JOURNAL OF CLINICAL RESEARCH BEST PRACTICES

Vol. 10, No. 5, May 2014 "Happy Trials to You"

Making Sense of Biostatistics: Latin Squares

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The Latin square design can be used in clinical research to control the variation in two independent dimensions within an experiment when each patient receives each treatment. The treatments are assigned within rows and columns. Rows and columns can be any two sources of variation in an experiment. In this design type, each treatment option may appear only once per row and once per column. Therefore, there are equal numbers of rows, columns and treatments.[1] A significant assumption with the Latin square design is that the three factors being evaluated do not interact; if this assumption is violated, invalid results will be obtained.

The Latin square design (Figure 1) provides a simplified alternative to a three-way analysis of variance (ANOVA) design, avoiding the large numbers typically required by ANOVA.

Figure 1. Latin Square Design

A	B	C
B	C	A
C	A	B

This design is probably under-used in clinical research because statistics textbook examples tend to be restricted to the field of agriculture. Agricultural examples often reflect geographical designs, where the rows and columns are literally two dimensions of a grid in a field. This representation does, however, provide a good way to visualize this design type. In this sense, a Latin square design is a generalization of a randomized block design with two different variables, e.g., patient and treatment.

Example

Say we want to test five different skin cream dosages on five patients over five weeks. Testing for a single dosage on a single patient will require one day, allowing six days to eliminate any carryover effect from one treatment to the next.

To provide structure to the set of treatments, we can design the experiment using the Latin square (order of 5). In Figure 2, the rows are the patients (P1-P5), the columns are the weeks (W1–W5), and the cells are the dosages (A-E). There is no need to assign dosages randomly to cells. With this design, every dosage is tested on every patient.[2]

Figure 2. Example of Latin Square Design

	W1	W2	W3	W4	W5
P1	A	B	C	D	E
P2	B	A	D	E	C
P3	C	E	A	B	D
P4	D	C	E	A	B
P5	E	D	B	C	A

References

1. Dénes, J.; Keedwell, A. D. (1974). *Latin squares and their applications*. New York-London: Academic Press. p. 547
2. R. A. Bailey, Orthogonal partitions for designed experiments, *Designs, Codes and Cryptography* 8 (1996), 45–77.

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