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# Cost-effectiveness of laparoscopic versus open appendectomy in developing nations: a Colombian analysis



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## ABSTRACT

**Background:** Colombia is a developing nation in need for efficient resource administration in fields such as health care, where innovation is constant. Since the introduction of laparoscopic appendectomy (LA), direct costs have been increasing without definitive results in terms of clinical outcomes. The objective of this study is to determine the cost-effectiveness of open appendectomy (OA) versus LA and thereby help surgeons in clinical decision-making in a limited resource setting.

**Methods:** A retrospective cost-effectiveness analysis comparing OA versus multiport LA during 2013 in a third-level university hospital (Hospital Universitario San Ignacio) in Bogota, Colombia was performed. Effectiveness was determined as the number of days in additional length of stay (LOS) due to the complications saved. A total of 377 clinical histories were collected by the authors and analyzed for the following variables: surgery type, conversion to open laparotomy, complications (surgical site infection, reintervention, and readmission), hospital LOS, and total cost of hospitalization for initial surgery and subsequent complications-related hospitalizations. The total accumulative costs and LOS for OA and LA plus complications were estimated. The cost-effectiveness threshold was set at US \$46 (139,000 Colombian Peso [COP]), the cost of an additional day in LOS. An incremental cost-effectiveness ratio was calculated for OA as the comparator and LA as the intervention.

**Results:** The number of LA was 130 and of OA was 247. The two groups were balanced in terms of population characteristics. Complication rate was 13.7 % for OA and 10.4% for LA ( $P < 0.05$ ), and LOS was 2 days for LA and OA ( $P = 0.9$ ). No conversions from LA to OA were recorded. The total costs for complications for OA were US \$8523 (25,569,220 COP) and US 3385 (10,157,758 COP) for LA. Cumulative costs including cost of surgery and complications and LOS for OA were US \$65,753 (197,259,310 COP) and 297, respectively. Similarly, for LA were US \$66,425 (199,276,948 COP) and 271, respectively. The incremental cost-

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effectiveness ratio was US \$25.86 (77,601 COP) making LA a cost-effective alternative with a difference of US \$20.76 (62,299 COP) under the cost-effectiveness threshold.

**Conclusions:** LA is a cost-effective alternative over OA with an increasing cost of \$25.85 per day of additional hospitalization due to complications saved. This is accounting the low cost of surgical interventions and complications in developing nations such as Colombia.

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## Introduction

Appendicitis is the most frequent surgical emergency in our country, and appendectomy is the treatment of choice since 1894. Historically, the management of this disease has been through open surgery. However, in recent years in Colombia and the world, this has changed with the introduction of the laparoscopic technique described by Semm in 1983.<sup>1</sup>

We have seen an incremental tendency in our institution to perform laparoscopic appendectomies (LAs) with a proportional decrease in the number of open cases. According to the institutional registry, 0.72% of appendectomies were performed by laparoscopy in 2010, reaching up to 73% in 2014.

However, this tendency is not the reflection of the country because the open technique is still preferred in most urban and rural hospitals, given the limited resources and training of surgeons.

The effectiveness and complications of both surgical techniques are well known. Multiple studies have compared LA versus open appendectomy (OA) finding relative advantages in LA such as shorter hospital stay, faster recovery, and fewer postoperative complications, and report increased costs, surgical materials used, and longer surgical time.<sup>2</sup> However, a consensus that establishes the superiority of LA versus OA has not yet been reached.

Colombia is a developing country with limited resources for health care. For this reason the objective of this study is to determine the cost-effectiveness of OA versus LA based on the experience of a Colombian third-level hospital (Hospital Universitario San Ignacio) and help surgeons in clinical decision-making in a limited resource setting.

## Patients and methods

### Ethical considerations

This study received approval by the Ethics and Research Board of the Pontificia Universidad Javeriana and the Hospital Universitario San Ignacio for the collection of information from the clinical histories and hospital's receipts. Confidentiality of personal information was kept by all investigators.

### Patient selection

We collected retrospective data of all patients aged >18 years, who consulted to the emergency room with symptoms of acute appendicitis and underwent multiport LA or OA during the time period from January 1 to December 31, 2013 in a third-level university hospital in Bogota, Colombia. During this time frame, adoption of LA in our institution was on the rise corresponding to

about 65% of all appendectomies performed during 2013. The surgeon based on personal experience or preference, equipment availability, or insurance coverage did allocation to either one of the treatment techniques. We excluded incidental appendectomies and patients with additional in-hospital-treated comorbidities such as heart failure or pneumonia. To observe if both groups are balanced, we also evaluated patients' age, complication rates, and individual length of stay (LOS).

### Determination of costs-effectiveness

To conduct a cost-effectiveness analysis, we conducted a retrospective cohort-based analysis. We defined effectiveness endpoints as the saved number of days in additional LOS at the hospital due to complications. Complications correspond to surgical endpoints such as surgical site infection, reintervention, or readmission. Outcomes such as surgical site infection may not contribute to additional hospitalization days but definitively contribute to additional costs. Calculated costs included the surgical intervention and all subsequent attentions derived from surgery including costs such as ambulatory wound management. We used a third-payer perspective for evaluating costs on the Colombian health-care system.

### Calculation of cost-effectiveness

The incremental cost-effectiveness ratio (ICER) is useful to establish whether an intervention is cost-effective in relationship to another. It is calculated by dividing the difference in costs of both interventions between the differences in effectiveness. It can be graphically represented in the cost-effectiveness plane and as for possible results. When the evaluated intervention compared to another intervention (usually the standard of care) is cheaper and less effective, and more expensive and more effective. In this last case, a cost-effectiveness threshold or willingness to pay must be settled.<sup>3</sup> This threshold represents the limit an institution or a health-care insurer can pay for the added benefit of an intervention. In this case, if LA is cost-effective compared with OA, the incremental costs of LA should balance the better effectiveness of this technique. Our threshold is set at 139,000 Colombian Peso (COP) (US \$46, conversion rate for COP \$ to US \$ is 3021 in 2013<sup>4</sup>). This value represents the cost of an additional day of hospital stay according to local tariffs, in contrast to US \$13,570 for the United States.<sup>5</sup> This also means that if paying for additional hospital days of stay is cheaper than paying for the widespread implementation of LA, OA would be a preferred choice for health-care providers and payers.

We estimated costs by including all expenses related to each intervention. Expenses include the following: operating time costs (including honoraria for attending surgeon, nurse staff,

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