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Quality Improvement Measures and Electronic Medical Record Alerts Increase Liver Cancer Screening in Patients with Cirrhosis

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Quality Improvement Measures and Electronic Medical Record Alerts Increase Liver Cancer Screening in Patients with Cirrhosis

A dissertation submitted in partial satisfaction of the

requirements for the degree

Doctor of Nursing Practice

by

Byung Sook Park

2022

ABSTRACT OF THE DISSERTATION

Quality Improvement Measures and Electronic Medical Record Alerts Increase Liver Cancer Screening in Patients with Cirrhosis

by

Byung Sook Park

Doctor of Nursing Practice

University of California, Los Angeles, 2022

Professor Wendie Robbins, Chair

Background: Patients with cirrhosis are at high risk for developing liver cancer/hepatocellular carcinoma (HCC). Adherence to HCC surveillance guidelines with abdominal ultrasound (US) and alpha-fetoprotein (AFP) blood test every six months improves detection of HCC in the early stages, providing opportunities for potentially curative treatments. However, the guidelines are underused, and literature shows that less than 10% of cirrhotic patients undergo surveillance in primary care settings. **Objectives**: This DNP project aimed to assess the effectiveness of implementing the quality improvement (QI) measures and electronic medical record (EMR) alerts along with patient education to improve HCC surveillance rates for cirrhosis patients in

community-based primary care clinics. **Methods:** An evidence-based practice (EBP) QI project with a pre-and post-intervention cohort study was conducted in federally qualified primary care clinics. Seventy-five cirrhotic patients were identified using the International Classification Diseases (ICD) 10^{th} codes before the intervention. The EMR alerts were built to assist providers in ordering surveillance tests (abdominal US & FP) when the surveillance becomes overdue or due. Patient education was incorporated by the providers using the HCC surveillance education brochure in English and Spanish. In addition, and data-driven HCC QI measures were created to monitor HCC surveillance status. **Results:** The HCC surveillance QI project began in September 2021. Over six months of the study period, 86 cirrhotic patients were enrolled in the HCC surveillance program. Before the intervention, the baseline surveillance rate was 6.7% (5/75). However, the surveillance rate increased to 22.4 % (19/85) after the intervention. In addition, in the comparisons by race/ethnicity within the post-intervention period, the Hispanic group had the highest number of cirrhotic patients. However, patients who did not report race/ethnicity had the highest post-intervention HCC surveillance rate. **Conclusion:** Implementing the HCC QI measures and EMR alerts effectively increased HCC surveillance rates among cirrhotic patients in federally qualified primary care clinics. The QI measures and EMR alert with patient education using a concise HCC surveillance education brochure are inexpensive, easy to use, and practical strategies to improve HCC surveillance, especially targeting PCPs in primary care settings.

Keywords: Liver cancer, Screening, EMR alert, Clinical Reminders, Primary Care Clinics.

The dissertation of Byung Sook Park is approved.

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2022

First of all, I dedicate this work to heavenly farther God, who has given me the strength, wisdom and knowledge that made this work possible. Secondly, I dedicate this dissertation to my loving parents, Kwang Soo and Yen Sim Park, and my uncle Chang Muk and aunt Jong Kum Yi with utmost pride. Mom and Dad, you had no or minimal formal education, yet your unconditional love, sacrificial support, wisdom, and trust in me are the reasons for this project. Uncle and aunt, your unselfish and kind act that brought me to America is another reason for this accomplishment. Therefore, this dissertation is in honor of my parents and my uncle and aunt in heaven. Also, I dedicate this work to my patients suffering from liver disease, who put their trust in my care and inspired me to provide the highest quality of care possible.

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VITA

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Education

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Professional Experience

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Honors and Awards

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2010	The UC Regent Scholar Graduate, UCLA, CA
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Media Appearances

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1999	KTE & KTAN TV Channels, Los Angeles, CA: *Promoting Organ Donation & Transplantation in the Korean Community*

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CHAPTER ONE: INTRODUCTION

Hepatocellular carcinoma (HCC) is primary liver cancer originating from hepatocytes. It is the third leading cause of cancer-related death worldwide, behind lung and stomach cancer (Bray et al., 2018). From 1990-2015, the incidence of liver cancer increased by 75% worldwide, and HCC represents up to 75-85 % of all current primary liver cancers (Akinyemiju et al., 2017; Bray et al., 2018). Cirrhosis is the primary risk factor for HCC, and patients with cirrhosis are at high risk for developing HCC regardless of etiology (Singal et al., 2020). The late discovery of HCC leads to poor patient survival and a high mortality rate, with a median survival of less than a year (Wolf et al., 2021). The early detection of HCC is associated with improved overall patient survival, decreased mortality, and reduced healthcare costs (Singal et al., 2014). The practice guidelines from the American Association for the Study of the Liver Diseases (AASLD) recommend HCC surveillance with biannual abdominal ultrasound (US) with or without an alpha-fetoprotein (AFP) for the early detection of HCC for patients with cirrhosis**.** However, continued low HCC surveillance rates are prevalent in practice, especially in primary care settings, indicating a clinical gap in HCC surveillance (Singal et al., 2012a; Wolf et al., 2021).

Hepatocellular carcinoma surveillance with the biannual abdominal US and AFP is associated with early detection of HCC, improving overall patient survival, decreasing mortality, and reducing healthcare costs (Lin et al., 2004; Parikh et al., 2020). However, studies (Singal et al., 2017a; Wolf et al., 2021) continue to show underutilized HCC surveillance with critically low surveillance rates in clinical practice, particularly in primary care settings. The most common reason for the lack of HCC surveillance is the failure to order required surveillance tests (US/AFP) by providers (Singal et al., 2012b). The PCPs follow most compensated cirrhotic patients yet have many competing tasks, and HCC surveillance is often overlooked. Thus, the

discussion on the importance of adherence to the HCC surveillance practice guidelines is crucial for DNP-prepared hepatology specialty providers to improve the outcomes among the patients with cirrhosis.

Problem Statement

Patients with cirrhosis are the primary risk-cohort for developing HCC, with an annual incidence of 1-8%, and one-third of cirrhotic patients will develop HCC during their lifetime (Singal et al., 2020). Hepatocellular carcinoma is a highly fatal tumor and a leading cause of death among cirrhotic patients, which is the fastest increasing cause of cancer-related death in the United States (Wolf et al., 2021). The adherence to HCC surveillance with biannual abdominal US and serum AFP is linked to early detection of HCC, providing potential curative treatment options, including surgery and transplantation, and improving overall patient survival (Costentin et al., 2018; Singal et al., 2014; Singal et al., 2017a). However, continued low surveillance rates in clinical practice are evident despite the HCC practice guideline recommendations and the benefits of adherence to surveillance (Goldberg et al., 2017; Singal et al., 2014; Singal et al., 2020; Wolf et al., 2021). In a retrospective cohort study among cirrhotic patients diagnosed with HCC, Singal et al. (2012b) found that the failure of HCC surveillance is multifaceted. The most common reason for the failure was providers' lack of surveillance orders (US/AFP), especially in primary care settings (Singal et al., 2012b). Singal and colleagues (2017b), in a retrospective cohort study, described that less than 2% of cirrhotic patients received biannual HCC surveillance from population-based community practices. Literature indicates an evident clinical gap and an urgent need for intervention to improve HCC surveillance to close this gap in clinical practice for patients with cirrhosis.

PICOT Clinical Question

Substantial evidence demonstrates that adherence to the surveillance guidelines increases the detection of HCC in the early stages, improving survival (Singal et al., 2014; Parikh et al., 2020). However, continued low HCC surveillance rates are prevalent in practice, indicating a clinical gap in HCC surveillance, which signifies a pressing need for an effective intervention to improve HCC surveillance. This DNP Scholarly Project focuses on the clinical gap in practice regarding the underutilization of HCC surveillance guidelines. The project is an evidence-based QI initiative to improve HCC surveillance by developing QI measures in the analytic data-driven electronic health record (EHR) system and creating an electronic medical record (EMR) alert for HCC surveillance in patients with cirrhosis. The clinical question for this DNP project is: In adult cirrhotic patients followed by primary care providers (P), does the creation of QI measures and EMR alerts for HCC surveillance with biannual abdominal US/AFP blood tests (I), compared to HCC surveillance without QI measures and EMR alerts (C), improve HCC surveillance rates by the providers, adhering to the surveillance guidelines (O), over a 6-month study time-period by March 2022 (T)?

Purpose and Objectives

The purpose of the Doctor of Nursing Practice (DNP) Scholarly Project was to 1) underscore the urgent need for practice change to improve HCC surveillance by primary care providers (PCPs) and 2) increase HCC surveillance rates among cirrhotic patients. This quality improvement (QI) project also aimed to promote adherence to the existing HCC practice guidelines by PCPs, ordering the US /AFP every six months to detect HCC early to improve patient survival, ultimately to improve population health, and to reduce healthcare costs.

CHAPTER TWO: THEORETICAL FRAMEWORK

Hepatocellular carcinoma surveillance failure is multifactorial, involving providers, patients, and healthcare delivery processes (Goldberg et al., 2017; Singal et al., 2012b). Efforts to increase HCC surveillance rates require changes in the process or services to improve patient care. Quality improvement involves a systematic, continuous, and formal approach to analyzing practice performance and improving the targeted patient group's health status (US Department of Health Resources and Services Administration, 2011).

Concepts

This DNP Project is a QI initiative with system-based interventions aiming for clinical practice changes to improve surveillance by developing the analytical data-driven HCC surveillance QI measures and EMR alerts in patients with cirrhosis. An iterative quality improvement process should intervene in the failure points in continuous cycles to improve the HCC surveillance process. Thus, the Institute for Healthcare Improvement (IHI) Model with the Plan-Do-Study-Act (PDSA) method was selected for the theoretical framework to guide this DNP project (see Appendix A). The Model for Improvement provides a structured framework that the project team can utilize when planning a QI project to improve health care processes and outcomes (Picarillo, 2018). The Model for Improvement has been a widely used template for QI in various healthcare settings to bring about positive clinical changes (Picarillo, 2018).

Framework: IHI Model for Improvement

The Institute for Healthcare Improvement (IHI) Model for Improvement was developed by Associates in Process Improvement based on Edward Deming's Change Model (Picarillo, 2018). Deming developed the Plan-Do-Study-Act cycle (PDSA), a scientific method for improvement, and four logical cyclical steps for continuous improvement (Taylor et al., 2014).

The IHI Model for Improvement begins with three fundamental questions in the analysis phase: (1) *What are we trying to accomplish? (2) How will we know a change is an improvement? (3) What change can we make that will result in an improvement?* This process encompasses setting an aim of the project, selecting measurement for data collection, developing ideas for changes leading to improvement, and testing and implementing changes using the PDSA cycles (Picarillo, 2018; Taylor et al., 2014).

The PDSA cycle is a continuous QI model and presents a practical scientific method for testing changes/interventions in a complex system in four steps and has been the central component of QI initiatives in healthcare (Knudsen et al., 2019; Taylor et al., 2014). In the Planning stage (P), the focus is on developing change concepts, making predictions, and planning to carry out the cycle. In the Doing step (D), implementation involves carrying out the action plan, documenting unexpected observations, and beginning data analysis. In the Studying phase (S), results are prepared by completing the data analysis, comparing the data predictions, studying results, and summarizing what was learned. In the Acting phase (A), changes are implemented, disseminated, and prepared for the next cycle (Moen & Norman, 2010).

Multiple failure points are identified in the HCC surveillance process among cirrhotic patients at risk for developing HCC (Singal et al., 2012b). The lack of HCC surveillance is multifactorial, and all facets need to be reviewed and tackled in a continuous interactive process. The IHI Model for Improvement with the PDSA cycles is a concept similar to developing a hypothesis in a scientific experiment. The team proposes an intelligent guess, utilizing evidence-based approaches to produce a system change that leads to desired improvement (Pricarillo, 2018). In this scientific theoretical method, the DNP project lead tested the effectiveness of HCC surveillance QI measures and EMR alerts, improving the surveillance, collecting data to test the

hypothesis, analyzing the data and interpreting the results, and making inferences to iterate the hypothesis (Taylor et al., 2014). The IHI Model for Improvement is an appropriate theoretical framework for this DNP project aiming at clinical practice change to increase HCC surveillance rates to improve patient outcomes in patients with cirrhosis.

CHAPTER THREE: REVIEW OF LITERATURE

Patients with cirrhosis are a high-risk cohort for developing HCC. Practice guidelines, including the American Association for the Study of the Liver Diseases (AASLD), The Asian Pacific Association for the Study of the Liver (APASL), and the European Association for the Study of the Liver (EASL), unanimously recommend HCC surveillance for early detection of HCC (Harris et al., 2019). The adherence to HCC surveillance with biannual abdominal US and serum AFP is associated with detecting HCC in the early stages, thus improving overall survival rates (Parikh et al., 2020; Singal et al., 2014; Yang et al., 2018). However, HCC surveillance rates remain continually low in clinical practice, indicating the need for effective interventions to improve HCC surveillance and close the gap in clinical practice among cirrhotic patients.

Evidence Search and Methodology

A literature search was conducted using several databases to identify relevant articles on the topics, including PubMed, CINAHL Plus, EMBASE, and Cochrane Library. The keywords for search terms included "liver cirrhosis, liver cancer, hepatocellular carcinoma, surveillance, liver cancer screening, improving surveillance, clinical reminder, electronic medical record or EMR alert." The initial search yielded 5,529 articles. The second search with modified keywords (liver cirrhosis, hepatocellular carcinoma, HCC surveillance, improving surveillance, clinical reminder, electronic medical record alert) resulted in 1,250 articles. As keywords were broad, the search terms were further redefined with keywords: liver cancer or HCC surveillance, improved

HCC surveillance, clinical reminder, or EMR alert. The third search identified 639 articles, and the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) method was utilized to evaluate these articles (see Appendix B). After the initial review of titles, 579 articles were removed, including articles unrelated to HCC surveillance, duplicates, and abstracts without full texts.

Sixty articles with full texts were reviewed, and 29 out of 60 full-text articles were excluded, including studies with no HCC surveillance outcome. Thus, 31 articles related to various issues on HCC surveillance were examined. These articles included quantitative, retrospective, prospective cohort studies, randomized control trials, quasi-experimental studies, systematic reviews, and meta-analyses. Of these 31 articles, 6 studies conducted outside of the United States were further removed, and 25 articles related to various issues on HCC surveillance were kept. Of these 25 articles, two studies were identified that assessed the effectiveness of EMR alerts and QI measures to improve HCC surveillance among patients with cirrhosis, consistent with the focus of this DNP Scholarly Project interest. The literature search was further expanded with manual searches by reviewing the reference lists of systematic reviews, meta-analyses, and expert review articles.

Underutilized HCC Surveillance Guidelines

Singal et al. (2012a) performed a systematic literature review to quantify HCC surveillance utilization rates among cirrhotic patients and evaluate the association between surveillance rates and patients' socio-demographic characteristics. This systematic review of nine studies conducted in the United States showed low HCC surveillance rates, with a pooled surveillance rate of 18.4%. Surveillance rates were higher among patients followed in subspecialty clinics compared to patients followed in primary care clinics, 51.7% vs. 16.9%, $P<$

0.001 (Singal et al., 2012a). African Americans, non-Caucasians, and patients with low socioeconomic status had lower surveillance rates, indicating disparities in HCC surveillance. The limitation of this systematic review was the inability to identify failure reasons for underused HCC surveillance.

Eight years later, Wolf et al. (2021) conducted another systematic review and meta-analysis of 29 studies performed in 12 countries from the United States, Europe, and Asia to quantify the HCC surveillance rates. Patients followed by hepatology had the highest surveillance rates compared to community-based primary care cohorts, 73.7% vs. 8.8%, $P <$ 0.001, indicating continued low HCC surveillance rates and a clinical gap in HCC surveillance, especially in community-based primary care settings. Notably, the latter review indicated that automated EMR reminders paired with the provider and patient education increased biannual HCC surveillance from 0% to 63.6 % in a small cohort of 22 patients followed in the tertiary hepatology clinic (Kennedy et al., 2013). The limitations of the systematic review included the varying definitions for HCC surveillance; some studies used a guideline-concordant definition of semiannual surveillance, and others used operational definitions.

Most studies in HCC surveillance were performed in racially and socioeconomically similar populations. Singal et al. (2015) conducted a retrospective cohort study among cirrhotic patients followed at a safety-net system in Dallas County, which integrates eleven primary care *clinics in low-income neighborhoods. In this safety-net health system, patient populations were* racially and socioeconomically diverse, with 22% African Americans, 40% Hispanics, and 43% uninsured patients. This study showed only 1.7 % of patients (13 out of 786) received biannual HCC surveillance. Low HCC surveillance rates among African Americans and uninsured

patients signified the racial and socioeconomic disparities in HCC surveillance among patients with cirrhosis (Singal et al., 2015) (see Table of Evidence).

Singal and colleagues (2017b) further conducted a retrospective cohort study to characterize HCC surveillance among cirrhotic patients followed in the large population-based integrated healthcare delivery system in Washington State. In this study, among 1137 patients with cirrhosis, 22 patients (2%) underwent guideline-consistent biannual surveillance, and 744 patients (65%) received no HCC surveillance. Such literature findings demonstrate a critical clinical gap in practice, especially in community-based practice settings (Table of Evidence).

Best Practice in HCC Surveillance

Hepatocellular carcinoma screening has been conducted since the 1970s without conclusive evidence of the effectiveness of the screening in decreasing HCC mortality rates (Zhang et al., 2004). In 2004, Zhang and colleagues performed the first milestone randomized controlled trial to evaluate the effect of biannual HCC surveillance with the abdominal US and serum AFP. In this study done in China, 18,816 patients with chronic hepatitis B virus (HBV) infection or chronic hepatitis were randomly assigned to the surveillance group (n = 9373) or the control group (n = 9443). After five years of follow-up, the study showed a reduced HCC mortality by 37% in the surveillance group and an increased five-year survival rate in the surveillance group (46 % vs. 0 %). However, a limitation of these findings in patients with HBV infection includes that the results cannot be generalized to Western countries where patients have different causes of liver diseases such as alcoholic liver disease, hepatitis C infection, and fatty liver disease (see Table of Evidence).

Randomized control trial (RCT) studies to assess the effect of HCC surveillance are unfeasible as putting patients at risk for HCC into the control group with no surveillance would

be considered unethical**.** However, the lack of RCT data does not equate to a lack of data supporting the effectiveness of HCC surveillance. Singal and colleagues (2014) performed a systematic literature review using Medline from 1990 to 2014. In this systematic review of 47 studies conducted in 13 countries from Asia, Europe, and the United States, 6,284 out of 15,158 cirrhotic patients had HCC detected by surveillance (41.4%). This review showed that HCC surveillance was associated with improved early detection of HCC (odds ratio [OR] 2.08, 95% CI 1.80-2.37), increased curative treatment rates (OR 2.24, 95% CI 1.99-2.52), and significantly prolonged survival (OR 1.90, 95 % CI 1.67-2.17). The limitation of the data included many studies having an insufficient duration of follow-up to evaluate survival. This systematic review concluded that HCC surveillance is linked to significant improvements in early detection of HCC and overall survival in cirrhotic patients.

Singal and colleagues (2017a) conducted a retrospective multicenter cohort study of patients diagnosed with HCC between 2012 to 2013 at four health systems in the United States to describe the effectiveness of HCC surveillance in the real world. In this study, among 374 patients with HCC, 42% of HCC was detected by surveillance. The surveillance-detected patients had a significantly higher proportion of early-stage tumors (63.1 % vs. 36.4 %, $P < 0.001$) and were more likely to receive curative treatment (31% vs. 13%. $P < 0.02$). This study showed HCC surveillance is associated with increased early detection of HCC and concluded that biannual HCC surveillance with abdominal US and serum AFP is the best practice and should be a standard of care for patients with cirrhosis in clinical practice (Table of Evidence).

Despite the evidence that adherence to HCC surveillance guidelines improves early detection of HCC, continued low HCC surveillance rates are prevalent in practice. It is critical to identify contributing factors for the failure to improve surveillance. In the retrospective cohort

study, Singal et al. (2012b) showed that only 20 % had undergone HCC surveillance among 178 patients with HCC. Furthermore, multiple reasons for the failure in the surveillance process were identified: unrecognized liver disease, unrecognized cirrhosis, lack of surveillance orders, and failure to complete the tests despite orders. The most common reason for surveillance failure was providers' lack of required surveillance orders (US/AFP) in patients with known cirrhosis. The study limitations include a retrospective analysis of patients with HCC at a large urban safety-net hospital, thus not be generalized to other practice settings. Studies with larger sample sizes are necessary to further identify other potential reasons for underused surveillance and determine the possibility of generalization (Table of Evidence).

Interventions to Improve HCC Surveillance

Due to the lack of availability of hepatologists, PCPs follow most compensated cirrhotic patients. However, underused HCC surveillance is evident in primary care settings. Beste et al. (2015) conducted a quasi-experimental study to assess the efficacy of a primary care-oriented EMR reminder to improve HCC surveillance by PCPs at Veterans Affairs (VA) hospitals. This study showed increased HCC surveillance rates by 51% (27.6 % vs. 17.5%, $P < .001$), and HCC detection was higher (3.1 % vs. 1.9%, $P = .034$) after the EMR reminder at the intervention site. However, the providers ignored 39.9 % of EMR reminders, and it indicates other interventional strategies are necessary along with the EMR reminder. Although it may not be generalized due to VA patient characteristics, this study with EMR reminders can apply to primary care settings to prompt PCPs to order the surveillance tests when the tests are due (Table of Evidence).

The failure of HCC surveillance is multifaceted. Not only does surveillance failure exist in the realm of providers but also in the overall healthcare system. Aberra et al. (2013) performed a prospective study to analyze the effectiveness of quality improvement measures to increase

HCC surveillance in a tertiary hepatology practice. Cirrhotic patients were enrolled in a chronic disease management program that integrated nursing-based protocols with automatic EMR reminders for biannual HCC surveillance when the tests were due. In this study, enrolling cirrhotic patients in chronic disease management with automatic EMR reminders increased the surveillance rate from 74% to 93 % *(P* < 0.001) over three years. The study's limitations included nonrandomization. The result may not be generalized to other practice settings as the study was conducted at a hepatology clinic in an academic center. Patients followed by hepatology might have undergone HCC surveillance, which poses potential selection bias (Table of Evidence).

Synthesis of Literature Review

Patients with cirrhosis are the primary risk cohort for HCC, and HCC surveillance has been conducted for decades in cirrhotic patients without concluding evidence of effectiveness. The first and only RCT performed by Zhang et al. (2004) among patients with HBV infection demonstrated significantly improved patient survival and reduced HCC mortality in the surveillance group (46% vs. 0% in 5-year mortality rates). The RCT in patients with cirrhosis is not feasible in the US as it is unethical to assign cirrhotic patients to a control group without surveillance. However, Singal and colleagues (2017a) demonstrated the effectiveness of HCC surveillance in a retrospective, multicenter cohort study. The study revealed that adherence to surveillance was associated with HCC detection in the early stages; a solitary tumor less than 2 cm or up to 3 nodules less than 3 cm without microvascular invasion (Bruix et al., 2016).

Professional societies have developed HCC practice guidelines and recommend HCC surveillance with biannual abdominal US and serum AFP. However, research has suggested that these guidelines are not always translated to clinical practice. Singal and colleagues (2012a) performed a systematic review to quantify the utilization of surveillance guidelines showing low

pooled surveillance rates (51.7% in specialty practice vs. 16.9 % in primary care practice). Eight years later, a systematic analysis by Wolf et al. (2021) revealed similar results, continued underutilized surveillance, especially in primary care settings (73.7 % vs. 8.8 %, $P < 0.001$).

Despite the benefits of surveillance guidelines, continued low surveillance rates remain prevalent in practice. In a retrospective cohort study, Singal et al. (2012b) characterized the reasons for HCC surveillance failure among cirrhotic patients diagnosed with HCC. The most common reason for failure is the lack of surveillance orders (US/AFP) by providers of patients with known cirrhosis.

The failure of HCC surveillance is multidimensional, making the development of effective interventions essential. Beste et al. (2015) tested the effectiveness of EMR alerts in the primary care setting, which showed improved surveillance rates by 51 %. However, the surveillance rates were still relatively low (27.6 % from 18.2%), with about 39% of eligible reminders ignored by PCPs. Similarly, Aberra et al. (2013) performed a study to evaluate an automated EMR reminder with the QI measures by enrolling patients in a chronic disease management program. This study increased surveillance rates from 74 % to 93%.

Summary of Literature Review

Patients with cirrhosis are at high risk for developing HCC. The literature review demonstrates that adherence to biannual HCC surveillance guidelines increases HCC detection early and improves patient survival. However, the research also showed continued underutilization of surveillance guidelines with critically low surveillance rates, especially in primary care settings, which indicates the clinical gap in HCC surveillance among cirrhotic patients. Enrolling cirrhotic patients in chronic disease management programs and incorporating EMR alerts into the clinical care flow have significantly improved HCC surveillance rates. A

system-based approach with QI measures and an EMR alert system would be an excellent interventional strategy to improve HCC surveillance, especially in primary care settings. Although this DNP project focused on these aspects to improve HCC surveillance, future studies on systematic approaches to include all levels of clinical practices, including providers, patients, and healthcare systems/government, are warranted to identify further and develop effective interventional strategies.

CHAPTER FOUR: METHODS

Ethics/ IRB Statement

The DNP project protocol description was presented to the University of California, Los Angeles, and it was determined that this project was a QI initiative and did not require approval from the institutional review board because it did not meet the UCLA IRB definition of human subject research.

Project Design

The study was an evidence-based practice (EBP) quality improvement project with a pre- and post-intervention design. Data collected included the receipt of abdominal US & AFP during the study period of 6 months. In addition, the DNP project lead documented patient characteristics, including gender, age, insurance status, and race/ethnicity, to evaluate variables that may contribute to the project results.

Sample and Setting

The target population for this DNP QI project were patients with liver cirrhosis, followed by PCPs. The sampling was a convenience sample from the Los Angeles Christian Health Centers (LACHCs), community-based primary care clinics. The LACHCs operate four full-time clinics and eight part-time satellite clinics. The study setting was the federally qualified health

centers (FQHCs) that provide healthcare for underserved patients with chronic liver disease. The clinics offer comprehensive health care for the underserved, underinsured, and uninsured in the Skid Row area of Los Angeles, where vulnerable homeless people reside. The inclusion criteria for this study were patients diagnosed with liver cirrhosis, adults aged 18 to 75 years old, male and female, followed by PCPs. The exclusion criteria were patients with a diagnosis of HCC at the time of the EMR alert and the QI measure implementation for HCC surveillance.

Sample study patients with cirrhosis were identified based on International Classification of Diseases (ICD) 10^{th} revision codes: K74.60, K74.69, K70.31, K71.7, P78.81, E83.110, K76.1. Before the intervention, the identified baseline sample size was 75, and newly diagnosed cirrhotic patients were automatically enrolled in the HCC surveillance program by the intervention software developed for the DNP project.

When developing the study design, a sample size of 100 patients with surveillance information during both pre- and post-intervention periods was proposed to allow detection of a large effect odds ratio of about 6.5 (equivalent to d = 1.0) with the one-tailed alpha of 0.05 and the power of 0.80, using the McNemar test and assuming the proportion of discordant pairs at 12 %. This calculation would detect an improvement in surveillance from the current estimated 10% surveillance rate to approximately 18% post-intervention. One study in the literature by Beste et al. (2015) found a slightly larger increase of 10 percentage points from 18% to 28% in the primary clinic. However, because the proposed sample size was not achieved, a post hoc power analysis was run. This showed that the obtained sample size of n = 43 patients appearing in both pre- and post-analysis (used for McNemar test comparing surveillance rates) provided the power of .98 to detect the large effect (odds ratio = 13) pre- to post-intervention differences as seen in the results, with alpha = .05.

Instruments and Measures

In this DNP QI project, the instruments for the intervention included the data-driven analytical QI measures and EMR alert systems, and a patient education brochure in English and Spanish. The validity and reliability of the EMR systems are whether the EMR system consistently triggers the alerts at the right time when the surveillance tests (the US and AFP blood tests) are overdue or due within one month or missing and whether the EMR alerts trigger scheduling of the surveillance tests. Technical malfunction for the EMR system and inaccurate QI measure reports was the potential threat to the validity and reliability of the intervention that could arise, in which the HCC alerts may not get triggered. Therefore, the DNP project lead and QI coordinator evaluated and validated the EMR and QI programs before implementing the project, monitored monthly whether the alerts were functional, and worked closely with the clinic staff and the EHR support team to resolve technical problems promptly.

Intervention

Project interventions included creating and implementing analytical data-driven HCC QI measures and EMR alerts for PCPs to carry out biannual abdominal US and AFP blood tests for patients with cirrhosis for HCC surveillance. The QI measures and EMR alerts for HCC surveillance were linked to the diagnosis of liver cirrhosis using ICD 10th revision codes (K74.60, K74.69, K70.31, K71.7, P78.81, E83.110, K76.1), and patients diagnosed with cirrhosis were identified and automatically enrolled in the HCC surveillance program. In addition, a concise patient education brochure on HCC surveillance in English and Spanish was developed by the DNP project lead for patient education by the providers and made them available in electronic and printed forms.

Procedures

Upon the Vendor's completion of the QI measures and EMR alerts in August 2021, the HCC surveillance programs were released and implemented on September 10, 2021, after validating the programs twice. The EMR alerts triggered the providers/staff to order HCC surveillance tests using the pre-created order sets for providers when the abdominal US and serum AFP were overdue/due within one month or missing (Appendix C & D). The DNP project also incorporated the provider's patient education on HCC surveillance, using the patient education brochure in English and Spanish. In addition, a pre-populated plan of care clinic note was created for providers to promote general health maintenance care for patients with cirrhosis (Appendix E). The patient navigator also conducted outreach by phone calls, phone text messages, and letters to reach out to those patients who lacked HCC surveillance (Appendix F & G) . Patients' health plans paid for the US and AFP blood tests. Patients with emergency Medi-Cal paid $10 for the tests on a sliding fee schedule. In addition, the clinic paid $11 for the AFP blood test for uninsured patients and patients enrolled in the Los Angeles County-sponsored My Health LA Program (Appendix H for the Project Clinical Workflow).

For the accuracy of the HCC measure reports for patient adherence, the project lead and QI coordinator monitored and analyzed monthly QI measure reports and then communicated the information to the team, including the EHR support team. After observing monthly surveillance QI measure reports from September 2021 to December 2021, it was noted that some providers continued to order only the AFP blood test without the abdominal US for HCC surveillance. This pattern of providers' practice was concerning as the AFP alone does not have a role in HCC surveillance. Thus, the project lead discussed with the Committee Chair and agreed to modify the alert system to maximize the patient benefits from the surveillance alert program. The CMO in

the clinic also agreed with the modification plan. As a result, on February 01, 2022, the alert for the AFP blood test was disabled, and only one alert system was kept for HCC surveillance driven by the abdominal US performed for both the abdominal US and AFP blood test every six months.

Analysis

Study Outcomes

Hepatocellular carcinoma surveillance with the biannual abdominal US and AFP is the best practice and is considered a standard of care, improving overall patient survival, decreasing mortality, and reducing healthcare costs (Lin et al., 2004; Parikh et al., 2020). The AASLD Practice Guidelines incorporated AFP with the US every six months for HCC surveillance in patients with cirrhosis known for high risk for HCC (Marrero et al., 2018; Lim & Singal, 2019). Thus, the primary outcome was that adequate HCC surveillance followed the guidelines of consistent HCC surveillance with abdominal US and AFP performed every six-month time period after the project implementation. The secondary outcome was the HCC detection rate by the surveillance

Data Collection and Statistical Analysis

In this DNP QI project, independent variables were the EMR alert and QI measures for HCC surveillance. The outcome/dependent variables were the HCC surveillance tests of the abdominal US and AFP blood test every six months. The measures for outcome variables were the receipt of the abdominal US and AFP blood tests performed at the appropriate time (every six months) before and after the QI measures and EMR alert implementation. The data for the HCC surveillance rates of pre- and post-intervention was obtained through the data-driven analytical

EHR system and transferred to SAS version 9.4 for statistical analysis. The DNP project lead and QI coordinator manually reviewed the data to validate the information gathered.

The proportions of pre- to post- surveillance rates were calculated after the intervention in this pre and post cohort study design. Descriptive statistics are presented for the complete pre- and post-intervention cohorts for the primary outcome measures. Statistical comparisons between pre- to post-intervention surveillance rates were not computed on the total sample pre- and post because of the partial overlap of these cohorts. Chi-square and Fisher's exact tests were used in the post-intervention cohort to compare surveillance rates across the selected demographic subgroups. Since some of the patients were determined to be unavailable for surveillance contact, surveillance rates are also presented descriptively for the "available' portion of the cohorts. For the sample of patients that are included in both pre- and post- intervention periods ("matched samples"), pre- to post- surveillance rates were compared using the McNemar Chi-square statistic to answer the clinical PICOT question. Also, bar charts and line graphs were used to show the frequency or trend of HCC surveillance with the abdominal US and AFP blood tests pre- and post-intervention with QI measures and EMR alert. SAS version 9.4 was used for all statistical tests

Timeline of the Project

Upon completion of building the QI measures and EMR alerts for HCC surveillance in August 2021, the project began on September 10, 2021. The baseline pre-intervention HCC surveillance rate of August 2021 was obtained and compared with six months post-intervention HCC surveillance rate in March 2022. This HCC surveillance QI project continues until March 2023.

Budget

This DNP QI project was partially supported by the Sigma Theta Tau International UCLA/CSUN/CSU-CI Gamma At-Large Chapter Evidence-Based Practice (EBP) Project Grant 2021-2022 and by the investigator and "In-Kind" by other project team members in the clinic.

CHAPTER FIVE: RESULTS

This DNP Scholarly project aimed to evaluate the effectiveness of the intervention by implementing QI measures, EMR alerts, and patient education in order to increase HCC surveillance rates for cirrhosis patients who are followed by PCPs in community-based primary care clinics.

Patient Characteristics

Seventy-five cirrhotic patients were identified and enrolled at baseline before implementing the QI interventions. Subsequently, new cirrhosis patients and patients who lost follow-up for more than a year but returned to the clinic were enrolled in the HCC surveillance program automatically and continuously after the intervention started by the intervention software developed for the HCC surveillance QI project. Over six months after the project began on September 10, 2021, 85 cirrhosis patients were enrolled in the HCC surveillance program by March 2022.

Table 1 presents the characteristics of cirrhosis patients, including age, gender, race/ethnicity, and type of insurance. In the age groups, cirrhosis patients aged 45-to 64 have the highest number compared to other age groups: 54 out of 75 (72.0%) in the pre-cohort and 53 out of 86 (61.7%) in the post-cohort. There were more men than women in both groups: 50 males (66.7%) vs. 25 females (33.3%) in the pre-cohort and 62 males (72.1 %) vs. 24 females (27.9%) in the post-cohort. Regarding race and ethnicity groups, Hispanic/Latino was the highest number

of cirrhosis patients among the racial/ethnic groups: 41 (54.7%) in the pre-cohort and 50 (58.1%) in the post-cohort. Over 40% of patients (42.7 % for pre-intervention and 40.72% for post-intervention) had Medi-Cal coverage, followed by Medicare (26.7 % and 32.6%), dual Medicare/Medi-Cal (25.3% and 30.2%), and Uninsured (22.7% and 19.8%). In addition, a few patients had private insurance, a few had no insurance records, and one patient's insurance was unmapped/unidentified (Table 1).

Table 1: ***Characteristics of Cirrhosis Patients Enrolled in HCC Surveillance QI Program***

Variable	Pre-Intervention (n = 75)	Post-Intervention (n = 86)
Age (years)		
20-34	1 (1.3%)	2 (2.3%)
35-44	5 (6.7%)	7 (8.1%)
45-64	54 (72.0 %)	53 (61.7%)
65+	15 (20 %)	24 (27.9%)
Gender (n)		
Male	50 (66.7%)	62 (72.1 %)
Female	25 (33.3%)	24 (27.9 %)
Race/Ethnicity (n)		
Hispanic/Latino	41 (54.7%)	50 (58.1%)
White/Non-Hispanic	5 (6.7%)	6 (7.0%)
AA/Black	7 (9.3%)	10 (11.6%)
American Indian/Alaska Native	4 (5.3%)	1 (1.2%)
Unreported	18 (24.0%)	19 (22.1%)
Finance (n)		
Uninsured	17 (22.7%)	17 (19.8%)
Medicare	20 (26.7%)	28 (32.6%)
Dual Medicare/Medical [a]	19 (25.3)	26 (30.2%)
Medical	32 (42.7%)	35 (40.7%)
Private Insurance	1 (1.3%)	2 (2.3%)
No Record	3 (4.0%)	2 (2.3%)
Unmapped [b]	1 (1.3%)	2 (2.3%)
Other Public	1 (1.3%)	0

[a] Dual Medicare and Medi-Cal include patients with Medicare and Medical

[b] EHR system did not specify an individual's insurance status

Primary Outcome Measures

Pre-and-Post QI Intervention HCC Surveillance Rates

The number of cirrhotic patients enrolled in the HCC surveillance program increased to 86 from 75 since the project implementation (Table 2). The guidelines concordant HCC surveillance rate was 6.7% (5/75) before the start of the project. However, the post-QI intervention surveillance rate over a 6-month study period (with the US and AFP received at

least six months apart) increased to 22.4 % (19/85), a 15.7% increase and 3.34 times higher than the pre-intervention HCC surveillance rate (see Table 2).

Table 2: ***Pre-to-Post-HCC Surveillance Rate Comparison Over the 6-Month Study Period***

Group	Cirrhosis patients (n)	Received surveillance (n)	Exclusion: HCC (n)	Surveillance rate (%)
Pre-intervention	75	5	0	6.7
Post-intervention	86	19	1	22.4

Sub-Analysis After Removing Patients Unreachable (Lost to Follow up)

Due to underserved patient population characteristics, some patients had no working phone numbers or home addresses. Thus, the outreach navigator could not reach those patients with no surveillance to schedule clinic appointments because they lacked the communication methods (23 in the pre-period and 29 in the post-period). Table 3 shows the details of the reasons for being reachable/unavailable over the 6-month study period.

Table 3: ***Characteristics of Unreachable Cirrhosis Patients***

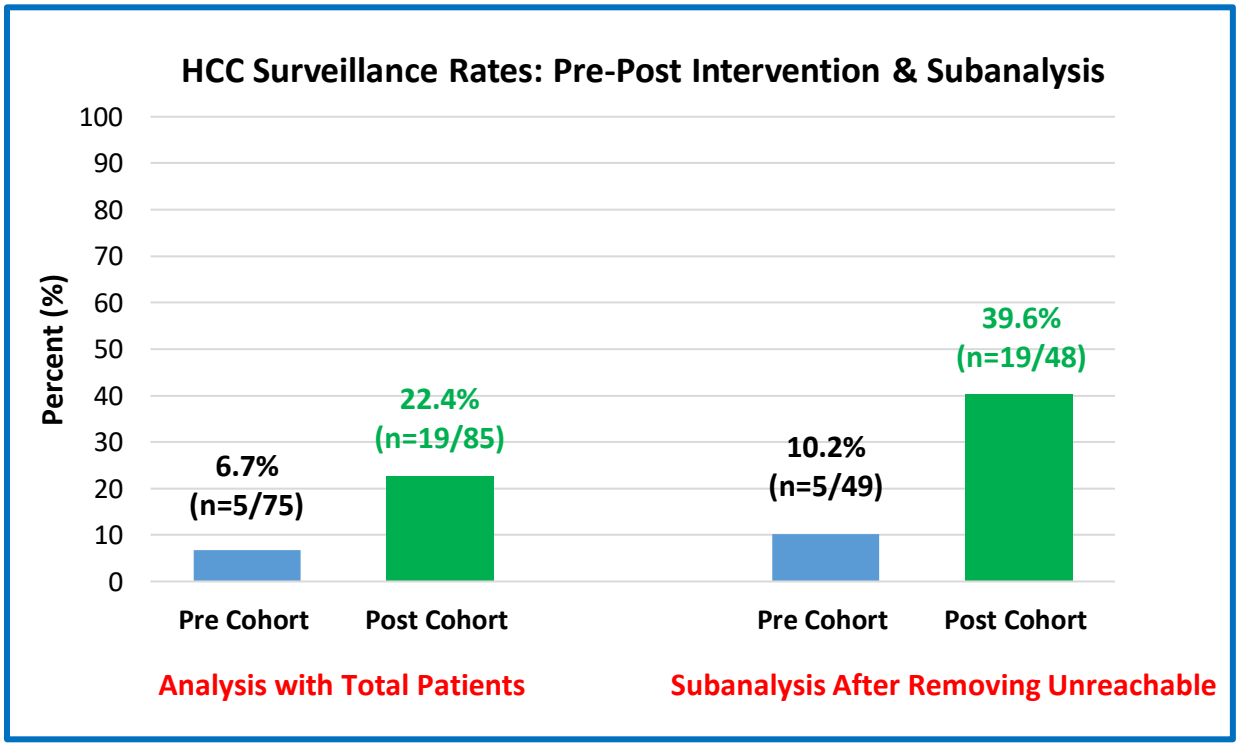
Category	Pre-Intervention: August 2021 (n = 75)	Post Intervention: March 2022 (n = 86)
Diagnosed with HCC	0	1
Deceased	0	5 (1 HCC included)
Unreachable	23	29
Seeing outside provider	1	1
No address/no phone number	1	1
Refused surveillance	1	1
Moved to another state	0	1
Total patients removed	26	38
Total patients in the HCC surveillance program	49	48

After removing these unavailable/unreachable patients (26 in the pre-cohort and 38 in the post-cohort), the post-intervention surveillance rate became 39.6% (19/48) compared to 10.2 % (5/49), 29.4%increase, and 3.86 times higher than the pre-intervention rate (See Table 4 and Figure 1).

Table 4: ***Sub-Analysis: Pre-to- Post Surveillance Rate Comparison after Removing Unreachable Patients***

Group	Total patients (n)	Unreachable (n)	Reachable (n)	Received surveillance (n)	Exclusion (HCC) (n)	Surveillance rate (%)
Pre-intervention	75	26	49	5	0	10.2
Post-Intervention	86	38	48	19	1	39.6

Figure 1: ***Pre–Post Surveillance Rates & Sub Analysis***



Matched (Same) Group SubAnalysis: Pre-Post Surveillance Comparisons Over 6-months

In addition, a subanalysis for the same group in the pre-and-post periods was performed using the McNemar Chi-square test to further evaluate the effect of the intervention. Among 75 cirrhotic patients in the pre-intervention period, the HCC surveillance QI program dropped 13 patients out of the list who had no qualifying clinic encounter within the last 12 months. (See Table 5 for Adjustment). In the post-intervention period, 24 cirrhotic patients, including newly diagnosed patients with cirrhosis, were further enrolled in the surveillance program after the intervention began in September 2021. These 24 cirrhotic patients added to the post-intervention period were removed because they were not part of the pre-intervention group. In addition, two patients added and received the surveillance in the post-period were also removed (See Table 5).

Table 5: ***Matched Same Group Sub-Analysis: Reasons for Adjustment***

Category (n)	Pre-QI Intervention Period	Post-QI Intervention Period
Total patients (n)	75	86
Total received Surveillance	5	19
Dropout of study	13	n/a
Added to the list post-period	n/a	22
Added to the list post-period and received surveillance	n/a	2
Total number in Surveillance	62	62
Deceased	3	3
Unreachable	14	14
Refused Surveillance	1	1
See an outside provider	1	1
Total unreachable	19	19
Total reachable patients	**43**	**43**
Received Surveillance	**5**	**17**
Did not receive Surveillance	38	26
Received surveillance in the post-period among five who received in the pre-period	n/a	4
Did not receive surveillance in the post-period among five who received surveillance in the pre-period	n/a	1
Surveillance rates	**11.60%**	**39.5%**

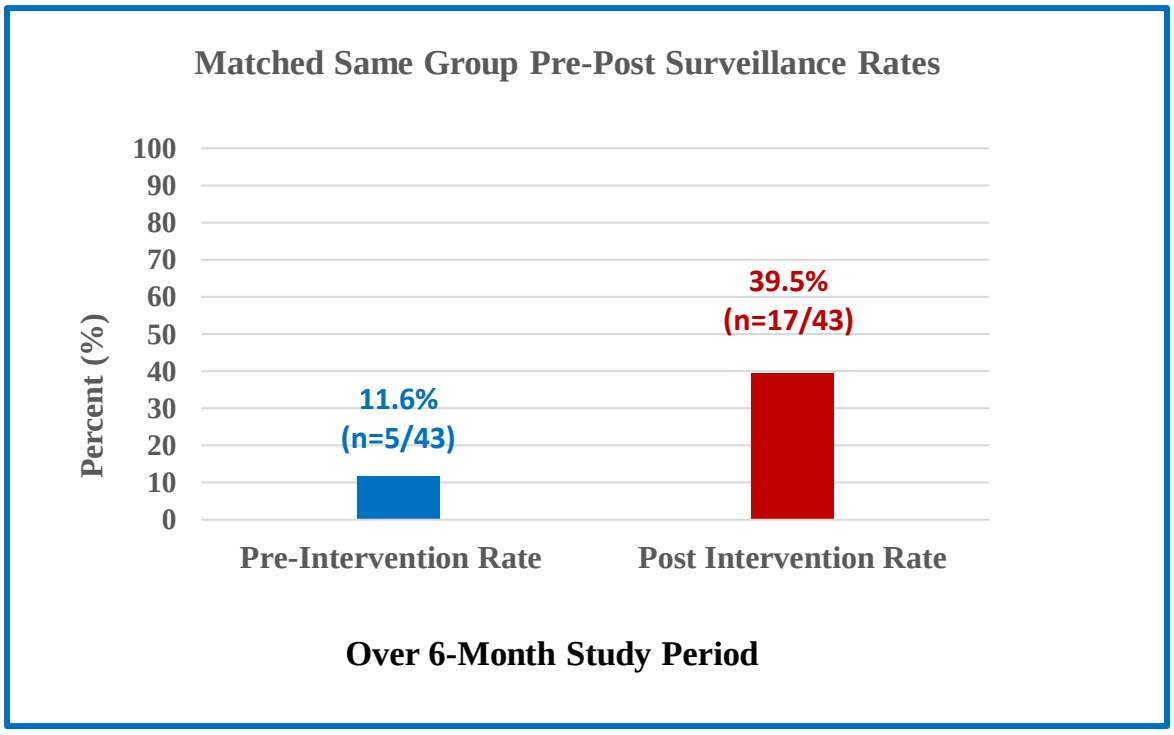
The total number of reachable patients in both pre-and-post surveillance groups was 43. Among these cirrhotic patients, the post-intervention surveillance rate over the 6-month study period was 39.5% (17/43) compared to 11.6% (5/43) in the pre-intervention period, a 27.9% increase. Thus, the post-intervention HCC surveillance rate was 3.41 times higher than the pre-surveillance period. This difference in the same group analysis was statistically significant (p = .001) (see Table 6 and Figure 2)**.**

Table 6*: Matched Same Group Sub-Analysis: Pre-to-Post Surveillance Rate Comparison* [a]

Group	Total patients (n)	Total reachable (n)	Received surveillance (n)	Exclusion (HCC) (n)	Surveillance rate (%)
Pre-intervention	75	43	5	0	11.6
Post-intervention	86	43	17	0	39.5

[a] McNemar Chi square = 10.286, df = 1, p = .001

Figure 2: ***Matched Same Group Analysis: Pre-Post Surveillance Rate Over 6-Month Periods***



Additional Analysis

Subgroup Analysis with Demographic Variables

Additional analyses by age groups, race/ethnicity, and insurance were performed to evaluate if surveillance rates differed by selected demographic post-intervention.

i) Comparisons by Age Groups within the Post-QI Intervention Period Surveillance Rates

Surveillance rates differed only slightly across age groups, with the highest rate at 26% for those over 65 years of age; differences were not statistically significant *(p* = .917), (Table 7).

Table 7: ***Comparisons by Age Groups within the Post- Intervention Period*** [a]

Age (years)	Cirrhosis patients (n)	Received surveillance (n)	Exclusion: HCC (n)	Surveillance rate (%)
20-44	9	2	0	22.2
45-64	53	11	0	20.8
65+	24	6	1	26.1
Total	86	19	1	

[a] Chi square comparing age groups = 0.173, df = 2, *p* = .917

ii) Comparisons by Race/Ethnicity within the Post QI Intervention Period Surveillance Rates

Table 8 shows the race/ethnicities of the post-intervention group of cirrhosis patients in this federally qualified primary care clinic. The Hispanic/Latino group has the highest number of cirrhotic patients (50/85 in the post cohort); but patients who did not report race/ethnicity had the highest rate of surveillance (42%). The surveillance rate differed significantly across the post-intervention race/ethnicity subgroups ($p < .001$).

Table 8: ***Comparisons by Race/Ethnicity within the Post QI Intervention Period*** [a]

Race & Ethnicity	Cirrhosis Patients (n)	Received Surveillance (n)	Exclusion: HCC (n)	Surveillance Rate (%)
Hispanic/Latino	50	9	1	18.4
White/Non-Hispanic	6	0	0	0
AA/Black	10	2	0	20.0
American Indian/Alaska Native	1	0	0	0
Unreported	19	8	0	42.1
Total	86	19	1	22.6

[a] Chi square = 30.233, df = 4, Fisher exact $p < .001$

iii). Comparisons by Insurance within the Post QI Intervention Period Surveillance Rates

Table 9 presents patients' healthcare finances enrolled in the HCC surveillance program for the post-intervention cohort. The uninsured group of the post-intervention cohort had the highest surveillance rate (47%). A comparison of surveillance rates between uninsured (8/17) and those with any type of insurance (11/65) was significant ($p = .009$). (see Table 9)

Table 9: ***Comparisons by Insurance within the Post-Intervention Period*** [a]

Financial Class	Cirrhosis Patients (n)	Received surveillance (n)	Exclusion: HCC (n)	Surveillance Rate (%)
Uninsured	17	8	0	47.1
Medicare	28	5	1	18.5
Dual Medicare/Medical [b]	26	5	1	20.0
Medical	35	6	0	17.1
Private Insurance	2	0	0	0

[a] Comparing uninsured to insured: Chi square = 6.875, df =1, $p = .009$

[b] Dual Medicare/Medical includes patients with Medicare and Medical (Duplicate)

Comparisons by Providers Pre- to- Post QI Intervention HCC Surveillance Rates

The project site of the federally qualified primary care clinics is composed of five physicians, nine physician assistants (PA), and six nurse practitioners (NP) who actively provide medical care. Descriptive analysis of the pre-post-QI intervention HCC surveillance by the providers was conducted. Table 10 & Figure 3 show that all three provider groups had less than a 10 % of HCC surveillance rate before implementing the QI intervention (an average of 5% for the MD group; 8.1% for the PA group; 2.1% for the NP group). However, after the interventions with EMR alerts and QI measures and patient education in September 2021, the surveillance rates in all three provider groups increased, as shown in Table 10 & Figure 3.

Figure 4/Table 11 (MD group), Figure 5/Table 12 (PA group), and Figure 6/Table 13 (NP group) show the trends of HCC surveillance by each provider group, and all three groups showed improved HCC surveillance rates after the interventions. There were three high performing providers in each group. However, the high surveillance rates by these providers were associated with the small number of patients followed by them; one MD had 4/5 patients, one PA had 1/1 and 2/2 patients, and one NP had 1/1 patients who received the surveillance during that time. Figure 7 represents overall surveillance trends for six months before and after intervention from March 2021 to March 2022. The surveillance rate was less than 10 % before the intervention was implemented in September 2021, but the surveillance rates continuously improved over the 6-month study period (Figure 7).

Table 10: ***HCC Surveillance Rate by All Providers (n = 20)***

Period (TY) [a]	Rate by MD (5)	Rate by PA (9)	Rate by NP (6)
TY 3/21	3% (1/33) [b]	5% (2/41)	3% (1/33)
TY 4/21	3% (1/34)	4% (2/45)	3% (1/34)
TY 5/21	6% (2/35)	6% (3/47)	3% (1/34)
TY 6/21	6% (2/34)	11% (5/45)	3% (1/33)
TY 7/21	6% (2/34)	12% (5/45)	3% (1/31)
TY 8/21	6% (2/36)	10% (5/48)	0% (0/32)
TY 9/21	5% (2/40)	9% (5/54)	0% (0/34)
TY 10/21	12% (5/42)	14% (8/57)	8% (3/37)
TY 11/21	18% (8/44)	21% (12/57)	17% (6/36)
TY 12/21	22% (10/46)	28% (16/58)	16% (6/37)
TY 1/22	25% (11/46	28% (16/57)	24% (9/38)
TY 2/22	23% (11/47)	25% (15/59)	18% (7/38)
TY 3/22	22% (10/45)	25% (16/63)	21% (8/38)

[a] Trailing year; [b] Number of patients followed and number of patients received surveillance

Figure 3: ***HCC Surveillance Rates by All Providers (n = 20)***

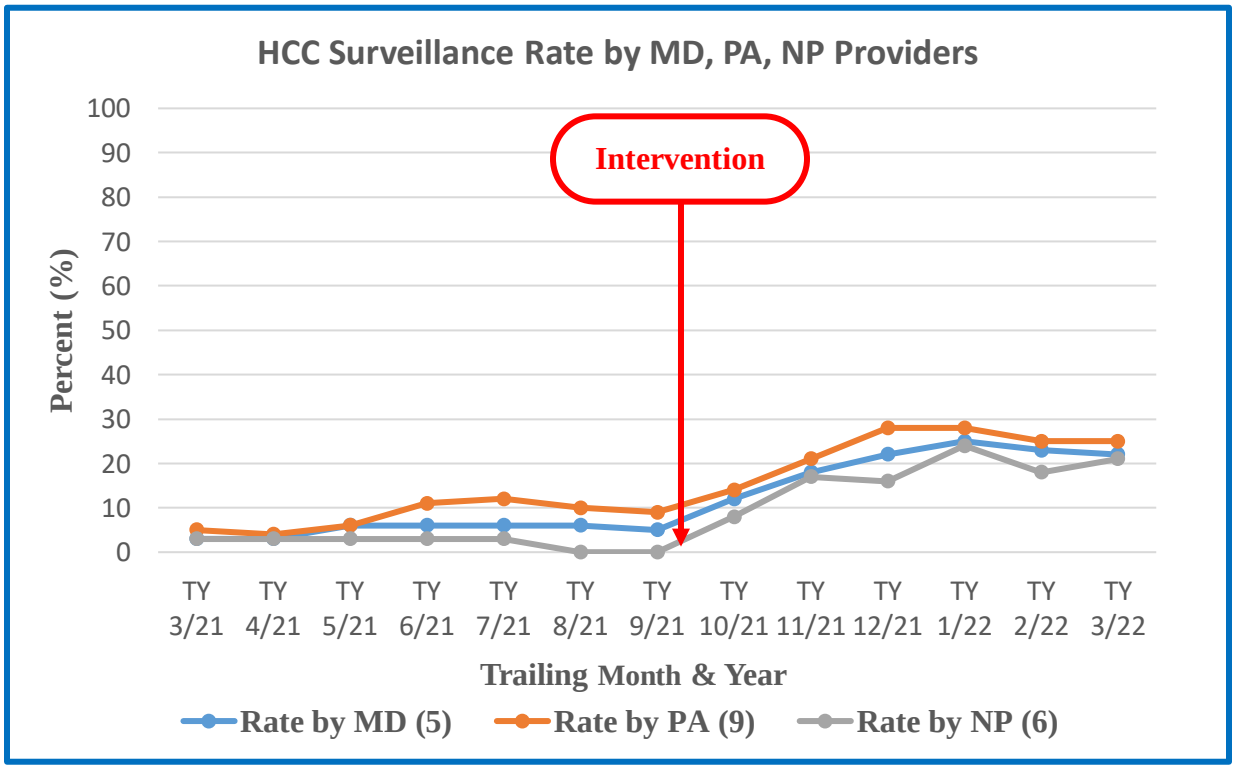


Figure 4: ***HCC Surveillance Rates by MD Providers (n = 5)***

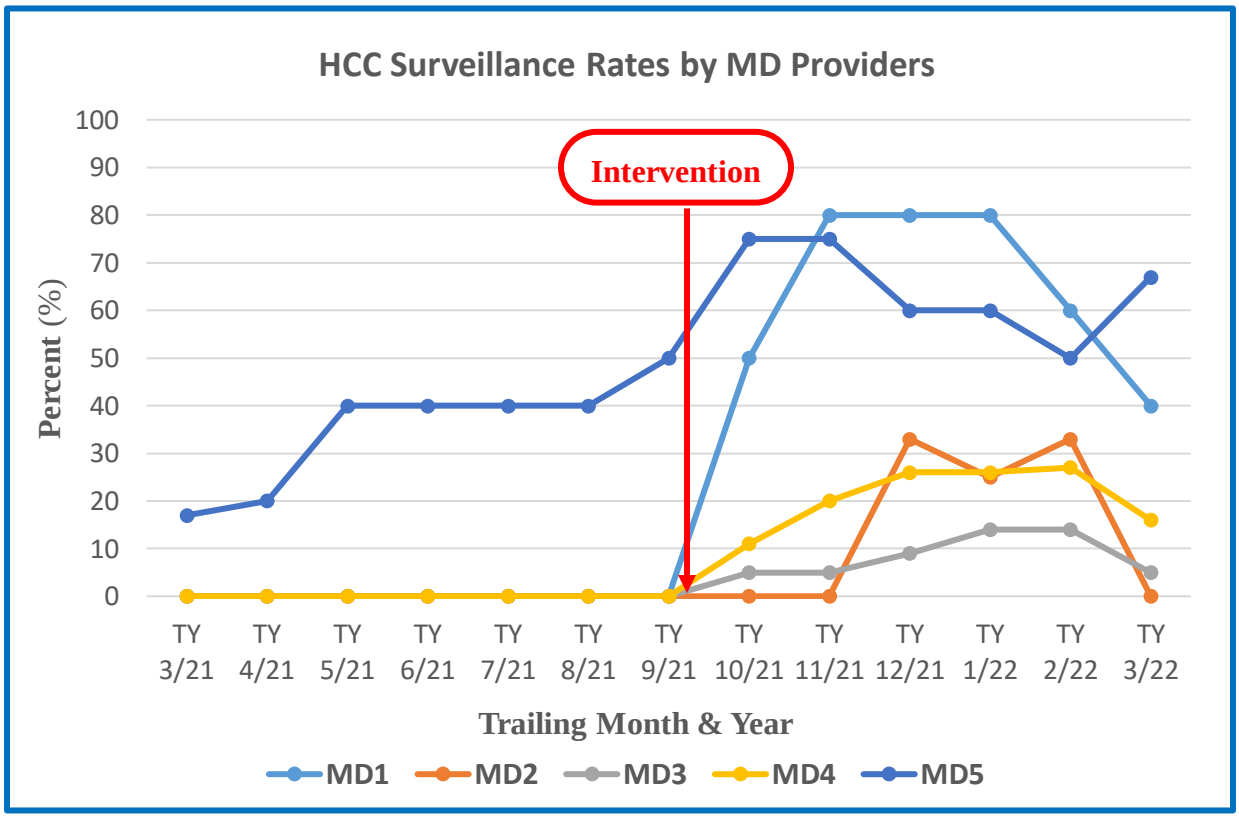
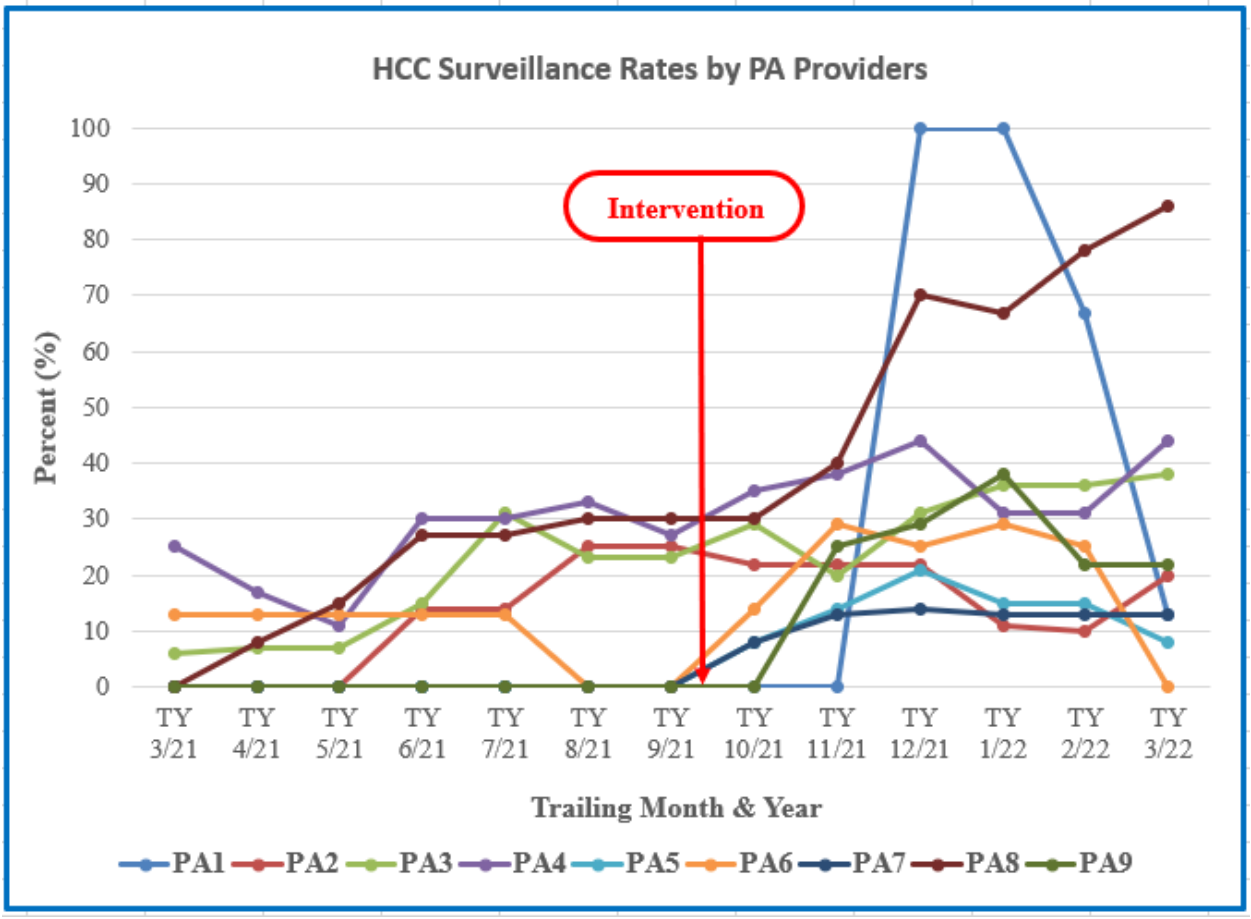


Table 11: ***HCC Surveillance Rates by MD Providers (n = 5)***

Period	MD1	MD2	MD3	MD4	MD5
TY 3/21 [a]	0% (0/0) [b]	0% (0/4)	0% (0/18)	0% (0/10)	17% (1/6)
TY 4/21	0% (0/0)	0% (0/4)	0% (0/20)	0% (0/12)	20% (1/5)
TY 5/21	0% (0/0)	0% (0/4)	0% (0/19)	0% (0/14)	40% (2/5)
TY 6/21	0% (0/2)	0% (0/3)	0% (0/19)	0% (0/14)	40% (2/5)
TY 7/21	0% (0/2)	0% (0/3)	0% (0/19)	0% (0/15)	40% (2/5)
TY 8/21	0% (0/2)	0% (0/2)	0% (0/18)	0% (0/16)	40% (2/5)
TY 9/21	0% (0/4)	0% (0/2)	0% (0/21)	0% (2/18)	50% (2/4)
TY 10/21	50% (2/4)	0% (0/2)	5% (1/22)	11% (2/19)	75% (3/4)
TY 11/21	80% (4/5)	0% (02/2)	5% (1/22)	20% (4/20)	75% (3/4)
TY 12/21	80% (4/5)	33% (1/3)	9% (2/22)	26% (5/19)	60% (3/5)
TY 1/22	80% (4/5)	25% (1/4)	14% (3/21)	26% (5/19)	60% (3/5)
TY 3/22	40% (2/5)	0% (0/2)	5% (1/20)	16% (3/19)	67% (4/6)

[a] Trailing year; [b] Number of patients followed and number of patients received surveillance

Figure 5*: HCC Surveillance Rates by PA Providers (n = 9)*



PA is physician assistant; Y-axis is surveillance percentage; TY is trailing month/year.

MD is medical doctor; NP is nurse practitioner

Table 12: ***HCC Surveillance Rates by PA Providers (n = 9)***

Period	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9
TY 3/21 [a]	0% (0/0) [b]	0% (0/5)	6% (1/16)	25% (1/4)	0% (0/4)	13% (1/8)	0% (0/4)	0% (0/11)	0% (0/7)
TY 4/21	0% (0/0)	0% (0/6)	7% (1/15)	17% (1/6)	0% (0/4)	13% (1/8)	0% (0/5)	8% (1/13)	0% (0/5)
TY 5/21	0% (0/0)	0% (0/6)	7% (1/15)	11% (1/9)	0% (0/4)	13% (1/8)	0% (0/6)	15% (2/13)	0% (0/4)
TY 6/21	0% (0/0)	14% (1/7)	15% (2/13)	30% (3/10)	0% (0/4)	13% (1/8)	0% (0/8)	27% (2/13)	0% (0/3)
TY 7/21	0% (0/0)	14% (1/7)	31% (4/13)	30% (3/10)	0% (0/4)	13% (1/8)	0% (0/8)	27% (3/11)	0% (0/3)
TY 8/21	0% (0/0)	25% (2/8)	23% (3/13)	33% (4/12)	0% (0/4)	0% (0/9)	0% (0/11)	30% (3/10)	0% (0/4)
TY 9/21	0% (0/0)	25% (2/8)	23% (3/13)	27% (4/15)	0% (0/4)	0% (0/9)	0% (0/13)	30% (3/10)	0% (0/6)
TY 10/21	0% (0/0)	22% (2/9)	29% (4/14)	35% (6/17)	8% (1/12)	14% (1/7)	8% (1/12)	30% (3/10)	0% (0/7)
TY 11/21	0% (0/0)	22% (2/9)	20% (3/15)	38% (6/16)	14% (2/14)	29% (2/7)	13% (2/16)	40% (4/10)	25% (2/8)
TY 12/21	100% (1/1)	22% (2/9)	31% (5/16)	44% (8/18)	21% (3/14)	25% (2/8)	14% (2/14)	70% (7/10)	29% (2/7)
TY 1/22	100% (2/2)	11% (1/9)	36% (5/14)	31% (5/16)	15% (2/13)	29% (2/7)	13% (2/15)	67% (6/9)	38 % 3/8)
TY 2/22	67% (2/3)	10% (1/10)	36% (5/14)	31% (5/16)	15% (2/13)	25% (1/4)	13% (2/15)	78% (7/9)	22% (2/9)
TY 3/22	13% (1/8)	20% (2/10)	38% (5/13)	44% (7/16)	8% (1/13)	0% (0/4)	13% (2/15)	86% (7/9)	22% (2/9)

[a] Trailing year; [b] Number of patients followed and number of patients received surveillance

Figure 6*: HCC Surveillance Rates by NP Providers (n = 6)*

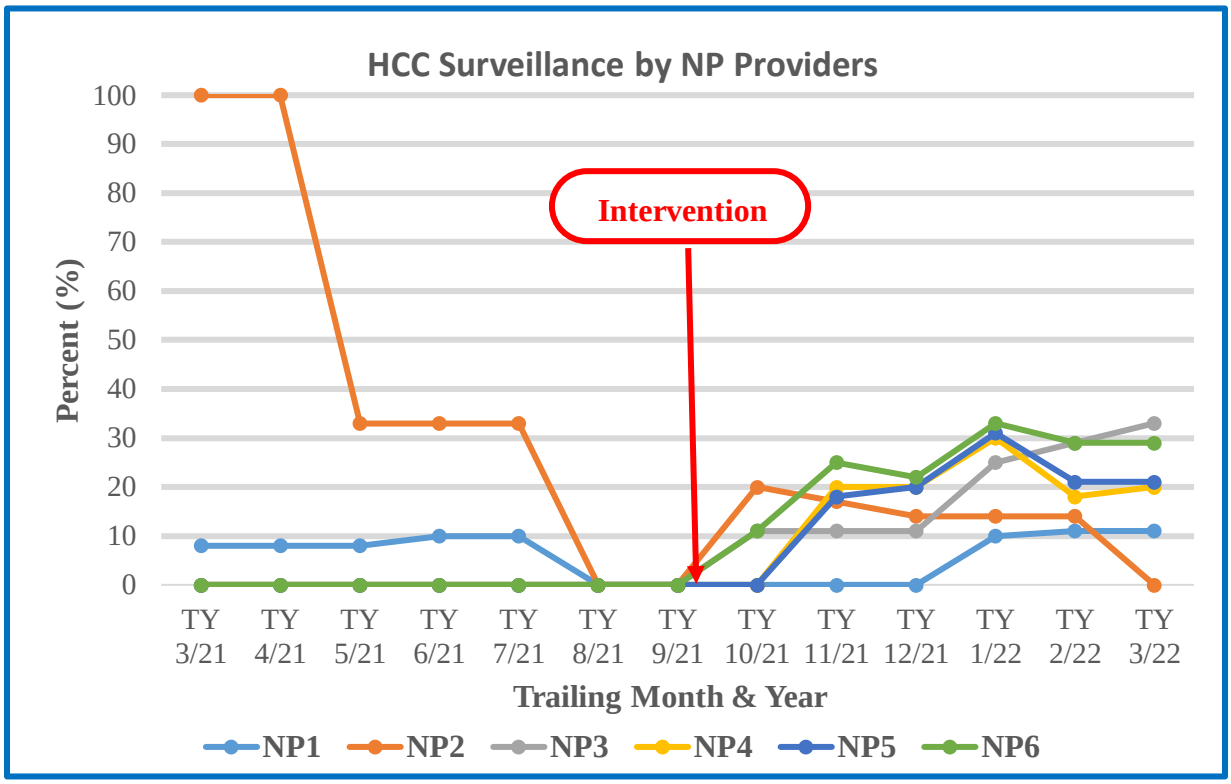
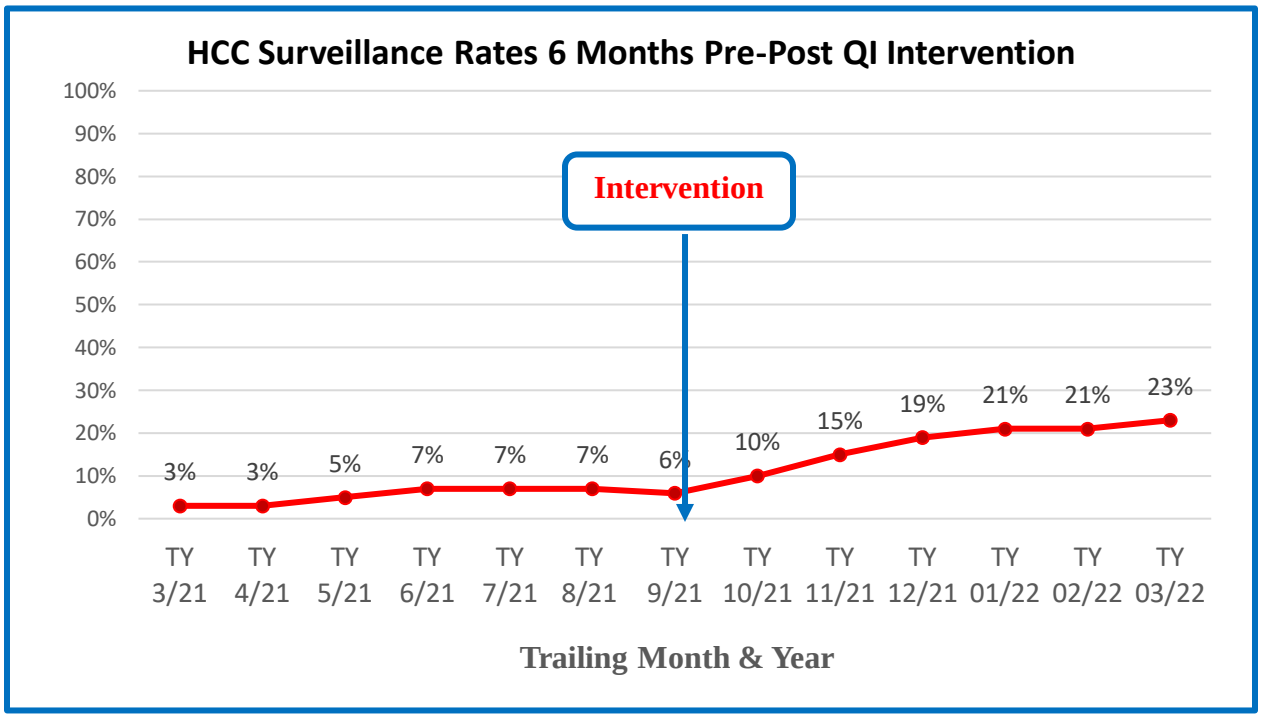


Table 13: ***HCC Surveillance Rates by NP Providers (n = 6)***

Period	NP1	NP2	NP3	NP4	NP5	NP6
TY 3/21 [a]	8% (1/12) [b]	100% (1/1)	0% (0/11)	0% (0/3)	0% (0/11)	0% (0/0)
TY 4/21	8% (1/13)	100% (1/1)	0% (0/11)	0% (0/3)	0% (0/8)	0% (0/7)
TY 5/21	8% (1/12)	33% (1/3)	0% (0/12)	0% (0/3)	0% (0/9)	0% (0/7)
TY 6/21	10% (1/10)	33% (1/3)	0% (0/12)	0% (0/3)	0% (0/8)	0% (0/8)
TY 7/21	10% (1/10)	33% (1/3)	0% (0/9)	0% (0/5)	0% (0/7)	0% (0/7)
TY 8/21	0% (0/9)	0% (0/3)	0% (0/11)	0% (0/5)	0% (0/6)	0% (0/7)
TY 9/21	0% (0/11)	0% (0/3)	0% (0/10)	0% (0/8)	0% (0/8)	0% (0/7)
TY 10/21	0% (0/10)	20% (1/5)	11% (1/9)	0% (0/6)	0% (0/10)	11% (1/9)
TY 11/21	0% (0/10)	17% (1/6)	11% (1/9)	20% (2/10)	18 % (2/11)	25% (2/8)
TY 12/21	0% (0/12)	14% (1/7)	11% (1/9)	20% (2/10)	20 % (2/10)	22% (2/9)
TY 1/22	10% (1/10)	14% (1/7)	25% (3/12)	30% (3/10)	31 % (4/13)	33% (3/9)
TY 2/22	11% (1/9)	14% (1/7)	29% (4/14)	18% (2/11)	21 % (3/14)	29% (2/7)
TY 3/22	11% (1/9)	0% (0/6)	33% (4/12)	20% (2/10)	21 % (3/14)	29% (2/7)

[a] Trailing year; [b] Number of patients followed and number of patients received surveillance

Figure 7: ***HCC Surveillance Rate Trails 6 Months before and after the Intervention***



Secondary Outcome Measures

The secondary outcome measure of this DNP Scholarly Project was to evaluate the HCC detection rate through the HCC surveillance with the interventions. After the interventions began in September 2021, one patient enrolled in the HCC surveillance program was diagnosed with HCC in October 2021, a Hispanic aged 66. The patient was referred to a specialist for further evaluation and treatment for HCC.

Summary of Results

The DNP Scholarly QI project addressed the clinical question of whether implementing the intervention with QI measures and EMR alerts with patient education increase HCC surveillance rates by PCPs in the primary care clinic settings. Seventy-five cirrhotic patients were identified prior to the intervention, and 85 patients with cirrhosis were enrolled between September 2021 and March 2022 by the HCC QI surveillance program developed for this DNP

Scholarly Project. The study demonstrated the overall positive effect of the QI interventions with an increase in surveillance from 6.7 % to 22.4 % in the complete sample of patients. In addition, for the n=43 patients in both pre-and post-intervention cohorts, the difference in the pre-post intervention HCC surveillance rates was statistically significant (11.6 vs. 39.5 %, $p = .001$). Additional analyses revealed that among the total group of post-intervention patients, statistically significant differences were found in post-intervention surveillance rates between uninsured vs. insured patients ($p = .009$).

CHAPTER SIX: DISCUSSION

Hepatocellular carcinoma is the leading cause of death among cirrhotic patients. Early detection of HCC through surveillance provides opportunities for potentially curative treatment options, whereas the late discovery of HCC leads to a poor prognosis. Patients with cirrhosis are the primary risk cohort for developing HCC. Adhering to HCC surveillance guidelines with the US and AFP every six months is associated with detecting HCC in the early stages (Singal et al.,2020). However, HCC surveillance guidelines are underused, and surveillance rates are critically low, especially in primary care settings, indicating a clinical practice gap in HCC surveillance (Singal et al., 2017b). Despite the benefits of adherence to the surveillance, the continued critically low HCC surveillance rates signify the urgent need for developing evidence-based effective interventions to improve HCC surveillance, especially targeting PCPs in primary care settings to close the clinical gap. This DNP project implemented the interventions with the QI measures, EMR alerts, and patient education by providers using the concise patient education brochure in English and Spanish to improve HCC surveillance by PCPs in the primary care clinic.

Primary Outcome Measures

Pre-to-Post QI Intervention Surveillance Rate Comparisons

Before the intervention, the pre-surveillance rate was 6.7%, in which 5 out of 75 cirrhotic patients received the guideline-concordant HCC surveillance with the abdominal US and AFP. The finding of this low surveillance rate in this primary care clinic is consistent with the literature findings that continued low HCC surveillance rates are prevalent in clinical practice, especially in community-based primary care clinics (Singal et al., 2012a; Singal et al., 2017b; Wolf et al., 2021). However, after implementing the interventions with QI measures, EMR alerts, and patient education, the post-QI intervention HCC surveillance rate among all cirrhotic patients increased to 22.4%, a 15.7 % increase, 3.34 times higher than the pre-surveillance rate (Table 2, Figure 1).

Sub-Analysis after Removing Unreachable Patients

Some patients identified during the pre-intervention surveillance period were unreachable during the post-intervention period due to the characteristics of the underserved patient characteristics (Table 3). After removing the unreachable cirrhotic patients, the descriptive analyses showed that the post-intervention surveillance rate increased to 39.6% from 10.2%, a 29.4 % increase, 3.9 times higher than the pre-intervention surveillance rate. Similar to prior studies (Aberra et al., 2013; Beste et al., 2015; Kennedy et al., 2013), this DNP project significantly improved the HCC surveillance rate after the interventions. This substantial improvement in HCC surveillance suggests that the interventions with QI measures, EMR alerts, and patient education effectively increased HCC surveillance rates, targeting PCPs in primary care clinics.

Matched Same Group Sub-Analysis Pre-to-Post QI Intervention Periods

A prior study by Beste and colleagues (2013) tested the effectiveness of implementing the EMR alert at the primary care clinics at VA hospitals to improve surveillance rates by the PCPs. This study reports that the intervention site increased the surveillance rate from 18.2% to 27.6%, a 9.4% increase after the EMR implementation, while the control sites remained unchanged surveillance rate of 17.5% (Beste et al., 2013). In this DNP Scholarly project, the sub-analysis of the matched same group in the pre-post intervention periods showed that the pre-intervention surveillance rate was 11.6%. However, the post-intervention HCC surveillance rate showed a statistically significant increase to 39.5%, a 27.9 % increase, 3.4 times higher than the pre-intervention surveillance rate. The surveillance rate in the matched sample (39.5%, n = 43) is statistically higher than the 28% in the VA study ($z = 1.684$, $p = .046$). The significant differences in the pre-post HCC surveillance rates in this DNP Scholarly project confirm that incorporating the intervention with the QI measures, EMR alerts, and patient education is an effective interventional strategy to improve HCC surveillance in primary care clinic settings.

Comparisons by Demographic Variables

This federally qualified primary care clinic provides health care to the underserved patient population in downtown Los Angeles, and the demographic characteristics of this patient population could have affected the surveillance rates. Subgroup analyses comparing the post surveillance rates across the age groups did not show statistically significant differences. However, comparisons across the race/ethnicity groups showed that the unreported race/ethnicity group had the highest increase in post-QI intervention HCC surveillance rate, and the differences in the surveillance rate across the race/ethnicity groups were statistically significant. In addition, the uninsured cirrhotic patients had the highest increase in post-intervention surveillance rate,

and the comparison of the surveillance rates between the uninsured cirrhotic patients and those patients with other types of insurance significantly differed. (Table 7, 8, 9).

Literature reports that patients with underinsured/uninsured, lower socioeconomic status, and African Americans have lower HCC surveillance rates than counterpart patients (Singal et al., 2012a; Singal et al., 2015). In the primary care clinics where this DNP intervention project was conducted, over 40 % of patients had Medi-Cal, and 20 % were uninsured. In addition, this DNP study revealed that approximately 34% (29/86) of patients were unreachable in the post-intervention group (Table 3). Furthermore, the HCC surveillance software program dropped 17.2% (13/75) of patients in the pre-intervention period because they had no qualifying clinic encounters within the last year period (Table 5). The underprivileged patient population with low socioeconomic status might have caused the low surveillance rates and contributed to barriers to improving HCC surveillance in this primary care clinic, the limitation of this DNP project.

Clinical Practice Changes in HCC Surveillance by PCPs

Surveillance failure is multifactorial, and the most common reason for the failure was the lack of HCC surveillance tests by the providers (Singal et al., 2012b). This DNP study also revealed overall low HCC surveillance rates by the PCPs in this primary care clinic, consistent with the prior study reports, critically low surveillance rates of less than 2% in community-based practice (Singal et al., 2015; Singal et al., 2017b). In this DNP project, four out of five MD providers, four out of six NP providers, and four out of nine PA providers had zero surveillance rates before the interventions started in September 2021 (Figures 3, 4, 5). This finding indicates that the clinical practice patterns in HCC surveillance by the PCPs in the primary care clinic appear similar to the prior studies; providers do not order the required HCC surveillance test (abdominal US and AFP). However, all providers demonstrated practice changes in HCC

surveillance and had improved surveillance rates after the interventions. The sustainability in practice change in HCC surveillance needs to be monitored over time. However, changed practice patterns in HCC surveillance by the PCPs in this primary care clinic are encouraging and suggest the success of this DNP project, as this DNP project aimed to promote adherence to the existing HCC surveillance guidelines by PCPs (Figures 3, 4, 5, 6, 7).

Secondary Outcome Measures

The secondary outcome of the DNP project was to evaluate the HCC detection rate through the guideline consistent HCC surveillance with biannual US and AFP. One cirrhotic patient enrolled in the surveillance program was diagnosed with HCC in October 2021. This patient was male, over 65 years old, and Hispanic. Unfortunately, he was diagnosed with the advanced-stage HCC in October 2021 and deceased in February 2022 within less than six months. The incident of this patient is consistent with the literature that the late discovery of HCC leads to a poor prognosis with high mortality with a median survival of less than a year (Wolf et al., 2021). The incident of this patient underscores the importance of adherence to the existing HCC practice guidelines to detect HCC in the more treatable early stages, the purpose of this DNP Scholarly Project.

Alignment with Theoretical Framework

The DNP project is a quality improvement (QI) initiative with system-based interventions to improve HCC surveillance in primary care clinics. The positive results of this DNP project interventions by the practice and the process changes in HCC surveillance align with the chosen theoretical framework, the IHI Model for Improvement with the PDSA method. Quality improvement involves a systematic approach to analyzing practice performance to enhance the targeted patient group's health status. The HCC surveillance failure is multidimensional and

involves providers, patients, and healthcare delivery processes (Singal et al., 2012b). Thus, all facets need to be reviewed and tackled in a continuous interactive process.

Changes to Bring Positive Results

Efforts to improve HCC surveillance rates require changes that bring positive effects and target the multiple failure points, including providers, patients, and the care delivery system. Due to the shortage of hepatologists in community-based practice, PCPs follow compensated cirrhotic patients who benefit the most from the early detection of HCC. However, PCPs have many demanding tasks, and often HCC surveillance in cirrhotic patients is ignored. Thus, this DNP project tackled the issues related to providers and developed the customized EMR alert system to assist the providers in ordering the abdominal US and AFP every six months for HCC surveillance (Appendix C). The HCC surveillance alerts appear on the patients' EHR system when the US and AFP are due/overdue or missing within the last six months for HCC surveillance in cirrhotic patients and trigger PCPs to order the tests. As a result, the DNP project intervention yielded substantially increased surveillance rates by the providers ordering the HCC surveillance tests with the US and AFP blood tests every six months.

In addition, empowering patients to increase their knowledge of cirrhosis and associated risk factors for HCC is crucial, as patients must undertake their surveillance tests when ordered and scheduled (Farvardin et al., 2017). Hence, the DNP project lead/hepatology NP developed a succinct patient education brochure in English and Spanish for patient education by the providers and shared the brochures with their patients (Appendix E & F). Also, staff education was provided on the HCC surveillance initiative during the staff meeting for the providers, nurses, and office staff who scheduled the imaging tests/abdominal US and emphasized the importance of HCC surveillance among cirrhotic patients to detect HCC early. Educating and sending the

message to the multiple levels of care providers involved in the HCC surveillance process is crucial, as the success of the quality improvement initiative requires interprofessional team efforts.

Process Improvement in HCC Surveillance

Effective interventions to improve the HCC surveillance require an iterative quality improvement process to intervene at the multiple failure points in continuous cycles to improve the HCC surveillance. However, in current clinical practice in HCC surveillance, most clinics have no systematic method to follow patients with cirrhosis and their biannual HCC surveillance status, which accentuates the urgent need for intervention with a systematic approach in the HCC surveillance process. Therefore, this DNP project developed the HCC surveillance program utilizing the EHR system and created the quality improvement measures for HCC surveillance (the US and AFP every six months for adult cirrhosis patients). As a result, the data-driven analytical surveillance program automatically enrolls patients diagnosed with cirrhosis in the HCC surveillance program. In addition, the program also provides the individual patients' HCC surveillance status with the dates of the US and AFP blood tests performed within the six months, indicating whether patients are compliant with the guideline accordant HCC surveillance.

Monthly HCC surveillance measure reports provide comprehensive information on cirrhotic patients enrolled in the program. By reviewing the monthly HCC surveillance reports, clinicians and the QI team can monitor individual patients' surveillance status and overall practice performance in HCC surveillance as a whole system. The DNP project lead and the QI coordinator ran and analyzed the monthly HCC QI measure reports to monitor the practice performance status on the HCC surveillance and communicated the findings with the QI team,

including the Chief Medical Officer (CMO) to improve the care delivery process. Also, by monitoring the monthly measure reports, potential technical issues with the HCC surveillance program were recognized and promptly reported to the EHR customer support team to resolve the system issues.

Patient Outreach

In addition, while monitoring the monthly measure reports, the QI team/DNP project lead identified cirrhotic patients who had no surveillance and referred them to the outreach coordinator to schedule a clinic appointment with a provider for HCC surveillance. Along with the interventions with the QI measures, EMR alert, and patient education, patient outreach was incorporated by the patient navigator to reach out to those patients with a lack of surveillance by phone, text messages, and letters. As a result, some patients who lost follow-up were captured and returned to the clinic and received the surveillance through patient outreach.

Limitations

A randomized controlled study design assigning cirrhotic patients with the known risk for developing HCC into a control group with no surveillance would be unethical; therefore, this investigation has several limitations. These include small sample size, lack of randomization, no control group, which poses selection bias, and the inability to generalize findings outside the chosen setting. In addition, as a nonrandomized study design without a control group, selection bias could pose a threat to internal validity issues for the causal inferences to support translating the study results into practice. Note, however, analysis of change in surveillance rate for the group of the same patients seen in both pre- and post- intervention revealed the significantly increased surveillance rates in the post period.

The project was implemented at the federally qualified primary care clinics located in the Skid Row area in downtown Los Angeles, which provide health care to underserved populations, including the homeless. Some patients often lack communication methods such as working phone numbers or valid home addresses; thus, they were unreachable and contributed to attrition, another limitation of this DNP Scholarly QI project.

The short period of implementation and evaluation may have also hindered robust results. What helped overcome these project limitations was the communication method via the EMR alert system to reach as many PCPs as possible to follow prescribed guidelines for HCC surveillance in cirrhotic patients, alerting the practitioners to signs of HCC early in the more treatable stages. Convenience sampling from the same clinics, without a control group, represents narrow sample characteristics, posing external validity issues, thus limiting the generalizability.

In addition, the technical problems with the EHR system are another potential limitation of using the computerized software programs for healthcare. For example, the QI measure report for February 2022 was unavailable until March 2022 due to the issues with the computer programs that the EHR customer support team resolved. Therefore, continued ongoing monitoring of the monthly HCC surveillance measure reports to recognize early signs of technical problems and prompt communication with the team was crucial for the success of the DNP QI project to improve HCC Surveillance.

The COVID-19 pandemic caused an unparalleled pivot in care provision for patients, clinics, and hospitals. While the DNP project was initiated in September 2021, Los Angeles County was experiencing a surge in the COVID-19 cases again, which profoundly affected everyone, including patients and healthcare facilities. With the fear of being exposed to COVID-

19, clinic visits changed to telemedicine. Due to the fear of the COVID exposure, cirrhotic patients might have been discouraged from getting their scheduled abdominal US for the HCC surveillance. The patient navigator was able to schedule clinic appointments for over 30 patients who lacked HCC surveillance. However, these patients did not follow through with their clinic appointments, another limitation of the DNP project.

DNP Essentials for Project

The DNP Essentials are the foundational core competencies required for all DNP graduates, and DNP-prepared nurse practitioners are equipped for specialized practice (AACN, 2006). The complexity of healthcare and increased knowledge requirement has resulted in nursing practice specialization to ensure competencies in highly complex clinical practice areas. The DNP-prepared practitioner brings experiences and specific clinical expertise to the work based on a unique grounding in applying a scholarship and translational science to advance evidence-based practice for systematic practice change (AACN, 2006). In Essential VIII, *Advanced Nursing Practice*, the DNP clinician is the initiator of practice change. The DNP specialist demonstrates advanced clinical judgment, system-based thinking, and accountability in designing, delivering, and evaluating evidence-based practice to improve patient outcomes (AACN, 2006).

The DNP Essential VIII, *Advanced Nursing Practice,* provides the framework for the DNP hepatology specialist as a change agent to initiate practice change to close the gap in HCC surveillance among patients with cirrhosis. Patients with liver cirrhosis are at high risk for developing fatal HCC, and biannual HCC surveillance with the abdominal US and serum AFP promotes early detection of HCC and improves patient survival. However, critically low HCC surveillance rates are prevalent in clinical practice, especially in primary care settings. Thus, the

hepatology specialty-focused DNP practitioner initiated and led this DNP QI project to improve HCC surveillance and close the gap in practice. Also, in Essential IV, *Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care,* the DNP practitioner used informatics technology to improve patient care and the healthcare system and provide leadership in implementing innovative QI initiatives. Thus, the application of the Essential IV was a suitable framework for this DNP QI project to improve HCC surveillance in the primary care setting.

DNP Leadership and Interdisciplinary Practice

Leadership and collaboration are essential aspects of DNP-prepared clinicians in the complex healthcare system, whether in nurse executive positions, education, or clinical practice (Chism, 2019). The DNP Essential II (AACN, 2006) reinforces the *Organizational and Systems Leadership for Quality Improvement and Systems Thinking*. Also, the DNP Essential VI underlines the importance of "Interprofessional Collaboration for Improving Patient and Health Outcomes" (AACN, 2006). Effective leadership is a core competency for the DNP-prepared clinician in dealing with complexity and chaos to improve patient outcomes, eliminate health disparities, and promote clinical excellence by evaluating evidence-based best healthcare delivery practices (AACN, 2006). Proficient leadership is also integral in leading interprofessional teams effectively and fostering collaboration within the health care team (Chism, 2019). The DNP leader has knowledge and skills in systems and clinical expertise to promote organizational improvement and positively impact clinical outcomes (AACN, 2006).

Due to the lack of availability of specialists in the community, PCPs follow most compensated cirrhotic patients who still have preserved synthetic liver functions and have not developed complications, including portal hypertension, ascites, or hepatic encephalopathy from

further advanced liver cirrhosis. These compensated cirrhotic patients have the most benefit from early detection of HCC as they have a chance to receive potentially curative treatment options such as surgery or liver transplant (Poordad, 2015). Hence, the leadership of an initiative on adherence to the HCC practice guidelines is appropriate for the DNP-prepared hepatology practitioner to improve patient outcomes and population health. The clinical gap in HCC surveillance, the published evidence of the effectiveness of HCC surveillance QI measures and the EMR alert for HCC surveillance led to this DNP Scholarly Project. This DNP project is an evidence-based practice QI initiative to improve HCC surveillance in the primary care setting by incorporating the EMR alert into existing clinical workflow to prompt PCPs to order the HCC surveillance tests. Thus, the proposed hypothesis was that implementing QI measures and EMR alerts improves HCC surveillance by primary care providers. The DNP lead tested this hypothesis and proved the effectiveness of implementing QI measures and EMR alerts to improve HCC surveillance, with the findings of statistical significance.

The DNP QI project was team-based and required interprofessional collaboration to successfully develop and implement the project. The development of HCC surveillance QI measures and EMR alert involved an interprofessional team, including the Chief Medical Officer (CMO), lead clinician, the QI project coordinator, and engineers to develop the software computer program. Also, nursing staff, schedulers, and other ancillary office staff were essential to the interdisciplinary team to implement the project successfully. Interprofessional collaborative practice is working across the healthcare profession to cooperate, collaborate, communicate, and integrate care (Golom & Schreck 2018). The DNP QI project leader must collaborate with the diverse interprofessional team members to meet patients' and populations'

needs and assume leadership to bring efficient and effective care to impact healthcare outcomes positively.

Implications for Practice and Future Research

Underutilized surveillance guidelines with critically low surveillance rates are evident in clinical practice, especially in primary care settings. Failure to order surveillance tests by providers for known cirrhotic patients is the most common reason for the HCC surveillance failure, indicating the pressing need for clinical practice change. This DNP QI Scholarly Project emphasized this urgent need for clinical practice change in HCC surveillance and promoted adherence to existing HCC practice guidelines. Implementing EMR alerts and reliable data-driven analytical QI measures is easy to use, inexpensive, and effective in improving HCC surveillance. In addition, this system-based approach is sustainable. It can be applied to other clinic settings, including hepatology clinics and other community-based primary care clinics where underserved populations receive healthcare, which will reduce disparities in HCC surveillance. Further research should focus on continued primary care provider education on cirrhotic patient care, developing provider-centered programs, system-based audit feedback interventions, and reducing inequities in HCC surveillance.

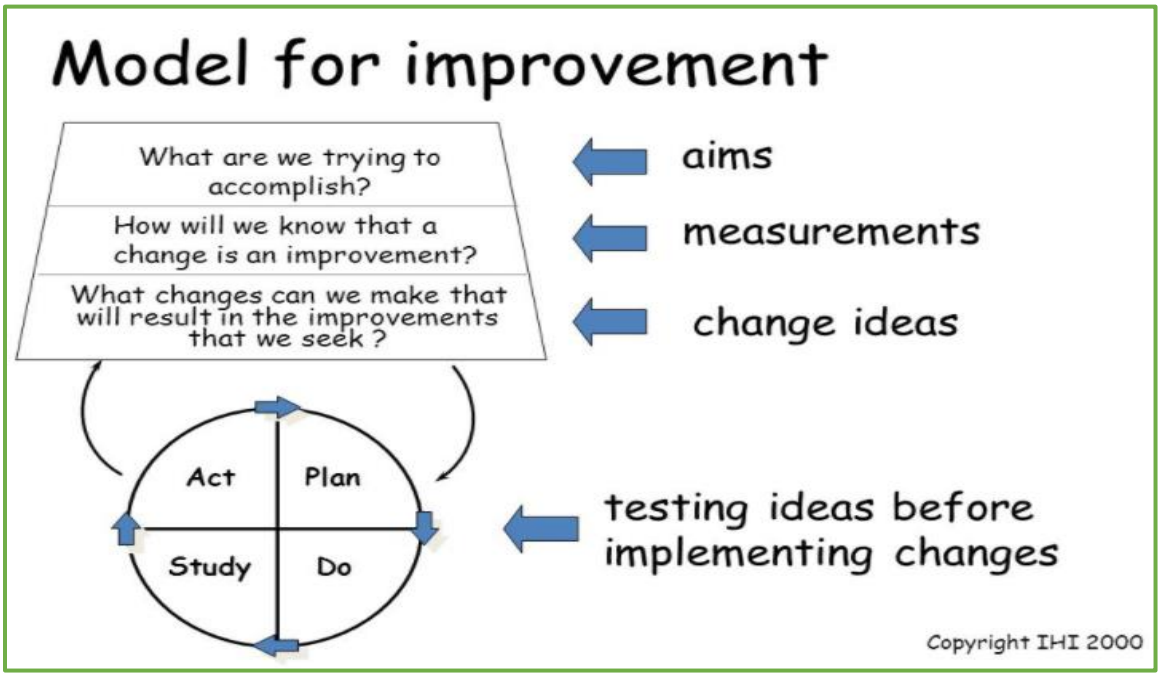
CONCLUSION

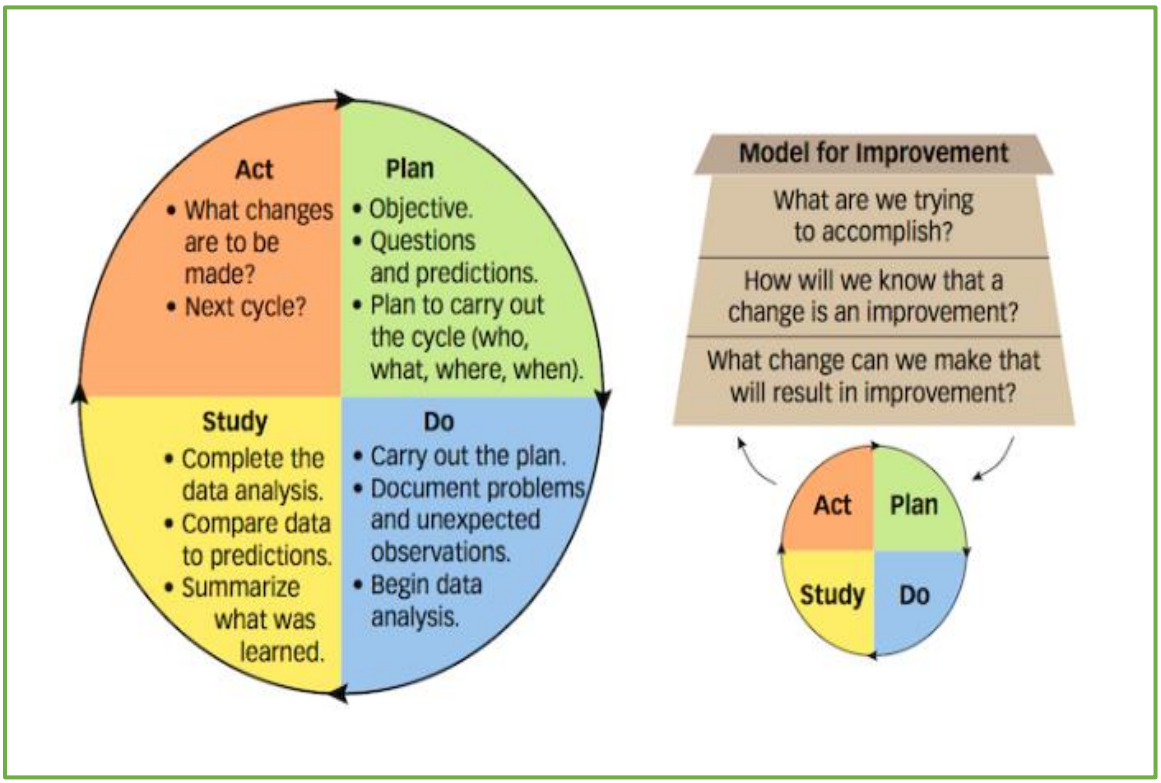
Hepatocellular carcinoma is the leading cause of death among patients with cirrhosis worldwide and in the United States. The advanced tumor stage is the strong prognostic indicator in patients with HCC, and potentially curative treatments are only available for patients with early-stage HCC. The surveillance with biannual US abdomen and AFP blood test is associated with detecting HCC early, improving overall patient survival, reducing all-cause mortality, and cost-effectiveness. However, continued low surveillance is prevalent in practice, indicating the

clinical gap in HCC surveillance, especially in primary care settings. Effective interventional strategies to improve surveillance among cirrhotic patients are crucial to closing the HCC surveillance gap, reducing disparities, and promoting population health. The DNP Scholarly QI project addressed the urgent need for effective interventional strategies to improve HCC surveillance rates by PCPs in primary care settings. Despite the small sample size and nonrandomized project design, the DNP project resulted in statistically significant findings in pre-post comparisons for the overall effect of the intervention and increased HCC surveillance rates. Implementing EMR alerts, the QI measure, and patient education with interprofessional collaboration has improved HCC surveillance by PCPs in the primary care clinic. However, further studies with a larger sample size at multi-sites are warranted to validate the innovative system-based interventions to close the clinical gap in HC surveillance.

APPENDICES

Appendix A: IHI Model for Improvement with PDSA Method





http://www.ihi.org/resources/Pages/HowtoImprove/default.aspx

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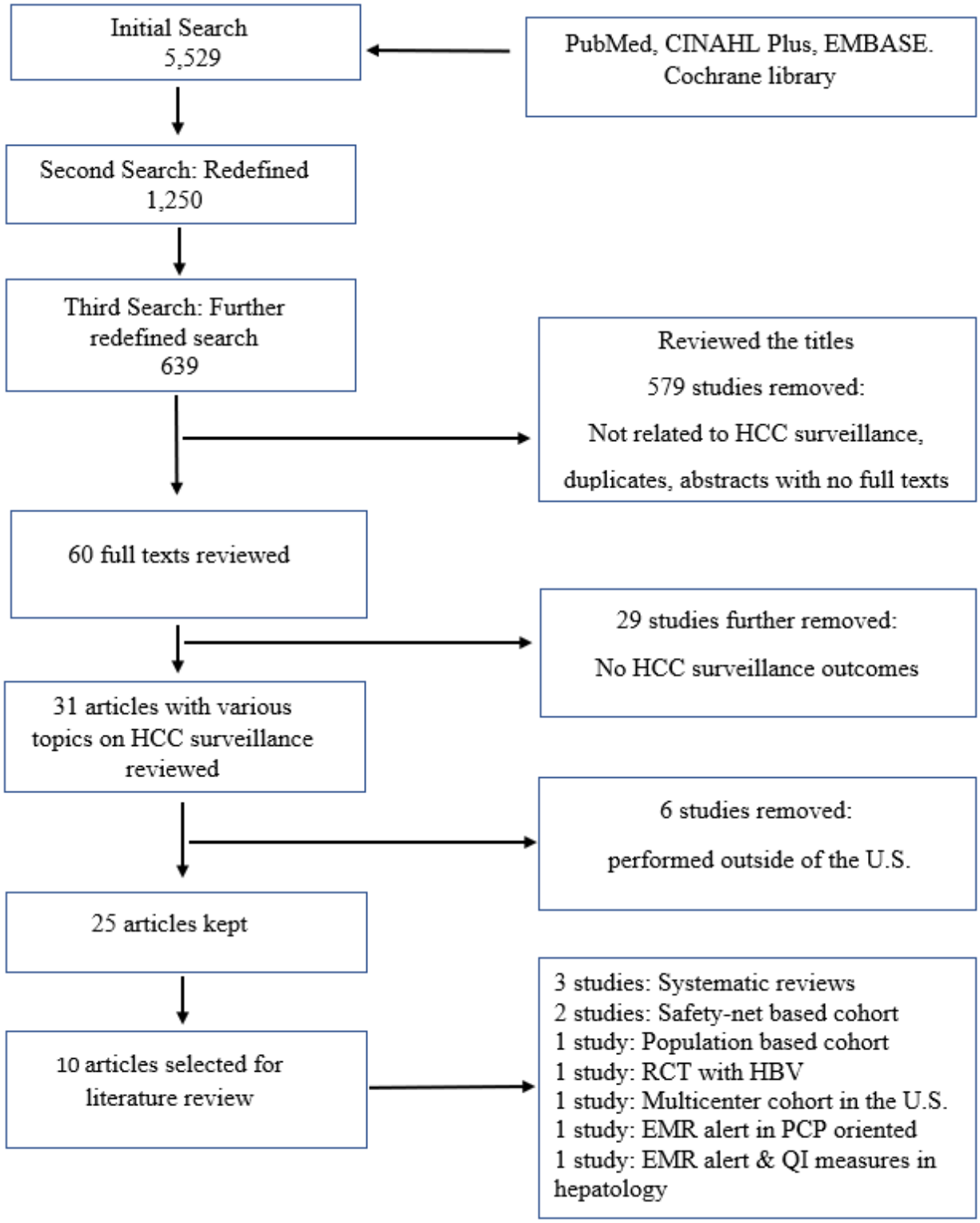
Appendix B: PRISMA Flow Diagram for Literature Search

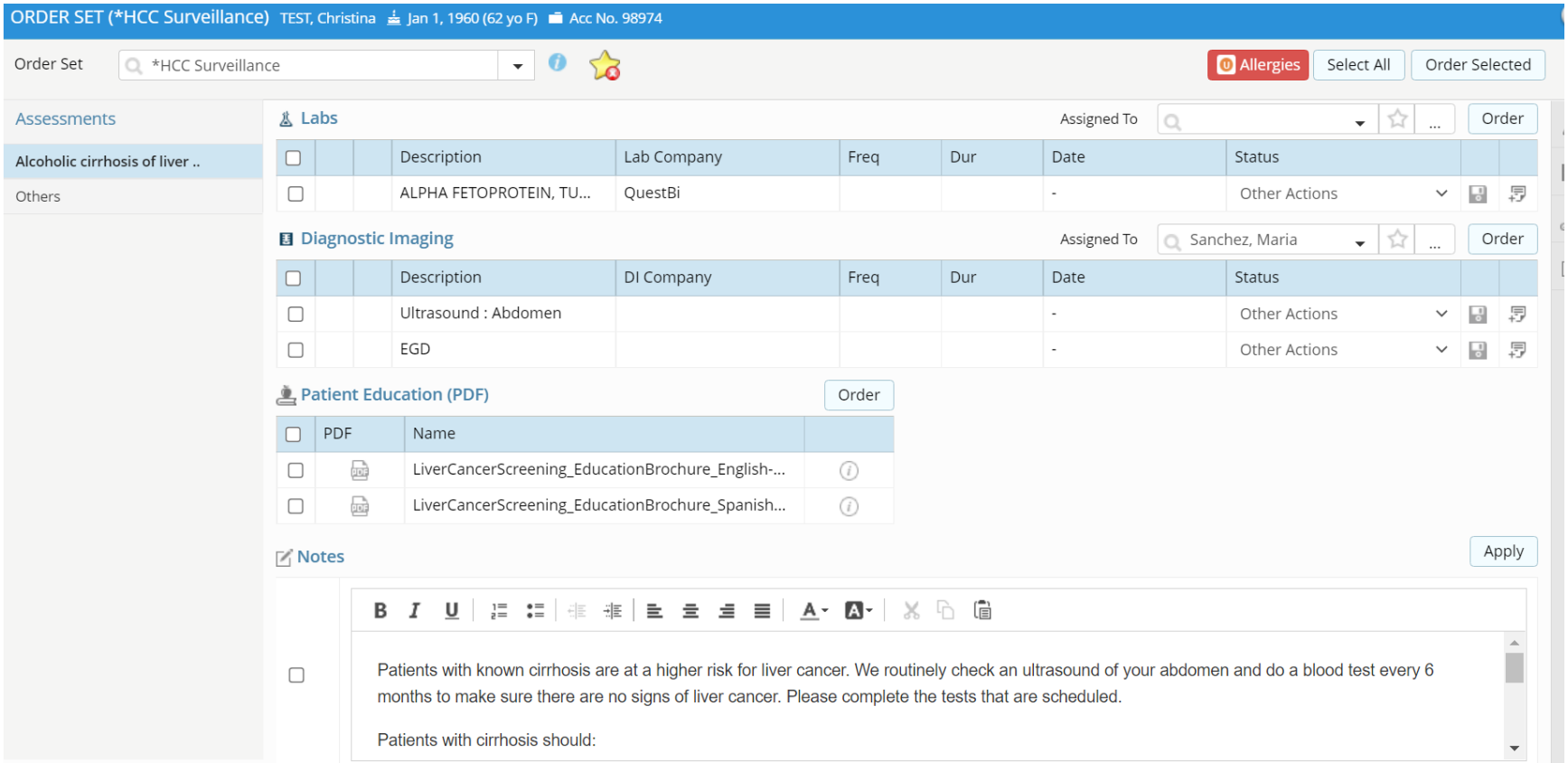


Appendix C: EMR Alert for HCC Surveillance

Alerts (3)

ALERT	MESSAGE	MOST RECENT DATE	MOST RECENT RESULT
Colon CA 45+	Missing		
HCC Surveillance- Abdominal US/AFP Blood Test	Missing		
Pneumovax23	Missing		

Appendix D: Order Set for HCC Surveillance Tests



Appendix E: Pre-Prepared Clinic Note for Providers.

Plan:

1. Others

LAB: ALPHA FETOPROTEIN, TUMOR MARKER

Imaging: Ultrasound : Abdomen

Notes: Patients with known cirrhosis are at a higher risk for liver cancer. We routinely check an ultrasound of your abdomen and do a blood test every 6 months to make sure there are no signs of liver cancer. Please complete the tests that are scheduled.

Patients with cirrhosis should:

1. Avoid alcohol and beer of any kind
2. Limit acetaminophen/Tylenol <2g per day
3. Avoid NSAIDs, like ibuprofen, Advil, Aleve, naproxen
4. Avoid over the counter dietary or herbal supplements
5. Avoid raw oysters and raw shellfish to avoid bacterial infection.

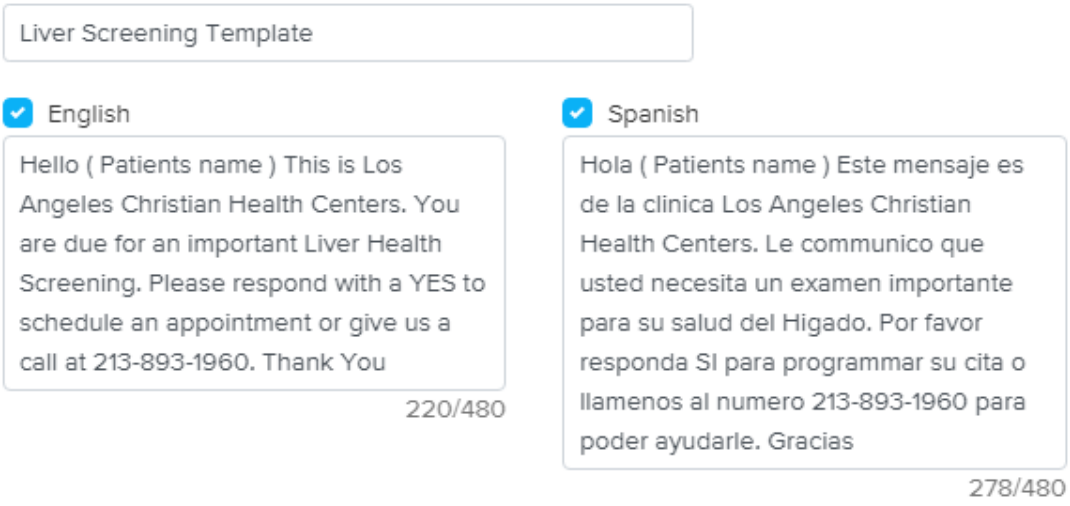
Imaging:

Imaging: Ultrasound : Abdomen

Labs:

Lab: ALPHA FETOPROTEIN, TUMOR MARKER

Appendix F: Phone Text Messages to Patients with Lack of Surveillance



Appendix G: Letter to Patients with Lack of Surveillance

This is our first attempt to contact you by letter. As your primary care provider we would like to follow up with you as soon as possible for your Liver Health Screening.

Please come in to our clinic or contact our clinic at (213) 893-1960 to schedule an appointment at a time convenient for you. You may call anytime Monday- Friday 8:30 AM to 4:30 PM. We thank you for choosing *Los Angeles Christian Health Centers* as your Primary Care Provider.

Appendix H: HCC Surveillance Clinical Workflow

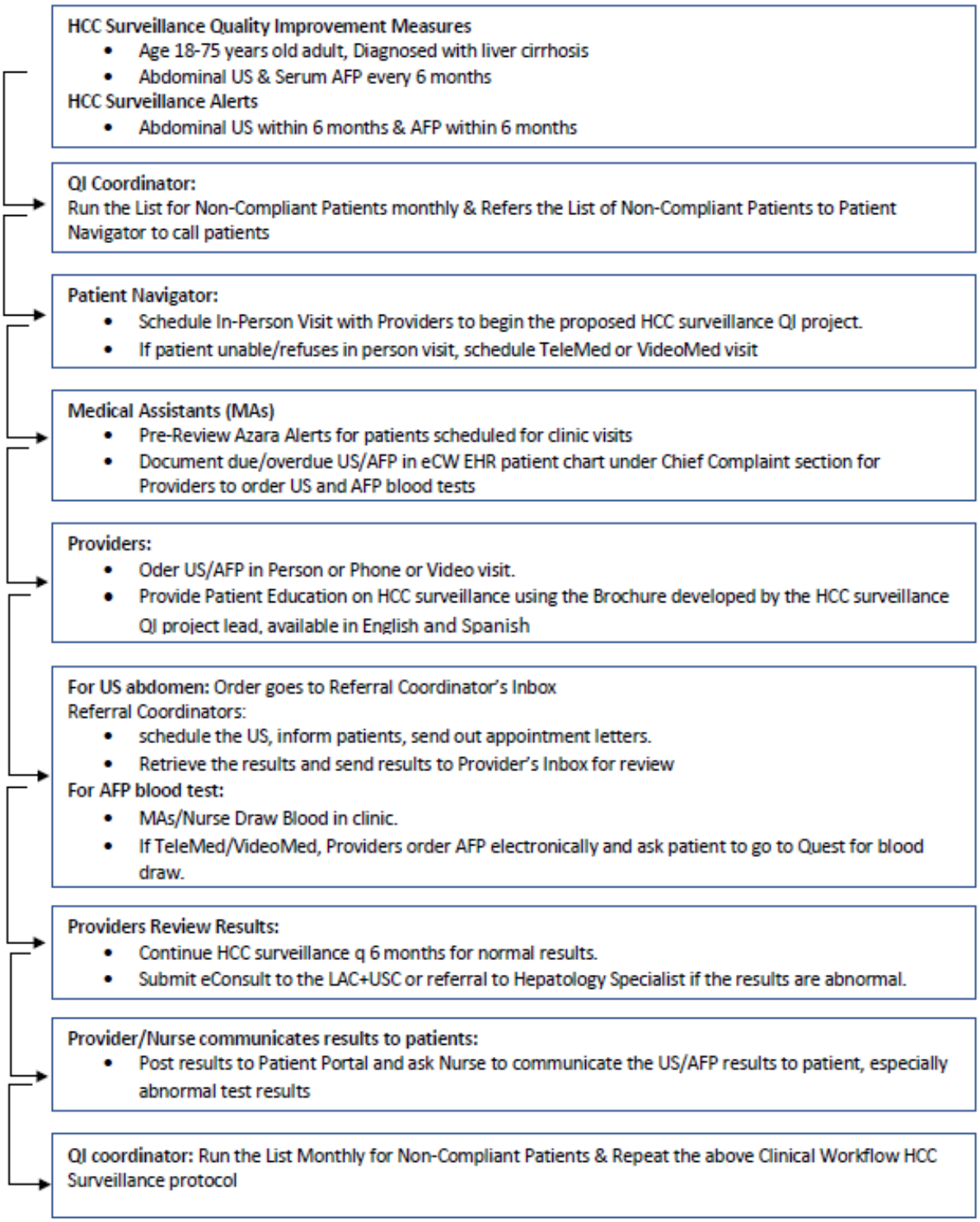


TABLE OF EVIDENCE

Citation	**Purpose**	**Sample/Setting**	**Methods (Designs, Interventions, Measures)**	**Results**	**Discussion, Interpretation, Limitations**
Singal, A. G., Li, X., Tiro, J., Kandunoori, P., Adams-Huet, B., Nehra, M. S., & Yopp, A. (2015). Racial, social, and clinical determinants of hepatocellular carcinoma surveillance. *The American Journal of Medicine*, *128*(1), 90.e1–90.e907. https://doi.org/10.1016/j.amjmed.2014.07.027	-To characterize guideline-consistent HCC surveillance rates among cirrhotic patients. - To characterize surveillance rates among those with recognized cirrhosis. - To identify patient-level determinants of HCC surveillance among a racially and socioeconomically diverse	Sample: - Patients diagnosed with liver cirrhosis N = 904 Inclusion: - Required to have 1 outpatient PCP clinic visit in July 2008 to July 2011 - Continued to have follow up through the study period Aug 2010 to July 2011 - Patients identified by ICD 9th codes - Cirrhosis was confirmed by liver biopsy.	Study Design: Retrospective cohort study. Procedures/Data Collection: - Demographics, clinical history, laboratory data, imaging results were obtained via EMR review - Two authors extracted data using standardized forms - Third investigator available to resolve discrepancies. - Dates of all HCC surveillance testing with the abd US in July 2008 to July 2011 were extracted. - Imaging exams for diagnostic reasons were excluded Measurements: Receipt of HCC	Statistical Analysis: - Fisher exact and Mann-Whitney rank-sum tests - Multivariate logistic regression models - Predictor variables with $P < 0.01$ in univariate included to minimize type II error - Alpha $P < 0.05$. **Results:** ***Patient Characteristics***: - 22% of AA; 36 % of non-Hispanic Caucasian - 40% of Hispanic Caucasian - 43% of uninsured - 53 % with Medi/Medi	Discussion: - Multiple steps prone to failure exist - Providers must identify/order surveillance testing - Healthcare system must schedule the tests - Patients must complete the tests. Interpretation: - Only 1.7 % had guideline-adherent surveillance - Racial and socioeconomic disparity exists - Low surveillance rates in AA and uninsured patients. Limitation: The study done at the

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
	cohort of patients with cirrhosis. Background: - Most studies performed in racially and socioeconomically homogenous populations - Few used guideline-based definitions for surveillance.	 Setting: - Parkland Health and Hospital; the safety-net system for Dallas County. Integrated with 11 PCP clinics in low-income neighborhoods. - A hepatology outpatient clinic, a tertiary hospital.	surveillance: 3 definitions; - Inconsistent surveillance (IS); 1 abd US over the study period. - Consistent annual surveillance; at least 1 abd US every 12 months - Consistent biannual surveillance rates; receipt of consistent surveillance q 6 months. Covariates: Age, gender, race, ethnicity, preferred language, marital status, insurance type	- 4% with private insurance ***HCC surveillance status*** - 66.7% had IS surveillance - Insurance status positively associated with IS (P = 0.05) - IS negatively associated with the AA race (*P* = 0.07) - 1.7% had consistent biannual surveillance - Number of hepatology visits per year associated with receipt of biannual surveillance *(P* < 0.001)	safety net hospital, may not be generalized to other settings. Future Study: Further studies to characterize PCP's knowledge, attitudes, barriers to surveillance Conclusion Low biannual HCC surveillance among AA and uninsured patients exist, indicating disparity in HCC surveillance.
Singal, A. G., Tiro, J., Li, X., Adams-Huet, B., & Chubak, J. (2017b). Hepatocellular carcinoma surveillance	- To characterize patterns of HCC surveillance testing. - To	Sample: - Cirrhotic patients enrolled at Group Health. - Cirrhotic patients identified by	Study Design: Retrospective cohort study Procedure/Data Collection: Demographics, clinical history, laboratory data, imaging results extracted from Group Health's	Statistical Analysis: - In univariate analysis, Fisher exact and Mann Whitney rank-sum tests to identify baseline patient-factors associated with	Discussion: - Less than 2% had guidance-concordant HCC surveillance rates in the community practice - Specialty care is associated with high

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
among patients with cirrhosis in a population-based integrated health care delivery system. *Journal of Clinical Gastroenterology*, *51*(7), 650–655. https://doi.org/10.1097/MCG.0000000000000708	characterize patient-level factors associated with surveillance receipt among population-based cirrhotic patients in a large integrated healthcare delivery system.	ICD-9 codes. - Patients required at least 1 outpatient PCP visit from Jan.2010 to December 31, 2010. - Patient's Index visit: Jan 2010-Dec 2010. Exclusion: - Not Group Health Members - History of HCC & liver transplant prior to index visit - Followed less than 6 months after the index visit. Sample size: n = 1137 Setting: Integrated	computerized clinical and administrative databases. HCC Surveillance Outcomes: - Dates of abd US extracted for 2 years following the index visit. - Abd US done in emergency or inpatient exam excluded. Measurements: Receipt of HCC Surveillance: - Consistent: abd US every 6 months. - Inconsistent: at least 1 abd US during the study period - No surveillance: no abd US during the study period. Covariates prior to Index Visit: - Liver disease etiology: (HCV, HBV, alcohol, NASH, other) - Child-Pugh score - Presence of alcohol and	receipt of HCC surveillance. - Multivariate logistic regression model included variables (baseline Child Pugh class, receipt of specialty care), other significant factors - Predictor variables with $P < 0.01$in univariate to minimize type II error. - P <0.05 for statistical significance. **Results:** Receipt of Surveillance - Consistent surveillance: 2%, had US q 6 months - Inconsistent: 33%, - No surveillance: 65%. - Higher surveillance	surveillance rates, but PCPs follow most patients with cirrhosis due to limited specialist availability. - Surveillance decisions are left up to individual clinicians. Interpretation: - Only 2% had guideline-consistent surveillance. - Higher surveillance rates among patients with specialty care - Alcohol and NASH cirrhotic patients had low surveillance rates. Limitation: The study focused on cirrhotic patients at the single integrated health delivery system, may not be

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
		healthcare delivery system in Washington state	drug use determined by ICD-9 codes. - Primary care visits - Receipt of Specialty care	rates associated with specialty care (OR 1.88 95% CI 1.44 - 2.46). - Alcohol (OR 0.63, 95% CI 0.42-0.93) & NASH (OR 0.39, 95% CI 0.28-0.56) patients were less likely to undergo surveillance. - 89 % had CP-A cirrhosis	generalized to other settings. Future Study: High-quality study to characterize PCP's knowledge, attitudes, barriers on surveillance Conclusion: Low surveillance rates in community practice.
Zhang, B. H., Yang, B. H., & Tang, Z. Y. (2004). Randomized controlled trial of screening for hepatocellular carcinoma. *Journal of Cancer Research and Clinical Oncology*, *130*(7), 417–422.	To assess the effect of biannual HCC screening with AFP/US on HCC mortality in people at increased risk.	Sample: - Age 35-39, HBV infection, liver cirrhosis. - Exclusion: Known history of HCC, other malignancy, serious illness. - Sample numbers: 19,200 met criteria.	Study Design: - Randomized control trial. - Study design judged to be ethical/approved by the ethics committee. Procedure: - Cluster sampling, subjects recruited from Jan.1993 to Dec.1995, randomly assigned into screening (9,757) & Control group with no screening (9,9443).	Statistical Analysis**:** - X^2 for staging - Long-rank X^2 for survival rate. - Poison model **Results** HCC Detection: Intervention vs Control Number of HCC:86 vs 67 - Stage I HCC: 52 vs. 0	Discussion - Surveillance reduced HCC mortality and improved patient survival. - Study reported 58 % compliance to screening - Higher compliance to screening may further result in a greater reduction in

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
https://doi.org/10.1007/s00432-004-0552-0		Sample size: n = 19,200 Setting: Liver Cancer Institute at Fudan University, incorporated with Primary Care Centers, China	Intervention: - Screening group received AFP&US q 6 months: Control group received no intervention.. - Screen stopped Dec.1997. - All participants followed until Dec. 1998. - Validity of combined AFP/US reported elsewhere: 92% of detection rates, 7.5% of false positives, 3.0% of positive predictive values, respectively. Measurement - No. of HCC detection - Resection rates - 5-year survival rates - Staging HCC: Stage 1: Early HCC Stage II: Moderate HCC Stage III: Late-stage HCC	- Stage II HCC: 12 vs. 25 - Stage III HCC: 22 vs. 42 - Small HCC: 39 vs. 0 - 32 died vs. 54 died from HCC. Resection Achieved: - 40 vs 5 (46.5 % vs 7.8 %) - 37/52 subclinical HCC received surgical resection (72.2 %). Survival Rates -1 year survival: 65% vs 31 % -3 year survival: 52 % vs 7.2 % -5 year survival: 46.4 % vs 0 % No. of Death: 32 vs. 54 Significant survival advantage in HCC	HCC mortality. - Providers/Patients must adhere to HCC practice guidelines with biannual US/AFP Interpretation - After 5 year follow up, screening by q 6 months US/AFP led to reducing HCC mortality rate by 37% - Significant survival advantage in biannual HCC screening with US/AFP - Strengths of Study is the first and only RCT landmark study. Limitations - Sample includes only HBV patients, which may not apply in the US with other patient populations

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
				screening group P < 0.01	with other liver diseases (alcoholic, HCV, fatty liver cirrhosis). - Lack of outcome data & all-cause mortality information
Singal, A. G., Mittal, S., Yerokun, O. A., Ahn, C., Marrero, J. A., Yopp, A. C., Parikh, N. D., & Scaglione, S. J. (2017a). Hepatocellular carcinoma screening associated with early tumor detection and improved survival among patients with cirrhosis in the US. *The American Journal of Medicine*, *130*(9), 1099–	To characterize the association with HCC between HCC screening and early tumor detection, curative treatment, overall survival in a real-world clinical practice among a multicenter cohort of patients with cirrhosis in the US.	<u>Sample:</u> Inclusion: - Patients with newly diagnosed HCC from 06/01/2012 to 05/31/2013. - Mean age 59 (SD 55.2-66.5) - Racially diverse - 45.7 % with Medicaid - 57.2 % HCV Exclusion - Patients with no cross-sectional imaging	<u>Study Design:</u> Retrospective Cohort Study <u>Procedures: Data Collection</u> EMR reviewed at each site - ICD-9 codes 155.0 & 55.2 used to Identify the patients - Tumor conference lists - Databases of HCC patients - HCC confirmed based on AASLD criteria <u>Measurements</u> - Screen detected HCC if HCC was diagnosed prompted by screening imaging (the US, contrast-enhanced CT or contrast-enhanced MRI) within 6 months.	<u>Statistical Analysis:</u> - Univariate analysis - Generalized linear mixed models - Multivariate analysis - $P < 0.20$ in univariate - $P < 0.05$ in multivariate - Kaplan-Meier analysis for survival analysis - Univariate & multivariate Cox regression with frailty adjustment **<u>Results</u>** - 42 % HCC detected via screening,	<u>Discussion:</u> - HCC screening improves early detection, overall survival among cirrhotic patients. - PCPs follow the most stable cirrhotic patients but have low screening rates by PCPs; PCPs' involvement in screening is needed. - More curative treatment needs to be pursued among early-stage HCC. - Multicenter cohort study in the US. <u>Interpretation</u>

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
1106.e1, https://doi.org/10.1016/j.		- Patients with prior HCC treatment - Patients with unknown screening status Sample Size: 374 (278 men) Setting: - 4 health systems in the US; - 2 academic tertiary centers - 2 safety-net health system	-Screening indication; Cirrhosis HCC treatment categorized: - Liver transplant; - Surgical resection; - Local ablative treatment (LAT) • Transarterial chemotherapy (TACE); • Transarterial Radioembolization (TARE) • Stereotactic body radiation systemic therapy (SBRT) Best supportive care. Considered Curative HCC treatments: -Liver transplant -Surgical resection -Local ablative treatment	ranging 35-49%. - HCC was detected by screening in 80.4% of patients receiving hepatology care. vs.17.9% without hepatology care. - 47.6% of patients with HCC detected at early stage 0 or Milan criteria (44.4%): these patients received curative treatment - Treatment underused for patients with early-stage detection - 1-3-year survival rates were 75.3% & 68.7% among screened group vs 53.4 % & 35.5% in non-screened group.	- HCC screening associated with improved early detection of HCC and curative treatment receipt, improved patient survival Limitation Nonrandomization Implications for Practice HCC surveillance needs to be improved by providers/ PCPs. Conclusions HCC surveillance improves early detection & patient survival.
Singal, A. G., Yopp, A. C., Gupta, S.,	To characterize the reasons for	Sample: - Cirrhotic patients	Study Design: Retrospective cohort study	Statistical Analysis: - Fisher exact and Mann-Whitney rank-	Discussion: - Adherence to surveillance

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
Skinner, C. S., Halm, E. A., Okolo, E., Nehra, M., Lee, W. M., Marrero, J. A., & Tiro, J. A. (2012b). Failure rates in the hepatocellular carcinoma surveillance process. *Cancer Prevention Research, 5*(9), 1124–1130. https://doi.org/10.1158/1940-6207.CAPR-12-0046	failure in HCC surveillance process among cirrhotic patients with HCC. Background - Understanding which steps in HCC surveillance is not performed is essential for designing effective interventions to improve HCC surveil	diagnosed with HCC from Jan. 2005- June 2011. - Required first visit more than one year before HCC diagnosis - Median age 57;75% men;40% AA; 28% Hispanic; 23% non-Hispanic white; - 49% uninsured - 7% private insurance **Etiology:** - 72.5% HCV - 11.2% EtOH - 6.7% NAFLD - 39% CP-A Exclusion -No PCP hepatology clinic visits within 2 years	Procedures: Identifying Study Subjects: - ICD-9 code 155.0 and 155.2 - Tumor presentation lists - Surgical resection records. - Interventional HCC treatment Data Collection: EMR records - Date of liver disease/cirrhosis diagnosis: Date of First medical encounter: Number of PCP clinic visits: Number of Hepatology visits: HCC surveillance & HCC diagnosis - 4 phase CT/ MRI Measurement: Primary outcome: Receipt of HCC surveillance - Inconsistent surveillance: 1 abd US over 2 years before HCC diagnosed - Consistent surveillance: at least 1abd US every 12 months for screening	sun tests for identifying patient and system factors associated w/ process failures at each step. - Univariate analysis to identify predictors of failure - Multivariate logistic regression - Alpha < 0.05 **Results:** - Inconsistent surveillance:36, 20.2% - NO surveillance:142, 79.8% in last 2 years. - Consistent surveillance: 9 (6%) - Patients with consistent surveillance had a higher portion of early-stage HCC (66.7 % vs. 37.1 %, P=0.09).	improves early detection of HCC. - Lack of surveillance orders by providers was the most common reason for the failure. - But multiple failure points in the surveillance process exist. Interpretation: - Providers not ordering surveillance is the most common failure. - Multiple failure points exist in the process - Strength of Study: Identified surveillance failure points Limitation: Non-randomization, posing possible sample &

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
		of HCC diagnosis Sample size n = 178 Setting: A large urban safety-net hospital with 11 primary care clinics in a low-income community in Dallas.	purposes over 2 year-period before HCC diagnosis.	Reasons for failure to complete surveillance & process of care failure rates - Failure to recognize liver disease (20.2%) - Failure to recognize cirrhosis (23.2 %) - Lack of surveillance order (61.5%) for known cirrhosis - Failure to complete surveillance despite orders (14.3 %)	measurement bias. Future Research: Interventions to improve multiple failure points including provider' knowledge in liver disease Conclusions: Awareness of liver disease, cirrhosis, HCC surveillance by PCP is imperative to improve surveillance
Beste, L. A., Ioannou, G. N., Yang, Y., Chang, M. F., Ross, D., & Dominitz, J. A. (2015). Improved surveillance for hepatocellular carcinoma with a primary care-oriented clinical reminder. *Clinical*	To assess if primary care-oriented EMR clinical reminder increases HCC surveillance or HCC detection rates. Backgrounds:	Sample: - VA patients with cirrhosis - Mean age 60-61 (SD 8.0) - Male and Female - White, Black, Hispanic, and other race Sample Size:	Study Design: Quasi-experimental study Procedure/Intervention: - EMR HCC surveillance clinical reminder appearing to PCP as "DUE" for cirrhotic patients Measurements: - Pre EMR reminder HCC surveillance base rates measured from 06/30/2009	Statistical Analysis: - Chi-square for patient characteristics - 2 Sample t-test with alpha 0.05 for all tests - Logistic regression - Propensity score **Results:**	Discussion: - Clinical reminder system is an inexpensive and effective way to increase HCC surveillance - Simple & easy EMR reminders should be utilized to help providers to order HCC

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
Gastroenterology and Hepatology, *13*(1), 172–179. https://doi.org/10.1016/j.cgh.2014.04.033	- HCC surveillance with liver US every Six months is linked to improving patient survival, but less than 20% of patients undergo HCC surveillance. - Failure to order surveillance tests by providers is the most common reason for low surveillance rates.	2884 (790 at intervention site) 2094 (Control sites) Setting: - Inpatients & Outpatients - 1 intervention site with two campuses: A tertiary care facility/Primary care-focused facility - 7 control sites: Regional liver transplant center/Six lower complexity sites	to 12/30/2008. - Post EMR reminder HCC surveillance rates. - Pre & Post surveillance rates were compared. For Primary Outcomes: Adequate HCC surveillance defined: Two or more US, multiphase CT or MRI more 6 months apart For Secondary Outcomes: (1) New enrollment in HCC surveillance (2) Sporadic imaging surveillance (3) New HCC diagnosis	Surveillance Outcomes - Post-EMR reminder surveillance rate increased by 51% at Intervention sites compared to Controls (27.6 % vs 17.7 %, *P* <0.0001) HCC Outcomes: - Higher HCC diagnosed at Intervention sites (3.1 % vs 1.9% *P* = 0.34; [OR] 1.72, 95% CI, 1.03-2.86.	surveillance tests. - The study produced 9.4 % absolute improvement - But providers ignored 39.8% of eligible reminders. Interpretation: - EMR reminders increased the HCC surveillance rate and resulted in a higher HCC detection rate. But provider ignored eligible reminders. Strength of Study: - Large sample size - Quasi-experimental design with controls. - Integrating EMR reminders with PCP's clinical workflow. Limitation Predominant VA's sample population and lack of randomization,

Citation	Purpose	Sample/Setting	Methods (Designs, Interventions, Measures)	Results	Discussion, Interpretation, Limitations
					making generalizability difficult. Future Study: A qualitative study investigating provider factors is needed.
Aberra, F. B., Essenmacher, M., Fisher, N., & Volk, M. L. (2013). Quality improvement measures lead to higher surveillance rates for hepatocellular carcinoma in patients with cirrhosis. *Digestive Diseases and Sciences, 58*(4), 1157–1160. https://doi.org/10.1007/s10620-012-2461-4	To evaluate the effectiveness of implementing quality measures in increasing HCC surveillance rate among patients at a tertiary care facility.	Sample: - Patients with cirrhosis. Male& female from March 2010 to April 2011. - Control group in 2008-2009 Exclusion - Noncirrhotic HBV infection patients - Hx of HCC Sample size: n = 355	Study Design: Prospective study Procedures - Cirrhotic patients identified by hepatology attending. - Cirrhosis based on histology, imaging findings, splenomegaly, varices, thrombocytopenia. Quality Improvement Program: - A box was added for attending to indicate cirrhotic patients: clerks notify designated staff; the staff enters patients into	Statistical Analysis: SPSS version 19 used for all data analysis. - T-test used to compare the mean age in two groups. - Chi-square test to compare the proportion of patients receiving surveillance in two groups - Chi-square to analyze characteristics	Discussion: - QI measures along with EMR reminders can significantly increase HCC surveillance. Strength: study design utilized the staff for QI measurement Interpretation - Post QI cohort had 19% improved surveillance rate vs.Pre QI cohort with statistical significance, from 74 to 93 %, $P < 0.001$.

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		- 7 out of 362 with a History of HCC excluded. Setting: Hepatology Clinic, in the tertiary center, in the USA.	chronic disease management. - Protocol for nursing staff to order the US: - Reminder system established for US/AFP q6 mons - Disease management programmed to alert nurses for patient delinquent > 1 month Measurement - Underwent surveillance defined: 1 abd US performed in the prior year for surveillance purpose - Pre and Post QI. surveillance rates measured compared.	associated with receiving surveillance - Alpha < 0.05 **Results** 71% was CP-A cirrhosis 21 patients with CP-C were excluded. - Post QI cohort-93.2% received surveillance vs. 74%, p<0.001. - 6/331 detected HCC; - 3 had early-stage HCC. - Lack of insurance-most common reason for no surveillance	-Early-stage HCC detected by surveillance. Limitations - Not randomized, - Possible sample bias, - The study was done at the academic center, may not be generalized - Pose a risk for selection bias as the study was done at a hepatology clinic. Future Research - Study to assess if surveillance improvement leads to patient outcomes.

Note: Abbreviations
AA = African American; AASLD = American Association for Study of Liver Diseases; abd = abdominal; Aug = August; CI = confidence interval; CP-A = Child Pugh-A; CT = computerized tomography; Dec = December; EMR = electronic medical record; EtOH = Alcohol; HBV = hepatitis B virus; HCC = hepatocellular carcinoma; HCV= hepatitis C virus; ICD = International Classification of Diseases; IS = Inconsistent; Jan = January; LAT = local ablation treatment; Medi/Medi = Medicare/Medi-Cal; MRI = magnetic resonance imaging; NASH = non-alcoholic steatohepatitis; No = number; OR = odd ratio; PCP = Primary care provider; SBRT = stereotactic body radiation; SD = standard deviation; TACE = trans arterial chemotherapy; TARE = trans arterial radioembolization; US = ultrasound; VA = Veterans Affairs; X^2 = Chi-Square

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