The Transradial Learning Curve and Volume-Outcome Relationship

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KEYWORDS

• Cardiac catheterization • Learning curve • Percutaneous coronary intervention

KEY POINTS

- Learning curves involving medical procedures are confounded by many known and other poorly recognized factors.
- Despite the limitation in the medical science of learning curves, recent data suggest a learning curve of 30 to 50 cases for transradial interventional procedures.
- Although learning can be measured based on x-ray exposure or contrast use, the metrics of improved patient safety from access site complications or preservation of procedural success seem to have no learning curve.
- Benefits from conversion to transradial from transfemoral catheterization seem to start immediately in the learning process and exist despite differences in volume.

INTRODUCTION

Adoption of transradial technology in the United States during cardiac catheterization has trailed that of many other countries around the world. One of the explanations offered for this lagging transition in the United States has concerned the concept of learning curves and inadequate procedural volume in the United States. In this article these issues are discussed and the present understanding of the evidence explored.

BACKGROUND

Learning curves in health care typically follow a power curve relationship although a wide variety of other relationships are potentially observable.[1] The power curve typically measures an outcome on the y-axis as cumulative experience is documented along the x-axis, as shown in Fig. 1. The learning curve can be used to quantitate the number of procedures needed to start to attain proficiency by statistically defining the point or region of the curve where incremental benefit starts to diminish with each additional procedure or experience. Although this point should not be considered the true point of mastery, it does seem to indicate an initial level of proficiency in the learning cycle.

DESCRIPTORS OF LEARNING CURVES

The use of the adjective steep, as in steep learning curves, can indicate either a portion of the learning experience in which incremental advancement is large per unit of experience, or may also refer to a learning experience that is long to attain the required proficiency. Therefore, the use of the term steep, or its contrary descriptors, can be confusing and at times inappropriate unless the procedure or outcome is being compared with a known learning curve. A curve is only steep or long when it is comparable with another curve measuring a similar activity.

LEARNING CURVES IN MEDICAL FIELD

The learning curve is conceptually simple and self-evident as an extension of the classic proverb: practice makes perfect. It is the application

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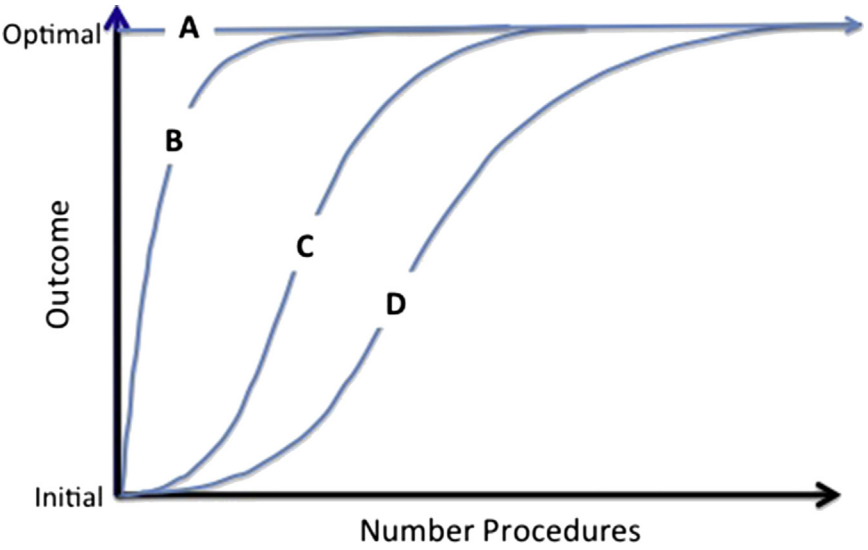

Fig. 1. Typical learning curves plotting increasing number of procedures against outcome. Curve A represents no effective learning curve with advantages of a new procedure instantly available on the switch to new procedure. This curve might be representative of the reduction in access site complication seen immediately on starting radial procedures. Curve B shows a quicker or shorter learning experience versus curve C. Curve D represents a longer learning experience versus curve B, and curve C and represents a steeper or harder learning curve.

of this concept in the medical field and use in the individual physician that presents a variety of issues.

- Medical procedures and treatments are done in an environment with confounders distinctly different from what might be easily controlled on an industrial factory floor.
- Each procedure is performed on different patients with individual characteristics affecting outcome, and different operators with varying background experience and individual learning personalities.
- Each institution where these procedures are performed differs by institutional provisions and variations in support staff capabilities.

CONFOUNDING FACTORS

Variability in Operators

In transradial procedures, the mix of variables to adjust can be daunting. For example, the following considerations are related to operator or physician learners:

- Transradial techniques are new procedures being adopted by operators whose background experience may vary from those fresh from fellowship training to others who have been in practice for multiple decades.
- In measuring outcomes, there is often difficulty in retrospectively defining why the operator chose the patient to undergo the selected procedure verses another approach.
- Operator confidence is difficult to ascertain.

Operator Confidence

An early positive experience on low-risk patients with a new technique could skew the curve if later exuberance causes the operator to take on higher risk patients before the skill set has matured. An example of this phenomenon can be seen in Fig. 2 from the arterial closure literature in which later patients subjected to the procedure were at higher risk for adverse outcome. The net success therefore decreased, at least transiently, while further experience was acquired.[2] The reverse is also possible: a lack of confidence despite a reasonable outcome can delay rapid adaption of new skills. Operators starting a new procedure in a nonsupportive environment might experience a delayed learning curve. Some of the delay in transradial adaption in the United States may be considered an example of this phenomenon.

Different Modes of Learning Same New Information

The medical learning environment is difficult to understand and model for understanding.