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ORIGINAL RESEARCH

Health Economics

Cost of surgical management of laparoscopically treated ectopic pregnancies at a tertiary referral hospital: A 10-year review of admission costs and contributing factors

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Abstract

Background: Laparoscopic management is the gold standard for treating ectopic pregnancies (EP), but its cost limits its widespread use in developing nations. A 10-year period audit was conducted evaluating laparoscopically treated EPs at a tertiary referral hospital, focusing on admission cost and contributing factors.

Methods: This was a retrospective observational study conducted at the Aga Khan University Hospital. All women admitted with surgically managed Eps were included. Analysis of data was done against a preset checklist. Descriptive statistics for continuous variables were computed and presented in tables and figures.

Results: The adjusted admission cost for patients with surgically managed EP ranged from US $2 017 (KES 220 252) to US $ 6,326 (KES 690 828). The mean cost of admission was US $ 3 254 (KES 355 384; n=259). The following factors were significantly associated with an increased admission cost: increasing patient age (p=0.000), volume of hemoperitoneum(p=0.000) duration of surgery (p=0.003) and duration of hospital stay (p=0.000).

Conclusion: The mean admission cost for surgically managed EP was similar to that in high-income countries. However, when adjusted for per capita gross domestic product, the cost was disproportionately high. No consistent decline in the mean annual cost was observed over the study period. Increasing patient age, hemoperitoneum volume, surgery duration, and duration of hospital stay all significantly impacted on the admission cost.

Keywords: cost of admission, ectopic pregnancy, laparoscopy, surgery

Introduction

Ectopic pregnancies (EP) are a significant cause of pregnancy-related morbidity and mortality (1, 2). Laparoscopic management is the gold standard surgical treatment of EP, with its increasing use in low- and middle-income countries (LMIC) gaining traction (3-5). Subsequently, in LMIC, the cost of

admission for laparoscopic surgery may limit its use and hence its widespread access (6, 7). Many factors have been linked to an increased admission costs for EP laparoscopic surgery (8, 9). These include: technique of surgery, occurrence of complications, length of hospitalization, need for additional treatment, and duration of surgery (10-12). However, the specific cost of laparoscopic EP treatment and the contributing factors remain poorly defined in the LMIC, including Kenya. Addressing these factors may help reduce surgical costs and improve access to laparoscopic management (9). This study aimed to analyze the admission cost over a 10-year period (2011-2020) and the associated factors impacting the cost at a tertiary referral hospital in Nairobi, Kenya.

Methods

Study design and setting

This was a retrospective observational study conducted at the Aga Khan University Hospital (AKUH), Nairobi, a private teaching and referral hospital in Kenya.

Study population

The study population comprised women admitted to AKUH with a diagnosis of ectopic pregnancy that was surgically managed between January 1, 2011 and December 31, 2020. All women diagnosed with ectopic pregnancies who were surgically managed at the AKUH and met the surgical criteria outlined in the AKUH Early Pregnancy Bleeding protocol were included in the study. Patients not treated at the Aga Khan University Hospital, those treated using conservative or medical methods, those with heterotopic pregnancy, and patients' files with missing data were excluded.

Data collection and management

Data were collected from clinical records during admission at AKUH. All patients were subjected to a full history taking, physical examination, and laboratory tests including complete blood count, qualitative or quantitative Beta-human chorionic gonadotrophin (HCG), transvaginal and/or transabdominal ultrasound with determination of adnexal mass if present and presence and quantification of intraperitoneal hemorrhage according to AKUH protocols.

The data collection tool was a questionnaire incorporating preoperative ultrasound findings, intraoperative findings, postoperative complications, and costs attributed to the surgery. Standards of best practice were in accordance with the Royal College of Obstetricians and Gynaecologists Green Top Guideline, Number 21 (4).

The data collected was independently reviewed by two separate individuals during the collection and analysis stages of the study. This minimized bias and reduced potential errors in data handling.

Data analysis

Data analysis was performed against a preset checklist. Descriptive statistics for continuous variables were computed and presented in tables and figures. The correlation of various factors with the cost of admission was analyzed with the p-value set at 0.05. The statistical package for social sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY, USA) was used for data analysis.

Ethical consideration

Approval for the study was granted by the Aga Khan University, Nairobi Institutional Ethics Review Committee (IERC) (registration number 2021/IERC-19(v1). Collected data did not include patient identifiers to protect confidentiality. The files were accessed at medical records and did not leave the custody of the medical records office. Data was collected using a data collection tool designed from the

database file. Data were then entered directly into the database document created for use in this audit. The primary investigator (PI) was the sole custodian of this document, which was submitted to the research office for archiving. The hard copies of the data collection tools were also submitted to the research office for archiving. A back up copy of the document was kept on an online data cloud that will be password protected and accessible to the PI.

Results

During the study period (2011-2020), we recorded 347 cases of surgically managed ectopic pregnancies. Based on a hospital census, it was estimated that 20,000 livebirths occurred during this period. Therefore, the hospital-based incidence rate of surgically managed ectopic pregnancies between 2011 and 2020 was 1.78 per 100 livebirths. The median age was 31.0 years (+/- years), with 28.2 % (n=98) of the participants being older than 35 years. These data were documented and submitted for publication in a separate manuscript.

Of the total study population, 260 patients (86.45%) had admission cost data available. These data only covered from 2012 to 2020 because the admission cost data could not be retrieved for patients from 2011 because hospital records were not available. Moreover, 2012 and 2013 included only the admission cost data for one patient each (**Table 1**).

To reduce the error of cost analysis, the cost of surgery was adjusted using inflation rates obtained from the Central Bank of Kenya (CBK), with the baseline cost being in 2020 and retrospective inflation applied using the previous years' inflation (**Table 2**).

The indicative exchange rate, according to CBK, between the Kenya Shillings (KES) to the United States Dollar (US $) at the end of the study period was KES 109.2, which was equivalent to 1 US$. This rate was used for conversion for the study period since the retrospective adjusted cost of the inflation rate in KES had already been calculated.

The adjusted admission cost for patients with surgically managed EP varied from as low as US$2 017 (KES 220 252) to as high as US$6 326 (KES 690 828). There was one cost that was US $8 402 (KES 917 492) that was excluded due to it being an outlier. The mean admission cost was US$ 3 254 (KES 355 384; n=259). The 25th, 50th, and 75th centile of cost of admission was US$ 2 789 (KES 304 586.25), US$ 3 137 (KES 342 539.50), and US $3 615 (KES 394 766), respectively. Analysis of the average annual cost of surgery to assess trends over time was also performed (Figure 1).

Table 1: Number of patients with laparoscopically managed ectopic pregnancies and available admission cost data at Aga Khan University Hospital, Nairobi between 2012–2020

Year	Number of patients with cost of admission data
2011	0
2012	1
2013	1
2014	25
2015	36
2016	46
2017	37
2018	36
2019	31
2020	47

A univariate analysis was done to examine the association of different factors with admission cost. Increasing patient age was significantly associated with increasing cost of admission (p=<0.001). Increase in the sonographic size of a mass was not significantly associated with an increasing cost of admission (p=0.976). However, an increased hemoperitoneum volume was associated with an increasing admission cost (p=<0.001). Surgical technique (p=0.388) and whether the procedure was converted to open surgery (p=0.490) did not affect the cost of admission. Finally, an increase in the duration of surgery (p=0.003) and duration

of hospital stay (p=<0.001) were both significantly associated with an increase in the admission cost (Table 3).

Table 2: Central Bank of Kenya inflation rates and adjusted rates from 2011 to 2020

Year	Annual average inflation rate (%)	12-Month inflation rate (%)	Adjusted inflation compared with 2020 cost (%)
2011	14.02	18.93	189.87
2012	9.38	3.2	166.52
2013	5.72	7.15	152.24
2014	6.88	6.02	144.00
2015	6.58	8.01	134.70
2016	6.3	6.35	126.42
2017	7.98	4.5	118.92
2018	4.69	5.71	110.13
2019	5.2	5.82	105.20
2020	5.41	5.62	100.00

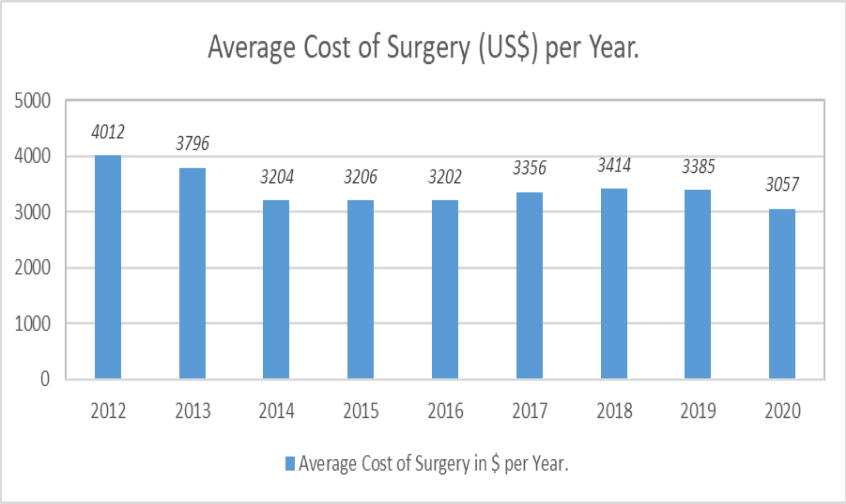

Figure 1: Average annual cost of surgery (US $) for laparoscopically managed ectopic pregnancies at Aga Khan University Hospital, Nairobi between 2012 and 2020

Table 3: Factors associated with total admission cost for laparoscopically managed ectopic pregnancies at Aga Khan University Hospital, Nairobi between 2012 and 2020

Factors	95% confidence interval for cost of admission (KES)	Impact on cost of admission (p value)
Increasing patient age	(-1590.1) – (2756.2)	<0.001
Increasing sonographic mass size	(-361.6) – (540.1)	0.976
Increasing hemoperitoneum volume	(10,204.6) – (57,305.2)	<0.001
Surgical technique	(-18,240.3) - (13,194.9)	0.388
Conversion to open surgery	(-79,710.4) – (142,669.3)	0.490
Increasing surgery duration	(9,838.4) – (44,399.3)	0.003
Duration of hospital stay	(19,734.6) – (54,442.6)	<0.001

Discussion

Ectopic pregnancies are a significant contributor to pregnancy related morbidity and mortality (13, 14). Laparoscopic surgery is the mainstay of surgical management with obvious benefits over open surgery (12, 15-17). However the cost of minimal access surgery is still prohibitive in developing regions, with this being the biggest hindrance for its widespread use (18-20). Several factors have been shown to impact on this cost, and cost reduction strategies often focus on addressing these variables.

Over the study period, a total of 347 patients underwent laparoscopy for EP. Of these, 260 patients (86.45%) had complete data, with missing records primarily from earlier years. The cost data were adjusted for inflation using the CBK rates and converted to USD using the 2020 exchange rate, enhancing

comparability and generalizability across settings. The adjusted cost of admission ranged from US$2 017 to US$6 326, with a mean of US$3 254. This range is consistent with studies conducted in high-income countries (HIC) (10-12, 21). Although costs across Europe and North America are comparable, interpretation should account for national economic indicators. For example, at the end of the study period, Kenya's per capita GDP was US$1 099 (22) compared with US$42 109 in Europe and US$50,066 in the United States (22). This highlights the disproportionately high financial burden of laparoscopic ectopic pregnancy management in Kenya. The high cost has been attributed to several factors, including high cost of equipment and lack of trained personnel, which increases the duration of surgery (20). The same factors could be postulated to have caused the relatively high cost in this study.

Despite expectations of declining costs over time, the mean annual cost remained relatively constant throughout the study period (excluding 2012 and 2013 due to insufficient sample sizes). Average yearly costs ranged narrowly from US$3 057 to US$3 414. This finding contradicts earlier studies that reported cost reductions over time, attributed to improved efficiency, reduced hospital stays, and lower equipment costs (8-10, 21, 23). This reduction in cost has been attributed to the lower cost of laparoscopic equipment coupled with the shortening hospital stay and the increase in the number of trained personnel (9, 10, 20). This study's findings suggest that persistent high equipment costs and limited training opportunities may have stalled similar gains in Kenya.

In the univariate analysis, patient age was significantly associated with increased admission costs (P < .001). Although no studies have directly addressed this relationship in ectopic pregnancy, advanced maternal age has been associated with comorbidities, such as prior surgeries or chronic illness, which may prolong operative time and recovery (2, 5, 8, 15). These factors may explain the increased costs observed in older patients. Sonographic size of the adnexal mass did not significantly impact admission cost (P = .976), which is consistent with findings from other studies (8, 24-26). This may be because sonographic measurements do not always correlate with intraoperative complexity or the need for extended surgery (9, 20, 27). In contrast, increased hemoperitoneum volume was significantly associated with increased costs (P < .001), likely due to prolonged operative time required for suctioning and managing blood loss (28).

Surgical technique did not significantly impact cost (P = .388), although other studies have shown that procedures like salpingotomy can be more costly than salpingectomy due to longer duration (10). Our study included a variety of techniques, including total and partial salpingectomy, salpingostomy, fimbrial milking, excision, and resection, which were analyzed separately in another paper. Smaller subgroup sizes may have diluted potential differences in cost. Conversion to open surgery also did not significantly affect cost (P = .490), which contrasts with previous studies reporting higher costs with laparotomy due to longer hospital stays and complication rates (6, 28, 29). This is attributed to the advantages of laparoscopy, including reduced hospital stay and operation-related complications, which will both reduce the admission cost (5, 17). In our cohort, only 7.6% (n = 19) of patients underwent conversion to open surgery, and this small number may have limited the ability to detect cost differences. Both the duration of surgery (P = .003) and length of hospital stay (P < .001) were significantly associated with increased admission cost. This is consistent

with previous findings (16, 20, 28). Operating rooms at our institution charge by the minute, which, along with extended resource use and monitoring, contributes to increased costs during prolonged procedures. Longer hospital stays can result from several clinical factors, including the extent of hemoperitoneum, duration of surgery, and postoperative complications (8, 18, 20, 28, 30). Strategies to reduce length of stay, such as standardized postoperative protocols could help lower total admission costs (9, 20, 23).

This study was limited by its retrospective design; a prospective approach would have allowed comprehensive and standardized data collection. However, due to consistent institutional protocols, the data retrieved were complete and reliable.

Conclusion

The mean cost of admission for surgically managed EP was similar to that in HIC. However, this cost was significantly higher than that of HIC when per capita GDP was considered. The mean annual cost of surgery remained the same despite an expected decline as years advanced. Patient age, hemoperitoneum volume, duration of surgery, and length of hospital stay were all significantly associated with increased admission costs. In contrast, the sonographic size of the adnexal mass, surgical technique, and conversion to open surgery did not have a significant cost impact. Targeted strategies aimed at reducing modifiable cost drivers, particularly operative duration and length of stay, may help optimize resource use and improve accessibility to laparoscopic management of ectopic pregnancy in LMIC.

Declarations

Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of interests

The author declares no conflict of interests.

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