ORIGINAL ARTICLE

Patients Hospitalized for Complications of Cirrhosis may Have Benefited From Medicaid Expansion Under the Affordable Care Act

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Abstract

Objective: The benefit of the Affordable Care Act (ACA) for patients with cirrhosis is unclear. We determined the impact of ACA expansion on outcomes in patients hospitalized for complications of cirrhosis.

Patients and Methods: We compared hospitalizations; in-hospital outcomes; and readmissions among patients with cirrhosis identified using International Classification of Diseases, Ninth Revision, and International Classification of Diseases, 10th Revision, codes in states that expanded Medicaid under ACA (expanded [E] states) and those that did not (nonexpanded [NE] states). Data from the State Inpatient Databases were obtained for 3 pairs of contiguous E and NE states with both pre-ACA expansion and post-ACA expansion data. The difference-in-difference analysis was performed to compare the pre- and post-ACA data between the E and NE states. The outcomes were admission rates, hospital complications, resource utilization, length of stay, in-hospital mortality, discharge destination, cost of initial hospitalization, and readmission characteristics.

Results: There were 228,349 admissions (E states, 149,705; NE states, 78,644). After ACA implementation, the E states had lower rates of admission increase per 100,000 population (22.9 in E states vs 25.5 in NE states, $P=.005$), sepsis (relative risk, 0.884; $P=.0084$), and hepatic coma (relative risk, 0.763; $P<.001$) than the NE states. The length of stay was lower by 0.21 days ($P=.00028$), with a $587.40 lower cost per hospitalization ($P=.00091$), in the E states than in the NE states. The readmission rates within 30, 60, and 90 days decreased in the E states after ACA implementation but increased in the NE states after ACA implementation.

Conclusion: Among patients hospitalized for cirrhosis, quality indicators, such as the rate of admission increase, complications, costs, and readmissions, were more favorable in the states that expanded Medicaid. Medicaid expansion under ACA may have benefited patients with cirrhosis.

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The Patient Protection and Affordable Care Act (ACA) came into effect in January 2014 and included a provision to expand Medicaid eligibility, requiring states to provide insurance coverage to adults with incomes up to 138% of the federal poverty line ($35,535 for a family of 4). States that did not comply with the requirements of the law risked losing federal Medicaid funds. A US Supreme Court ruling in 2012 rendered Medicaid expansion optional by deeming the threat by the federal government to terminate Medicaid funding for noncompliant states as unconstitutional. As a result, under the initial rollout, 14 states elected not to expand Medicaid. In the first year, ACA was implemented, and states that expanded Medicaid had a greater increase in insurance rates, an increase in the number of check-ups, and a decrease in the need to forgo physician visits among patients with chronic illnesses.[1] Adults aged 18-64 years with chronic diseases saw higher rates of coverage than those without chronic disease after ACA implementation, particularly in the states that expanded Medicaid.[2] Patients in community health centers reported increased numbers of preexisting conditions among those who gained coverage after ACA implementation, mostly among those who gained Medicaid coverage.[3]

This increase in coverage affected patients with chronic diseases, such as nondialysis-dependent kidney disease, with increases in pre-emptive listings for kidney transplantation and increased coverage for patients of racial and ethnic minorities.[4] A recent study found substantial association between Medicaid expansion and decrease in liver-related mortality.[5] However, patient characteristics associated with lower mortality and hospitalization outcomes were not addressed clearly in the study.

Approximately 4.5 million adults in the United States had a diagnosis of liver disease in 2018, with approximately 42,000 deaths attributed to the consequences of chronic liver disease or cirrhosis,[6] the 12th leading cause of death. Among patients with cirrhosis, 49.5% of deaths are related to alcohol,[7] followed by nonalcoholic fatty liver disease, which is related to obesity.[8] There are racial and ethnic differences in how alcohol[9] and obesity[10] affect minorities. The prevalence of cirrhosis is disproportionately higher among non-Hispanic Blacks, Mexican Americans, and those with low education levels or socioeconomic status.[11] Because there is a disproportionate negative impact of cirrhosis on racial minorities and those of low socioeconomic status, who traditionally have lower rates of health insurance, these populations may gain the most from Medicaid expansion. Because nationally, states that expanded Medicaid under ACA (expanded [E] states) generally had higher socioeconomic indices than states that did not expand Medicaid (nonexpanded [NE] states), to maintain socioeconomic balance, we studied only 3 pairs of E states with a neighboring NE state and obtained both pre- and post-ACA expansion data. Within this population, we evaluated the characteristics of hospitalizations and care utilization for cirrhosis-related hospitalizations. We also factored into the analysis the effect of increased availability of directly acting hepatitis C virus (HCV) antiviral treatment because the clearance of the virus may be associated with lower risks of complications of cirrhosis and, therefore, reduced hospitalization risk.[12]

METHODS

A patient cohort was identified using the State Inpatient Databases (SID), developed and maintained by the Healthcare Cost and Utilization Project through a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality.[13] The SID includes hospital admission and discharge information on all patients, regardless of the payer type. Western states, except Wyoming, all the Northeastern states, and most of the mid-Western states expanded Medicaid, whereas Texas and the Southeastern states did not. To maintain similar demographic characteristics and socioeconomic distribution, we only included E states that had a bordering NE state. Only 3 paired states met this criterion for inclusion: Arkansas (E)-Mississippi (NE), Colorado (E)-Kansas (NE), and Michigan (E)-Wisconsin (NE). Pre-expansion data were obtained for the years 2012 and 2013 using each SID. Because there was a variable interval between the adoption of ACA and its implementation (implementation was staggered in 2014 and 2015), we analyzed data from 2016 and 2017 for post-ACA implementation. This pairing provided 2-year pre-expansion and 2-year postexpansion data for comparison, with 1 exception: Mississippi was not a part of SID in 2012 and, thus, had only 1-year pre-expansion data for analysis. Index hospitalizations for cirrhosis were identified using International Classification of Diseases (ICD), Ninth Revision, and ICD, 10th Revision, codes (Supplemental Table 1, available online at http://www.mcpiqojournal.org). Because Wisconsin (an NE state) did not align completely with the other NE states because of more complicated eligibility criteria for Medicaid over the study time frame, we also performed a separate analysis excluding the Wisconsin-Michigan pair.

The patient characteristics and the details of index hospitalization gathered included age, sex, race, primary payer, median household income on the basis of the patient's postal code, indication for hospitalization, complications during hospitalization, and interventions performed (dialysis, ventilation, etc). Because of population differences between the states, we analyzed the admission rates per 100,000 population. The costs were determined using total charges submitted per hospitalization as provided by SID. We applied the cost-to-charge ratio to convert charges into costs adjusted for inflation. Readmission data up

TABLE 1. Patient Characteristics in Pre-Expanded and Postexpanded Medicaid Time Periods[a]

	Before expansion (2012-2013)			After expansion (2016-2017)		
	Expanded Medicaid					
Variable	Did not expand Medicaid (N=32,758)	Expanded Medicaid (N=68,757)	*P* value	Did not expand Medicaid (N=45,886)	Expanded Medicaid (N=80,948)	*P* value
Hospital state, n (%)			<.0001[b]			<.0001[b]
AR		10,145 (14.8)			12,031 (14.9)	
MS	4831 (14.7)			12,912 (28.1)		
CO		18,697 (27.2)			21,143 (26.1)	
KS	8545 (26.1)			10,905 (23.8)		
MI		39,915 (58.1)			47,774 (59.0)	
WI	19,382 (59.2)			22,069 (48.1)		
Payer (insurance), n (%)			<.0001[b]			<.0001[b]
Medicare	15,507 (47.4)	31,963 (46.5)		23,207 (50.7)	41,238 (51.0)	
Medicaid	5760 (17.6)	13,240 (19.3)		8809 (19.2)	20,948 (25.9)	
Private insurance	6981 (21.3)	15,889 (23.1)		9730 (21.2)	15,509 (19.2)	
Self-pay	3110 (9.5)	4031 (5.9)		2724 (5.9)	1001 (1.2)	
No charge	35 (0.1)	633 (0.9)		154 (0.3)	85 (0.1)	
Other	1308 (4.0)	2942 (4.3)		1182 (2.6)	2095 (2.6)	
Missing	57	59		80	72	
Income quartile, n (%)			<.0001[b]			<.0001[b]
First quartile	9628 (29.8)	25,860 (38.4)		17,488 (38.6)	31,018 (39.0)	
Second quartile	11,142 (34.5)	19,652 (29.1)		14,306 (31.5%)	21,748 (27.3)	
Third quartile	7756 (24.0)	14,296 (21.2)		9240 (20.4)	17,743 (22.3)	
Fourth quartile	3791 (11.7)	7620 (11.3)		4310 (9.5)	9037 (11.4)	
Missing	441	1329		542	1402	
Sex, n (%)			0.1596[b]			<.0001[b]
Male	19,411 (59.3)	41,063 (59.7)		27,270 (59.4)	47,038 (58.1)	
Female	13,345 (40.7)	27,693 (40.3)		18,606 (40.6)	33,873 (41.9)	
Missing	2	1		10	37	
Died in hospital, n (%)			0.0014[b]			0.6069[b]
Did not die in hospital	30,447 (92.9)	64,276 (93.5)		42,660 (93.0)	75,319 (93.0)	
Died in hospital	2311 (7.1)	4481 (6.5)		3226 (7.0)	5629 (7.0)	
Race, n (%)			<.0001[b]			<.0001[b]
White	25,109 (79.0)	45,580 (74.5)		35,142 (77.5)	59,695 (75.8)	
Black	3553 (11.2)	8520 (13.9)		6248 (13.8)	10,008 (12.7)	
Hispanic	1576 (5.0)	4293 (7.0)		2304 (5.1)	5838 (7.4)	
Asian or Pacific Islander	401 (1.3)	360 (0.6)		426 (0.9)	600 (0.8)	

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TABLE 1. Continued

Variable	Before expansion (2012-2013): Did not expand Medicaid (N=32,758)	Before expansion (2012-2013): Expanded Medicaid (N=68,757)	*P* value	After expansion (2016-2017): Did not expand Medicaid (N=45,886)	After expansion (2016-2017): Expanded Medicaid (N=80,948)	*P* value
Race, n (%), continued						
Native American	619 (1.9)	705 (1.2)		953 (2.1)	765 (1.0)	
Other	527 (1.7)	1739 (2.8)		277 (0.6)	1802 (2.3)	
Missing	973	7560		536	2240	
Admission type, n (%)			<.0001[b]			<.0001[b]
Emergency	18,953 (57.9)	49,775 (72.4)		28,877 (62.9)	60,105 (74.3)	
Urgent	9539 (29.1)	11,055 (16.1)		11,643 (25.4)	13,059 (16.1)	
From outpatient facility	4101 (12.5)	7448 (10.8)		5088 (11.1)	7124 (8.8)	
Trauma center	165 (0.5)	479 (0.7)		278 (0.6)	660 (0.8)	
Discharge disposition, n (%)			<.0001[b]			<.0001[b]
Discharged to home or self-care	18,668 (57.0)	37,510 (54.6)		24,849 (54.2)	40,077 (49.5)	
Transfer: short-term hospital	1316 (4.0)	2680 (3.9)		1755 (3.8)	3164 (3.9)	
Transfer: other type of facility	5951 (18.2)	12,210 (17.8)		8847 (19.3)	16,504 (20.4)	
Home health care	4007 (12.2)	10743 (15.6)		6415 (14.0)	13,969 (17.3)	
Against medical advice	505 (1.5)	1133 (1.6)		794 (1.7)	1605 (2.0)	
Died in hospital	2311 (7.1)	4481 (6.5)		3226 (7.0)	5629 (7.0)	
			<.0001[c]			<.0001[c]
Mean (SD)	6.3 (8.14)	6.5 (7.70)		6.3 (8.09)	6.3 (6.81)	
Median (IQR)	4.0 (2.0-7.0)	4.0 (2.0-8.0)		4.0 (2.0-7.0)	4.0 (3.0-8.0)	
n (Missing)	32,758 (0)	68,756 (1)		45,886 (0)	80,947 (1)	
Age			0.4453[c]			0.0257[c]
Mean (SD)	58.8 (12.35)	58.8 (12.48)		59.8 (12.65)	59.9 (12.79)	
Median (IQR)	58 (51-66)	58 (51-66)		60 (52-68)	60 (52-68)	
n (Missing)	32,758 (0)	68,757 (0)		45,886 (0)	80,948 (0)	

[a]AR, Arkansas; CO, Colorado; IQR, interquartile range; KS, Kansas; MI, Michigan; MS, Mississippi; SD, standard deviation; WI, Wisconsin.
[b]Chi-square *P* value.
[c]Kruskal-Wallis *P* value.

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TABLE 2. Risk Ratios of Difference-in-Difference Analysis of In-hospital Complications, Interventions, and Hospital Outcomes: Multivariable Analysis: After Expansion vs Before Expansion[a,b]

	Relative risk ratio	95% confidence interval	*P* value
Complication			
Shock: septic, cardiogenic, other	0.99	0.91-1.07	.7228
Severe sepsis	0.88	0.81-0.97	.0084
Cardiopulmonary arrest	0.99	0.83-1.17	.8830
Kidney failure	1.04	0.99-1.08	.0837
Hepatic coma	0.76	0.67-0.86	<.0001
Intervention			
Mechanical ventilation	1.04	0.98-1.10	.2092
Arterial line	1.53	1.20-1.94	.0005
Vasopressor use	0.87	0.74-1.02	.0944
Pulmonary artery/wedge pressure	0.66	0.42-1.06	.0834
Hemodialysis	0.88	0.82-0.95	.0014
Outcome			
Died in hospital[c]	1.10	1.02-1.18	.0086
Emergency admission type[d]	1.03	0.97-1.09	.42
Urgent admission type[d]	1.21	1.13-1.29	<.0001
Trauma center admission type[d]	1.01	0.80-1.28	.94
Discharge disposition: died in hospital[e]	1.15	1.06-1.23	.0003
Discharge disposition: transfer: short-term hospital[e]	1.09	0.99-1.20	.08
Discharge disposition: transfer: other type of facility[e]	1.12	1.07-1.18	<.0001
Discharge disposition : home health care[e]	1.02	0.97-1.08	.43
Discharge disposition: against medical advice[e]	1.12	0.98-1.30	.11

[a]Reference is nonexpanded states.
[b]Data adjusted for location, payer type, race, sex, and age.
[c]Reference: Did not die in hospital.
[d]Reference: Admission via outpatient facility.
[e]Reference: Discharged to home or self-care.

to 1 year were captured, including the interval between index hospital dismissal and readmission.

The reasons for index hospitalization included variceal bleeding, hepatic encephalopathy (hepatic coma), spontaneous bacterial peritonitis and other infections, ascites, and hepatorenal syndrome among others and were identified using the ICD-9 and ICD-10 codes (Supplemental Table 1). Aggregate data were analyzed using the difference-in-difference analysis, which was performed to compare the pre- and post-ACA data between the E and NE states. The NE states and the pre-expansion period served as reference categories for the comparison. We evaluated complications during hospitalization and the need for intervention, such as dialysis and ventilation, as disease severity markers and the prevalence of sepsis and hepatic coma as quality-of-care markers. Event outcomes were analyzed on the basis of relative risk using logistic regressions modeling of the occurrence of each outcome independently. These models were adjusted for location, payer type, race, sex, and age. These analyses treated the classification of E and NE states and the pre-expansion vs postexpansion data as indicator variables. Additionally, these analyses used an interaction term to identify E states in the post-expansion period. We implemented log-linked, generalized linear models with gamma distribution for analyzing costs and length of stay (LOS), with bootstrapped standard errors, repeated 200 times. Not all states include the necessary identifiers to link multiple hospitalizations to unique patients. For this reason, readmission data were identifiable only for Mississippi and Wisconsin (NE states) as well as Arkansas (E state).

RESULTS

Overall Admission Demographics and Insurance Coverage

There were 228,349 admissions, 149,705 in the E states (n=68,757 before ACA; n=80,948 after ACA) and 78,644 in the NE states (n=32,758 before ACA; n=45,886 after ACA). The descriptive details of patient demographics are provided in Table 1. A review of census data reported that the poverty rates and race or ethnicity in the paired states were overall similar (Supplemental Table 2, available online at http://www.mcpiqojournal.org). Regarding race distribution, the E states had a smaller percentage of White patients (74.5% vs 79% before ACA implementation; 75.8% vs 77.5% after ACA implementation) and a larger percentage of Hispanic patients than the NE states (7.0% vs 5.0% before ACA implementation; 7.4 vs 5.1% after ACA implementation).

In the pre-expansion period, primary payer distribution reported that more patients in the E states had private insurance (23.1% vs 21.3%) and that fewer were self-pay (5.9% vs 9.5%). After expansion, the E states had an increase in the percentage of patients using Medicaid (from 19.3% before ACA implementation to 25.9% after ACA implementation) and a decline in self-pay patients (5.9% before ACA implementation to 1.2% after ACA implementation). In contrast, the NE states saw a smaller increase in Medicaid use (17.6% before ACA implementation to 19.2% after ACA implementation [Table 1]). Patients hospitalized in the E states were more likely to be insured by Medicaid and less likely to be insured by private insurance, self-pay, have no charge, or be covered by other insurance. The paired states of Mississippi and Arkansas had restricted access to HCV antiviral treatment before and after expansion; both Colorado and Kansas had lenient access, whereas the NE state of Wisconsin had more access to HCV treatment after expansion.

Because there were no data from 2012 available for Mississippi, we compared the change in admissions between 2013 and 2016. The E states had lower rates of increase in admissions per 100,000 population (192.4 in 2013 to 215.3 in 2016) than the NE states (164.8 in 2013 to 190.2 in 2016). This change in admissions per 100,000 was significant, with 22.9 in the E states vs 25.5 in the NE states (P=.0049). After expansion, admissions were more likely to be urgent than from an outpatient facility in the E states (relative risk [RR], 1.21; 95% confidence interval [CI], 1.133-1.295; P<.0001), after adjusting for sex, race, income, and payer type (Table 2). The admission data for the individual paired states were comparable with pooled data and are summarized in Supplemental Tables 3 and 4 (available online at http://www.mcpiqojournal.org).

Complications and Interventions

The RR ratios of complications and interventions are provided in Table 2. The E states had lower rates of severe sepsis (RR, 0.884; 95% CI, 0.806-0.969; P=.0084) and hepatic coma (RR, 0.763; 95% CI, 0.673-0.865; P<.001) than the NE states. The interventions, including ventilation, invasive monitoring, and pressor use, were similar between the E and NE states, except for lower rates of hemodialysis (RR, 0.884; 95% CI, 0.82-0.954; P=.0014) and increased use of arterial lines (RR, 1.53; 95% CI, 1.2-1.94; P=.0005) in the E states.

In-hospital Mortality

The observed, unadjusted in-hospital mortality percentage was 7.1% in the NE states and 6.5% in the E states before ACA implementation (P=.0014) and 7.0% in both the E and NE states after ACA implementation (P=.6069).

LOS and Cost of Index Admission

In the E states, there was a reduction in LOS by 0.21 days (95% CI, 0.1-0.33 days; P<.001) and a reduction of $587.40 in the cost per hospitalization (95% CI, $240.30-$934.49; P=.001) compared with those in the NE states (Table 3).

Discharge Destination

The discharge destinations analyzed included home or self-care (reference) or transfer to a short-term hospital or other facilities (Table 2). After ACA implementation, patients in the E states were more likely to die in the hospital than to get discharged for home or

TABLE 3. Difference-in-Difference Analysis of Payer Mix, Length of Stay, and Cost of Index Hospitalization[a,b]

	Relative risk ratio	95% confidence interval	*P* value
Payer mix[c]			
Medicaid	1.23	1.16-1.30	<.0001
Private insurance	0.75	0.72-0.79	<.0001
Self-pay	0.32	0.29-0.35	<.0001
No charge	0.032	0.02-0.05	<.0001
Other	0.83	0.74-0.92	.0004
	Difference (d)	95% confidence interval	*P* value
Length of stay			
Difference in difference[d]	−0.21	−0.33 to −0.1	.00028
	Difference (d)	95% confidence interval	*P* value
Outcome			
Difference in difference[d]	−587.40	−934.49 to −240.3	.00091

[a]Reference is nonexpanded states.
[b]Data adjusted for location, payer type, race, sex, and age.
[c]Reference: Medicare.
[d]Reference: Before expansion, nonexpanded.

self-care (RR, 1.15; 95% CI, 1.04-1.27; *P*=.0085) and were more likely to be discharged to another, nonhospital facility than patients in the NE states (RR, 1.12; 95% CI, 1.07-1.18; *P*<.0001). There was no difference in the numbers of patients who underwent liver transplantation.

Readmissions

Before ACA implementation, 57.8% of patients in the E states and 37.0% in the NE states were readmitted within 1 year. The rate of increase in readmissions was lower after ACA implementation in the E states than in the NE states (Table 4). After expansion, the 1-year readmission rate increased to 62.4% in the E states (8% relative increase, unadjusted) compared with 59.2% in the NE states (60% relative increase, unadjusted). A lower readmission risk was also seen at 30, 60, and 90 days: there was a decrease in the percentage of readmissions in the E states, whereas the percentage of readmissions increased in the NE states evaluated. The cost of each readmission was higher in the E states (Table 4).

Results Excluding Wisconsin-Michigan pair

When the Wisconsin-Michigan pair was excluded, quality indicators, such as the rate of admission increase, costs, and readmissions, continued to be more favorable in the E states. The following results changed: LOS, dying in a hospital, and arterial line use were no longer relevant, but kidney failure, mechanical ventilation, and hepatic coma became statistically relevant (Supplemental Tables 5 and 6 [available online at http://www.mcpiqojournal.org]).

DISCUSSION

This study found that among patients hospitalized for complications of cirrhosis, the rate of increase in admissions; quality-of-care indicators, such as lower rates of sepsis and hepatic coma; cost; LOS; and access to out-of-hospital facilities were more favorable in the states that expanded Medicaid under ACA than in the states that did not expand Medicaid. Decreasing hospital readmissions and improving hepatic encephalopathy-related symptoms (categorized as hepatic coma in SID) are considered to be among the most important quality measures to be achieved in patients with cirrhosis by the American Association for the Study of Liver Diseases Practice Metrics Committee.[14] The rate of severe sepsis, another quality measure, was also lower in the E states. Thus, on the basis of this study and the previous study, which reported lower mortality,[5] patients with cirrhosis may have benefited from ACA, which is associated with increased insurance coverage provided by the

TABLE 4. Readmissions: Descriptive Outcomes and Difference-in-Difference Analysis of Readmissions[a]

	Before expansion (2012-2013), n (%)[b]	After expansion (2016-2017), n (%)[b]
Total readmissions		
NE	8317 (37.0)	19,259 (59.2)
E	5482 (57.8)	6984 (62.4)
Readmissions by state		
AR (E)	5482 (57.8)	6984 (62.4)
MS (NE)	2879 (64.1)	7537 (62.8)
WI (NE)	5438 (30.2)	11,722 (57.1)
Readmitted within 30 d		
NE	1886 (8.4)	4472 (13.7)
E	1352 (14.3)	803 (7.2)
Readmitted within 60 d		
NE	2347 (10.4)	5538 (17.0)
E	1662 (17.5)	927 (8.3)
Readmitted within 90 d		
NE	2466 (11.0)	6011 (18.5)
E	1847 (19.5)	957 (8.6)

Difference-in-difference of readmission cost

	Cost, $	95% CI, $	*P* value
Readmission, d			
30	4267.90	1064.1-7471.8	.009
60	5185.39	1814.8-8556.0	.0026
90	6859.15	3504.8-10,213.5	.000061
Index hospitalization with readmission, d			
30	5515.89	1962.3-9069.45	.0023
60	5073.55	2259.65-7887.4	.00041
90	5188.89	2340.1-8037.7	.00036

[a]AR, Arkansas; CI, confidence interval; E, expanded; MS, Mississippi; NE, not expanded; WI, Wisconsin.
[b]Percentage of discharges.

expansion of Medicaid. This benefit is not attributable to increased access to HCV antiviral treatment because access to pre- and post-Medicaid expansion was similar in the pairs Mississippi -Arkansas and Colorado-Kansas but higher in Wisconsin (NE state) than in Michigan (E state). In addition, the exclusion of the Wisconsin-Michigan pair from the analysis altered some conclusions reached by the analyses of all 3 paired states, but the quality indicators, such as the rates of admission increase, costs, and readmissions, continued to be more favorable in the E states than in the NE states.

The major goals of ACA were to improve the quality of care and decrease costs, with the cumulative reduction in costs in the 10 years after establishment estimated to be $667 billion.[15] In support, the Medicare spending from 2010 to 2018 increased by only 4%, less than half the rate of increase from 2000 to 2010. However, it is unclear whether the overall hospital readmissions, an important benchmark of the quality of care, decreased. Previous studies have suggested a reduction in readmission risk even before the establishment of ACA, more likely related to changes in risk classification rather than actual readmissions.[16] After the implementation of the Hospital Readmissions Reduction Program under ACA, readmissions for congestive heart failure, pneumonia, and myocardial infarction may have decreased, but the readmission rates seemed unchanged among patients with cirrhosis.[17] In this study, we addressed current gaps in knowledge related to cirrhosis and ACA. In our study, the states that did not expand Medicaid provided a control group to analyze the impact of ACA. Because the E states nationally were generally in proximity with and geographically distant from the NE states, by design, we did not pool national data with those of the E and NE states. Doing so might have resulted in comparisons that would not be balanced for race and socioeconomic distributions. Therefore, we only targeted states that expanded Medicaid under ACA that had a bordering state that did not expand Medicaid to study hospitalization outcomes in patients with cirrhosis.

The specific quality indicators for patients with cirrhosis include the reduction of hospitalizations, a decrease in infections, improvement in the quality of life related to hepatic encephalopathy, and the prevention of readmissions. The general quality indicators in hospitalized patients, besides reducing infections, include the utilization of procedures, mortality, and resources available on dismissal.[18] Therefore, the lower rate of increase in hospitalizations, lower rates of severe sepsis and hepatic encephalopathy, shorter hospitalization with reduced costs, and increased access to out-of-hospital health care facilities that were seen in the E states favorably support ACA. The specific indication for hospitalization could not be compared directly with the study population because of multiple diagnoses at admission. However, the lower rate of severe sepsis and hepatic encephalopathy in patients hospitalized in the E states suggests better preventive care in these states for patients with cirrhosis. This may also be reflected in the increase in "urgent" vs "from outpatient facility" admissions in the E states, suggesting that the admissions that occurred were nonpreventable. A lower rate of admissions for the other complications of cirrhosis, including ascites and variceal bleeding, could not be reported. In addition, the increased access to out-of-hospital care after discharge from the hospital available in the E states allows smoother transition of care. The social benefits of such access are not measurable but are likely to help the family of the patient and prevent readmissions. The slightly increased in-hospital death rate in the E states after ACA implementation is difficult to explain but may reflect the availability of terminal care, which allows patients to stay on in the hospital rather than encouraging them to leave.

Several studies have suggested that the readmission rate after discharge from the hospital in patients with cirrhosis is more than 30% at 30 days[19] and approximately 60% at 1 year.[20] The approximately 60% readmission rate at 1 year in at-risk patients in our study mirrors published figures. The 1-year outcome after the first hospitalization in patients with cirrhosis is dismal. Of patients never readmitted (40% of those initially admitted) and still alive at 1 year, only approximately one half (or 20% of the initial cohort) were functioning at home by the end of that year, whereas the remaining were in skilled nursing facilities, rehabilitation centers, hospice care, or nursing homes.[20] In the current study, hospital readmissions were favorably affected by ACA. Before ACA implementation, the annual readmission rate in the E states was 57.8% compared with 37.0% in the NE states; after ACA implementation, the readmission rate was only marginally increased in the E states compared with a major increase in the NE states (8% in E states compared with 60% in NE states; relative increase, unadjusted). The major causes of hospital readmissions in patients with cirrhosis are infections and hepatic encephalopathy. The increased rate of readmissions in the NE states may be accounted for by an increase in preventable readmissions due to reduced access to out-of-hospital care. The lower rates of readmissions at the earlier time points of 30, 60, and 90 days in the E states compared with those in the NE states may reflect better access to care. Because readmission data were available in only 3 states, conclusions regarding readmissions are likely to be less robust. There was a higher rate of discharge to other facilities as well as a nonsignificant increase in the rate of discharge to short-term hospitals or home health care after initial hospitalization in the E states after ACA implementation, improving postdischarge care; this is the most likely explanation for the considerable decrease in readmissions. We acknowledge that the exact reason for the difference in the readmission rates, including the effect of outpatient interventions, such as weight loss and decreasing the use of alcohol, cannot be determined from this data set. Regardless, reducing readmissions is important beyond economic considerations because readmissions create negative consequences for the patient and their family.

The postindex hospitalization annual costs in patients with cirrhosis have been nationally estimated to be more than $4.45 billion. The costs for individual patients readmitted at 30 days are substantially higher ($73,252) than those readmitted after 30 days ($62,053) or those not readmitted ($5719).[20] Reducing readmissions would, therefore, reduce costs considerably. Our study found that the increase in the readmission rate was much smaller after the implementation of ACA in the states that expanded Medicaid than in those that did not, which could result in considerable cost savings nationally. However, the cost of each individual readmission was higher in the E states. We speculate that readmissions that are not preventable are more likely related to the progression of the severity of liver disease, less reversible, and associated with a longer length of hospitalization and increased costs. Better access to care will reduce preventable readmissions, resulting in a higher proportion of readmissions that cannot be prevented, with associated higher costs. Longer-term follow-up may be necessary to determine the actual cost-saving impact of these differences in readmission metrics.

Several weaknesses in the study need to be acknowledged. First, because this study focused only on patients hospitalized for cirrhosis in a limited number of states, the overall reduction in out-of-hospital mortality nationally under ACA could not be ascertained. In other disciplines, Medicaid expansion has been associated nationally with reductions in 1-year mortality from cardiovascular[21] and end-stage renal disease,[22] with an estimated 15,600 avoidable deaths in states that did not expand Medicaid.[23] Second, markers of the severity of liver disease, such as the Model of End-stage Liver Disease score,[24] which is an important risk factor for the need for hospitalization, readmission[19] and in-hospital mortality could not be ascertained from SID. Third, readmissions may not be captured if they occur in another state, and readmission data were only available in 1 E state, Arkansas. The conclusions regarding readmissions may, consequently, not be applicable nationally. Fourth, although the paired states were contiguous, the median incomes were somewhat higher in the states that expanded Medicaid than in those that did not expand Medicaid, although the poverty rates were similar. Fifth, the eligibility criteria for Medicaid in the NE states were not uniform, and therefore, potential Medicaid expansion under ACA in some states may be associated with greater benefits than in others. Finally, there are multiple factors, including social factors affecting readmissions, that cannot be determined from such databases.

CONCLUSIONS

Among patients hospitalized for complications of cirrhosis, the quality indicators, such as lower rates of admissions; sepsis and hepatic coma; cost, LOS, access to out-of-hospital health care facilities; and readmissions, were more favorable in the states that expanded Medicaid under ACA than in those that did not, supporting the benefit of Medicaid expansion.

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POTENTIAL COMPETING INTERESTS

Dr Borah is a consultant to Exact Sciences Corporation and Boehringer Ingelheim Corp USA on unrelated projects.

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SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mcpiqojournal.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: **ACA,** Affordable Care Act; **E,** expanded; **HCV,** hepatitis C virus; **ICD,** International Classification of Diseases; **LOS,** length of stay; **NE,** nonexpanded; **RR,** relative risk; **SID,** State Inpatient Databases

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