

The health economic impact of complications following liver resection surgery: a systematic review

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Introduction

Whilst liver resection has been integrated into modern hepatobiliary surgery as a dedicated speciality, there remains limited data concerning the health economics of liver resection, and there is an absolute dearth of statistics in an Australasian context. Even less information exists on the costs emerging from complications occurring as sequelae to liver resection, despite this remaining an important target from a health economic perspective.

An estimated 9.9% of global GDP was utilised on healthcare expenditure in 2014, a figure reflected by the 10% of GDP spent on healthcare in Australia in 2014-15 (1). With over 38% of annual health expenditure in Australia directed towards hospitals over the 2014-15 fiscal periods, hospital expenditure, particularly the specific costs associated with treating complications, remains the single greatest economic target for healthcare expenditure reduction.

Given the limited costing data regarding surgery for adult liver resection, we performed a review of the existing evidence with respect to costs and complications. Further, we identify the association between complication severity, operative technique (laparoscopic vs. open vs. robotic), length of stay and readmission, and hospital costs. Lastly, we establish an understanding of areas requiring further research and analysis.

Methods

- Findings have been presented as a narrative synthesis with focus on the in-hospital cost of complications
- MEDLINE Ovid, Embase Ovid, The Cochrane Library and EconLit databases were searched, with articles in all languages being considered.
- Titles, abstracts, and full-text articles were screened by two authors independently in a blinded manner to determine eligibility (Figure 1)
- Risk of bias assessment was undertaken independently by two authors.

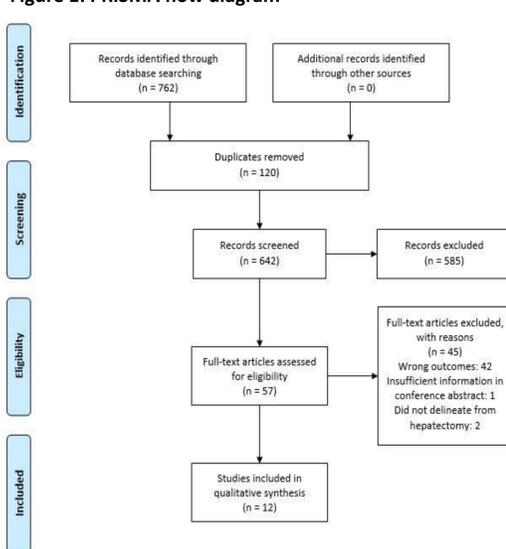
Inclusion criteria:

- Eligible studies included randomised controlled trials (RCTs), comparative observational studies, case series and abstracts containing a full or partial economic evaluation of complications of liver resection.
- All indications for liver resection in adults (>18 years) were considered.
- Combined liver resection with other surgeries (ie. liver resection and hemicolectomy) were included.
- All techniques including open, hand assisted laparoscopy, laparoscopy and robotic.
- Excluded procedures were liver transplantation, radio-frequency and microwave ablation, and other radiological procedures.

Primary outcome: in-hospital cost of complications following liver resection surgery.

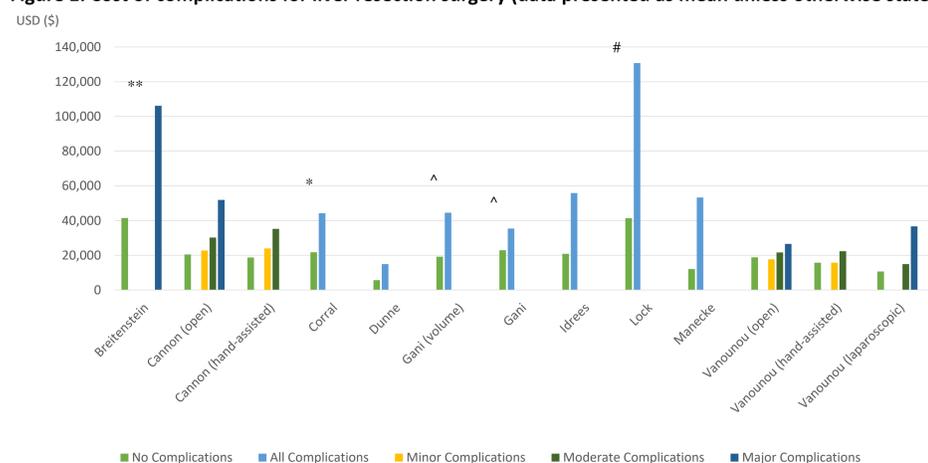
Secondary outcomes: costs of liver resection and complications by surgical technique (open vs. laparoscopic) and extent of resection (major vs. minor).

Figure 1: PRISMA flow diagram



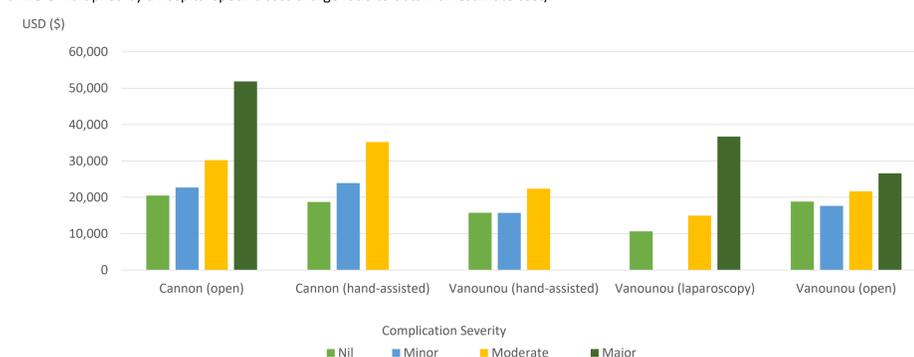
Results

Figure 1: Cost of complications for liver resection surgery (data presented as mean unless otherwise stated).



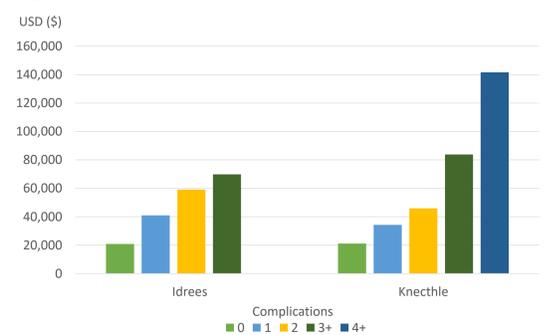
^ cost reported as median, *only assessed major bleeding, # only assessed postoperative liver failure, **no complications group includes Clavien-Dindo grade I/II, complications group includes Clavien-Dindo grade III/IV. To allow for comparison, the charges reported in Cannon et al (10) were multiplied by a hospital specific cost-charge ratio (2) to obtain an estimate of costs.

Figure 2: Costs of complications by severity based on deviation-based cost modelling. (Costs reported by Cannon et al were multiplied by a hospital specific cost-charge ratio to obtain an estimate cost).



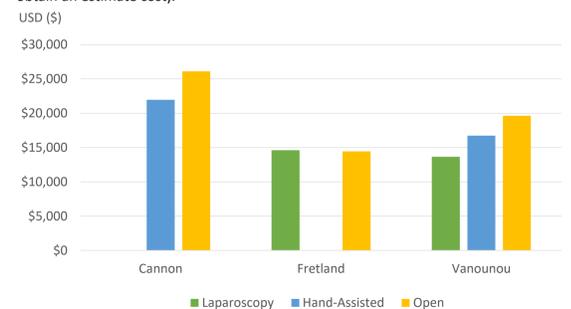
- Twelve studies were included in the final review.
- Seven (3-9) were cohort studies, three (10-12) were economic evaluations and one (13) was a RCT. The remaining study (14) was a conference abstract.
- Eleven of the studies were completed retrospectively, with only Fretland et al (13) being completed prospectively.

Figure 3: Cost by number of complications



- The complication incidence across all studies was between 7.6% and 73.2%.

Figure 4: Costs of liver resection by surgical technique. (Costs reported by Cannon et al. were multiplied by a hospital specific cost-charge ratio to obtain an estimate cost).



- The wide disparity is attributable to variability in definitions of complications across studies.

- Increasing costs with the occurrence of complications was a common finding across all studies (Figure 1).

- All four studies which graded complications demonstrated that costs increased along with severity of complications (Figure 2).

- Two studies reported increasing costs with increasing number of complications (Figure 3).

- Three studies reporting mortality showed greatly increased costs associated with mortality.

- Postoperative liver failure was the most expensive complication, costing \$89,450 more than uncomplicated patients.
 - 87.5% patients with postoperative liver failure died, highlighting the extreme clinical cost of postoperative liver failure.

- There was disagreement amongst the three studies reporting financial information for surgical technique (Figure 4).
 - Cannon et al (10) found laparoscopic and open techniques were equivocal with the exception of major deviations from postoperative course, where the open technique cost more.
 - Vanounou et al (12) found that laparoscopy cost less than open surgery.
 - Fretland et al (13) found the overall costs of laparoscopic and open resection to be equivocal.

- Increased length of stay following the occurrence of complications was a consensus finding amongst the six studies reporting the outcome.
 - Knechtle et al (11) demonstrated that length of stay increased as the number of complications increased.
 - Idrees et al (11) reported a mean incremental cost of \$8929 (95% CI \$3321-14536, p<0.001) for patients exceeding a length of stay beyond eight days.

- Knechtle et al (7) reported the rate of readmission increased from 5% for patients with no complications, to 14.3% for patients with 4 or more complications.

- Two studies compared the cost of major and minor resection, and showed an increased cost associated with major liver resection.
 - Idrees et al (11) reported a mean incremental cost of \$15,291 (95%CI: \$5,272 to \$25,310, p<0.001) for hemi-hepatectomy compared to a partial resection.

Risk of bias

- Fretland et al (13) was considered to have 'low risk' of bias.
- Excluding the conference abstract (14), six (3-8) of the retrospective cohort studies were considered to have an 'acceptable' risk of bias, whilst one (9) was thought to be of 'low quality'.
- The three (10-12) economic evaluations were deemed to be of 'high quality'.
 - However, as the primary outcome data required for this review were not primary outcomes for the economic evaluations, these studies were also assessed against the SIGN Cohort Study Checklist and found to be of 'acceptable' quality.

Conclusion

Postoperative complications following hepatectomy have a major impact on the clinical and economic burden facing health care providers, at both the systemic and individual level. This burden is worsened as the severity of complications increases.

We found robust evidence supporting the increasing economic burden arising from complications after liver resection. Despite considerable heterogeneity in study designs, patient populations, and outcome definitions, we found weak evidence of increased costs associated with major liver resection compared to minor resections. Robust evidence supporting that costs increase with the development and severity of complications was found. The development of postoperative liver failure was associated with the highest costs. Our review found strong evidence concerning the association of length of stay with costs.

In order to allow effective implementation of strategies to reduce this burden, future studies assessing the economic impact of complications require improvements in quality, reliability, and consistency of methodology.

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