THE USE OF SINGLE-CASE EXPERIMENTAL DESIGNS TO EVALUATE NURSING INTERVENTIONS FOR INDIVIDUAL CLIENTS

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ABSTRACT

Nurses are increasingly called upon to devise interventions for individual clients. These interventions must be effective for the purpose for which they are designed if they are to be considered appropriate for the client for whom they were devised. Single-case research methodology offers the practising nurse an easy to use strategy for assessing the efficacy of individualised interventions, with the controls of an experimental design and the flexibility required for use in applied settings. This paper describes the basic principles underlying the use of these designs and illustrates their application in assessing the efficacy of interventions with individual clients.

INTRODUCTION

The role of the experienced registered nurse increasingly requires them to devise nursing interventions for individuals with complex and often unique problems. Individualised interventions must, by definition, be appropriate for the client served but may or may not be effective for a larger cohort of patients. One criterion for appropriateness is effectiveness. An intervention may be effective but not appropriate; however, it cannot be appropriate if it is not effective.

Interventions must, therefore, be assessed to ensure that they are indeed effective for the individual concerned (Hens 1989; La Grow and Murray 1992). To date, the formal assessment of planned nursing interventions for individual patients has, at best, been challenging and time consuming and, at worst, not done at all. One reason for this has been the apparent lack of an appropriate methodology that is both easy and flexible enough to use in applied settings, yet still maintains the necessary controls for demonstrating the effectiveness of individualised interventions. Single-case research designs have been specifically recommended for use by nurses as a design that meets these specifications (Behi and Nolan 1996; 1997; Newell 1992; 1998). However, a literature search shows that to date they have not been used to any extent by the nursing profession. In fact, out of 81 studies which used single case designs identified in this search, only five (Beecroft 1993; Day and Monsma 1995; Duff 1996; McMahon and Kermode 1998; Stewart et al 1994) were published in nursing journals.

In single-case methodology, the individual or single-case is the focus of the study. The subjects serve as their own control, objective measures are taken repeatedly over time and the results are portrayed graphically and analysed

visually without the need for sophisticated statistical analysis or inference from standardised distributions (Bobrovitz and Ottenbacker 1998; Van Hasselt and Hersen 1981). Although generalisation beyond the confines of a given study is possible, it is only done after a great deal of direct and systematic replication has been carried out. The point of this type of research is not to generalise to other cases, as is commonly the case for more traditional group designs, but to demonstrate the efficacy of a particular intervention for a given subject or subjects.

Single-case experimental designs, also known as single-subject research designs refer to a class of designs including the simple A-B design, the withdrawal or reversal design, the multiple baseline design and the alternating treatment design, among others. These designs may be used with one or more subjects. The subjects or cases are not samples representative of populations. Rather, they are single subjects or cases even if they are made up of a number of persons. As a result, a patient, patients in a program, a ward, a hospital or even a region may be seen as a single case and therefore be an appropriate subject for one of these designs. The independent variables are interventions designed to change behaviour in a desired direction. In this case, the interventions used are nursing interventions and the behaviours observed are those which nurses seek to alter, affect, change or promote through intervention. They may be those which are necessary for sustaining life (e.g. breathing, control of body temperature, eating and swallowing, bladder elimination, bowel elimination, sleep and rest, maintenance of skin integrity), participating in life (e.g. personal hygiene and grooming, written or spoken communication, movement, mobility, sexuality and sexual function, work and recreation, accessing home and community, and coping behaviours), or simply making life more enjoyable or endurable (e.g. reading, recreation, levels of comfort) (Dittmar 1989).

Simple A-B design

The A-B design is the simplest of the single-case designs. Three examples of its use were found in nursing journals from our search. In these, the A-B design was used to investigate:

(a) the use of Fruitlax, a natural laxative, on the bowel movements of seven children with a variety of disabilities who experienced chronic constipation (Day and Monsma 1995),

(b) the differential effects of psychosis versus behavioural manipulation on the social behaviour of a patient with schizophrenia (Duff 1996), and

(c) the efficacy of aromatherapy on motivational behaviour in a dementia care setting (MacMahon and Kermode 1998).

The A-B design is the most basic of all single-case designs. In it, the subject's behaviour in the A or baseline phase is directly compared to that in the B or intervention phase. In baseline, the behaviour is allowed to occur naturally under normal or near normal conditions. The target behaviour is observed for at least three sessions to ensure that a stable rate of behaviour is being observed. If the behaviour is seen to be stable or deteriorating during these three observations, treatment may begin. If the behaviour is unstable or improving, however, the baseline condition is continued until stability or a counter therapeutic trend is observed (Barlow and Hersen 1984).

Treatment or intervention is then introduced and its effect on the target behaviour is observed during the B phase. No other conditions are altered. Thus the two phases are identical except that intervention is introduced in one phase (B) and not the other (A). Behaviour across the two phases is directly compared using visual analysis to see if there has been a change in the level of response. A marked difference in the behaviour across the two phases with no or minimal overlap occurring across phases is required before it is accepted that a difference has been observed.

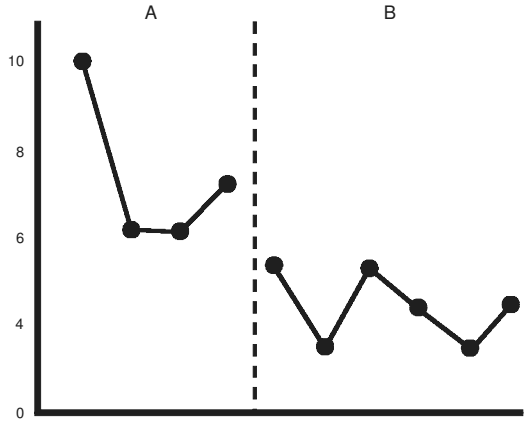

Figure 1: Quasi-experimental A-B design with marked change across phases.

The A-B design is a quasi-experimental design at best and, as a result, provides no real way of determining if any change observed across phases is in fact due to the intervention used or to other variables not under the experimenter's control. Therefore, little can be said about the controlling effects of the treatment variable or if the intervention used is indeed effective. Any improvement observed could be the result of any number of factors not directly under control (Van Hasselt and Hersen 1981).

Further manipulation of the independent variable is required before we can confidently conclude that control has been established and that improvements observed in the target behaviour are indeed due to the intervention used. This is accomplished by reintroducing the conditions

of the study including both the baseline and intervention phases (A-B-A-B) in what is known as a simple withdrawal design.

The withdrawal design

None of the studies found in the nursing journals used the simple withdrawal design. However, Stewart et al (1994) used a similar design, the randomisation design which uses the same logic but relies on statistical manipulation of the data and random introduction of the A and B conditions to establish control of the independent variable over the dependent variable.

Control is established in both the withdrawal and randomisation designs by directly replicating the conditions of the A-B design. In doing so, the researcher seeks to demonstrate that:

(1) change in the dependent variable occurs in the desired direction only when treatment is applied,

(2) the change is in the undesired or non therapeutic direction when treatment is removed, and

(3) behaviour changes in the desired direction once again when treatment is reinstated (Bellack and Hersen 1977).

Only if all three of these conditions are fulfilled can it be said that control has been demonstrated.

The A-B-A-B or withdrawal design is the simplest of the single-case designs to meet the criterion for establishing experimental control. The more often this can be demonstrated, the more confident the researcher can be that control has been established. Thus, the simple A-B-A-B or withdrawal design may be extended to include additional demonstrations of control (e.g. A-B-A-B-A-B) to meet this end.

While the simple withdrawal design may be used to demonstrate that a given intervention is effective in controlling the target behaviour, it is not useful in itself for determining if the intervention selected is indeed the most effective intervention of those available. This may be accomplished with a number of designs that extend the simple withdrawal design, including the randomisation design, while continuing to follow its basic pattern (Barlow and Hersen 1984).

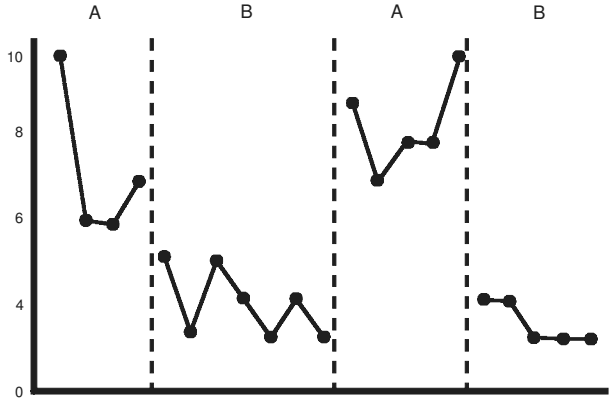

Figure 2: The simple withdrawal design, an experimental design with marked change across phases and an adequate demonstration of the controlling effect of the intervention over the dependent variable.

Extending the withdrawal design

Using these extended designs, interventions may be compared against one another, as well as against baseline conditions. This is generally done by extending the simple withdrawal design (A-B-A-B) to include a comparison between the intervention used in B to one in a new phase labelled C to designate that a different intervention is now being used. Generally in single case designs only one variable is changed at a time, so it would be typical to use the following strategy to do this: A-B-A-B-C-B-C-B. In this way, the researcher can evaluate if B results in a marked change of behaviour over A and likewise if C results in a marked change over B. It is also possible to determine if the two are more effective together than just one alone. This question would be examined in the following manner: A-B-A-B-BC-B-BC.

Any number of combinations can be made for comparison as long as researchers are systematic about the way they alter the conditions. The relative effectiveness of a number of interventions may also be examined before deciding which to employ. In this case the alternating treatment design could be employed which is also a variation of the simple withdrawal design.

In the alternating treatment design, a comparison phase (B) follows the initial baseline phase and precedes the true intervention phase (B'). This design would follow the same pattern as the simple withdrawal design and look like the following: A-B-B'-A-B' and is often used when researchers don't know which intervention would prove best, or the level at which a given intervention should be employed.

No example of the use of an extended withdrawal design was found to be published in nursing journals in our literature search. Duff (1996) added a C phase to the simple A-B design to make it essentially an A-B-C design. However, since there were no return to baseline phases in Duff's study it cannot serve as an illustration of these designs. Therefore, figure three is taken from a study by Ponchillia, Richardson and Turner-Barry (1990) published in the *Journal of Visual Impairment and Blindness* for this purpose. In this study, the alternating treatment design was used to determine the relative accuracy and safety of six commonly used devices for measuring insulin for three blind diabetic subjects. Figure three contains the data from this study for both percent accuracy and safety for one of the three subjects involved.

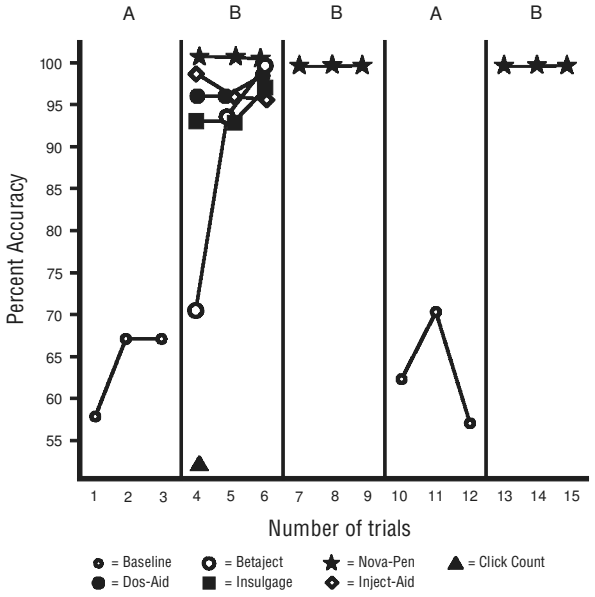

Figure 4. Subject Two, percent accuracy

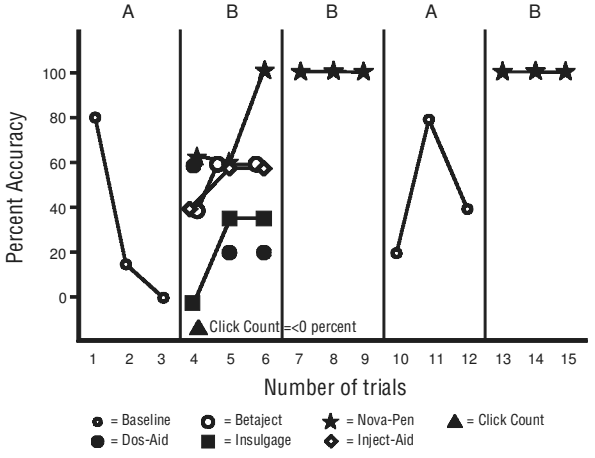

Figure 5. Subject Two, percent safety

Figure 3: From Figure 5 Ponchilla, S. Richardson, K., and Turner-Barry, M. 1990. The effectiveness of six insulin management devices for blind diabetic persons. *Journal of Visual Impairment and Blindness*. 84, 364-369. Reprinted by permission from the American Foundation for the Blind.

Multiple-baseline designs

In some cases the use of simple withdrawal designs and their variants may not be feasible. For example, effective treatment cannot be ethically withdrawn when the withdrawal would result in harm to the subject. Even if withdrawing the intervention would not prove harmful, some therapists are reluctant to revert to baseline when sought after gains had been achieved with treatment.

Withdrawal designs are also inappropriate when interventions include or consist of irreversible instructional or cognitive components. Under these circumstances, the multiple baseline design is likely to be the approach of choice (Van Hasselt and Hersen 1981).

Beecroft (1993) used a multiple baseline design across six subjects to evaluate the effectiveness of a social skills and cognitive restructuring intervention for adolescents undergoing haemodialysis. The multiple baseline design essentially evaluates the effects of treatment applied in succession to subjects, settings or targeted behaviours which are independent of one another (i.e. a change in one subject, setting or behaviour should not result in a change in the others). Control is demonstrated with the multiple baseline design through systematic internal replication over at least three different conditions (i.e. subjects, settings or behaviours). 'The controlling effects of the intervention are inferred from the rate changes [which occur] in the treated subjects, behaviours or settings, while rates remain unchanged in the untreated conditions' (Hersen and Barlow 1976, p.240).

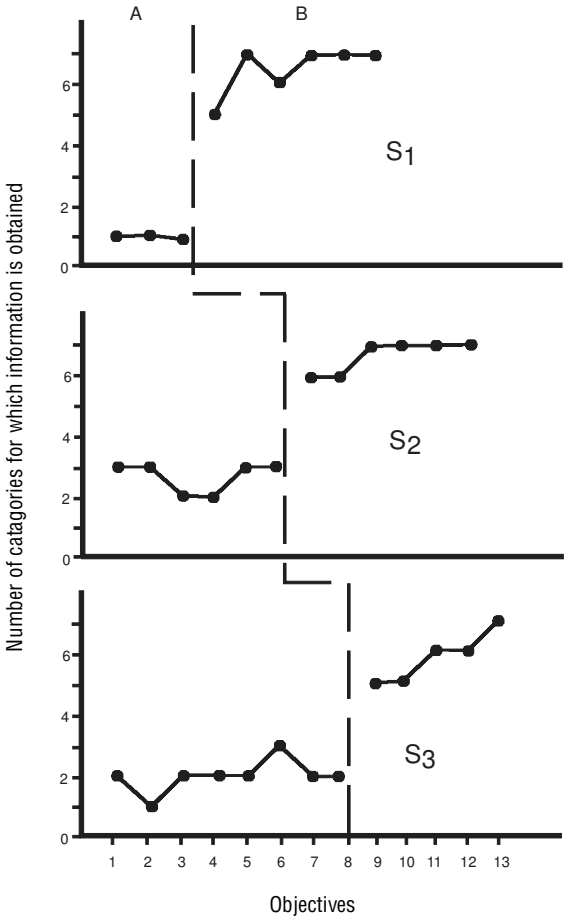

Figure 4: The multiple baseline design across subjects in an experimental design with marked change across phases and subjects and adequate demonstration of the controlling effect of the intervention over the dependent variable.

This design, like the simple withdrawal design, requires a demonstration that behaviour changes with direct intervention and remains unchanged without intervention. To accomplish this with the multiple baseline design, a staggered introduction of the intervention is required with correspondingly longer baselines for each successive subject, behaviour or setting that is observed.

The relative effectiveness of interventions may be evaluated by extending the multiple baselines in much the same way as done when extending the withdrawal designs, as long as the principle of successive and sequential introduction of each new condition is observed. Thus, the minimum of three subjects, settings or behaviours may be extended to four, five, six or more.

CONCLUSION

Single-case research designs have been specifically recommended for use by nurses (Behi and Nolan 1996; 1997; Newell 1992; 1998). Yet, the use of these designs has not been taken up by this profession to any noticeable degree to date. Only five studies, of 81 identified in a literature search were found in nursing journals. Most of the others were in psychology, rehabilitation, physiotherapy and occupational therapy journals. Furthermore, only one of the five was carried out with a subject who did not have a psychiatric or physical disability (Beecroft 1993). This is not too surprising as these designs are most commonly employed in rehabilitation or special education settings. It does however, serve to illustrate the fact that these designs have yet to be used to investigate more mainstream nursing interventions.

One reason that these designs are so commonly used in rehabilitation and special education settings is that interventions in these settings are generally individualised to meet specific needs, and therefore these designs are well suited for evaluating the effectiveness of such interventions. As the role of the experienced registered nurse continues to require them to devise individualised interventions for their clients, it is likely that the utility of these designs will be increasingly appreciated by this profession and their use become more common. One would expect that as their use becomes more widespread so too will the sophistication of the designs employed. At this time, only the most basic designs have appeared in the nursing literature, with three of the five identified using the simplest A-B design, which at best may be considered a quasi-experimental design, and therefore does little to demonstrate the controlling effects of the interventions studied.

Ethically, there are no special considerations to make when using these designs that should not be considered as a matter of course when conducting any study that requires the application of an intervention. The specific design used may be dictated by a number of ethical principals, as are the procedures and practices involved in the study. Probably of more concern is the ethical issue that arises when interventions are utilised and their effectiveness is not assessed when an appropriate methodology exists. Single-case research designs are ideal for evaluating the effectiveness of interventions with individuals and are therefore ideal for use by experienced registered nurses, especially those working in community settings.

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