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REVIEW ARTICLE

This is not the end, nor is it the beginning—but it is the end of the beginning—getting to grips with the research process

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INTRODUCTION

This is the second article in the series. The first article provided a clear rationale for the integration of research into clinical practice. This article will build on this by illustrating practically how to get to grips with research terminology and to begin thinking about, planning and doing research.

The purpose of this article is to provide a basic introduction to research and to present a guide to the practical stages involved in undertaking research. First the article will consider a rationale for undertaking health research. Second the nature of the research will be explored by focusing into two distinct approaches—experimental type research and naturalistic inquiry. This will give the reader a broad perspective of research design. The different levels of research training will then be described considering the relevance to clinical practitioners. The article will then focus on defining and structuring research questions, choosing a method (or methods) and preparing a research proposal.

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RATIONALE FOR UNDERTAKING HEALTH RESEARCH

In order to develop our knowledge base further, detailed investigations must be carried out to review, assess and interpret the world around us. This is particularly relevant in the area of health care where small advances in knowledge can make a significant difference to patient management. Such research can contribute to the development of a scientific body of professional knowledge in three ways. First, it generates relevant theory and knowledge about human experience and behaviour; second it can be used to develop and test theories that form the basis of specific diagnostic methods and treatment approaches; third it validates professional and health service delivery practices. In addition, the knowledge that we obtain through research is critical in guiding legislators and regulatory bodies.

THE NATURE OF RESEARCH

The essential nature of research lies in the intent to create new knowledge in a field or discipline. It is also important to recognise that it is not only the

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discovery of new facts, which adds to the available knowledge, but also that of new relationships. This is achieved through a process of systematic enquiry governed by scientific principles. The principles differ according to the specific science or discipline in which the research is undertaken.

There are many definitions of research. Kerlinger [1] defined research as a

> systematic controlled, empirical, and critical investigation of natural phenomena guided by theory and hypotheses about the presumed relations among such phenomena

This viewpoint implies that the only legitimate approach to scientific inquiry is that of hypothesis testing. In contrast Depoy and Gitlin [3] define research as

> multiple, systematic strategies to generate knowledge about human behaviour, human experience, and human environments in which the thought and action process of the researcher are clearly specified so that they are logical, understandable, confirmable, and useful

This definition recognises the legitimacy and value of the many distinct types of investigative or research strategies. One method of categorising these multiple research strategies is to define them as either 'naturalistic inquiry' or 'experimental type research' Each strategy follows a distinct form of reasoning and obtains knowledge in a different manner. The major differences between them are defined in Fig. 1.

Radiography research can encompass all the roles and responsibilities that radiographers undertake—for example education, administration and all areas of clinical practice. Radiography research also represents a unique mix of several disciplines including physics, imaging science, physiology and psychology. It is therefore important to recognise that questions initiating research can originate in any discipline within radiography. The breadth of knowledge underpinning radiography means that both naturalistic inquiry and experimental type research will be appropriate.

Domains	**Naturalistic**	**Experimental type**
Primary thinking process	Inductive	Deductive
Purpose	Reveal complexity Uncover meanings of human experience	Predict Explain
	Theory generating	Theory testing
Context setting	Natural environments	Controlled setting

Figure 1 Major differences between naturalist inquiry and experimental type research.

Naturalistic inquiry and experimental type research are founded in two distinctive forms of human reasoning: inductive and deductive, respectively. Experimental type researchers use deductive reasoning and begin with the acceptance of a general principle or belief and then apply that principle to explain a specific case or phenomenon. Radiography research may set out to test theories developed in other settings—for example theories developed in industry have been tested in clinical practice. It may also set out to test theories or models developed by other researchers in radiography. Conversely, researchers working within a naturalistic framework primarily use inductive reasoning. This type of approach involves a process in which general rules evolve from individual cases or observations of phenomena. Inductive reasoning might result in the identification of certain patterns, eventually leading to the formulation of hypotheses or the advancement of general theories, which can be tested deductively.

Consider the following examples:

1. I've noticed previously that every time I kick a ball up, it comes back down, so I guess the next time when I kick it up, it will come back down, too
2. Everything that goes up must come down. And so, if you kick the ball up, it must come down. This is called Newton's law.

The first example uses inductive reasoning, arguing from observation, while the second uses deductive reasoning, arguing from established theory (in this case the law of gravity). As can be seen, the difference between inductive and deductive reasoning is mostly in the way the arguments are expressed. Any inductive argument can also be expressed deductively, and any deductive argument can also be expressed inductively. With naturalistic inquiry and experimental type research there are many research designs. Within experimental type research the

continuum below highlights some of the major categories of the experimental method.

METHODOLOGICAL DESIGNS—EXPERIMENTAL . . . QUASI-EXPERIMENTAL . . . NON-EXPERIMENTAL

The methodological designs range along the continuum according to their degree of control and investigator imposed structure. It is important to note the term design, as it emphasises that all good research should have been planned or worked out in advance. With experimental type research the study should be planned to maximise the amount of control over the research situation and variables. Through control, the influence of extraneous variables (variables which are not being studied but which could influence the results of the study by interfering with the actions of the ones being studied) is reduced. This is to ensure, as far as possible that at the end of the experiment the researcher can draw conclusions. For example

> The introduction of, or change in variable *A* (the independent variable) caused the change in *B* (the dependent variable)

This will only be possible if the experimental design has ruled out the possibility that a variety of factors other than *A* could have caused the change in *B*. Some of the mechanisms of control at the researchers disposal include:

- Sampling—the selection of a sample of subjects that is representative of the population being studied.
- Randomisation—this ensures that each member of the population has an equal chance of being selected.
- Consistency of conditions—ensuring that the study design is such that the conditions inherent in the research are the same for all participants.

At the top of the continuum were experimental designs that have the primary purpose of predicting and identifying causal relationships. These designs have the most degree of control and have been upheld as the gold standard in research. However, in radiography research it may not always be possible or ethical to use randomisation, or to manipulate the introduction and withholding of a diagnostic test or treatment. Also not all research considers causal relationships. Quasi-experimental designs are characterised by the presence of control and manipulation but do not contain random group assignment. At the bottom of this continuum are non-experimental designs, which have the least degree of control. Non-experimental designs can be used to examine naturally occurring phenomena and describe or examine relationships. Any manipulation of variables is done post hoc through statistical analysis. Designs typically used in health research include surveys and observation studies.

For naturalistic research there is great diversity in the designs. Each design is rooted in a different philosophical tradition and theoretical perspective. The language and thought processes used by researchers vary with each design structure and are also quite different from experimental researchers. Naturalistic research designs vary in purpose from developing descriptive knowledge to evolving theories about observed or experienced phenomena. These designs are exploratory and seek to describe, understand, or interpret experiences from the perspective of those in the field. This type of research is generally conducted in the natural context of the participants.

The designs differ according to the extent to which inquiry involves the personal experience and insights of the investigator and also the extent to which the researcher imposes structure in the data collection and analytic processes. The data are qualitative and may comprise of interview transcripts or field notes from an observation study. In addition, data gathering and analysis are interdependent processes. As data are collected the researcher engages in an active analytic process, which also frames the scope and direction of further data collection. It is beyond the scope of this article to give a detailed description of the different research designs. However, article 5 in this series will provide a more detailed explanation.

RESEARCH TRAINING

What is clear from either the inductive or deductive stance is that research requires a rigorous approach. In order to conduct good quality research, education in research design is required. Research education is provided as part of undergraduate degree training. Typically, within undergraduate training and

education, a student will follow a research methods module and then undertake a research project, which usually contributes 20–25% of the degree. However, this training can only be considered an introduction to research skills. Postgraduate education allows further study of research design. This may follow a taught masters degree, where again further research methods training and completion of a dissertation forms part of the programme. An alternative is a masters in research methodology where modules covering the broad perspective of research will be followed. Alternatively higher degrees by research do not comprise of a taught element and are assessed by the completion of a thesis. These include Master of Science degree by thesis, Master of Philosophy degree (MPhil) and Doctor of Philosophy (PhD). They differ in the degree of originality. The MPhil is a less advanced qualification than the PhD in which the researcher is expected to master a content area but does not have to demonstrate originality to the level of that in a PhD. Following a PhD, postdoctoral work should be undertaken which would allow for experience to be gained in managing research teams, bidding for research money, writing for quality peer reviewed forums and also collaborative work with experts from other similar and other disciplines.

In relation to clinical practice a graduate may have the skills to appraise evidence and may have basic skills to complete clinical audit. During the completion of these qualifications there are also various mechanisms that exist to develop research capability in the health professions both formal and informal. Initially health professionals may participate as a data collector, interviewer or in the recruitment of research subjects. However, higher degrees allow more intellectual input into research. A criticism of the current model for research degrees is that normally the research students work on their own and therefore have not gained the managerial skills required to lead research teams. However, Postdoctoral education allows a researcher to work with an experienced mentor to begin bidding for research funds and lead teams. This will lead to taking the role of a principal investigator and assuming responsibility for initiating and overseeing the scientific integrity of the entire research effort. Postdoctoral posts, positions and mentors are, however, limited in the area of health. The new taught clinical doctorate may offer a broader perspective of doctoral training with the expectation that the student gains a much wider understanding of ways of conducting research investigations. However, this is likely to be at the expense of the in-depth intellectual rigor gained conducting the thesis within the traditional PhD. It is beyond the scope of this article to detail these roles in depth, however project management will be the topic of article 4.

BEGINNING A RESEARCH STUDY

So how do you set about planning and commencing a research study? The first steps can often be the most difficult. How do you find a research area; choose a research method in order to develop and undertake a study; disseminate the data? The important thing is to get started—if you spend too much time worrying at the outset about how things will turn out then those first steps may well become the last! This does not mean that this part should be hurried, but it is easy to spend so much time thinking and mulling over issues that nothing gets off the drawing board. We all differ in the way in which we approach life and our attitude to research is no different. As with anything there are certain tasks we are better at than others. Some people find it easy to generate ideas and themes, gaze into a crystal ball, and think laterally. Others may be better at carrying through a task having been sent on their way, systematically working through a set pattern. It does not matter which we are better at, or prefer, the important thing is to begin.

As suggested by Kerlinger [5] and also Depoy and Gitlin [3], research should be approached in a logical and systematic manner, thus a plan of action is vital if you are to reach a successful conclusion. Burns and Grove [2] define this plan as a 'framework'; a development tool which acts as a guide throughout the study and ultimately links outcome to the body of knowledge. The benefits of a well thought out plan or framework cannot be underestimated, it is much easier to think through the results, discussion and conclusions when you know the direction in which you are going. In good research the framework upon which the study is built should be easily identifiable. As shown in the initial article of this series, the first step in the research process is to define a broad area from which the study can be developed, the next is a refinement of the initial idea/thoughts, to 'focus down', leading to the nub of the research. This is often a statement of intent, the research question,

from which hypotheses (if appropriate) may be identified and then supported in the aim(s) and objectives. Once the initial concepts and/or theories take shape the process then moves on to more practical issues such as choosing the research method, study population and sample, ethics, funding and so on. There is a lot to think about and plan but in order to undertake a research study you must start with a subject area. Where does this come from?

FINDING A RESEARCH AREA

Finding a subject or topic to research is sometimes the hardest part of the whole process; it can be intimidating, particularly as a student (undergraduate and postgraduate), when you have to submit a research proposal as part of your degree. The problem is often daunting because people try to create topics from thin air. Brainstorming and abstract thinking form a valuable source of ideas particularly in terms of theories and inductive reasoning but unless you are the sort of person who is adept at this, other starting points may be more beneficial. Further sources of research topics are as follows.

Previous research

Past studies are often a good source of ideas, the benefits of reviewing published literature (electronically and manually), searching the Internet and perusing copies of projects in university libraries far outweigh the time and effort spent investigating. Not only will there be suggestions for further work, triggers for new ideas, they may also have been poorly conducted or deficient so repeating the study (with the appropriate corrections) may be beneficial. A proposed topic area may have already been extensively researched, thus a reasonably quick search could save a lot of wasted effort in the long run.

Clinical practice

The primary purpose of research in the healthcare setting should be to help the patient, whether through improved diagnosis, treatment or standards of care. Observing the actual context or setting may also generate ideas: why/how does this technique work? Is it effective? What are the needs of a particular patient or group? When based on actual practice, research is thus 'applied'. Don't just restrict the process to radiography; research ideas can be translated across from other healthcare settings.

Other people

If you struggle to think of ideas then ask other radiographers, students or colleagues in different health professions if they have any thoughts on a topic. The benefit of undertaking research in multidisciplinary teams is that it enables professionals to view the same situation from different angles and backgrounds. Patients may also be a source of inspiration, informally on a one to one basis or more formally through audit surveys, focus groups etc. A simple comment or even complaint could light the fuse!

Having decided upon a research topic the next stage is to refine it in order to produce the actual question.

FORMULATING THE RESEARCH QUESTION, HYPOTHESES, AIMS AND OBJECTIVES

The nature of healthcare research is such that it regularly attempts to define, describe, predict or explore relationships and issues in clinical practice rather than produce theoretical frameworks or concepts. Thus research questions are often utilised to identify the variables under study, they help direct the initial thoughts to a more tangible enquiry. De Vaus [4, p. 25] suggests four questions to help focus the research

1. What am I trying to explain?
2. What are the possible causes?
3. What causes will I explore?
4. What are the possible mechanisms?

Research questions in radiography could include:

1. What are the core skills of a radiographer?
2. Does giving a patient information leaflet improve compliance/understanding in an investigation or treatment?
3. Is MRI better than CT in imaging soft tissue injuries?
4. Are age and gender useful in predicting the prognosis of childhood leukaemia?

Research questions differ from hypotheses in that a hypothesis is a more definitive statement, an

'educated guess' of the relationship between the variables under study [6]. The decision to use a research question rather than an hypothesis often rests upon the amount of background knowledge a researcher may have about the topic and the outcomes can be 'anticipated or predicted' [2]. In the above examples, the first question on core skills would be inappropriate for producing an hypothesis, the others could be stated as follows:

1. Using a patient information leaflet will improve patient's understanding of a barium enema examination/the effect of radiotherapy.
2. Magnetic Resonance images have greater diagnostic value in the interpretation of soft tissue injuries than those produced by Computed Tomography.
3. Prognosis in acute leukaemia is related to the age and gender of the child.

The research design would be selected, put into practice (operationalisation) and statistically tested to determine whether the hypothesis should be accepted or rejected.

In order to further refine the research it is normal to develop aims and detailed objectives. The aim is often similar to the research question but it does not have to be, although in many cases the two are used interchangeably. Objectives are more detailed and as Bowling [1, p. 38] suggests they are 'operational tasks which have to be accomplished in order to meet the aims'. In simple terms, an aim can be considered as 'what you want to know', the objectives 'how you are going to do it'. An example of an aim and objectives are shown below:

The aim is to investigate whether the introduction of a patient information leaflet improves patient's understanding of the side-effects of radiotherapy to the head and neck region.

The objectives are to:

1. Design a patient information leaflet for patients undergoing radiotherapy to the head and neck region.
2. Undertake a questionnaire survey of patient response to the design, suitability and understanding of the content of the leaflet.
3. Identify the number/percentage of patients who did/did not feel that such a leaflet was helpful in improving their understanding of the side-effects of radiotherapy to the head and neck region.
4. Identify the number/percentage of patients who did/did not feel that such a leaflet was of benefit to them.

Aims and objectives are vital to the overall process as they invariably appear in different parts such as the review of the literature, results, discussion and conclusions. Well written aims and objectives will guide the researcher throughout the study, they should be continually referred to and help 'glue' the work together. They are also important when a study is reviewed for funding or ethical approval, as the assessors will want to see succinct and achievable measures. In summary, it is not always necessary, or even possible to have a hypothesis, but you should always have a research question/aim(s) and objectives that enable you to fulfil the research.

THE RELATIONSHIP BETWEEN RESEARCH QUESTION, HYPOTHESES AND SELECTING A RESEARCH DESIGN/METHOD

The nature of the research design also determines whether it is a research question or a hypothesis that is used. In experimental designs causal relationships are predicted and tested, whereas qualitative research often looks for reasons behind relationships, the first *must* use a hypothesis in order to make full benefit of inferential statistical tests, the second *might*, but invariably utilises a research question. Polgar and Thomas [7] suggest that when qualitative research utilises a grounded approach, where themes and concepts emerge from the research, it can become prejudiced when predictive statements (hypotheses) are used prior to the research being completed. The specifics of selecting a research design will be explored further in Article 5 of the series.

ETHICAL IMPLICATIONS FOR PLANNING RESEARCH

An important consideration that can often be overlooked when planning research is the impact of ethical issues. It is inappropriate to subject patients/

clients or colleagues to investigation, questioning or observation purely for research purposes. Such activities must be defensible and proper in the eyes of the people being researched not just those of the researcher. To this end the National Health Service (NHS) utilises Local Research Ethics Committees and Multi-centre Research Ethics Committees (LREC/MREC) to make sure that any research within the NHS, on patients or staff, conforms or complies with expected national and international ethical standards. The underpinning principle is one of beneficence—no harm should be allowed to occur and the outcome of any research project should have palpable benefit, if not directly for the people/subjects involved, then for those who come after them. In terms of designing research this means there must be due deliberation given to the ethical issues that may arise and an explanation of how these would be overcome. This could include such areas as anonymity and confidentiality, informed consent, possible harm, changes from 'normal' practice, storage of data, and with reference to radiographic research, the use of ionising radiation. A more in-depth review of the ethical issues of research will appear in a later article.

THE RESEARCH PROPOSAL

Once the research has been put together one is very likely to submit a formal proposal before commencing the study. This may include a variety of submissions to a university committee, NHS Trust-Research and Development committee, Ethics committee and funding body. Dependent upon the committee this may involve scrutiny of scientific validity as well as ethical implications, thus the more time and effort given to producing an acceptable proposal, the greater the chance of acceptance. The actual layout and question construction of proposal forms will differ but essentially they ask you the reasons why the study is being proposed (justification), aims and objectives, benefits, the research method, data analysis, costs, ethical issues and timescale. Committees may also ask to see some evidence of a questionnaire, interview schedule or experimental protocol, if not complete, at least in outline.

THE END OF THE BEGINNING

The mechanics of putting together and completing a proposal, is often the end of the planning stage in the research process, it helps to define and make the research idea tangible as it sets out the background, method, data analysis and ethical issues. It also gets the researcher to formulate a timetable of events or project milestones that should be used as a reminder of where you ought be at for the different stages of the research.

In the next issue of *Radiography* we will look at how to find and undertake reviews of peer/grey literature and also show how the existing body of knowledge should/could be used to shape your research.

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