evaluate	22.8%
Analyse	26.9%
Apply	24.4%
Understand	10.4%
Remember	5.1%

A total of 316 individual posts were analysed from 23 discussion threads. Most posts demonstrated either application, analysis or evaluation of information. Ten percent of the content was unclassifiable. There was substantial intra-rater agreement in the levels assigned: 69% agreement, with Cohen's Kappa = 0.61, p=0.00. Nineteen posts underwent secondary review in Review 3. These had a poor inter-rater reliability of K=0.131, p=0.157.

### Conclusions

The results suggest that higher levels of learning can be achieved through online discussion boards. This promises that further development of this aspect of online education could be beneficial. For future work improvements should be made to the methodology, with more calibration between reviewers to agree on appropriate coding of content.



### **1.11.3 Appendix 3. Example of a flipped classroom model for teaching medical students on a 3<sup>rd</sup> year rotation at Manchester Royal Infirmary.**

This shows how topics are linked to online reusable learning objects (RLOs). Participants are expected to visit the online learning materials in advance of the allocated face-to-face session. They then use the face to face time to discuss the online content and to reflect on how this relates to the patients they have seen in the ED.

## Medical student teaching plan

Week	Day	Topic	Resource to read/visit in advance.
1	Mon 4-5	Major Trauma	<ul style="list-style-type: none"> <li>• <a href="#">Major Trauma in the ED</a></li> </ul>
	Tue 4-5	Chest pain in the ED	<ul style="list-style-type: none"> <li>• <a href="#">Let's talk about Chest Pain</a></li> </ul>
	Wed 4-5	Syncope	<ul style="list-style-type: none"> <li>• <a href="#">Syncope in the ED</a></li> </ul>
	Thur 4-5	Cardiac Arrest	<ul style="list-style-type: none"> <li>• <a href="#">ALS guidelines</a></li> </ul>
2	Mon 4-5	Resp emergencies	<ul style="list-style-type: none"> <li>• <a href="#">Let's talk about shortness of breath</a></li> </ul>
	Tue 4-5	ECGs	<ul style="list-style-type: none"> <li>• <a href="#">ECG Library at LITFL</a></li> <li>• <a href="#">LITFL ECG quizzes</a></li> <li>• <a href="#">ECG clinical quizzes</a></li> </ul>
	Wed 4-5	Blood gases	<ul style="list-style-type: none"> <li>• <a href="#">Venous or arterial? St. Emlyn's</a></li> <li>• <a href="#">Interpreting blood gases in the ED</a></li> </ul>
	Thur 4-5	Pain	<ul style="list-style-type: none"> <li>• <a href="#">Pain management in the ED</a></li> <li>• <a href="#">Sedation in the ED</a></li> </ul>
3	Mon 4-5	Suturing	<ul style="list-style-type: none"> <li>• <a href="#">Wound care in the ED</a></li> </ul>
	Tue 4-5	Thromboembolism	<ul style="list-style-type: none"> <li>• <a href="#">DVT and PE at LITFL</a></li> </ul>
	Wed 4-5	Paed emergencies	<ul style="list-style-type: none"> <li>• <a href="#">Let's talk about kids in the ED</a></li> </ul>
	Thur 4-5	O&G emergencies	<ul style="list-style-type: none"> <li>• <a href="#">Let's talk about O&amp;G emergencies</a></li> </ul>
4	Mon 4-5	Headache	<ul style="list-style-type: none"> <li>• <a href="#">Let's talk about headache in the ED</a></li> </ul>
	Tue 4-5	Sepsis in EM	<ul style="list-style-type: none"> <li>• <a href="#">Sepsis in the ED</a></li> </ul>
	Wed 4-5	Toxicology in EM	<ul style="list-style-type: none"> <li>• <a href="#">Toxicology emergencies</a></li> </ul>

	Thur 4-5	Feedback	
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The resources are designed to be used in a [flipped classroom model](#) students and tutors can read the materials before the session and then come together to discuss.

You may use alternative presentation methods if you prefer (traditional PowerPoint). Some presentations are available on the journal club website.

## 1.12 Glossary

3PQ	Three Part Question
ACEP	American College of Emergency Physicians
BestBets	Best Evidence Topics
BMA	British Medical Association
CAT	Critically Appraised Topic
CCT	Certificate of Completion of Training
CPD	Continuing Professional Development
CSA	Casualty Surgeons Association
EBM	Evidence Based Medicine
EM	Emergency Medicine
EMCRIT	Emergency Medicine Critical Care (blog)
EMJ	Emergency Medicine Journal
EMMSA	Emergency Medicine Society of South Africa
#FOAMed	Free Open Access Medical Education
GEMNET	Guidelines in Emergency Medicine Network
HEMS	Helicopter Emergency Medicine Services
IFEM	International Federation of Emergency medicine
JC	Journal Club
KT	Knowledge Translation
LITFL	Life in the Fast Lane (blog)
MMC	Modernising Medical Careers
MMU	Manchester Metropolitan University
MOOC	Massive Open Online Course
MSc	Master of Science
NIHR	National Institute for Health Research
PBL	Problem Based Learning
PICO	Four Part Question
PMJ	Post Graduate Medical Journal
RCEM	Royal College of Emergency Medicine
RLO	Reusable Learning Object
SGEM	Skeptics Guide to Emergency Medicine
SMACC	Social Media and Critical Care

SMi	Social Media Index
#SoMe	Social Media
VLE	Virtual Learning Environment

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