

Past, Present, and Future of Emergency Dispatch Research: A Systematic Literature Review

Isabel Gardett, PhD¹; Jeff Clawson, MD¹; Greg Scott, MBA¹; Tracey Barron, MCPA²; Brett Patterson¹; Christopher Olola C, PhD¹

1. International Academies of Emergency Dispatch, Salt Lake City, Utah, USA
2. International Academies of Emergency Dispatch, Bristol, UK

Correspondence:

Gardett MI, PhD
International Academies of Emergency Dispatch
110 S. Regent Street Suite 800
Salt Lake City, Utah 84111, USA
Ph. 801-363-9127 Ext 309
Fax. 801-359-0996
isabel.gardett@emergencydispatch.org

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ABSTRACT

Introduction: Emergency dispatch is a relatively new field, but the growth of dispatching as a profession, along with raised expectations for help before responders arrive, has led to increased production of and interest in emergency dispatch research. As yet, no systematic review of dispatch research has been conducted.

Objective: This study reviewed the existing literature and indicated gaps in the research as well as potentially fruitful extensions of current lines of study.

Methods: Dispatch-related terms were used to search for papers in research databases (including PubMed, MEDLINE, EMBASE, EMCARE, SciSearch, PsychInfo, and SCOPUS). All research papers with dispatching as the core focus were included.

Results: A total 149 papers (114 original research, and 35 seminal concept papers) were identified. A vast majority dealt with medical dispatching (as opposed to police or fire dispatching). Four major issues emerged from the early history of emergency dispatch that continue to dominate dispatch studies: dispatch as first point of care, standardization of the dispatching process, resource allocation, and best practices for dispatching.

Conclusion: Substantial peer-reviewed research does exist in dispatch studies. However, a lack of consistent metrics, the near-nonexistence of research in fire and police dispatching, and a relative lack of studies in many areas of interest indicate a need for increased participation in research by communication center administrators and others “on the ground” in emergency dispatch, as well as increased collaboration between research organizations and operations personnel.

INTRODUCTION

Emergency dispatch is a relatively new and still emerging field, both in practice and in terms of experimentation and research. Prior to the mid-1970s, emergency dispatchers, whether in medical, fire, or police dispatch centers, tended to be laypeople with little or no specific training. The 3-digit emergency number itself had only recently been implemented,¹ and the dispatcher’s job was more akin to a telephone operator’s than a paramedic’s, firefighter’s, or police officer’s. Dispatchers and dispatch services often felt the brunt of this reality, facing budget difficulties, low status, lack of training, nonprofessional certifications, and other difficulties in their interactions with emergency responders and political agencies. A move to change the profession began in the 1970s, when the value of emergency dispatch as an early triage point, as well as the value of dispatchers as providers of responder information and help over the phone, became more apparent.

Since that time, emergency dispatching has undergone a revolution. Emergency dispatchers are professionals in their fields, trained and certified to perform life-saving functions well before responders arrive on scene. One of the results of this revolution has been an ever-increasing need for dispatch research to measure and improve dispatchers’ ability to accurately identify and triage a caller’s problem, provide the appropriate instructions or help, and send the most appropriate response safely. As emergency dispatching becomes more complex, and as the public comes to expect certain kinds of help, well-conducted scientific research becomes increasingly important.

OBJECTIVES

The objectives of this study are to: (a) outline the early research priorities set by the first implementers of dispatching as a profession in the mid-to-late 1970s and early 1980s; (b) provide an overview of the areas of study most commonly addressed by more recent dispatch research (past 20 years); (c) describe the limitations, gaps, and problems in that research; and (d) suggest needed directions for future research and for the expansion of current research streams.

METHODS

The authors searched databases of scientific papers, including PubMed, MEDLINE, EMBASE, EMCARE, SciSearch, PsychInfo, and SCOPUS, using dispatch-related search terms (EMD/EPD/EFD, dispatch/dispatcher, nurse triage/telenurse, emergency telecommunications, TCPR, etc.). Papers were selected for inclusion if: (1) they presented original research; (2) dispatching was a central or identified key term; (3) dispatching or dispatch data was central to the methodology of the study; and (4) the results of the study had implications relevant to the practice or study of dispatching. Only published work was reviewed; unpublished work such as dissertations, although valuable, was not reviewed.

Studies were excluded if dispatching was only tangentially mentioned or used as a peripheral term (for example, mentioned once in passing) or if no implications for dispatch were identified in the results, discussion, or conclusion. The only partial exception to this rule was that some studies were included that discussed response times but only mentioned dispatching as one element of response time, rather than taking dispatching time as the central object of study. These were included to indicate a major trend in prehospital research that relates to, but has not generally focused on, dispatching. The vast majority of response time studies—those that do not address dispatching—were excluded. The included response time studies are identified as only partially relevant in the body of the text below.

This study also references a number of early “concept” papers in dispatch research. These are generally not peer-reviewed, largely because opportunities for peer-reviewed publication of dispatch research was incredibly limited, if not nonexistent, in the early years of emergency dispatcher professionalization. Nonetheless, because they outlined the key areas of study that would become central in dispatch research over the ensuing thirty years, they have been included as relevant, indeed necessary, to an understanding of the progression of dispatch research in that period.

Although it was impossible to ensure that every study of dispatching was located and identified, the limited amount of explicitly dispatch-oriented research makes it highly likely that the thorough search conducted for this study has returned at least a representative sample—and whether or not every study is mentioned, the trends in terms of com-

mon topics are very likely to be representative. 149 total studies or papers were identified; of these, 35 were concept papers, while 114 presented original research (see Table 1 for breakdown of papers by study design and outcome).

Each study was assigned to a category by primary focus of study. In general, the vast majority of the papers take medical dispatching (as opposed to police or fire dispatching) as their subject, so most of the categories relate to EMS. For the purposes of this paper, each paper was assigned only one primary topic for purposes of comparison, although certainly overlap did exist; for example, a number of the papers on cardiac arrest also deal with the identification of cardiac arrest by dispatchers, but because they are more centrally focused on cardiac arrest—and because they deal with other issues besides dispatcher identification—they are placed in the “cardiac arrest” category rather than the “identification” category. Overlaps are noted in the text where relevant.

RESULTS AND DISCUSSION

Setting the Stage: Early Issues in Emergency Dispatch Research

Four major issues emerged from the early history of emergency dispatch that continue to dominate dispatch studies—and the practice of emergency dispatching—to this day. The first is the opportunity to turn dispatch, which is the first contact a caller has with the emergency system, into a first point of care, with dispatchers providing medical, safety, and other information “pre-arrival,” or before emergency responders can arrive. Paramedic Bill Tune’s unscripted 1976 advice to a woman whose baby wasn’t breathing is widely credited as the first recorded and identified “pre-arrival instruction” in medical dispatch history. That child lived, and as a result, Tune’s center in Phoenix, Arizona began providing what they called “medical self help” from that point;^{2,3} such instructions became more common across the country as it became clear that lawsuits were more likely as a result of not providing instructions.^{4,5} Very early, cardiac arrest was identified as one of the conditions for which pre-arrival instructions were of most use, and studies of the value of telephone cardiopulmonary resuscitation (TCPER, or dispatcher-assisted CPR) were published as early as the 1980s.^{6,7} Measuring and improving the efficacy of such instructions—and determining what kinds of cases benefit most from them—continues to comprise a significant portion of the research in emergency dispatching.

The second ongoing issue to emerge from the early years of dispatching was the need for increased professional status and consistency in dispatching, particularly through the use of scripted protocols and specific training in the use of those protocols.⁸ Early, largely untrained dispatchers asked questions, provided information, and determined the nature and severity of events largely

ad hoc, with no guidance. This led not only to minimal information gathering in many cases, but also to inconsistent information gathering, customer service, and resource allocation from one dispatcher to another and one center to another. The beginning of the current, widely-adopted system of protocol-based dispatching began with Dr. Jeff Clawson, then the medical director for the Salt Lake City, Utah Fire Department, in 1978.² Clawson devised protocols for the Salt Lake City Fire Department's dispatchers, and these protocols became the Medical Priority Dispatch System. From that point, dispatch protocol systems began to be devised and implemented in communities across the United States and then throughout the world, with medical dispatch generally adopting protocol systems earlier than fire or police. This early interest in the development of scripted protocols also reflected the ongoing concern that protocols develop and evolve through sharing of experience and research among centers, calltakers, agencies, and countries to determine optimal performance, not just local "make-do" solutions,⁹ especially given the higher potential for legal problems in systems without consistent practices.¹⁰ In addition, a few early concept papers laid out the kinds of training necessary for effective dispatching¹¹ and the kinds of specific protocols needed, including those for specific situations such as dispatching in response to calls from officers on the scene.^{12,13}

Resource allocation emerged as a third concern during the early history of emergency dispatching. The Medical Priority Dispatch protocols, as well as the other early protocol systems, were intended not only to improve the help provided to callers, patients, and those in need, but also to improve the overall functioning of the emergency response system by reducing both waste (generally defined as sending an over-response) and risk (sending too little response for the situation).¹⁴ In addition, the desire to reduce the "hot" responses that pose such high risk of collision to responders and the public was set as an early agenda.¹⁵⁻¹⁷ The promise of improved system efficiency^{18,19} has been one of the driving forces behind the adoption of protocol-based systems, the increased training of emergency dispatchers, and the increased support for dispatch communication centers among politicians and administrators. However, the specific abilities of various systems to in fact reduce waste and risk, and the relative effectiveness of the many existing programs in doing so, remains contentious.

Finally, the fourth agenda set by the early papers in dispatch was the need to study and outline best practices for dispatching.²⁰ This included concept papers about model regulations and standards,²¹ best practices for dispatcher review and quality improvement,^{22,23} and best models for distribution of responders and allocation of response by location.²⁴ In addition, early papers on best practices often focused on what came to be called "dispatch life support"²⁵ (the science of pre-arrival instructions provided over the phone), including early arguments that EMDs should provide such support without asking for caller permission.²⁶

All of these early concerns about best practices in EMD have been taken up—largely in non-peer-reviewed public safety and public health journals—but more research work in these areas is also needed to confirm the findings of early researchers and standards setters.

Computer-aided dispatch and the use of "algorithms" to determine the appropriate response for a given situation was also, not too surprisingly, given significant attention as computers were introduced into emergency systems and the telecommunications network, and then more attention as these computers shrank from the size of a room to a personal console available to an individual calltaker. One early study in the use of algorithms to dispatch fire companies depending on the type and location of the incident and the time of day, for example, found that the algorithms could reduce response time to serious fires without impacting overall response times in the system.²⁷ Another, investigating the implementation of computer technology into a police dispatch center in San Diego, found that computer-aided dispatch could certainly improve system efficiency. However, in quite a forward-looking conclusion, the authors indicated that training the people using the system, and procuring their commitment to it, could be at least as important as improving the technology itself.²⁸ These two studies were conducted by management and productivity researchers, and unfortunately the particular issues they raise about computer-aided dispatch, the human aspects of dispatching and the use of protocols, and the legal and political implications of dispatching have been less fully addressed by dispatch researchers.

Common Topics of Dispatch Research, 1990 to Present

This section will provide an overview of the most common topics of study in dispatch research in the past approximately 20 years. The 1990 cut-off date was not selected randomly; between the very early studies in the mid-1970s and early 1980s, and a large increase in interest around the year 2000, little systematic, scientific research was published in the area of what is now known as dispatch studies. Studies of emergency response—especially emergency medical response and especially response times—was more widespread, but even emergency response research has experienced a surge of interest since around 1990. In part, this increase reflects a growing need, especially in the past 10 years, to make the most efficient use of limited resources because of financial restriction. In the medical dispatching environment, the increased use of emergency rooms and ambulance services as first-line care providers, especially for the uninsured, has increased interest in the ways in which emergency services are used and their resources prioritized.

Whatever the causes, the increase in dispatch research since 1990, and especially since 2000, indicates a growing need for such work and a growing interest not only among public health and safety personnel themselves, but among systems administrators and policy-makers as well. And as policy incentives for "evidence-based" health care solutions

increase, such research will become even more important for the implementation of any changes, improvements, or increases in emergency dispatching. Outlining the common topics of existing research will provide a grounding for suggestions for the future and will indicate the lines of thought and policy that have garnered the most interest.

Cardiac Arrest (CA) and Dispatch CPR

By far the most common topics of dispatch research are cardiac arrest and the type of pre-arrival instruction most commonly associated with it, dispatch-assisted CPR or telephone CPR (TCPR). This focus on cardiac arrest is far from surprising, given its emotional impact, high visibility in the public eye, and very low survival rates (only 5-10% of out-of-hospital cardiac arrest patients survive to discharge from hospital in the U.S. and Canada, according to the American Heart Association²⁹). Papers with cardiac arrest or TCPR as their central topic made up more than one quarter of the research studies identified for inclusion in this review, while at least three others took cardiac arrest or TCPR as a secondary topic. Moreover, there are almost certainly additional published papers on TCPR and dispatching for cardiac arrest, but database access issues and the limitation of this study to English-language journals may have artificially reduced this number.

Within CA and TCPR research, a few more specific themes emerge. The most common topics of interest are: the effectiveness of TCPR advice in either increasing the incidence or improving the performance of bystander CPR,³⁰⁻³² with several studies focusing on the effects of specific instructions³³⁻³⁶ or on the reasons why TCPR may not be effective;^{37,38} the ways in which CA can be identified over the phone in the nonvisual dispatch environment and EMDs' ability to do so;³⁹⁻⁴⁷ relationships between dispatch identification of CA and/or TCPR and patient outcomes;^{48,49} and the sensitivity of various specific protocol systems to correctly identify cardiac arrest.^{50,51}

Of particular interest, too, are a few studies that indicate potentially valuable but less-studied areas of CA research. In some studies, for example, researchers have focused on the identification of agonal, or dying, breathing in the dispatch environment or perhaps the most telling indicator of cardiac arrest.⁵²⁻⁵⁴ The identification of agonal breathing has in fact become a political issue as well as a scientific one, with recent debates revolving around the tension between the amount of time it takes to "definitely" identify agonal breathing and the desire to move to CPR as quickly as possible. One emerging consensus—that the key to resolving this tension is to provide CPR any time a patient is unconscious and their breathing is described as "abnormal"—is supported by the work of White et al, which determined that the risk of injury in providing CPR to alive patients was very low compared to its potential benefits, such that initiating CPR in patients not in cardiac arrest has lower risks than not initiating it, or not initiating it fast enough, in patients who are experiencing agonal breathing.⁵⁵ (However, the number of patients not in car-

diac arrest who received CPR in this study was very high, so further research is needed to indicate when CPR should be initiated as opposed to, for example, airway maintenance.) Another less-studied area of CA is the question of patient or caller gender and the effects that sex might have on the identification of CA or the management of symptoms by dispatchers.^{56,57} In both of the studies looking at the relationship between caller or patient sex and CA or chest pain management, identification of both AMI (Acute Myocardial Infarction) and CA was found to be more accurate for male patients.

Two final areas of CA and TCPR research that have been touched upon but not widely studied are cost and automated external defibrillator (AED) use. In one study, Deakin, Evans, and King compared the survival and health care costs of patients who were treated with onsite, dispatched, or no AED use; they found that the use of AEDs by members of the public already at the location held the greatest benefits,⁵⁸ suggesting that further study about how dispatchers can aid callers in using AEDs effectively is needed. As AEDs have become increasingly familiar and accessible to laypeople, the value of research about their use in the dispatch environment has also increased. Similarly, the low number of studies about the costs associated with cardiac arrest and dispatch- or EMS-associated cardiac arrest care is surprising, especially given the value of cost research to policy-makers and the increasingly limited resources available to dispatchers, EMS providers, and others in the cardiac arrest chain of survival. One study did investigate, as part of a larger look at the implementation of TCPR in a dispatch system, the costs of that implementation;⁵⁹ however, many questions about the costs of dispatch CPR, the potential healthcare cost savings of dispatch pre-arrival instructions, and many others related to cardiac arrest costs at dispatch have yet to be answered.

Protocol Effectiveness: Predictive Value

Another common topic of research—one that is less studied than CA even though it is potentially a far broader topic—is protocol effectiveness. Protocol predictive value studies address questions about how well a particular protocol, or protocol system, can accurately predict patient outcomes. Despite the fact that heart problems, cardiac arrest, chest pain, and other similar chief complaints may only make up a small portion of any protocol system, research testing the validity and predictive value of protocols generally was the focus of fewer research papers than CA and TCPR. Almost all of the studies that do exist dealt with the same metric: high versus low acuity. Acuity levels were defined differently in different studies, with definitions ranging from prehospital medicine administration as an indicator of high acuity to inappropriate response by Advanced Life Support (ALS) crews as an indicator of low acuity. This terminological difference aside, most of the studies focused on the ability of a protocol system to predict acuity levels accurately. The reason for this is clear: many EMS systems are tiered, meaning that they send out

both Advanced Life Support teams (generally including paramedics) and Basic Life Support (BLS) teams with less training and fewer options for medication or other intervention. For these systems, correctly identifying those calls on which ALS teams must be sent, as opposed to those on which BLS alone can be sent, is key to managing the more limited and more expensive ALS resources and keeping them available for true high-acuity emergencies. Moreover, even an “ALS-only” system may use first responders in tiered responses, so further work is needed on how many resources are sent and how fast they respond, as well as which types of responders are sent.

It is important, though, to note that despite the importance of acuity identification, no meaningful consensus has been reached in this area of study. Some studies investigate the ability of a certain protocol to identify low-acuity events,⁶⁰⁻⁶⁶ including those that can be handled by other agencies such as poison control⁶⁷ and the outcomes of patients assigned low acuities and handled as nonemergent,⁶⁸ while others look at the ability of a protocol to identify high-acuity events in need of immediate ALS interventions and medications⁶⁹⁻⁷³ or at the ability of protocols to predict emergency department outcomes.⁷⁴ Some look at specific dispatch systems, particular chief complaints, or even individual questions within a dispatch system,^{75,76} while still others attempt to measure the predictive value of an entire dispatch system in a single study.⁷⁷⁻⁷⁹ At least one study compares an entire dispatch system’s predictive value with another out-of-hospital patient acuity score,⁸⁰ and another examines the ability of a specific dispatch system protocol to identify the acuity of “unknown” problems—situations in which little is known about the patient’s condition.⁸¹

Perhaps even more important than the lack of consensus about ways to define high- versus low-acuity or whether to study whole dispatch systems or specific portions of them, however, is the lack of information in many of these studies about the dispatch systems themselves. More than thirty years after the introductions of the first dispatch protocols in the mid-1970s, many systems worldwide have adopted some form of priority dispatching system (one that identifies acuity level and/or triages calls). These vary widely from one to another and may be locally created for the specific issues encountered in an area or may be internationally recognized. They may be based on a series of scripted questions, or they may be guidelines or Criteria-Based Dispatch (CBD) systems, which leave terminology, phrasing, and extraneous questions to individual calltakers’ discretion. As a result, it is difficult to make any kind of generalization about the value of dispatch systems generally, or any dispatch system specifically, from work that does not describe, in detail, the dispatch system it studies (including version) and the specific aspects of that system that are relevant to the study at hand.

Tiered responses are used in many EMS systems, and many fire companies and some police agencies as well. As a result, the ability of dispatchers or dispatch systems to

predict patient or event acuity has been relatively well-studied, at least compared to many other aspects of emergency dispatching. However, this is also the reason that far more study in this area is needed.

Dispatcher Effectiveness: Chief Complaint Identification (Excluding CA)

Related to protocol predictive value is dispatcher chief complaint identification. Just as it is important to know whether the protocol being used in a given agency or system is accurately predicting low- or high-acuity events, it is equally important to know whether dispatchers using the system can correctly identify the primary problem or chief complaint being described by the caller. This not only helps ensure proper triage of the call but can help the dispatcher identify whether pre-arrival instructions are needed and what kind, whether a caller is in danger, and how to assist or inform the caller. In many cases, the correct identification of the problem is also the key to correct use of a dispatch system. In most cases, dispatch systems are divided into groups, categories, chief complaints, problem codes, or other breakdowns by primary problem; if the calltaker cannot properly identify that problem, his or her use of the protocol may be ineffective. It is not surprising, then, that this category had the next greatest number of research studies.

As noted above, the most commonly-studied identification problem in the dispatching environment is cardiac arrest, with a special focus on abnormal or agonal breathing. However, since each study is assigned to only one primary topic, and the CA-identification studies all took CA itself, rather than dispatcher identification, as their primary topic of interest, those are not included here. Of the studies assigned to this chief complaint identification section, the vast majority dealt with stroke, possibly in response to an early concept paper outlining a need for new best practices for stroke dispatch.⁸² Of these, eight dealt with dispatcher identification of stroke either in general or using a particular dispatch protocol system.⁸³⁻⁹⁰ Another two evaluated the diagnostic value of well-known stroke scales when used in the prehospital environment: the Ontario prehospital stroke screening tool⁹¹ and the Cincinnati prehospital stroke scale.⁹² The last investigated dialogue about consciousness between callers and calltakers in stroke cases, finding that level of consciousness was often difficult to determine in these cases⁹³. Although there is some disagreement about optimal questioning for stroke assessment, these studies generally agree that specific questioning for stroke, based on known stroke assessment scales, is valuable and that callers who report “stroke” voluntarily are almost always correct.

Unfortunately, dispatcher identification of other conditions has merited little or no study. Despite the rise in chronic diseases and age-related diseases, and the consequent increase in use of EMS systems by chronic disease patients and aging callers, the ability of dispatchers to identify any of these conditions has not been studied (and

the ability of dispatchers to accurately identify police or fire emergencies of any kind has yet to be explored). In this review, only three studies were determined to have chief complaint or problem identification as their focus that did not deal with stroke (or cardiac arrest). Two of these looked at seizure protocols—both, interestingly, with the intention of ruling out CAs that may have been mishandled on a seizure protocol because seizures can often accompany the initial anoxic phases of CA^{94,95}. The last study evaluated the ability of a priority dispatching system to identify Acute Coronary Syndrome⁹⁶, meaning that even of those problem identification studies whose focus is not cardiac arrest, two actually deal with cardiac arrest indirectly and one addresses a heart condition that is generally synonymous or concurrent with cardiac arrest or myocardial infarction.

Emergency Nurse Telephone Triage and Emergency Telenursing

Emergency nurse triage is a well-established practice in many emergency departments and public health agencies worldwide, especially in countries with nationalized health care systems. In those systems, nurses—whether “telenurses” who provide advice over the phone or more traditional triage nurses in emergency rooms or accident and emergency departments—often act as gatekeepers, deciding which patients to refer to an emergency department or physician and which to provide with self-care instructions (a role they are not always completely comfortable performing)^{97,98}. However, emergency nurse telephone triage, which combines the triage function of the emergency room nurse with the advisory role of the telephone nurse line, is relatively new. Although little research exists that deals specifically or only with emergency nurse telephone triage, some of the research about in-person nurse triage and telephone nurse advice lines is relevant to this newer field.

One area of particular relevance is patient compliance with nurse instructions. One of the potential roles of emergency nurse telephone triage is to handle calls that are determined to be of low enough acuity that no ambulance must be sent. If responders are not being sent, the patients’ best interests are served only if nurses can assume that at least most of the self-care advice will be followed and that patients will in fact contact or make appointments with the care providers suggested by the nurse. Two studies with particular relevance in this area are one that found very high patient compliance with self-care advice and slightly lower compliance with advice that patients should go to the emergency department or contact a physician within 24 hours⁹⁹, and a large meta-analysis that found high overall compliance, with (again) higher compliance rates in self-care than in emergency department or office-care instructions¹⁰⁰. Another study¹⁰¹ suggests that when children are “triaged out” of an emergency room, the large majority of parents do not contact a primary health care provider as advised. Because emergency triage nurses may, by definition, handle urgent or chronic cases that require a high level of care (although not immediate hospitalization or ambulance

service), future research in this area should look specifically at how compliance rates vary in emergency-specific nurse telephone triage situations. If patients are to be “triaged out of” the 911, 999, or other emergency system, there should be strong evidence that they will follow advice and instructions as provided.

Because of a long tradition of qualitative research in nursing, a number of studies investigated nurses’ experiences with telephone triage⁹⁸ and with the computer-aided decision support systems many use¹⁰². In addition, some research has looked at the costs and quality of these computerized decision systems¹⁰³ and at the consistency of triage decisions by telenurses¹⁰⁴. However, a significant need exists for more specific research on emergency nurse telephone advice lines connected to emergency dispatch centers and three-digit national emergency numbers.

Other Topics

A number of other important topics have generated some research, but significantly less than the areas above (or a large amount of research only tangentially related to emergency dispatching). Several studies have begun to investigate the uses of new technologies in emergency dispatching. So far these have been limited to the uses of video phones in increasing the frequency and quality of TCPR¹⁰⁵⁻¹⁰⁹, and the early results seem to indicate that CPR quality can in fact be improved when the calltaker can see what the caller or bystander is doing. Another interesting research direction in this area is to use technology (such as video) to study the workings of the dispatch center and the interactions of dispatchers themselves¹¹⁰.

One area in which a great deal of research has been conducted that is almost always only tangentially related to dispatching—sometimes touching on the dispatcher’s role but not focusing on it—is the study of response times. With political and public pressure high to conform to set response times (8 minutes, for example, in many systems), response time is a highly-charged and often-debated issue. A few studies mention or touch on dispatching and its role in response times¹¹¹⁻¹¹⁶, but these are rare in the larger set of response time studies. Perhaps the most important finding has been an indication that outcomes improve with response time only in a very small subset of cases, and only within a very short time window. This counterintuitive finding, which has potentially important implications for dispatchers, calls for more support as well.

The more qualitative or human aspects of dispatching have also generated interesting work—although unfortunately still less so than CA and other medicine-specific dispatching topics. Two studies of the effectiveness of particular dispatcher training programs were identified: one very early study of a training program for emergency dispatchers in Sweden when protocol-based dispatching was first being implemented there,¹¹⁷ and one study from Belgium that found that a number of patient and system outcomes improved after a training program.¹¹⁸ However, the more recent of these studies is 15 years old. Another

two studies were identified that dealt with quality improvement programs and/or quality improvement measures in the emergency dispatch environment,^{119,120} both of which indicate that implementation of quality management processes improve dispatch outcomes. In both of these areas, early research is intriguing but scarce.

Research on patient interaction or caller management is incredibly rare. While some studies do use caller-calltaker interactions—that is, recordings of calls—as data, very few make that interaction, or the improvement of that interaction, the focus of the study. For example, one study mentioned above used caller interactions with calltakers, and especially caller descriptions of the event, to study agonal breathing detection, and some telenursing research touches on patient interaction,⁹⁸ in part because of the qualitative tradition in nursing. Only one study, however, was identified as taking patient interaction (assessing the caller's emotional level and caller management) as its primary focus¹²¹—a study, incidentally, that built on very early interest in caller management^{122,123} that has not been elaborated upon fully as yet.

The vast majority of dispatch research is conducted in and relevant to mature EMS systems, especially in North America and western Europe, with significant work also originating in Japan. Three intriguing studies, though, indicate that the emergence of dispatching in so-called “developing” nations and nations with newly-developed EMS systems offers an opportunity to study the workings of dispatch in different cultures, the difficulties of implementing emergency services in sometimes unstable communities, and a host of other novel situations. Two of the studies, which provide a case study of Yazd, Iran¹²⁴ and an overview of a newly-established Korean protocol system,¹²⁵ suggest some of the new directions such research will take. The third, a study of the dispatch system in Barbados, provides insight into some of the ways in which existing (in this case, British) processes are being modified for use in developing EMS and dispatching systems,¹²⁶ including the reasons for the non-transport of certain patients.

Police dispatching and fire dispatching have both been studied much less fully—and when conducted, such studies are most often reported in industry magazines, not peer-reviewed journals. Interestingly, research on police dispatch has tended to focus not on appropriateness of resource allocation or proper identification of the problem (as in medical dispatching) but on the stress inherent in the job of police dispatch itself¹²⁷⁻¹³⁰ and methods of coping with that stress, whether individually or by agencies.^{131,132} Other work has expanded on this topic to identify the characteristics of individuals suited for such work.¹³³ Some recent policing research also mentions dispatching tangentially.¹³⁴ In fire dispatch, there is more research, but almost all of it focuses on the use of firefighters as first responders in medical emergencies;¹³⁵⁻¹³⁷ there is little or no published, peer-reviewed research on fire dispatch as a separate entity.

Finally, some work exists that focuses on operational

research: administration, management, and working conditions in emergency dispatching, primarily in EMS systems. Two studies look at implementation and management,^{138,139} several at work stress and PTSD in the dispatch center,¹⁴⁰⁻¹⁴² and another at emergency medical dispatch as a problem of teamwork and “distributed cognition.”¹⁴³ Language barriers between the caller and the dispatcher are the focus of another emerging area of work.¹⁴⁴ Collaboration between center administration and calltakers, and between call center personnel and larger system-level administrators, is necessary to increase the amount of research in this area.

Dispatch Research Study Design

A wide variety of study designs were employed in the dispatch research. Although the randomized controlled trial (RCT) is something of a “gold standard” in medical and clinical research, it is incredibly hard to conduct such studies in the emergency-driven, dynamic context of the communication center. As a result, retrospective and prospective studies are more common in dispatch research. Nearly half of the original research studies identified in this review were wholly or partly retrospective in design (see Table 1), while only 4% were randomized controlled trials. Clearly, an increase in the number of RCT studies of dispatch would be ideal. However, pre-/post- studies (comparing specific outcomes before and after a particular intervention) also make up a very small percentage of the total number of studies (5%), and increasing this number would be much simpler than increasing the number of RCTs. Indeed, pre-/post- studies offer a manageable and relatively simple design for centers or administrators who have not previously conducted research or do not feel particularly comfortable with it. Because they also often provide clear evidence of the value of a specific intervention, pre-/post- studies should be promoted as a way to increase the overall amount of dispatch research. However, in conducting such studies, researchers must be sensitive to the possibility that confounding variables, unless rigorously controlled, often mean that multiple or alternate explanations for the findings are possible.

Dispatch Research Study Settings

Almost all (89%) of the studies were conducted at only a single location (generally, a single communication center). Although data from a single center can be very valuable in pointing out trends and patterns, studies conducted simultaneously at more than one location tend to offer more generalizable findings—especially if parallel studies are conducted at centers that vary in size. Multiple-site studies also allow comparisons between outcomes in rural and urban areas, as well as comparisons between centers representing areas of different socio-economic status.

Dispatch Research Study Data Sources

The other significant trend we identified was the overwhelming reliance on dispatch and, to a slightly lesser extent, paramedic data for outcomes (see Table 1). It can be

difficult to access hospital data, and correlating individual hospital records to individual dispatch or paramedic case reports often includes an element of probabilistic linkage, especially since patients dispatched from a single center might be taken to several different hospitals. However, hospital outcomes data provides the most accurate and longest-term information about the patient: survival to discharge, for example, as well as length of stay. Equally important for dispatch researchers, hospital data can provide powerful insight into the accuracy of dispatch triage and coding. Despite the inherent difficulties, increased access to and use of hospital outcome data should be one of the goals of dispatch research in the near future.

Measure	Category	n (%*) (N= 114)
Study design [†] (n=147)	Randomized controlled trial (RCT)	6 (4.1)
	Retrospective	53 (36.1)
	Prospective	45 (30.6)
	Pre-/Post-	7 (4.8)
	Modeling/Algorithm	7 (4.8)
	Simulation	3 (2.0)
	Others [‡]	26 (17.7)
Study setting (n=114)	Single	101 (88.6)
	Multiple	13 (11.4)
Data type [†] (n=192)	Dispatch	76 (39.6)
	Paramedic	56 (29.2)
	Hospital outcomes	21 (10.9)
	Others [‡]	39 (20.3)

*The percentages are out of the total number of records in each measure group.

†A study may fall into more than one category.

‡Observational, literature review, or meta-analysis studies, including methods papers— some of the prospective studies were also observational.

‡Literature review, simulation, or meta-analysis data including methods papers data

Table 1. Study type and design

However, in calling for increased use of hospital and other “outcome” data to correlate with or validate dispatch decision making, it is important to remember that correlating emergency dispatcher findings with the ultimate determination of medical outcomes can be difficult or problematic. This is because the nature of triage and decision making at dispatch is fundamentally different from triage or decision making at the scene or in the hospital. In the first place, dispatch evaluation must be based on caller-described signs and symptoms, whereas hospital outcomes are nearly always described in terms of diagnostic categories (specific medical conditions), generally stated as ICD-9 or ICD-10 codes. Thus, dispatcher evaluations and diagnostic or hospital outcomes are generally not directly comparable.

This disparity underscores that a patient’s signs and symptom are not an end point, but change over time—sometimes quickly. What the emergency dispatcher “sees” during his or her short interrogation process can do one of three things during the time until responders arrive, or emergency department personnel evaluate the patient.

They can get better, get worse, or stay the same. Such changes in a patient’s condition do not necessarily invalidate the “correctness” of what EMDs have determined in their initial presentation evaluation and coding. Any comparisons drawn between EMD decisions and hospital or diagnostic evaluations must take into account that the dispatcher’s evaluation is based on a single moment in an evolving progression.

LIMITATIONS AND GAPS

Clearly, a significant amount of research in dispatch already exists, laying a strong foundation for a move toward a unified dispatch science. However, significant gaps and limitations also exist in the current research base. The most significant of these are: a lack of consistent or universal metrics; a lack of validation studies and comparative studies; a lack of specific information (in much of the research) about the protocols being studied; few outcomes-based studies and lack of consensus about the most valuable outcomes for study; and a simple dearth of studies in many of the areas listed above, especially in disciplines other than medicine (e.g. fire and police).

The lack of consistent or universal metrics for the conduct of studies is perhaps the most important of these gaps. It is nearly impossible to build upon studies that use different measures and definitions, and differing metrics also make comparing the findings of any two studies very difficult. Some work has been done that discusses ways in which new and consistent metrics and benchmarks could be developed,^{145,146} and several research groups have proposed new types or models for benchmarking in EMS and emergency triage.¹⁴⁷⁻¹⁴⁹ However, despite these attempts at consistency, major metrics continue to be both universally used and inconsistently defined, leading to an appearance of comparability between studies without a real grounds for comparison.

For example, many studies use “response time” as a key metric—appropriately, given that administrators are often given politically- or publically-motivated response time requirements and that the goal of emergency services (or one of them) is fast and appropriate response. Yet the definitions of “response time” are not consistent in their beginning or end times. In some cases, the “clock” starts when the call is received in the communications center. In others, it starts when the dispatcher sends information about the call to responders, or when a response vehicle leaves its garage. End times are similarly unclear; does the clock stop when responders arrive at the address of the emergency, when they report themselves directly by the side of the patient, or when they are en route to the hospital? Similar issues exist in measuring the dispatcher’s time-to-compressions (the time between the caller placing the emergency call for a cardiac arrest and the time they begin CPR): times have been measured from the moment of the initial call to the moment of the first pre-arrival instruction,

to the moment when the helper's hands are placed on the chest, and so on. In terms of protocol use, standard metrics for compliance levels are almost impossible to determine across protocols (since the level of required compliance to, for example, scripted questions varies widely), but some degree of comparability should at least be a goal of future compliance research.

Validation studies are unusual, and notoriously difficult to fund, in any field. However, in a developing and relatively recent field such as dispatch science, validation studies are critical to the creation of a knowledge base on which to grow and build. One reason for the lack of such studies in dispatch research is that many theses and dissertations conducted in this field never become published papers, perhaps because their authors work in operations or administration rather than in an academic setting. Greater efforts to help and persuade such front-line researchers to publish their work could lead not only to more published papers overall, but to more validation and confirmation studies specifically. In many cases, validation or repeat studies would help rectify two of the other key limitations of earlier research: the lack of specific information about protocols in studies that use them and the lack of comparison research. In the first case, the issue is that researchers studying individual agencies or emergency systems have not always described, in any detail, the protocol they are using—and in some cases, have not even provided the name of the protocol used.

Moreover, some researchers have suggested that studies should make it clear whether the "protocol" under examination is in fact scripted protocol systems or is a "guideline"-type system,¹⁵⁰ as this could affect the value of comparisons and generalizations. Information about compliance to protocol has also been conspicuously absent, a significant problem since drawing any conclusions at all about the value of a protocol is impossible unless the dispatchers can be shown to have used it as intended. As Clawson et al. have indicated, dispatch systems may need to be studied at the "atomic" level (by specific chief complaint or determinant/priority code rather than as a whole),¹⁵¹ and compliance levels should be included in all protocol-specific studies.¹⁵² Additionally, almost no studies mention quality improvement or quality management processes, meaning that it is rarely possible to determine what level or amount of feedback dispatchers receive on their protocol use. Confirmation or repeat studies of earlier work, with these vital pieces of information included, would help validate those studies and create a more solid ground on which to build future work.

Although the differences between local agencies and communities, proprietary issues with protocol systems, and other difficulties make comparative research—work that compares the effectiveness, validity, or predictive value of various protocols—unlikely, at least a common set of required information (such as compliance levels, name, type, and version of protocol, and quality processes) would make

comparisons between studies more valuable. Additionally, emergency dispatch researchers could potentially find great value in adapting research from other fields by applying those studies' models and approaches to the emergency dispatch environment. Especially relevant would be studies from high-stress, high-impact fields (flight and military work, for example) and other types of dispatching (air traffic control, railroad dispatch, trucking, etc.), as well as other kinds of shift-work.

Obtaining data about the ultimate outcomes of emergency calls can also be incredibly difficult. While paramedic run reports may be more easily obtained in some cases because paramedics are part of the EMS system, hospital data are often harder to obtain; barriers include multiple Institutional Review Board (IRB) applications to be completed, stringent privacy laws, and other structural factors.¹⁵³ Nonetheless, the determination of which outcomes are most valuable—and some consensus exists that hospital data are ideal—should be a priority. In addition, support for research in communication centers and collaborations between EMS systems, hospitals, and administrators should be encouraged.¹⁵⁴ Such support would help alleviate the last gap in the research, the fact that while much of interest has been done, there is simply not enough dispatch-specific work, and what there is tends to be overshadowed by EMS system research, response times, and other political considerations, and the overwhelming focus on cardiac arrest at the expense of other less visible, but equally important, topics of study.

CONCLUSION

Emergency dispatch and response have never been more important. With aging populations in many countries, increases in chronic disease around the world (and especially in Western nations), economic difficulties in many communities leading to limited or declining resources, increased use of emergency services as primary care by the uninsured, and increasing expectations from the public,^{155,156} emergency services agencies need strong, evidence-based cases for their practices and a deep foundation of research on which to base decisions. Dispatchers themselves, having finally obtained recognition as public safety and public health professionals, will also benefit from participating in research that validates their professional value.

The findings of this review indicate that a surge of interest in dispatch research has occurred over the past 15 years, and especially the past 10. A strong focus on cardiac arrest—although laudable and understandable in itself—has potentially obscured the need for work in many other areas. These include the training and certification of dispatchers and emergency calltakers, the recently-developed field of emergency nurse telephone triage, and studies of the effectiveness or predictive value of specific protocol systems. Also conspicuous by their relative absence are studies on the ability of dispatchers to correctly identify certain types

of conditions, chief complaints, events, and emergencies, and of course peer-reviewed work in the fields of police and fire dispatching. A need for consistent, widely-used metrics, by which studies could be compared and built upon, has also been demonstrated. Some intriguing work in the fields of new communications technologies and “emerging” emergency systems indicate a need for further work in these areas. And finally, this study’s findings suggest that the human side of dispatching, from administration to working conditions to caller interaction and management to quality improvement processes, has begun to receive considerable attention but offers many further avenues for research.

In 1962, just around the same time that emergency services were gaining a foothold in many countries, Thomas Kuhn first argued that scientific work moves in “paradigm shifts,” with new ways of seeing and interacting with the world both building on and replacing those that came before.¹⁵⁷ Dispatching has experienced a paradigm shift over the past 20 years, and dispatch science is now developing the base of work on which its future progress—and future evolution—will be built. For this reason, this is a prime moment in which to identify the priorities around which such progress should grow. A group of researchers in the UK recently published work outlining the highest priorities in emergency prehospital care research;¹⁵⁸ this paper has done the same for dispatch-specific research and the emerging field of dispatch science.

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