

Saudi Association for the Study of Liver diseases and Transplantation position statement on the hepatology workforce in Saudi Arabia

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Abstract

The field of hepatology has evolved significantly over the last two decades. Hepatology practice in Saudi Arabia (SA) was dominated by hepatitis B and C viruses but is now being overtaken by patients with non-alcoholic fatty liver disease. These patients require greater medical attention as their care is more complex compared to patients with viral hepatitis. In addition, liver transplantation (LT) has expanded significantly in SA over the last three decades. There is a necessity to increase the hepatology workforce to meet the demand in SA. The time has come to reinforce the transplant hepatology fellowship program, that was launched recently, and to develop a nurse practitioner practice model to meet these demands. In addition, SA is going through a health care reform to enhance health care delivery which may affect the financial compensation policies of various specialties including gastroenterology and hepatology. Therefore, the Saudi Association for the Study of Liver diseases and Transplantation (SASLT) established a task force to discuss the current and future demands in the hepatology workforce in SA, as well as to discuss different avenues of financial compensation for transplant hepatologists in LT centers.

Keywords: Advanced liver disease, hepatologist, liver transplant

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Submitted: 08-Nov-2021 **Revised:** 14-Nov-2021 **Accepted:** 15-Nov-2021 **Published:** 11-Feb-2022

INTRODUCTION


In 1988, ten gastroenterologists attended the first meeting for the Saudi Gastroenterology Association.^[1] At that time, hepatology was generally viewed as an important

but relatively minor component of gastroenterology. All gastroenterologists in Saudi Arabia (SA) were expected to manage patients with advanced liver disease. However,

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How to cite this article: Al-Judaibi B, Dokus MK, Al-hamoudi W, Broering D, Mawardi M, AlMasri N, *et al.* Saudi association for the study of liver diseases and transplantation position statement on the hepatology workforce in Saudi Arabia. Saudi J Gastroenterol 2022;28:101-7.

Access this article online	
Quick Response Code:	Website: www.saudijgastro.com
	DOI: 10.4103/sjg.sjg_576_21

due to the rapid evolution of liver transplantation (LT) in the country and the effectiveness of new therapies for many liver diseases, there was a necessity to establish the Saudi Association for the Study of Liver diseases and Transplantation (SASLT).

In 2001, the American Association for the Study of Liver Diseases (AASLD) defined hepatologists as gastroenterologists for whom 50% or more of the patient mix consisted of patients with liver disease.^[2] In the far past, there was no hepatology training. Presently, gastroenterology fellows who developed an interest in liver diseases seek training in hepatology. In the past, gastroenterology fellows who developed an interest in liver diseases sought additional training in hepatology. The primary pathway to become a hepatologist in the United States of America (USA) is through an accredited fellowship dedicated to advanced liver disease management and transplant hepatology.^[2] This accredited fellowship accepts candidates after completing their gastroenterology fellowship program.

Transplant hepatologists specialize in patients with advanced liver disease who may or may not require a liver transplant.^[2] The AASLD acknowledged that transplant hepatology is a distinct discipline that requires cognitive expertise over and above that provided during hepatology training in a standard gastroenterology program.^[2] The AASLD concluded, based on the waiting time for initial appointments, that transplant hepatologists were in high demand. This led to substantial efforts to increase the hepatology workforce in the USA through novel training pathways and improved compensation models.^[2] However, due to the significant demands for transplant hepatologists throughout the country, the AASLD launched a transplant hepatology pilot training program.^[3] This program grants exception for individual trainees to focus on achieving competency in transplant hepatology during the third year of gastroenterology fellowship using an outcome-based approach to design, implement, assess and evaluate their training.^[3]

In Saudi Arabia, the Saudi Commission for Health Specialties (SCFHS) is the main regulator of hepatology and liver transplant practice. The SCFHS defined hepatologist as a gastroenterologist or internal medicine physician who completed one year in hepatology fellowship training program. Transplant hepatologist was defined as a hepatologist or gastroenterologist or internal medicine physician who completed one year in transplant hepatology fellowship.

Due to the pronounced changes in the field of hepatology and liver transplantation in SA, it is important to evaluate the current hepatology workforce and the expected demands in the near future. The aim of this position statement is to provide an update on the current landscape of the issues facing the hepatology workforce, identify challenges and propose the next steps to address these issues.

CURRENT STATUS AND FUTURE DEMANDS OF THE HEPATOLOGY WORKFORCE IN SA

An assessment of the workforce in hepatology should include the current number of hepatologists practicing, the number of hepatologists entering the workforce, and the number of hepatologists leaving the workforce. Estimates of the number of practicing hepatologists and transplant hepatologists are difficult, in part because of the heterogeneity in defining these positions. In the SCFHS, approximately 20 hepatologists and five transplant hepatologists are registered. However, the number of well-trained hepatologists and transplant hepatologists may be underestimated by the SCFHS as it is not required by the SCFHS for gastroenterologists to register their advanced training in hepatology or transplant hepatology to practice and manage patients with advanced liver disease or post-LT. Furthermore, their organizations would recognize them as a hepatologist or transplant hepatologist although they may be registered as a gastroenterologist in the SCFHS. In addition, physicians may not have the incentive to register their advanced training as there is an additional registration fee to acknowledge their training in hepatology or transplant hepatology by the SCFHS. Therefore, the number of physicians who are practicing hepatology and LT in SA are not accurate. A web-based questionnaire is required to evaluate the current hepatology workforce and to assess the future need of hepatologists and transplant hepatologists. Nevertheless, if we estimated that the current total number of hepatologists and transplant hepatologists in SA is double what is registered in the SCFHS ($n = 50$), it means that there is one hepatologist per 660,000 individuals. In contrast, there is an average of one hepatologist per 330,000 individuals in the USA.^[2]

To estimate the hepatology needs in SA, it is important to evaluate current and project future liver disease burden. It is of concern that the present hepatology workforce in SA is not matching the demands due to rising incidence rates of non-alcoholic fatty liver disease (NAFLD) and hepatocellular carcinoma (HCC), and the growing number of LT recipients in need of post-transplant care.^[4-9] The prevalence of NAFLD is increasing, with an estimated 12 million individuals being diagnosed with NAFLD by

2030.^[4] Likewise, the cases of compensated cirrhosis, HCC and advanced liver disease secondary to NAFLD are projected to double by 2030, with an annual incidence of liver-related deaths of 4800.^[4,10] On the other hand, the prevalence of hepatitis B virus (HBV) has decreased in recent years in the younger Saudi population due to the vaccination program.^[8] But the prevalence of HBV in older generations has not been well-characterized and remains a source of concern.^[8] It is estimated that 240,000 individuals are chronically infected with HBV, many of whom may still be undiagnosed, putting them at a higher risk of advanced liver disease and HCC.^[8]

It is uncertain how the recent introduction of direct-acting antiviral agents (DAAs) for treatment of hepatitis C virus (HCV) will affect the demand for hepatologists in SA. Two DAA treatment strategies have been proposed to give an estimate of HCV-related complications by 2030.^[5] The first is a conservative management strategy in which the annual diagnosis of HCV-related HCC will be 350, liver-related deaths would be 480, and there will be 12,000 cirrhosis cases. The second strategy is more aggressive in screening and managing patients with HCV. This aggressive approach would result in significant reduction in HCC cases, liver-related deaths and cirrhosis compared to the conservative approach.^[5] This screening/management strategy is feasible to implement through a health care policy by the Ministry of Health.

The prevalence of other chronic liver diseases in SA is not well established. However, the acuity and complexity of care for hospitalized patients with advanced liver disease has increased significantly over the last several decades.^[4] Hospitalized patients with NAFLD have a high prevalence of obesity, diabetes, chronic renal impairment, and cardiovascular disease. These patients require a multidisciplinary approach to optimize their health care and improve prognosis.

TRANSPLANT HEPATOLOGY TRAINING PROGRAM

The first liver transplant in SA was performed in 1991; however, it was not until 1994 that the first structured LT program was launched. Until 1997, all LTs in the country were deceased donor transplantations. Currently, more than 2500 LTs have been performed by four centers in SA. Over 50% of those were performed at King Faisal Specialist Hospital & Research Center (KFSH&RC) in Riyadh.^[7] The majority of these transplants were living donor LTs. The high demand for LT in the country necessitated the urgency for establishing a local training program. The increasing

demand for general gastroenterologists throughout the country coupled with increasing difficulties in securing LT training positions in North American centers triggered the launch of the local LT fellowship program. The demand for transplant hepatologists in all four centers remains high; during the last three years a total of three hepatologist departed from two centers with only one new hepatologist joining the pool of transplant hepatologists. Such shortages will no doubt be further compounded by the anticipated retirement of senior transplant hepatologists across the country. Despite the comprehensive core curriculum program in many gastroenterology fellowship programs including the Saudi gastroenterology fellowship, trainees are not adequately exposed to advanced hepatology care including care of LT patients.^[11] In the current three-year gastroenterology program, fellows may not have adequate training to manage patients with advanced liver disease. The majority of trainees do not rotate in transplant centers and are less likely to be involved in the care of patients with fulminant hepatic failure, selection of LT candidates, as well as diagnosis and management of LT complications.

Advanced training in LT is becoming increasingly important as the number of liver transplants performed and the number of individuals surviving after transplantation are increasing.^[12] The American Board of Internal Medicine recognized the importance of training in transplant hepatology and has recently approved a certificate of added qualification for those working in a transplant setting.^[13] In addition, guidelines for training physicians in transplant hepatology have been recently published.^[14]

With the increasing number of LT in the Kingdom, transplant centers are facing an increased burden as these patients continue their care in their respective transplant centers from various parts of the country. This also has a large economic impact as the Ministry of Health sponsors the transportation and housing of the patients during their travel. A transplant training program will not only help in providing LT centers with trained hepatologists, it will also help in outsourcing the care of patients in their respective regions. Graduates from the liver transplant training program will help in taking care of pre- and post-transplant patients in general hospitals across the different regions of the country.

HEPATOLOGY PRACTICE COMPENSATION MODELS

Despite the documented demand, low perceived compensation for transplant hepatologists may impede trainees from considering the specialty. Payment models are

in need of revision to aid recruitment; these, however, must be balanced with the Ministry of Health's Vision 2030 that includes improving health care delivery with cost control.^[15] Delivering efficient healthcare requires a complex process of evaluating disease probabilities and promoting desired behaviors by health care providers and patients.^[16] It is well known that policies targeting physician remuneration are significant contributors to the efficiency of health care delivery.^[16] In addition, it is commonly accepted that payment methods influence physician practice behavior.^[17]

There are several physician payment methods such as fee-for service (FFA) or relative-value unit (RVU), capitation, basic salary, and pay-for-performance (P4P). RVUs are a measure of value calculated by the United States (US) Medicare system to compensate physicians for the patient care services they provide.^[18] The system was launched in 1989 and it contains over 7,000 services that physicians can perform for patient care and has been adopted by all insurance companies.^[19] In our public sector, the payment method for physicians is salary-based. However, several health care sectors are transforming to an RVU-based model to enhance physician performance and to improve healthcare delivery.

A financial discrepancy does exist between procedural and nonprocedural fields in medicine. Procedural fields have generated more direct income to institutions and have often been rewarded with decent benefits. On the other hand, non-procedure medical fields have been reimbursed at a lower level. Although less direct revenue may be generated, these subspecialties may be a substantial source of indirect revenue for an institution due to the additional ancillary services including radiology, pathology, and advanced therapies. In general, endoscopic procedures provide higher RVUs compared to hospitalized patients. Hepatologists and gastroenterologists perform endoscopic procedures on a regular basis. However, hepatologists spend more time on managing advanced liver disease patients, and perform less endoscopic procedures compared to their gastroenterology colleagues. For this reason, hepatologists will earn less RVUs compared to gastroenterologists.^[20] However, Cohen *et al.*^[20] evaluated the financial impact of a clinical hepatology practice relative to gastroenterology, in a large US academic center over a period of 12-months. The study evaluated direct and indirect charges from each practice. For every \$1 billed by hepatologists, the hospital system generated an additional \$26 in charges for non-LT patients and \$51 for LT patients. On the other hand, the hospital system generated only \$5 for every \$1 billed by gastroenterologists.^[20] It is therefore apparent that the hospital care provided by hepatologists for patients with

liver disease generates significant revenues for academic centers, and a portion of this revenue is being passed onto hepatologists in the form of salary support. However, we need to acknowledge the significant difference between our healthcare and US healthcare systems. In our current health model, it would be impractical to anticipate that hepatologists will generate more hospital's revenue compared to gastroenterologists in academic centers. Nonetheless, it would be important to acknowledge the significant non-procedural demands of hepatologists and transplant hepatologists in SA. Hence, hepatologists' income should not be jeopardized by the RVUs-model in academic and transplant centers in SA, and should be implemented with caution before it is generalized throughout the country. In a recent survey evaluating the RVU production and salaries earned by US hepatologists, those working at institutions with a LT program performed the fewest endoscopic procedures and received the highest compensation/RVU compared to hepatologists in non-LT setting or gastroenterologists (\$68-\$85 vs 44-\$63 vs \$50, respectively).^[21] Therefore, there is a necessity to establish a robust model to compensate hepatologists based on the service and level of care that they provide to their patients.

Several key performance indicators (KPIs) have been developed for LT programs.^[22] However, none of these KPIs can be utilized to assess the productivity of transplant hepatologists. Indeed, establishing KPIs for a transplant hepatologist is not only important for monitoring, measuring, and managing the performance of a healthcare provider but it will improve the efficiency, effectiveness, safety, equity and quality of the LT program. The proposed KPIs that can be used by SASLT to evaluate the clinical and academic productivity of a transplant hepatologist are shown in Table 1. However, these KPIs need to be universally defined and validated in the literature among LT centers before they are utilized in pay-for-performance reimbursement models.

LIVER TRANSPLANT COMPENSATION MODEL

Several hospitals in SA are transforming into a non-profit organization with the aim to establish an independent, financially sustainable hospital. Hence, it is critical to discuss the business model of solid organ transplantation in SA. However, there is a paucity of data on financial cost and reimbursement for LT in SA. In 1998, Al-Sebayel *et al.*^[23] estimated that the total cost of LT in SA was \$ 83,000. This estimated cost was evaluated based on hospital direct costs and did not consider other types of expenses. Cost is a tricky concept to pin down. In USA, there are three components of cost in transplantation: physician services,

Table 1: Key performance indicators for transplant hepatologist

Clinical
Patient access
Outreach clinic in underserved area
Number of new patients seen
Number of follow-ups seen
Hepatocellular carcinoma screening rate
Variceal screening rate
General hepatology clinic
Number of new patients seen
Number of follow-ups seen
Hepatocellular carcinoma screening rate
Variceal screening rate
Liver transplant evaluation clinic
Number of patients being evaluated for liver transplantation
Number of patients being listed for liver transplantation
Liver transplant wait-list mortality
Post-liver transplant clinic
Number of patients seen
Inpatient transplant hepatology service
Number of admissions
Number of patients being evaluated for liver transplant
Length of hospital stay
90-day readmission rate
Mortality rate
Endoscopy procedures
Number of esophagogastroduodenoscopies (EGD)
EGD intervention (e.g., banding and gluing)
Number of colonoscopies
Colonoscopy intervention
Patient safety indicators
Cardiac or respiratory arrest
Bowel perforation
Unplanned transfer to intensive care unit
Bleeding requiring transfusion
Patient satisfaction
Satisfaction with standard operating process (SOP)
Patient satisfaction rate in the outpatient clinic
Patient satisfaction rate in the inpatient service
Patient satisfaction rate with procedure
Symptoms control
Improvement in patient reported ascites control
Improvement in patient reported hepatic encephalopathy control
Reduction in variceal bleeding rate
Administrative
Documentation compliance
Percentage of completed records within 30 days
Leading a program related to the transplant service line
Leading the tumor board meeting
Establishing a comprehensive fatty liver clinic
Lead quality projects in your organization
Establishing a paracentesis clinic
Research
Presenting in national and international meetings
Publishing papers in scientific indexing (ISI) journals
Editorial member/associate editor in gastroenterology and hepatology journal
Education
Transplant hepatology program director
Contribution to the gastroenterology fellowship program
Involvement in morning rounds
Involvement in the gastroenterology and hepatology academic activities
Involvement in journal club
Mentoring gastroenterology and transplant hepatology fellows
Supervising fellows in research projects. The projects required to be presented in national or international meetings
Supervising fellows in quality projects that would result in improving the hospital's metrics

hospital services, and organ acquisition costs (OAC).^[24] Physicians cost is defined by RVUs assigned to each patient encounter. Hospital services for transplantation typically include costs incurred from 24 hours prior to the transplant procedure to the time of hospital discharge. However, ideally the hospital services for transplantation should include costs incurred from 24-48 hours prior to the transplant procedure to 90-days post-transplant. Organ acquisition costs include pre-transplant outpatient services related to the organ donor and recipient, and hospital inpatient costs associated with the donor, deceased or living.

Hospital services cost may vary greatly between institutions. However, there are two components of any cost that must be calculated in order to perform appropriate financial evaluation. The first is the variable cost, and the second the fixed cost. The variable cost of a procedure includes every cost directly associated with the procedure. There may be both direct and indirect costs associated to the variable cost. For a transplant procedure, these costs may include operating room costs, laboratory costs, room and board costs, and pharmacy costs, among others. These costs would not be incurred if the procedure were not performed. In contrast, fixed costs consist primarily of overhead costs, which may also have direct and indirect components. These costs may include salaries of nurses and other nonmedical staff such as administrators, building costs for the hospital, the cost of equipment and the cost of maintaining the facilities. In addition, allocation of indirect cost varies tremendously in dollar amounts, depending on the size of the institution and the number of beds.

Costs attributable to OAC include, in addition to the cost of the procuring organs transplanted, any costs incurred in the evaluation of all potential recipients and living donors at a specific institution for a defined period of time, regardless of whether the patients become actual transplant recipients. This may include the salaries and benefits of all personnel involved in these activities, as well as indirect costs directly attributable to these activities, including office rent, computers, office supplies, etc.

All transplant centers in SA are reimbursed by the government. However, there is no clarity on the method and type of reimbursement. The assumption being made is that each center in SA has a dedicated budget based on the size of the transplant center, and the number of beds. It would be easier and cheaper in general for the SA government to make global payments triggered by events such as LT. With Vision 2030, all LT centers in SA would require financial evaluation, to have a clear understanding of cost allocation and revenue generation. It is an important

principle for LT centers in SA to adopt charge-to-cost ratios to improve the profit margin; this is defined by the revenue minus the production cost, which in turn consists of both fixed and variable costs. Commercial payers in SA may have an important role in the near future on providing financial stability to LT centers. Hence, it is not only important for LT to be cost-efficient in order to compete but, transplant quality measures such as transplant outcomes and patient's satisfaction will also need to be evaluated.

ADVANCED NURSE PRACTITIONER (NP) PRACTICE MODEL IN HEPATOLOGY AND LIVER TRANSPLANTATION

The prevalence of cirrhosis in SA is increasing, and thereby outstripping the capacity of hepatologists and transplant hepatologists to provide optimum care. As such, there is a growing need for Nurse Practitioners (NPs) in hepatology and LT practice. Several studies have shown that NPs can provide the care that is equivalent in quality to physicians in both primary and specialty care when their practice is focused on one condition.^[25-27] Nazareth *et al.*^[28] showed that the NP model for the management of HCV was successful. NPs can order, interpret diagnostic tests, initiate HCV therapy, facilitate patients' access to treatment and refer patients to a specialist if needed.^[28] In addition, implementation of the NP practice model in hepatology practice is associated with improved quality of care and patient outcomes with advanced liver disease.^[27] Tapper *et al.*^[27] has demonstrated that patients who were seen by NP and gastroenterologist or hepatologist were most likely

to receive consistent HCC and variceal screening over time, compared to the model where patients are seen only by the gastroenterologist or hepatologist.

In North America, several institutions have integrated NPs as part of their hepatology and LT team with potential benefits including the improvement of accessibility, productivity, continuity of care and patient satisfaction.^[29-31] Chaney *et al.*^[32] have demonstrated that the NP practice model was associated with improvements in graft outcome and patient's survival post-LT. In addition, the NP practice model resulted in reduced healthcare costs by decreasing the readmission rate at 30- and 90-day post LT.^[33] In addition, NPs can be actively involved in clinical research and quality improvement projects. Table 2 describes the potential roles of NPs in a hepatology and LT transplant practice.

Several factors should be considered when defining the role of NPs in a hepatology and LT practice including type and size of practice, inpatient versus outpatient care, medical versus surgical service, procedures, and the scope of practice allowed by the organization and SCFHS.

CONCLUSION

The hepatology workforce in SA is headed for new challenges as there are pronounced forecasted changes in hepatology-related disease prevalence. In addition, new liver-related therapies will have a substantial impact on the population needs for hepatology providers. It was an important initiative by SCFHS to launch a transplant

Table 2: Nurse practitioner role in hepatology and liver transplant practice

Inpatient practice	Outpatient practice
Admission of patients to hospital	Types of patients: follow-ups, preprocedural evaluations, consults, routine annual post-LT evaluations
Direct management (history, physical examination, diagnosis, diagnostic ordering, and treatment/management)	Direct management (history, physical examination, diagnosis, diagnostic ordering, and treatment/management)
Management of care for end-stage liver disease patients (including possible adverse events), care of patients who have received a LT, and care of patients who have complications after transplant	Management of care for end-stage liver disease patients (including possible adverse events), care of patients who have received a LT, and care of patients who have adverse events after transplant
Discharge patients from hospital (eg, care coordination from inpatient to outpatient, home health care, prescriptions, arrangements for post-discharge follow-up visits, laboratory tests, and imaging)	Procedures: transient elastography, paracentesis
Procedures: paracentesis, thoracentesis	Urgent care visits in clinic to evaluate need for hospital admission, medications, procedures, and other indications
Surgical practice: first assist in surgery, wound care/wound checks, arranging outpatient follow-up for surgery cases	
ICU NP or PA: urgent evaluation of critically ill patients, and if required, transfer to ICU for further escalation of care, thoracentesis, paracentesis with pigtail placements, and central line placements	

hepatology program given the current and future demand in SA. However, a workforce hepatology study is needed to obtain data for optimal workforce estimates and to properly expand a transplant hepatology program. A well thought-out compensation plan is also vital to retain the current workforce and attract future practitioners. In addition, an integrated NP model in hepatology and LT is urgently needed to meet the needs of patients with advanced liver diseases and those undergoing LT.

Acknowledgments

The authors wish to thank Dr. Mohammed Alghamdi for his assistance in data collection from the SCFHS.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Saudi Gastroenterology Association. Available from: <https://www.saudigastro.com/tarykh-aljmayh>. [Last accessed on 2020 Oct 18].
- Russo MW, Koteish AA, Fuchs M, Reddy KG, Fix OK. Workforce in hepatology: Update and a critical need for more information. *Hepatology* 2017;65:336-40.
- Transplant hepatology pilot training program 2020. Available from: <https://www.abim.org/program-directors-administrators/competency-based-medical-education-pilot-programs/gastroenterology-transplant-hepatology.aspx>. [Last accessed on 2020 Oct 18].
- Alswat K, Aljumah AA, Sanai FM, Abaalkhail F, Alghamdi M, Al Hamoudi WK, et al. Nonalcoholic fatty liver disease burden - Saudi Arabia and United Arab Emirates, 2017-2030. *Saudi J Gastroenterol* 2018;24:211-9.
- Aljumah AA, Abaalkhail F, Al-Ashgar H, Assiri A, Babatin M, Al Faleh F, et al. Epidemiology, disease burden, and treatment strategies of chronic hepatitis C virus infections in Saudi Arabia in the new treatment paradigm shift. *Saudi J Gastroenterol* 2016;22:269-81.
- Aljumah AA, Babatin M, Hashim A, Abaalkhail F, Bassil N, Safwat M, et al. Hepatitis B care pathway in Saudi Arabia: Current situation, gaps and actions. *Saudi J Gastroenterol* 2019;25:73-80.
- Al Sebayel M, Abaalkhail F, Al Abbad S, AlBahili H, Elsiy H, Aleid M, et al. Liver transplantation in the Kingdom of Saudi Arabia. *Liver Transpl* 2017;23:1312-7.
- Abdo AA, Sanai FM, Al-Faleh FZ. Epidemiology of viral hepatitis in Saudi Arabia: Are we off the hook? *Saudi J Gastroenterol* 2012;18:349-57.
- Sanai FM, Al Khathlan A, Al Fadhl A, Jazzar AS, Hashim AM, Mansour E, et al. Clinical and economic burden of nonalcoholic steatohepatitis in Saudi Arabia, United Arab Emirates and Kuwait. *Hepatology* 2021;75:912-21.
- Alqahtani SA, Sanai FM, Alolayan A, Abaalkhail F, Alsuhailani H, Hassanain M, et al. Saudi Association for the Study of Liver diseases and Transplantation practice guidelines on the diagnosis and management of hepatocellular carcinoma. *Saudi J Gastroenterol* 2020;26(Suppl 1):S1-40.
- Bini EJ. Hepatology training during gastroenterology fellowship: Are we getting to the core of the curriculum? *Clin Gastroenterol Hepatol* 2008;6:608-9.
- Halegoua-De Marzio DL, Herrine SK. Training directors have positive perceptions of a competency-based gastroenterology and transplant hepatology fellowship program. *Clin Gastroenterol Hepatol* 2015;13:398-401 e3.
- Bacon BR. Certificate of added qualification in transplant hepatology. *Liver Transpl* 2005;11:4-6.
- Rosen HR, Fontana RJ, Brown RS, Wiesner RH, Schiano TD, Bass NM, et al. Curricular guidelines for training in transplant hepatology. *Liver Transpl* 2002;8:85-7.
- Al-Hanawi MK, Khan SA, Al-Borie HM. Healthcare human resource development in Saudi Arabia: Emerging challenges and opportunities-a critical review. *Public Health Rev* 2019;40:1.
- Wranik D. Healthcare policy tools as determinants of health-system efficiency: Evidence from the OECD. *Health Econ Policy Law* 2012;7:197-226.
- Forsberg E, Axelsson R, Arnetz B. Financial incentives in health care. The impact of performance-based reimbursement. *Health Policy* 2001;58:243-62.
- Hsiao WC, Braun P, Dunn DL, Becker ER, Yntema D, Verrilli DK, et al. An overview of the development and refinement of the Resource-Based Relative Value Scale. The foundation for reform of U. S. physician payment. *Med Care* 1992;30(11 Suppl):NS1-12.
- Dove HG. Use of the resource-based relative value scale for private insurers. *Health Aff (Millwood)* 1994;13:193-201.
- Cohen SM, Gundlapalli S, Shah AR, Johnson TJ, Rechner JA, Jensen DM. The downstream financial effect of hepatology. *Hepatology* 2005;41:968-75.
- Shiffman ML, Sussman NL, Ravendhran N, Ditmyer M, Kowdley KV, Kugelmas M. Financial compensation for hepatologists in different practice settings. *Hepatology* 2019;69:2664-71.
- Muller X, Marcon F, Sapisochin G, Marquez M, Dondero F, Rayar M, et al. Defining benchmarks in liver transplantation: A Multicenter outcome analysis determining best achievable results. *Ann Surg* 2018;267:419-25.
- Al Sebayel M. Starting a liver transplantation program: Experience at King Fahad National Guard Hospital in Riyadh. *Ann Saudi Med* 1998;18:330-2.
- Abecassis MM. Financial outcomes in transplantation—A provider's perspective. *Am J Transplant* 2006;6:1257-63.
- Horrocks S, Anderson E, Salisbury C. Systematic review of whether nurse practitioners working in primary care can provide equivalent care to doctors. *BMJ* 2002;324:819-23.
- Mafi JN, Wee CC, Davis RB, Landon BE. Comparing use of low-value health care services among U. S. advanced practice clinicians and physicians. *Ann Intern Med* 2016;165:237-44.
- Tapner EB, Hao S, Lin M, Mafi JN, McCurdy H, Parikh ND, et al. The Quality and outcomes of care provided to patients with cirrhosis by advanced practice providers. *Hepatology* 2020;71:225-34.
- Nazareth S, Piercy C, Tibbet P, Cheng W. Innovative practice in the management of chronic hepatitis C: Introducing the nurse practitioner model. *Aust J Adv Nurs* 2007;25:107-13.
- Tedesco J. Acute care nurse practitioners in transplantation: Adding value to your program. *Prog Transplant* 2011;21:278-83.
- Ohler L, Shafer T. Advanced practice: Implications for clinical and procurement transplant coordinators. *Prog Transplant* 2006;16:103-4.
- Aplin N. Advanced nurse practitioner-led abdominal therapeutic paracentesis. *Emerg Nurse* 2017;24:34-7.
- Chaney AJ, Harnois DM, Musto KR, Nguyen JH. Role development of nurse practitioners and physician assistants in liver transplantation. *Prog Transplant* 2016;26:75-81.
- Mahmud N, Halpern S, Farrell R, Ventura K, Thomasson A, Lewis H, et al. An Advanced practice practitioner-based program to reduce 30- and 90-day readmissions after liver transplantation. *Liver Transpl* 2019;25:901-10.