
Impact of Facility Type and Surgical Volume on 10-Year Survival in Patients Undergoing Hepatic Resection for Hepatocellular Carcinoma



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- BACKGROUND:** Previous studies have demonstrated improved in-hospital mortality after hepatic resection for hepatocellular carcinoma (HCC) at teaching hospitals. The objective of this study was to evaluate if resection of HCC at academic cancer programs (ACP) is associated with improved 10-year survival.
- STUDY DESIGN:** Using the National Cancer Data Base (NCDB) (1998 to 2011), we evaluated patients undergoing hepatic resection for HCC at ACPs, comprehensive community cancer programs (CCCPs), and community cancer programs (CCPs). High volume cancer programs (HVCPs) were defined as performing 10 or more hepatectomies per year. Multivariate Cox proportional hazard models by stepwise selection were applied to estimate hazard ratios (HR) of predictors of survival. The Kaplan-Meier method was used to generate survival curves at each facility type, and survival rates were compared using the log-rank test.
- RESULTS:** We identified 12,757 patients undergoing hepatic resection for HCC at ACPs (n = 8,404), CCPs (n = 483), and CCCPs (n = 3,870). Sixty-two percent (n = 5,191) of patients treated at ACPs were at high volume institutions compared with 11.6% (n = 446) and 0% of CCCPs and CCPs, respectively (p < 0.0001). On multivariable analysis, patients undergoing hepatic resection at transplant centers (p < 0.0001) and HVCPs had significantly improved survival (p < 0.0001). Adjusted 10-year survival rates were 28.7% at high volume ACPs, 28.2% at high volume CCCPs, 24.9% at low volume CCCPs, 25.1% at low volume ACPs, and 21.3% at CCPs (p ≤ 0.0001).
- CONCLUSIONS:** Patients undergoing hepatic resection for HCC at HVCPs had a significantly improved 10-year survival. Regionalization of HCC treatment to HVCPs may improve long-term survival. (J Am Coll Surg 2017;224:362–372. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)
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Disclosure Information: Nothing to disclose.

Support: This study was funded by the Department of Surgery at the University of Colorado School of Medicine.

Abstract presented at the American College of Surgeons 102nd Annual Clinical Congress, Scientific Forum, Washington DC, October 2016.

Received September 14, 2016; Revised November 18, 2016; Accepted November 22, 2016.

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The incidence of hepatocellular carcinoma (HCC) in the US has nearly tripled, from 1.6 per 100,000 in 1975 to 4.9 per 100,000 in 2005.¹ Hepatocellular carcinoma is associated with a poor prognosis, with overall 5-year survival rates as low as 11% to 30%.²⁻⁵ However, well-selected patients undergoing surgical resection can have a 5-year survival as high as 50% to 74%.⁶ Numerous studies have identified clinical factors, including tumor size,^{5,7} tumor stage,⁸ aminotransferase level,⁴ alpha-fetoprotein (AFP),^{4,5,7-12} Child-Pugh score,^{7,8,10,11} and vascular invasion^{7,8} to be associated with HCC survival.

There is also increasing evidence that survival after hepatic resection may be influenced by the experience of the hospital and surgeon performing the operation.

Abbreviations and Acronyms

ACP	= academic cancer program
AFP	= alpha-fetoprotein
AJCC	= American Joint Committee on Cancer
CCCP	= comprehensive community cancer program
CCP	= community cancer program
HCC	= hepatocellular carcinoma
HVCP	= high volume cancer program
INR	= international normalized ratio
LVCP	= low volume cancer program
MELD	= Model for End-Stage Liver Disease
NCDB	= National Cancer Data Base

In a meta-analysis, Richardson and colleagues¹³ reported an inverse relationship between hospital volume and perioperative mortality in patients with HCC undergoing hepatic curative intent operations. But Eppsteiner and associates¹⁴ determined that only patients undergoing hepatic resection by high volume surgeons at high volume hospitals were associated with improved in-hospital mortality. Conversely, Lin and Lin¹⁵ concluded that although both physician and hospital volume significantly improved survival, after adjusting for characteristics of physician and hospital, only surgeon volume remained a significant predictor of 5-year survival.

Additionally, facility type (ie teaching vs nonteaching) has been reported to influence perioperative mortality in patients undergoing complex hepatobiliary surgery. Patients undergoing hepatic resection at a teaching hospital had improved in-hospital mortality compared with those in nonteaching hospitals.¹⁶ To our knowledge, the effect of facility type on long-term survival in patients with HCC undergoing surgical resection remains unknown. The purpose of our study was to evaluate the effect of facility type on long-term survival in HCC patients undergoing potentially curative intent surgery.

METHODS

Data sources

Using the National Cancer Data Base (NCDB), we performed a retrospective cohort study of all patients undergoing major hepatic resection for HCC between 1998 and 2011. The NCDB is a nationwide oncology outcomes database for more than 1,500 Commission on Cancer-accredited facilities in the US and Puerto Rico. Approximately 70% of all newly diagnosed cancer cases in the US are captured and reported to the NCDB.

Each facility is assigned to a cancer program category based on the facility or organization type, services provided, and newly diagnosed and treated cancer cases per

year. A community cancer program (CCP) treats more than 100, but fewer than 500, newly diagnosed cancer cases each year, participates in cancer-related clinical research, and may train resident physicians. A comprehensive community cancer program (CCCP) treats 500 or more newly diagnosed cancer cases each year, participates in cancer-related clinical research, and may train resident physicians. An academic cancer program (ACP) provides postgraduate medical education in at least 4 program areas, treats more than 500 newly diagnosed cancer cases per year, and participates in cancer-related research.

Patient selection

A total of 137,325 patients were identified in the NCDB with a diagnosis of HCC (histology codes 8170, 8171, 8172, 8173, 8174, 8180). Only patients undergoing surgical resection of HCC were included: wedge resection (procedure codes 21), less than 4 segments (procedures codes 22 to 26), lobectomy or ≥ 4 segment resection (procedures codes 30 to 38), extended lobectomy (procedure codes 50 to 59), and hepatectomy not otherwise specified (procedure code 60) ($n = 14,192$; 10.3%). Patients were excluded if they did not have surgery ($n = 100,720$; 73.3%), had local tumor destruction using photodynamic therapy, fulguration, laser, percutaneous ethanol injection, radiofrequency ablation, or cryoablation ($n = 11,085$; 8.1%), underwent liver transplantation ($n = 10,321$; 7.5%), extrahepatic bile duct resection ($n = 38$; <1.0%), or unknown surgery type ($n = 969$; <1.0%). Patients with missing facility type, American Joint Committee on Cancer (AJCC) stage, and vital status were also excluded ($n = 1,435$; 1.0%).

Our final cohort included 12,757 patients (Fig. 1). Programs were grouped into low and high volume programs according to the total number of hepatectomies performed for all diagnoses at each cancer program per year. High volume cancer programs (HVCPs) were defined as facilities performing 10 or more hepatectomies per year. Programs were also categorized into liver transplant programs and nontransplant programs based on procedure codes 61 (total hepatectomy and transplant) and 75 (bile duct and hepatectomy with transplant).

Baseline characteristics

Patient demographics including age, sex, insurance status (not insured, private insurance, Medicaid, Medicare, unknown), income quartile (<\$38,000, \$38,000 to \$47,999, \$48,000 to \$62,999, >\$63,000, unknown), education (unknown, >93%, 87.1% to 93%, 79.1% to 87%, <79.0% achieving high school diploma), living location (metro, urban, rural, unknown), Charlson-Deyo Score, year of diagnosis (1998 to 2000, 2001 to 2003, 2004 to 2006, 2007 to 2009, 2010 to 2011),

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