Clinical research 5: Quantitative data collection and analysis

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Summary This six-part research series is aimed at clinicians who wish to develop research skills, or who have a particular clinical problem that they think could be addressed through research. The series aims to provide insight into the decisions that researchers make in the course of their work, and to also provide a foundation for decisions that nurses may make in applying the findings of a study to practice in their own Unit or Department. The series emphasises the practical issues encountered when undertaking research in critical care settings; readers are encouraged to source research methodology textbooks for more detailed guidance on specific aspects of the research process.
A couple of points:

1. It is artificial to describe research as qualitative or quantitative. Studies often include both dimensions. However, for the purposes of this paper/series, this distinction is drawn for clarity of writing.
2. It is common practice for quantitative studies to refer to study 'subjects' and qualitative studies to refer to study 'participants'. For ease of reading, the latter term will be used throughout this series.

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Introduction

This paper addresses the major principles of quantitative data collection and analysis. In quantitative research, there are fundamentally two approaches to answering research questions:

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descriptive (observation of phenomena without interference) and experimental (manipulation of phenomena to observe the effect). Data collection in both approaches has many similarities and these similarities are discussed below in terms of quantitative research methods overall. The analysis of data is determined by the research aims and design of a study (descriptive or experimental), the level of data collected and the characteristics of that data.

Quantitative data collection

The fundamental principles guiding data collection in quantitative research are that data are derived in a way that is independent of the expectations of the observer and that the data are true representations of a phenomenon. Quantitative data collection is guided by four major objectives:

Empiricism: observation and measurement that can be replicated by others.
Measurement: careful and explicit definition of the tools (scales or questionnaires) or devices (instruments such as sphygmomanometer) used to measure phenomena.
Replicability: ensuring that the results obtained can be repeated in replication studies by other investigators.
Objectivity: seeking to eliminate any biases in the way data are collected and interpreted so that conclusions reflect the true facts about a phenomenon.

Whether or not these objectives have been met in a particular research study can be determined by scrutinising the design of the study, in particular, the way the phenomena of interest are defined, the instruments or tools used to collect data and the procedures used to apply the measurement instruments.

Measurement

In quantitative research, the phenomenon of interest is generally assumed to vary between people, or within people before and after a particular event, hence, this phenomenon is termed a *variable*. Variables can refer to any characteristics relevant to a particular research question and therefore can take many forms. For example they can refer to the sex of a participant, the time it takes for a wound to heal or the coping strategies used in certain situations. The careful definition of variables of interest is essential in order to meet the fundamen-

tal assumptions of quantitative research discussed above and to select appropriate measurement instruments.

For example, Wynne et al. (2004) were interested in discovering whether three different types of sternotomy wound dressings applied after cardiac surgery affected wound infection, wound healing, comfort and cost. The variables of interest in this study were the three different wound dressings (gauze and tape, Duoderm thin®, and Opsite®), wound healing, infection, patient comfort and cost. This was an experimental study because a variable (wound dressing) was manipulated to test its effect on other variables (wound healing and comfort, etc.). In experimental studies, the variables manipulated are termed *independent variables*; in this case the independent variable was the type of wound dressing. The particular effects that manipulation of an independent variable are expected to have are termed *dependent variables*, in this case, the dependent variables were wound healing, infection, comfort and cost. The manipulation of the independent variable occurred by randomly allocating patients to one of the three different dressing types.

We can see that in order to ensure that the observed effect of the wound dressing on patient outcomes was a reflection of the true effect of these dressings and not the result of a myriad of other factors, it was essential to carefully define each variable, use the same procedure in both applying the dressings and collecting data from every patient, and to use appropriate tools to measure wound healing, infection and comfort. Importantly, making this process explicit makes it possible for other researchers to replicate the study and the findings. In addition, clinicians can judge whether the findings are reliable and should use them to inform their practice.

The careful *definition of variables* to ensure systematic measurement is termed *operationalising variables*. In the Wynne et al. study for example, wound healing was operationalised by assessing both wound approximation and skin integrity. Approximation had four categories: total, partial (<2 cm of superficial separation), moderate (>2 cm of superficial separation) and dehisced (complete separation of layers). Surrounding skin integrity had three categories: normal (pink, no redness), inflamed (heat, redness, swelling) or macerated within a 2.5 cm border of the incision.

Detailing the *data collection procedure* ensures the same protocol is used every time data are collected. This means that data are collected systematically and any potential confounders are controlled. That is, that any variability in measurement