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THE ROLE OF EMERGENCY DEPARTMENT PHYSICIAN STAFFING MODEL ON ACUTE MYOCARDIAL INFARCTION

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Abstract :- Since the introduction and passage of the Affordable Care Act (ACA), it has been clear that value-based service, without compromising quality or patient safety, will be necessary.Providing a value based service in the emergency department of a critical access hospital is in part dependent upon the physician staffing model. Although the literature is rich with information about many of the study key areas, very little was discovered that describes healthcare delivery service innovation, particularly as it relates to emergency department physician staffing models in a critical access hospital. This study utilized quantitative research methods, descriptive and an inferential statistical approach to investigate the performance of emergency department physician staffing models on acute myocardial infarction/chest pain outpatient core measures. The emergency department patient visit volume was less than 10,000 per year and three (3) different physician staffing models were evaluated over a five (5) year period; 2013 – 2018. The outpatient core measures for acute myocardial infarction/chest pain, that was analyzed was aspirin administration within 24 hours of admission and was an electrocardiogram done within 10 minutes of admission.

The research study discovered that there is a significant association between the emergency department physician staffing model and core measure performance for patients presenting with symptoms of an acute myocardial infarction/chest pain. Specifically, the board certified emergency medicine physician staffing model (B) and board certified primary care physician staffing model (C) outperformed the mixed specialty physician staffing model (A).This study highlighted the similarity in performance between different emergency department staffing models in a critical access hospital, as viewed by board certification and treating acute myocardial infarction/chest pain. Being able to determine that patients presenting with an acute myocardial infarction/chest pain are not compromised by changes within emergency department physician staffing composition is important when a decision to use an alternative staffing model is made by administrators.

Keywords: Acute myocardial infarction/chest pain, emergency department physician staffing model, core measure performance

1. Introduction

Most healthcare providers and patients acknowledge hospital quality of care as a fundamental component of an exceptionally performing healthcare system. As a consequence, quantifying and continuously enhancing healthcare quality is an increasingly crucial mission of most healthcare providers. For that reason, an uncompromising improvement in every segment of healthcare is very important to researchers, healthcare providers and patients in the U.S and around the globe. This study, along with other studies, target improvements in healthcare by providing evidence that can be used to influence policy makers who can alter regulations that positively impact cost, quality and access.

In the hospital setting, there have been numerous deliberations about how high quality can be defined best. According to Lohr, quality of care is defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (Lohr, 1990). Desirable health outcomes are further described by measuring clinical

indicators, which provide insight about performance (Mainz, 2003). Clinical indicators represent agreed upon standards of care that are often grounded in research and referred to as evidenced based practices (Mainz, 2003). Among clinical indicators of quality are those related to structure, process and outcome; these are the types of indicators used in thisstudy.

It is important to note that there is a significant difference between small rural and large urban hospitals in terms of resources, volume, staffing, finances, and so on. Therefore the outcome data generated from patient safety initiative studies conducted in larger urban hospitals should not be generalized to Critical Access Hospital's (CAH) (Casey, Wakefield, Coburn,Moscovice&Loux, 2006), which are at higher risk due to limited resources and vulnerable population (Joynt, Orav&Jha, 2013). However, healthcare safety initiatives are often developed from the studies undertaken by large urban hospitals and thereafter, generalized to small rural hospitals, despite the organizational delivery differences (Klingner, Moscovice, Tupper, Coburn & Wakefield, 2009). The small rural hospitals characteristics differ substantially from urban hospitals and therefore must be taken into consideration when generating strategies to improve quality of care.

Statement of Problem

The problem is that we need to ensure that quality care is delivered to patients presenting to an ED in a CAH. CAH's often have fewer resources, both human and financial, and therefore must be efficient while not compromising care. Therefore we must know if the CAH ED physician staffing model affects clinical quality indicators, in this study that indicator were AMI/CP.The purpose of this study is to determine if there is any significant difference in clinical outcomes under three different ED physician staffing models. Therefore the research question is: Does the ED physician staffing model effect core measure performance when treating AMI/CP?

METHODOLOGY

This non-experimental case study used data from a CAH to compare quality indicators under three staffing models. The data was extracted from approximately 30,000 medical records during 2013-2018. CMU IRB approval was determined to not be needed due to a lack of human subject involvement.

This study followed Donabedian's Structure-Process-Outcome model (Donabedian, 1980) as a useful tool for healthcare providers seeking to improve the overall quality of care for patients through structure and improved processes. The Donabedian Model is commonly used by healthcare researchers in hospitals (Kobayashi, Takemura& Kanda, 2010; Lilford, Mohammed, Spiegelhalter& Thomson, 2004), long-term care (Spector & Takada 1991), primary care (Kringos, et al, 2010) and other areas (Callaghan, Eales, Coates & Bowers, 2003). There does not appear to be any evidence of Donabedian's model being used to study quality in the CAH environment. Figure 1 represents overall Donabedian model and application of the model to this study.

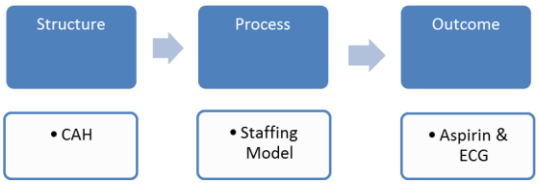

Figure 1. Conceptual Framework of the study, Based on Donabedian SPO Framework (Donabedian, 1980)

If a consumer is going to benefit from a positive health outcome, the consumer must be able to utilize the healthcare services in a timely manner, have a way to get to a healthcare location where needed services are provided, and have access to a trusted healthcare provider. Consumer disparities related to healthcare service access and cost significantly impacts some populations, which directly affects quality of life and that population's ability to realize its full potential.

Healthcare quality and safety improvements are absolutely critical to the viability of hospitals serving rural communities. Critical Access Hospitals (CAH) have

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unique characteristics that are not always taken into consideration by national hospital patient safety initiatives. Consequently, most of the patient safety standards are generally stemming from studies that are conducted in large urban hospitals. This study focused only on the CAH environment, specifically the ED physician staffing model, and how the models impact improvements in efficiency and quality of care for rural populations, which further indicates why this is an important study forpatients.

If the quality of care delivered in the ED to those patients presenting with AMI/CP is not compromised by the physician staffing model, then hospital executives may have alternatives to consider when staffing their ED. In this case, the researcher was interested in whether or not the primary care ED physician staffing model compromises the quality of core measures, because these physicians are easier to recruit and can fulfill an additional task, that being a hospitalist role. Therefore, this study may present significant results for health care administrators of small rural facilities.

Studies exploring the quality of care delivered in rural hospitals are limited, by extension this would include CAH's (Baernholdt, Jennings & Lewis, 2013). There are however some studies that evaluate mortality rates in CAH facilities as compared to non-CAH facilities, the conclusion indicates that outcomes were worse in the CAH facilities during the period of 2002 – 2010 (Joynt, Orav&Jha, 2013). Given the conclusions drawn by Joynt, et al it is important to conduct health services research as a study on small rural CAH facilities.

RESULTS

The purpose of the study was to gain knowledge about the association between ED physician staffing models and the management of patients presenting to the ED with symptoms of an AMI/CP. This study utilized secondary data collected in McKenzie Health System's EMR. As indicated earlier in the study, the data represents a period of 5 years beginning January 1st, 2013 and ending December 31st, 2012. Accordingly, the emergency department physician staffing Model A represents the period of time from January 1, 2013 to August 20, 2014; emergency department physician staffing Model B represents the period of time from August 21, 2014 to April 10, 2015 and emergency department physician staffing Model C represents the period of time from April 11, 2015 to December 31, 2018.

Overall, the percentage of correctly predicted outcomes (both aspirin administration and ECG) was around 4%; all improvement techniques did not change this percentage significantly.Given that an adequate logistic regression model would normally produce at least 60% of outcomes correctly predicted, the researched had to change the analytic methods. The study utilizedtheodds ratio (OR) test that does predict core measure performance by delivery model. The research is not aiming to find out the predicted value of the responding variable rather it is interested in determining the probability of a predictor variable being in a certain category ofthe responding variable. Thus, the researcher is interested in finding out the association, if any, between ED physician staffing models and the core measure management of patients presenting to the ED with symptoms of anAMI/CP.

Table 1 displays the number of cases which occurred under each staffing model, including absolute frequency and percentage. Patient records collected under Model C represented 45.4% of the total sample, which is slightly higher than a proportion of time in days under that model (34.5%). The researcher did not attempt to manipulate the data to reach equal representation of the three models; however, it is possible that the difference is related to overall demographic changes in Michigan. According to Michigan Department of Community Health percentage of people over 65 years old increased from 12.91% in 2007 to 14.6% in 2012, which is also reflected in more than 150,000 people (MDCH, 2012). Although the population served by CAH is limited by geographic area and the relationship between aging population andnumber of AMI/CP patients is not necessary linear, this trend may serve as a possible explanation for higher number of ED patients in the latest model. On the other hand, average age of patients was lower under the model3.

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Table 1. Number and Percentage of Observation under each Model

	Frequency	Percent
Model A	262	18.7
Model B	501	35.9
Model C	635	45.4
Total	1398	100.0

Table 2. Descriptive Statistics for Sample Characteristics under Difference Models of Emergency Department Physician Staffing

	Model A		Model B		Model C	
Average age of patients, years (st.dev)	55.87 (18.371)		55.81 (17.738)		54.59 (18.445)	
Minimum	20		19		20	
Maximum	93		97		101	
Total number of patients	262		501		635	
Model A, B & C Comparison						
Variables	Model A		Model B		Model C	
	#	%	#	%	#	%
Gender						
Males	131	50.0	221	44.1	315	49.6
Females	131	50.0	280	55.9	320	50.4
Insurance						
Medicare	114	43.5	216	43.0	235	37.0
BCBS	63	24.0	80	16.0	114	18.0
Medicaid	35	13.4	87	17.4	156	24.6
Other Insurance	50	19.1	118	23.6	130	20.4

One of common assumptions about AMI/CP is age distribution of the patients; therefore it was important to compare mean age of patients under each model to rule out a possibility of age being a factor in the outcome. The researcher conducted a one-way ANOVA in order to compare the means of the age groups among the emergency department physician staffing models for the purpose of determining if aspirin was administered or an EKG was done in the allotted time for patients presenting to the ED with symptoms of an AMI/CP. As reflected in Table 3 below, there were no statistically significant differences in age among the emergency department physician staffing models ($F(2,1395) = 0.8$, $p=0.449$).

Table 3. Monthly Proportion of Positive Outcome Variable for Patients presented in Emergency Room

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
ASA_Percent	60	13%	72%	43.5%	.13754
ECG Percent	60	17%	81%	55.6%	.12778
Valid N (listwise)	60				

While the average percentage of Aspirin administration during the study period was 43.5%, the research question is focused on possible differences of the rates between the three staffing models employed during the study period. Table 4 below presents a description of both rates (aspirin and ECG) under three staffing models.

Table 4. Monthly Proportion of Positive Outcome Variable by Model

	Model A	Model B	Model C
Aspirin rate, months	20	20	20
mean (sd)	34.5% (.11763)	49.0% (.14718)	47.0% (.10101)
Min	13%	17%	30%
Max	57%	72%	65%
ECG rate, months	20	20	20
mean (sd)	49.0% (.13384)	59.0% (.13227)	59.3% (.08644)
Min	17%	33%	43%
Max	71%	79%	81%

An analysis of variance was performed again in order to compare the means of the groups as indicated in Table 5 below. The F statistic of the ANOVA test ($F2, 57 = 8.134$, p-value<0.01) allowed the researcher to state that a difference in the mean aspirin rates among the three models was statistically significant. The F statistic of the ANOVA test ($F2, 57 = 5.198$, p-value<0.05) allowed the researcher to state that a difference in the mean ECG rates among the three models was statistically significant as well.For further data analysis, the researcher performed a post-hoc test referred to as Tukey's Honest Significant Differences (HSD) after an analysis of variance test (ANOVA) was conducted and produced statistically significant result. Since the researcher was interested in determining actual differences in groups performance, further analysis of data needed to determine which groups differ. Consequently, Tukey's HSD test was conducted in order to delineate which groups among the sample show significant variation. As shown in Table 5 below, when the percentage of patients who received aspirin and had an ECG done is calculated by month there is a difference between models 1 and 2, and 1 and 3 however, there is no significant or statistical difference between models 2 and 3.

Table 5. Groups Means Comparison (ANOVA)

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
asp_percent	Between Groups	.248	2	.124	8.134	.001
	Within Groups	.868	57	.015		
	Total	1.116	59			
ecg_percent	Between Groups	.149	2	.074	5.198	.008
	Within Groups	.815	57	.014		
	Total	.963	59			

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Table 6 Tukey Honest Significant Differences Test

Multiple Comparisons							
Turkey HSD							
Dependent Variable	(I) Models ABC	(J) Models ABC	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
asp_percent	A	B	-.14514*	.03903	.001	-.2391	-.0512
		C	-.12538*	.03903	.006	-.2193	-.0315
	B	A	.14514*	.03903	.001	.0512	.2391
		C	.01975	.03903	.869	-.0742	.1137
	C	A	.12538*	.03903	.006	.0315	.2193
		B	-.01975	.03903	.869	-.1137	.0742

Table 7. Tukey HSD Test

Multiple Comparisons							
Tukey HSD							
ecg_percent	A	B	-.10415*	.03781	.021	-.1951	-.0132
		C	-.10694*	.03781	.017	-.1979	-.0160
	B	A	.10415*	.03781	.021	.0132	.1951
		C	-.00279	.03781	.997	-.0938	.0882
	C	A	.10694*	.03781	.017	.0160	.1979
		B	.00279	.03781	.997	-.0882	.0938

Note: *The mean difference is significant at the 0.05 level.

The proportion chart below, Figure 2 Control Chart N-BREAK, demonstrates the fraction nonconforming of a different sample size in a given perpetual area of each period observed.

Because of the sample variation, the control limits were calculated for each time period. The limit lines on the control charts show dispersal of data – outliers or data that fell outside the control lines between 2014 and 2015. The observed change is aligned with Model A ending and Model B beginning and may be reflective of AMI/CP cases not being diagnosed during the model A period.

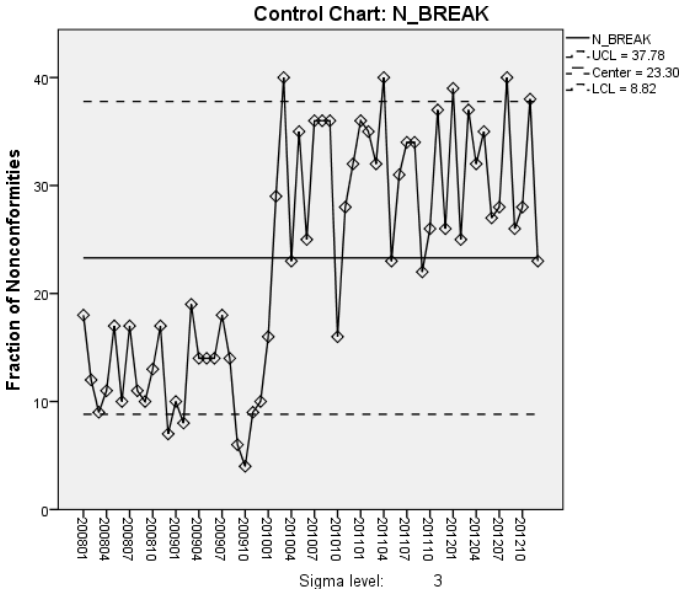

Figure 2. Depiction of Variation Control Chart for the Fraction of Nonconforming Units

As illustrated the appropriate statistical tests were employed to evaluate the significant difference, if any, in completing the two-outpatient core-measures for AMI/CP. The researcher was interested in determining if there is an association between the ED physician staffing models and the management of patients presenting to the ED with symptoms of an AMI/CP, therefore the statistical outcomes were compared and contrasted. The researcher performed Frequency Analysis for the initial examination of the data set. Descriptive statistics were utilized to demonstrate the essential characteristics of the data and provide clarity about the similarities of sample populations included in the study. A one-way ANOVA was conducted for the purposes of comparing the means of the age groups among the emergency departmentphysician staffing models to determine if aspirin was administered or an EKG was done in the allotted time for patients presenting to the ED with symptoms of an AMI/CP. The differences in age among the emergency department physician staffing models was not statistically significant $F(2,1395) = 0.8$, $p=0.449$.

Additionally, the chi-square test was performed to establish significance between the sample proportions, the proportion results of BCBS, as well as other binary variables between the models were examined, the analytical outcomes were compared accordingly in order to accept or reject the null hypothesis. In order to check for a difference, or lack thereof in proportion for all variables, the researcher employed a Kruskal-Wallis statistical test.Consequently, the outcomes of the distribution of BCBS was different between all models (p =indicating a statistical significance.

Subsequent to the analysis of variance test, the researcher performed a Tukey's Honest Significant Differences post-hoc test for further data analysis. The ANOVA test outcomes indicated that there were variations among the groups and because one of the assumptions for using Tukey's HSD is that there is independence within and among the groups, the Tukey's HSD test could be used to reveal which groups had significant variation (Brillinger, 1984). The Tukey's test results, when the percentage of patients who received aspirin and had an ECG done calculated by month, recorded a difference between models A and B, and A and C but not a significant or statistical difference between models B and C. The researcher also

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compared the group means by performing the ANOVA test again and the difference in the mean aspirin rates among the three models was statistically significant ($F_{2, 57} = 8.134$, p-value<0.01). In addition the difference in the mean ECG rates among the three models was statistically significant as well ($F_{2, 57} = 5.198$,p-value<0.05).

In summary, this study supports the association between ED physician staffing models and the management of patients presenting to the ED with symptoms of an AMI/CP. The study utilized secondary data located in McKenzie Health System's EMR. Statistical tests such as Logistic Regression, Chi-square, ANOVA, Independent Sample Kurskal Wallis test and Tukey's Honest Significant Differences were conducted to compare the analytical outcomes in order to accept or reject the null hypothesis.

DISCUSSION

Insurance companies, consumers and providers of healthcare are becoming increasingly interested in meeting quality expectations. Quality measures are being reported and when minimum standards are not achieved, payment is decreased. Consumers are able to view quality performance more easily than ever before and compare how their local hospital and provider is doing. This level of transparency on quality performance may become an important aspect of consumer decisions about where to seek healthcare in the near future. Rural populations are no different when it comes to providing quality care, however, achieving quality scores that are competitive can sometimes be challenging.

This research study examined the relationship between emergency department physician staffing models and performance on outpatient core measures when treating a patient presenting with symptoms of acute myocardial ischemia and/or chest pain. The administration of aspirin within 24 hours of ED admission and the administration of an electrocardiogram within 10 minutes of admission were selected for this study as commonly accepted outpatient core measures for patients with ED discharge diagnoses consistent with an AMI/CP..

While the insurance type did show a difference over the five years studied with a decline of Blue Cross Blue Shield coverage and an increase in Medicaid coverage, that difference can be explained by overall economic changes. In addition, the outcome measures are the same for all patients regardless of the type of insurance, and therefore the change in proportion of BCBS should not be affecting the quality of care. Same increase in BCBS can explain a slight downward shift in Medicare coverage during the physician staffing model C time period. Due to a significant economic shiftthat began in 2013 and is only now improving to measures of the economy, declining employment, employee loss of health benefits anda shift of Blue Cross Blue Shield coverage down, may lead to Medicaid increases (Gokay,2009). Medicaid is a state managed healthcare benefit plan that people qualify for when their income has declined to predetermined levels, this is seen when unemployment rises as we have seen during the period studied (BLS,2014).

The three different physician staffing models for the ED of a CAH that has less than 10,000 visits in the ED per year were evaluated, the diagnosis observed were (AMI) and chest pain (CP) in order to establish whether the outpatient core measures were satisfied for these particular discharge diagnoses. The data supported hypothesized associations of this CAH study. There is a significant association between the ED physician staffing models and both aspirin administration within 24 hours of a ED patient admission with symptoms of an AMI/CP from the ED ($F_{2, 57} = 8.134$, p-value<0.01), and an EKG being done within 10 minutes of a ED patient admission ($F_{2, 57} = 5.198$, p-value<0.05). In addition, assuming similarity in the patients during the study period, the analysis of the outpatient core process of care measures showed a significant difference between emergency department physician staffing model B & C as compared to model A.

Limitations

As with any health services research this study has certain limitations related to the data and methodology. These limitations include:

- The study utilized secondary data residing in an EMR, therefore a possibility of user entry errorsexists;
- The researcher has no control over how the data was collected, and if all ED visits that would have

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been included in this study were accuratelycaptured;

- Although the data validation indicates the data was reliable, there may be possible abstractionerrors;
- The inability of the researcher to control factors such as ED physician or patient preferences, the AMI/CP case volume;
- The unmeasured presence of one or more additional illnesses or symptoms co- occurring with AMI/CP that were not available from theEMR;
- The data utilized was from one critical access hospital, it was limited to only two quality measures and the researcher has no control over racial composition ofthe sample, therefore the study outcomes may not be representative of all critical access hospitals. Geographic diversity, community culture and medical staff dynamics may impact the application of any one of the ED physician staffing models described in thisstudy;
- The data was collected over the time period of 5 years beginning January 1st, 2013 and ending December 31st, 2018, consequently there may be more recent changes that can possibly impact the quality of AMI/CP care and quality measures since2018;
- In regards to the statistical limitation, the analytical method had to be changed to odds ratio because the intended statistical method, logistic regression, in the actual analysis lacked predictive power. In this study, the percentage of correctly predicted outcomes was approximately 4%; all improvement techniques did not change this percentage significantly. An adequate logistic regression model generally produces at least 60% of outcomes correctly predicted. Thereforetheodds ratio test predicting core measure performance by delivery model was employed;
- Finally in terms of the methodological limitation; since the study was based on actual staffing models, the findings are relevant to these models only, thereforeit cannot be assumed with certainty how quality of care would be impacted by any changes in any of themodels.

Nonetheless, despite the described limitations, the study offers an important input in the field of healthcare administration, specifically in the CAH environment. Most importantly, it demonstrated a possibility of positive quality changes in a CAH as well as providing administrators the ability to have some control over that. Overall, healthcare quality and safety improvements are very important to the viability of hospitals serving rural communities.

Furthermore, CAHs offer distinguished factors that are not always taken into consideration by national hospital patient safety initiatives, since most of the patient safety standards are generally stemming from studies that are conducted in large urban hospitals. This study contributes positively in regards to the ED physician staffing model specifically, and how the models impact improvements in efficiency and quality of care for ruralpopulations.

Recommendations for FutureResearch

Although the study found support for the hypothesized effect of staffing models on patient quality outcomes, the data was limited to one CAH. The study could be replicated among a broader population of critical access hospitals serving rural communities within a region, state or nationally to make the finding more generalizable. While outcome measures used in this study are commonly accepted indicators, quality is a multidimensional concept andfutureresearch could also be expanded to include other diagnoses that present to an emergency department and have core measures that could be analyzed for performance. Another important issue that was beyond the scope of this study, but can potentially be included in future research, is focus on the leadership traits of the medical director and his/her influence on expanding coverage including the hospitalist component in low volume emergency departments. In orderto determine the quality of care in rural environments, future studies have to consider several factors

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such as broader racial composition, geographic diversity, community culture, more quality measures as well as moreCAHs.

Finally, the researcher described the methodology and rationale for determining the relationships between the ED physician staffing models and the management of patients presenting to the ED with symptoms of an AMI/CP. The study findings demonstrated that it can be applied to other critical access hospitals as well as laying the groundwork for similar future studies. Consequently, it is critical that future studies examine the area of ED physician staffing models and the management of patients presenting to the ED with symptoms of an AMI/CP from a broader scale. More research studies need to focus on presenting a broader perspective on this subject since the existing literature is highly repetitive, insufficient and narrow in scope.

Conclusion

In conclusion, this study highlighted the similarity in performance between two different physician staffing models as viewed by board certification. Being able to determine that CAH performance in treating ED patients presenting with AMI/CP is not negatively impacted by changes within ED physician staffing composition is important when a decision to use an alternative staffing model is made by administrators. Quality of care and patient safety arealways considered when hospital executives make decisions about staffing, however the emergency department is one area that is very visible to the community served, and therefore requires special attention. Emergency medicine training and board certification certainly is desirable for staffing the emergency department, however the cost associated with this staffing pattern may not be warranted in a low volume environment.

When the same outcomes can be achieved with a different physician staffing model without compromising quality of care, and the model supports other assignments, the model adds value. In the age of healthcare reform where emphasis is placed on value added service, this study demonstrated no difference in core measure performance, and the primary care physician staffing model can do other tasks for the hospital. This study provides healthcare executives in CAH's with a demonstrated alternative to ED physician staffing coverage that typically was only provided by emergency medicine trained physicians.

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