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# What every emergency physician should know about research: Introduction to a research primer for low- and middle-income countries

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ABSTRACT

Research is the search for new, generalisable knowledge (Truth in the Universe) to improve our collective ability to correctly diagnose and treat human suffering. In the formal sense, medical research implies both creating new knowledge, and also disseminating that new knowledge as well as putting it into practice. This is the first paper in this Research Primer. It briefly covers why each emergency physician should know and care about research. The paper reminds us that it does not take a physician to do research, but that it is the practicing physician who best knows what new knowledge is needed at the bedside. It introduces the scope of the other papers included in this special issue. The paper reviews the definitions of research and the scope of research practice in emergency medicine; overviews the *hows and whys* of research, as well as discusses the research question, study justification, literature search and touching on research design.

## African relevance

- Most research is small, and changes are incremental.
- Medicine advances are due to the accumulation of small, incremental improvements in practice.
- Every emergency medicine researcher should know the basics of the research process
- any practitioner in emergency medicine, be she physician, nurse or other provide, should feel themselves empowered by this textbook to engage in research.

## The International Federation for Emergency Medicine global health research primer

This paper forms part 1 of a series of how to papers, commissioned by the International Federation for Emergency Medicine. This chapter introduces the Research Primer. It briefly covers why each emergency physician should know and care about research. Several research pitfalls are addressed.

## Background

Research is the search for new, generalisable knowledge (Truth in the Universe) to improve our collective ability to correctly diagnose and treat human suffering. In the formal sense, medical research implies both creating new knowledge, and also disseminating that new knowledge as well as putting it into practice.

Most research is small, and changes are incremental. No one study is definitive and even the best studies need to be scrutinised and challenged. Studies need to be repeated in order to verify results and conducting research in another setting improves generalisability. Medicine advances due to the accumulation of small, incremental improvements in practice. Quality improvement (QI), a related activity, focuses on optimising local practice towards an existing standard or benchmark.

Emergency medicine (EM) research can range from basic science on the physiologic mechanisms of disease or resuscitation, to improving the social and financial determinants of health. It covers better ways of doing what we already do, and better treatment of known diseases. Even the study of the delivery of EM and its practitioners is a legitimate area of study.

Every emergency medicine researcher should know the basics of the research process. This Primer chapter offers an overview: how to choose a topic of study; describes some of the steps in designing a study; and discusses pitfalls during these processes. Finally, we will discuss the importance of knowledge dissemination.

### *The search for truth*

Research is the search for Truth in the Universe. We can never know all of the truth, but from the results of our studies we can learn 'truth in the study' and extrapolate how likely it is that truth in the study represents Truth in the Universe. Sometimes, by chance alone, the results of our study are biased. Results can also be falsified. These are some reasons why research should be replicated. The more times 'truth in the study' has similar results in various regions and practice settings, the more likely it is to represent Truth in the Universe.

Research is fundamental to the evidence-based practice of medicine. Without research, we rely on tradition and teaching, never questioning why we do things a certain way, or if there is a better way. Medical

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practice has one basic goal: helping people to live longer and healthier lives.

If research is the systematic, structured search for new knowledge, what then, does research in emergency medicine (EM) cover? What can we claim as our own field? After all, many others in the house of medicine claim that everything we do overlaps some other specialty.

EM concerns itself with acute deteriorations of health and is the safety net for vulnerable populations. Patients are undifferentiated; presentations varied and often vague; severity ranges from inconsequential to life or limb threatening. EPs see patients who cannot access the local health care system for whatever reason. Our patients are the people whose problems are too acute for other health care providers or those persons who fall through the health system cracks. These are people injured by social infrastructure failures, those referred to EM or those abandoned by their other sources of care.

We make diagnoses when we can; we treat what we can and stabilise the rest. We try to get our patients to the best source of care for their needs. We advocate and fight for our patients and are their allies in the healthcare system. Any topic that falls within these broad limits, that potentially can improve the practice of EM, falls under EM research. It is perfectly appropriate to start small. In fact, that is the best way for the novice researcher to begin a career [1]. After all, a Chinese proverb advises us that a journey of a thousand miles starts with a single step.

We therefore claim as our area of research – our lane – trauma and medical resuscitation and the administration of emergency medical services, social engineering to reduce those injuries and illnesses; common and unusual presentations of diseases; diseases new to medical science and the basic science behind the specialty of emergency medicine. We should always look for new or better ways to improve the care we provide to patients. Evidence-based improvements in emergency care have been shown to improve morbidity and mortality and improve long-term outcomes. We can even propose the development of specialties, sub-specialties or areas of research or development [1,2]. EM research can take place on many levels, from a systems-level view down to a problem on the sharp end of practice. In our lane are: developing and testing clinical decision tools, describing and explaining unusual presentations, developing new diagnostic methods and anything else which can improve our ability to correctly diagnose and treat our patients. Furthermore, EM is not just about diagnosis; we often resuscitate before knowing the diagnosis. Developing tools to assess a patient's physiologic state is also research appropriate to EM. Since we need to know how good our interventions are, we need to follow patients after our intervention, and that is the essence of research: a systematic, structured observation of the results of our interventions.

## Our scope of research

Emergency medicine research, like EM in general, casts a wide net. First, we have the undifferentiated presentation of illness. How can we decide if this person is really sick or merely worried? Our first question is, "Is the patient going to live long enough for me to make a diagnosis? Or do I need to resuscitate first?" Resuscitation is our field. More fluids or less? Lactated Ringers or Saline? Whole blood or packed red blood cells? Is a central venous pressure line needed or an ultrasound of the inferior vena cava? Often in low resource settings and low- and middle-income countries (LMIC), emergency care requires out of pocket costs. Therefore, it is imperative that emergency care providers look for the best and most cost-effective means to evaluate a patient.

Next, we consider diagnosis. Can dehydration be best found with physical exam, lab tests, ultrasound or capillary refill? What tests are worth doing, and what tests waste money or time? Which give too many false positives or negatives? What about pre-test probability, sensitivity and specificity? These qualities change depending on the population.

We need to determine a disposition. "What is the best way to predict which patients need inpatient management and who can be safely discharged?" What medications are most helpful for patients like this one? In LMIC there are limited resources and emergency care providers may not have enough resources for all patients. Therefore, determining which patients will receive which limited resources can be a regular occurrence for EM providers.

We wonder, "Why did my patient get sick?" EM also considers the sociologic determinants of that illness. Which persons are at most risk, and for what? Since we are usually the first to see community outbreaks, we also serve as the early warning system for public health. Have you seen several unexpected cases of something rare, or new? Call your colleagues; maybe they have seen it too. Write up the case series. This is how Legionnaire's Disease was first noticed and later characterised.

Who should do the research? Yes, physicians should be scientists, but science and research can be done by anyone. Research doesn't have to be conducted by physicians. Research at its most basic level requires only a question, a source of data, a way to analyse that data and a way to disseminate the results and conclusions of that analysis. Lyme disease, for example, was discovered by mothers comparing their children who had been diagnosed as having Childhood Rheumatic Disease. The mothers thought there were too many in their small town and wondered if there was a common aetiology. They kept asking questions and gathering data. This disease did not fit the diagnosis and they discovered it was a new disease.

### *Can we do this better?*

Additionally, it is always worthwhile to scrutinise current practice to see if things can be done faster, better, more accurately and with less cost. (Much of this is quality improvement which can be researched.) We can look at current practice and flow. Is there a better way to do this procedure? Less painful? Can the diagnosis be made by ultrasound or by percussion instead of by x-ray or computed tomography scan? Would this medicine do as well if given nasally or rectally, with less risk, instead of intravenous? If we don't have the standard tool, is there something else we can use? If so, should our colleagues know about it? All of these things can be researched.

Although it may take an experienced provider to know what questions should be asked to improve the practice of emergency care, performing research in settings with low resources is critical to advancing care around the world. Seeking help in settings with sparse resources is a necessity. The lack of and shortage of internationally known tools and equipment in LMIC's has created a need for improvisation using locally available materials to makeshift devices. EM organisations often offer assistance with mentoring and assisting junior researchers. Utilising universities in your area that have professors or graduate students who can help with statistical analysis and writing the results section in exchange for authorship is another way to utilise scarce resources and increase chances for success in research.

Not all research requires vast resources. As an example, Christoph had only 25 subjects in a study of lidocaine buffering [4]. Lidocaine is more shelf-stable in an acidic solution. When injected, it burns before it numbs, because it must be first buffered by tissue buffers. Would buffering reduce injection pain? This study showed that it did.

Later studies took the principle further and showed that more buffering was necessary when injecting into the acidic environment of an abscess [5]. This illustrates how one study builds upon another.

## The research question

All research starts with a question or an observation. The ***form*** of that question matters. It has to be specific, operationalised, and observable. A well-formed research question is one that can be answered without ambiguity; and the answer can be statistically manipulated to determine how closely it reflects reality or truth. And, to be do-able, it can be answered with the *resources at your disposal*. Research questions can be conceptualised with defining the population, intervention, comparison and outcome (PICO) or determining if the study is feasible, interesting,

novel, ethical, and relevant (FINER), as *evidence-based medicine focused questions* or as *Refutable Questions*.

The PICO Format is used for Comparative Questions. PICOs always compare two things: two drugs or treatments, the prognosis of two groups, two diagnostic tests, or the harms or benefits of two approaches (Table 1). FINER is a tool to help you organise your thinking (Table 2).

*Refutable Questions* or questions with a *Null Hypothesis* are questions with only an opposite. You want to learn if something is true or not. You hope it will be true, but if it isn't, that is also valuable information. This kind of question is analysed with simple statistics. It only tells you information in one direction.

Example: "Forearm fractures reduced under ultrasonic guidance have shorter emergency department (ED) length of stay than forearm fractures reduced blindly, then checked by standard radiography." The null hypothesis is, "There is NO difference in patient length of stay between the two groups." The study seeks to *reject the null hypothesis*.

Then there are questions which could be answered more than one way. For example, is a new way as good as the old way, better than the old way, or worse than the old way (3 possible outcomes). How you write a question that reflects what the outcome should be? "Is drug X superior to drug Y in lowering blood sugar" would be countered by its' null hypothesis (drug X is not superior). If instead you asked, "What is the difference in blood sugar levels after drug X compared to drug Y?" This implies that X could be superior or inferior or even just the same as Y.

## The literature search

The next part of research is *Who has done what before? Has the question been answered yet?* This is where you take a first look at the literature. The literature review will be covered in Chapter 2. It is important to look more than once. As you read relevant articles, you may change the question, or refine it. From the literature, the background section is written. As you write, make statements and reference them. Make it flow logically. It should look as though prior research has led up to just your question, and that your question is clearly the next logical question to be answered. This demonstrates the small, incremental steps we take to improve medical practice.

### *Justification, or so what? who cares?*

Part of the background should address the relevance and name of the stakeholders who would be interested in the outcomes of your study question. Not only you, but perhaps Public Health Officials want to know if you have seen more than an expected number of cases of diarrhoea in previously healthy young men? (This was how AIDS began to be discovered in the 1980s.) [6] If ultrasound (US) is as good as radiography at diagnosing fractures, but is quicker and less expensive, hospital administrators and finance would want to know. So would the equipment manufacturers. In fact, the manufacturers might even be willing to fund your study to prove it.

**Table 1**
Research question conceptualising using PICO for comparative questions.

| PICO variables | | Example |
|---|---|---|
| P | **Population** (patients or disease): to whom or what does this question pertain? Children only? People who have had a heart attack? Persons with active malaria? | In patients with acute traumatic brain injury… |
| I | **Intervention** (such as a drug or test): What do you plan to do? Give a medication? Count the number of days between episodes of shaking chills? Give aspirin? | …is tranexamic acid… |
| C | **Comparison** (another drug, placebo or test): What is the difference between those who got the intervention and those who didn't? Or those who had the chosen characteristic and those who didn't have it? | …as good as, or better than, placebo… |
| O | **Outcome** (what difference does it make?): What difference do you expect/want to find? | …at reducing head injury related death for patients treated within 3 h of head injury? |

**Table 2**
Research question conceptualising using FINER to organise thinking.

| FINER variables | | Example |
|---|---|---|
| F | Feasible? Can you do this with the resources at your disposal? Be honest with yourself, think about the time it will take (hint: it will always take more time and effort than you expect). Will you have help to do it? Do you have the knowledge and the tools? | Via Surveys, do hospitalised patients… (we have surveyors, we have patients, we have permission to do surveys in the hospital) |
| I | Interesting? Is the question of interest to others, or just to yourself? (This is your *who cares* part, which you should already have begun to address). Show your colleagues why it would matter to them, and/or to your patients, or to politicians, or others. | Do patients think they are routinely HIV tested on each hospital admission? If they think so, they may live with HIV and pass it on, unknowingly. |
| N | Novel? Since you already looked at the literature, you know if someone has already answered the question. But, have they answered that question *for your population*? Perhaps it is well known that IV fluids are helpful in resuscitating septic children in developed countries. Is the same true in your population? And if you learn that it is not, perhaps the next question is *Why not? What is different in this population?* | No articles were found in PubMed on this topic. |
| E | Ethical. Is it ethical to do this? Is it safe for human subjects? Are the benefits likely to outweigh the risk? | Anonymous surveys are generally considered ethical. |
| R | Relevant. What influence will the answer have on whom? | Elucidates the expectations of hospitalised patients. It also affects HIV transmission. Since HIV is epidemic, this question is relevant to all hospitals and to public health. |

## Research design

After you have your question figured out, and you have described the work that has come before and explained why various parties should be interested in your results, you need to address the study design. (Chapter 5 addresses study design in depth. This is a brief overview.) You will need to choose a design that you have the resources to complete. Perhaps you are interested in which medications and illegal drugs are most associated with car accidents. You might not be able to drug test everyone who is in a car accident, because you can't afford to pay for the tests. But, you could ASK them. Of course, there are limitations to a survey: the subjects might provide a biased answer, or they might not be conscious. However, the results of a survey might be valuable, although not as robust as a comprehensive laboratory evaluation.

Before you get further, you have to decide how you will know the answer. Getting information from data is the job of statistical analysis. There are lots of different statistical tests, and which one(s) you use depends on the form of your variables. Are they binary (yes/no, on/off, better or not better) or are they categorical and contain ordinal variables [1,2,3]? (Statistics are covered in Chapter 11). It is IMPERATIVE that you figure out what you are going to do with your results BEFORE you start collecting data. There is nothing more heart-breaking for a researcher than doing a lot of work only to result in useless data that cannot become information.

Once you have your design worked out, and you have chosen all the

variables you need to collect, you have to actually collect the data. (More on acquiring data in Chapter 9.) Once collected, you need analyse the data. Analysed data becomes information. Was there a difference? Did the answers go together or was one thing causal for the other? Your design is different depending on which question you want to ask. Things that commonly go together are *correlated* but correlation does not always imply cause and effect. When one thing *causes* another, there must be a reasonable mechanism proposed for how that could work. For example, skirts are more commonly worn by women. This is a correlation. Clearly, skirts do not cause people to be women instead of men. How could they? There is no reasonable mechanism to postulate that skirts cause femaleness. There is no *causation*. But beards are more common on men. The beard didn't cause maleness, but maleness did cause the beard. When a correlation is found, sometimes it takes more research to learn the causation.

Furthermore, chance must always be taken into account. Did you get these results just by chance or were they likely to have been as a result of what was done? (Again, see Chapter 11.)

Finally, you have your analysed results, from which you must draw conclusions. Be honest! You should describe the limitations of your work (all work has limitations!) and discuss the implications of your work to the various stakeholders.

Once you have completed a research study, the results need to be made known. If you do all that work and never present your work publicly, you have inconvenienced yourself and possibly others without benefiting the practice of emergency medicine. So, present your work! (More on this in Chapters 13 and 14.)

## Pitfalls

- Choose a question/topic that *matters* to both you and lots of others: If there is no passion to answer the question, it will never get done. On the other hand, don't try to do a study all alone. Others will be more likely to help you if they have a stake in the outcome, too. Research is better, and more fun, when it is shared with a team.
- Don't bite off more than you can chew: There is a tendency among novice researchers to want to address big issues, and to collect lots of variables *because we are collecting data anyway*. Remember, it is not ethical to further inconvenience human subjects beyond what is necessary to answer the clinical question. Rather, choose a small subject, one that can be answered with only a few variables, gather that information and complete the study. Small successes lead to bigger successes. A single failure can stop your forward momentum for a long time.
- Talk to a statistician or someone experienced in research design and statistical analysis *before* you begin your study: Waiting until after you have collected data to talk to your statistician can lead you down the wrong path. Remember, you can't fix by *analysis* what you messed up in the *design*. Talk to a statistician and determine your analysis plan BEFORE gathering any data, and before you go to your ethics or institutional review board.
- Failure to do your initial and subsequent literature searches: If you don't know *who has done what* before you start, you cannot stand on the shoulders of giants to see further. If someone publishes almost exactly what you had in mind, celebrate! Not only may the answer to your question be discovered, you can now replicate their study in a different setting to validate (or refute!) what they learned. The methods are yours to replicate.
- Overstating your conclusions: Even the best research intentionally studies only a small sample of the universe. Be humble. Keep your words factual and concise.
- Failure to disseminate the findings: Publication is not guaranteed. Expect to submit to at least 3 journals before your article finds a home. If you get feedback, take it seriously. The reviewers may not sound like they understand what you were talking about. If that's the case, assume they are like potential readers, and re-write your article so they DO understand what you want to say.

## Annotated bibliography

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## Additional resources

Free on-line statistical resources like EpiData; "R"; RedCAP, on-line research primers and books; FOAM-ed [7, 8]

1. Free Stats book http://onlinestatbook.com/
2. Statistics and Probability | Khan Academy https://www.khanacademy.org/math/statistics-probability.

Budget:

1. Doing Great Research Without a Big Budget https://www.pm360online.com/doing-great-research-without-a-big-budget/
2. Creating a Budget | Office of Undergraduate Research undergradresearch.northwestern.edu/budget

## CRediT authorship contribution statement

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: VT contributed 70%; YO, WS and ES contributed 10% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

## Declaration of competing interest

The authors declared no conflicts of interest.

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