Chapter 1
Introduction

Gregory Adam Whitley and Aloysius Niroshan Siriwardena

Chapter Objectives

This chapter will cover:

- The definition of research and an explanation of its importance for prehospital and paramedic practice
- Theory and evidence-based practice
- Advances in prehospital research
- Clinical audit and quality improvement
- Explanation of the research process from initial idea to dissemination
- Areas for future development

What is Research?

Research is the:

> 'creative and systematic work undertaken in order to increase the stock of knowledge'
>
> (OECD, 2015).

Research is *creative*: it is as much an art as it is a science. Answering a research question requires the development of a comprehensive research project, which involves selecting the appropriate research team, study design, population, data collection techniques and methods of analysis; this all requires creativity. The development of novel methods and innovative use of existing methods also require creativity.

Research is *systematic*: following the prescribed steps of published methods and careful consideration of published guidelines are important to maintain rigour. **Systematic reviews** (discussed in **Chapter 3: Systematic Reviews**) and **randomised controlled trials** (discussed in **Chapter 5: Experimental and Quasi-experimental Designs**) have robust guidelines and reporting standards, which should be followed to maintain quality (Moher et al., 2009; Schulz et al., 2010).

Research should *increase the stock of knowledge*: this should allow gaps in the evidence base to be addressed, answer important research questions or create a deeper understanding of complex clinical problems. A problem for researchers is that with more than 1,000,000 articles added to the PubMed database every year (Landhuis, 2016), it is becoming increasingly challenging to manage and synthesise the ever-growing volume of research. When searching PubMed (on 18 April 2021) for 'prehospital' in the year 2000 and 2020, the number of articles found were 235 and 1,887, respectively (an 800% increase in 20 years). Whilst increasing the stock of knowledge is desirable and to be encouraged, we need careful consideration of how the increasing volume of research will be managed effectively, so that important research is implemented into clinical practice to improve patient **outcomes**.

If research increases the stock of knowledge, it is important to briefly consider: what is knowledge? This question relates to the division of philosophy called **epistemology**, which simply refers to the nature of knowledge, and asks questions such as 'how can we know anything with any certainty?', 'must we have evidence to know the truth?', 'what are the limits of knowledge?' and 'how is knowledge acquired?'. The nature of knowledge has been debated for thousands of years, going back to the birth of Western philosophy in ancient Greece during the time of Socrates (470–399 BCE), Plato (429–347 BCE) and Aristotle (384–322 BCE). When we start to question our own knowledge, uncertainty arises. Some may find this concerning. Remember, it is better to be uncertain than overconfident. As Richard Feynman once said:

> 'I can live with doubt, and uncertainty, and not knowing. I think it's much more interesting, to live not knowing than to have answers which might be wrong'
>
> (The Pleasure of Finding Things Out, 1981).

Why is Research Important?

How can we know anything with any certainty? This is an important question to consider when determining the importance of research. Clinicians develop experience during their practice. The longer they practise, the more experience they gain. Over time, clinicians develop opinions about which interventions are effective or not. This is referred to as anecdote and is highly dependent on the exposure of the clinician to various patients and conditions. Anecdotal evidence is useful, especially when there is a paucity of research evidence. However, it is highly biased because the clinician may have been exposed to an unrepresentative group of patients. This may lead them to develop opinions about that group of patients that do not accurately reflect the group at the population level. This means that their opinion may not be useful to inform national guidelines for example.

The **hierarchy of evidence** is useful to consider here. Many variations of the evidence hierarchy exist; see **Figure 1.1** for a standard example.

There are several problems with standard hierarchy of evidence illustrations, as shown in the example provided in **Figure 1.1**. They often do not show the full range of study

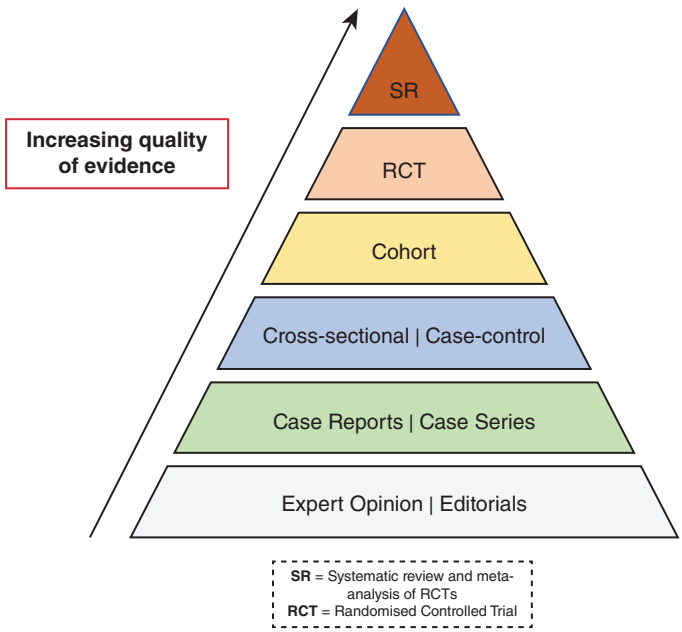

Figure 1.1 – Hierarchy of evidence.

types, such as qualitative or mixed methods studies, nor other types of reviews such as systemic reviews of qualitative studies, literature reviews or **rapid reviews**. These figures do have a simple purpose; they illustrate that in general, as the level of evidence increases from expert opinion to more advanced, robust research methods, the quality of evidence (**validity** and **reliability**) also increases. Validity generally relates to how closely the findings of a study represent the 'truth', and includes the notion of **internal validity**, that is, does the study show what it purports to, and **external validity**, that is, are the findings generalisable, for example: would the findings of a survey of 25 adults suffering diabetes represent the entire adult diabetic population of the UK? This would be extremely unlikely. Reliability generally relates to the repeatability of a study; if it were to be repeated, would the same findings be generated?

A single clinician's expert opinion is unlikely to have high validity or reliability; however, a clinical trial of airway management strategies for out-of-hospital cardiac arrest **enrolling** 9,296 patients across England (Benger et al., 2018) would have much higher validity and reliability. This simple example explains why research is important.

We need high-quality, robust evidence to inform prehospital clinical practice to ensure patients receive optimum care. We need to constantly challenge *current* clinical practice and ask difficult questions, such as 'does this adrenaline I'm giving to my patient with cardiac arrest cause more harm than good?'. The PARAMEDIC2 trial aimed to answer this clinical question, and concluded that the use of adrenaline in out-of-hospital cardiac arrest increased rates of 30-day survival, but did not increase rates of survival with favourable neurological outcome because more survivors had

severe neurologic impairment in the adrenaline group (Perkins et al., 2018). This finding has challenged decades of paramedic practice in which adrenaline has been routinely used as part of paramedic practice.

We need to ask questions about *new* medical devices, such as 'which is the most effective airway management strategy for out-of-hospital cardiac arrest, a strategy of i-gel or tracheal tube first?'. The AIRWAYS-2 trial aimed to answer this and found no significant difference between strategies (Benger et al., 2018). The results of AIRWAYS-2 have influenced the debate about which airway device is better and have reduced the need for paramedics to routinely use tracheal tubes with their risks of injury or incorrect placement.

We also need to ask questions about other new *health technologies*, such as 'do mechanical chest compression devices improve survival in out-of-hospital cardiac arrest compared to manual chest compressions?'. The PARAMEDIC trial aimed to answer this and found no significant difference between the LUCAS-2 device and manual chest compressions (Perkins et al., 2015). Although external cardiac compression devices are still being used in out-of-hospital cardiac arrest, their use is largely limited to specific situations, such as prolonged resuscitation efforts or during ambulance transport.

Research is also important for the professionalisation of ambulance services and the paramedic profession. Civilian ambulance services were first created in the 1860s in the UK and US (Caroline, 2007; Ciottone, 2006), the 1880s in Canada (Ontario Paramedic Association, 2015) and the 1890s in Australia (Ambulance Service of New South Wales, 2018; Queensland Ambulance Service, 2018). The birth of the modern paramedic occurred in the late 1960s and early 1970s (Caroline, 2007; Chamberlain, 2018; White et al., 1973). Ambulance services have developed significantly since the late 19th century and have moved away from the traditional transport model where ambulance personnel were viewed as 'drivers' (Newton, 2012). In England during 2017, in 38% of calls to ambulance services attended by an ambulance, the patient was not transported to hospital (Coster et al., 2019). This illustrates the paradigm shift in prehospital clinical care that has occurred over the last 50 years.

As ambulance services and clinicians become more advanced and focused on patient satisfaction and outcomes, the more urgent is the need for high-quality, prehospital research to inform clinical practice. Prehospital research is important for the professionalisation of ambulance services and clinicians, and high-quality research specific to the prehospital setting is needed to improve patient outcomes.

Theory and Evidence-based Practice

Theory

All research is framed by theory, whether it is made explicit or not (Green and Thorogood, 2018). The use of theory within research should strengthen the purpose or rationale for conducting the research (Green, 2014; Lederman and Lederman, 2015)