The Pareto Analysis for Establishing Content Criteria in Surgical Training

Kelvin H. Kramp, MD,* Marc J. van Det, PhD, MD,*,† Nic J.G.M. Veeger, PhD, MD,‡,§ and Jean-Pierre E.N. Pierie, PhD, MD*,¶

*Department of Surgery, Leeuwarden Medical Centre, Leeuwarden, The Netherlands; †Department of Surgery, Hospital Group Twente, Almelo, The Netherlands; ‡Department of Epidemiology, Leeuwarden Medical Centre, Leeuwarden, The Netherlands; §University of Groningen, University Medical Centre Groningen, Department of Epidemiology, Groningen, The Netherlands; and ¶Post Graduate School of Medicine, University of Groningen, University Medical Centre Groningen, Groningen, The Netherlands

INTRODUCTION: Current surgical training is still highly dependent on expensive operating room (OR) experience. Although there have been many attempts to transfer more training to the skills laboratory, little research is focused on which technical behaviors can lead to the highest profit when they are trained outside the OR. The Pareto principle states that in any population that contributes to a common effect, a few account for the bulk of the effect. This principle has been widely used in business management to increase company profits. This study uses the Pareto principle for establishing content criteria for more efficient surgical training.

METHOD: A retrospective study was conducted to assess verbal guidance provided by 9 supervising surgeons to 12 trainees performing 64 laparoscopic cholecystectomies in the OR. The verbal corrections were documented, tallied, and clustered according to the aimed change in novice behavior. The corrections were rank ordered, and a cumulative distribution curve was used to calculate which corrections accounted for 80% of the total number of verbal corrections.

RESULTS: In total, 253 different verbal corrections were uttered 1587 times and were categorized into 40 different clusters of aimed changes in novice behaviors. The 35 highest-ranking verbal corrections (14%) and the 11 highest-ranking clusters (28%) accounted for 80% of the total number of given verbal corrections.

CONCLUSIONS: Following the Pareto principle, we were able to identify the aspects of trainee behavior that account for most corrections given by supervisors during a laparoscopic cholecystectomy on humans. This strategy can be used for the development of new training programs to prepare the trainee in advance for the challenges encountered in the clinical setting in an OR. (J Surg Ed 73:892-901. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: pareto principle, surgical training, laparoscopic cholecystectomy, content validity

COMPETENCIES: Medical Knowledge, Interpersonal and Communication Skills, Practice-Based Learning and Improvement

INTRODUCTION

In 1887, the Italian economist Vilfredo Pareto observed an exponential relationship between the amount of wealth an inhabitant owned and the rank order of the inhabitant.[1] He discovered that 80% of property is owned by merely 20% of the inhabitants, a pattern which later was popularized in the 1950s by management consultant Joseph M. Juran[2] as the Pareto principle or "80-20 rule". The Pareto principle is best known for its use in increasing business returns by identifying the vital-few causes responsible for the bulk of income within a company and consequently increasing its efficiency by focusing investments on these company facets.[2-5] The Pareto principle has also been observed in many other fields such as literature (the frequency of words in a book), sociology (intensity of wars) and astronomy (intensity of solar flares).[6]

In the surgical profession, the operating room (OR) is the ultimate teaching venue for learning surgical skills. However, learning how to operate costs significant amounts of money and time.[7-9] Bridges and Diamond[9] compared the operative times of cases performed by faculty with those

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Correspondence: Inquiries to Kelvin H. Kramp, MD, Department of Surgery, Leeuwarden Medical Centre, P.O. Box 888, 8901 BR Leeuwarden, The Netherlands; fax: +31 0582866946; e-mail: k.h.kramp@gmail.com

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performed by residents and calculated that the increased operative times during surgical training cost $47.970 per year per resident. Furthermore, it seems that the exposure of residents to surgical procedures is decreasing because of the implementation of work hours restrictions.[10] These findings underline the need for higher training efficiency in the OR.

Previous studies that have described content criteria for surgical training based their findings mainly on cognitive task analysis, human reliability analysis, or expert opinion.[11-13] A cognitive task analysis consists of the identification of the different cognitive and procedural steps that have to be undertaken to complete a procedure.[11] Information about these steps is obtained through an interview of experts and can be used as a "blueprint" for the development of training tasks for a procedure. Human reliability analysis has been used in high-risk technological advanced industries, such as aviation and nuclear power plant development, but it has recently also been used in laparoscopic surgery as a means for developing surgical training content.[14-16] Human reliability analysis consists of identifying what can go wrong, estimating the probability and consequences of the errors and consequently developing (training) methods to minimize the risk and consequences of these errors. Although cognitive task analysis, human reliability analysis, and expert opinion all provide valuable information for surgical training curriculum development, they do not provide us with a description of the aspects of surgical expertise that require the most time and energy during training in the OR. Meanwhile, the Pareto analysis might provide a valuable tool in the reduction of training duration in the OR by identifying those aspects of surgical skills that require the most resources to instil in trainees. This study attempts to answer the following research questions:

(1) Does the Pareto principle exist in the surgical training of a basic surgical procedure?
(2) What is the content criteria for more efficient surgical training stated by means of the Pareto principle?
(3) How can surgical training in the dry laboratory and in the OR be adapted to these content criteria?

METHODS

This study was a retrospective analysis of operative videos of laparoscopic cholecystectomies recorded for other study purposes. All the videos were recorded in Leeuwarden Medical Centre, a regional high-volume teaching hospital performing >200 laparoscopic cholecystectomies per year.

Data Collection

The laparoscopic cholecystectomy, a frequently performed laparoscopic training procedure, was used for the Pareto analysis. The audio-visual recordings of laparoscopic cholecystectomies performed during 2 prospective studies conducted in our institution were retrospectively reviewed. The first study was conducted by van Det[17] and the second by Kramp.[18] The trainees in these videos had performed 0 to 30 procedures as first surgeon. Because the current research was focused on identifying novice surgical behavior, only videos of trainees that had performed ≤ 10 laparoscopic cholecystectomies were included.

Surgical Training

In both study periods, each trainee was a resident in surgery and had completed a simulator course in basic laparoscopic skills training on the SIMENDO laparoscopy trainer (Simendo, Rotterdam, The Netherlands) before commencing supervised laparoscopic surgery on patients. Knowledge of the relevant anatomy and procedural steps necessary to complete the procedure was acquired by trainees through the usual sources available online and within our institution (anatomy books, online information, example videos, etc.).

During supervised surgical training in the OR, supervising surgeons aim to find a balance between creating the optimal learning experience and guarding the patient safety during the operation. They therefore guide trainees through the procedure by giving verbal guidance and taking over when necessary while they act as assistant surgeons. The verbal guidance was divided into 2 different categories, verbal instructions and verbal corrections. Verbal instructions were defined as the verbal guidance provided to initiate a certain surgical behavior (e.g., "make an incision from point a to point b"). Verbal corrections are given to reduce potentially unsafe surgical behavioral patterns or to optimize the degree of skillfulness, while a specific surgical behavior is being exhibited by a trainee (e.g., "stay closer to the gallbladder"). Medical declarative knowledge is usually evaluated by the supervising surgeon through a quizzing behavior, by Sutkin et al.[19,20] described as "socratic-like questioning to assess the surgical trainee's knowledge." Although the aim of these questions is primarily to stimulate thinking about a particular aspect of the procedure, the corrections of wrong answers on these questions were also classified as verbal corrections. Furthermore, if a supervising surgeon perceives an operative step as a particularly difficult dissection (e.g., as a consequence of variation in anatomy), or perceives the trainee as incompetent to deal with a certain aspect of the operation, he or she might temporarily take over one or both instruments to guard the flow and safety of the procedure. The exact content of the verbal guidance and reasons for a takeover are based on the supervising surgeon's judgment of the observed situational characteristics of the operation (e.g., time pressure, anatomic variation, and inflammation) and surgical behavior of the trainee.