Archives of Gerontology and Geriatrics 83 (2019) 263–270

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Systematic review and meta-analysis on the effect of hospital competition on quality of care: Implications for senior care

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ARTICLE INFO

Keywords:
Hospital competition
Quality of care
Elderly
Acute myocardial infarction
Meta-analysis

ABSTRACT

Background: Empirical studies examined the associations between hospital competition and quality of care by using different methodology, measures, patient groups and geographic locations; however, results remained inconclusive. This study aimed to apply meta-analysis to evaluate the effect of hospital competition on quality of care and to explore the potential implications to care for senior patients.
Methods: A systematic review and meta-analysis combining results from various studies to obtain an overall outcome was performed. Measure of effect size, I^2 test, meta-regression to find sources of heterogeneity, tests for publication bias, sensitivity analysis and cumulative analysis were performed. The mean effect size is estimated by coefficient and standard error with P values less than 0.05 which was considered statistically significant.
Results: Based on the selection criteria, only 11 studies were eligible for this meta-analysis. The pooled effect of hospital competition on quality of care was reported by all of the 11 included studies. Results of the meta-analysis suggested that hospital competition reduced quality of care, but the overall effect was relatively insignificant from a statistical perspective (Point estimate = 0.008, 95% CI = -0.004 ˜ 0.020, $P >$ 0.05).
Conclusions: Hospital competition slightly increased mortality rates of acute myocardial infarction, but not statistically significant. The negative impact may be lessened over time as medical technology, practices, and techniques improve. Older patients with complex care needs may be at risk for poorer quality of care related to hospital competition.

1. Introduction

Economic theory suggested that competition may lead to better quality in price-regulated markets where price was set above marginal cost. Institutes may compete in non-price dimensions, e.g. quality of service, and enhanced quality to increase market share until profits were equal to zero (Gaynor et al., 2010). However, when prices were set, the impact of competition on quality depicted mixed results (Gaynor, 2006). In countries adopt a fixed price regime for healthcare services, e.g. United Kingdom and Taiwan, hospitals may compete for quality to achieve better development. Various empirical studies have examined the associations between hospital competition and quality of care, but results were inconsistent due to the differences in methodology, geographic locations, time periods, patient groups, and quality measures (Chen & Cheng, 2010; Mutter, Wong, & Goldfarb, 2008). Mutter et al. (2008) used the 1997 Healthcare Cost and Utilization Project State Inpatient Databases to explore the potential associations between hospital competition and quality of care, and showed negative results. However, other studies indicated that hospitals may perform differently in different quality domains under the circumstances of hospital competition (Mutter et al., 2008; Romano & Mutter, 2004). Hospital competition seemed to enhance quality of care in dimensions related to physician skills, expertise, and domains that are comprehensible to patients. In contrast, quality was reduced in dimensions associated with hospital infrastructure, nursing mix, and hospital staff where the dimensions of quality are less obvious to patients. In the competitive markets, physicians may be the most critical factor linking to patient flows, so more resources would be allocated by the hospital authorities to improve professional skills and expertise for physicians. Furthermore, a cost-shifting phenomenon has been identified to enhance quality domains that were visible to patients and expenses for others, such as infrastructure and support staff were reduced. Propper,

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https://doi.org/10.1016/j.archger.2019.05.001
Received 2 April 2019; Received in revised form 2 May 2019; Accepted 2 May 2019
Available online 03 May 2019

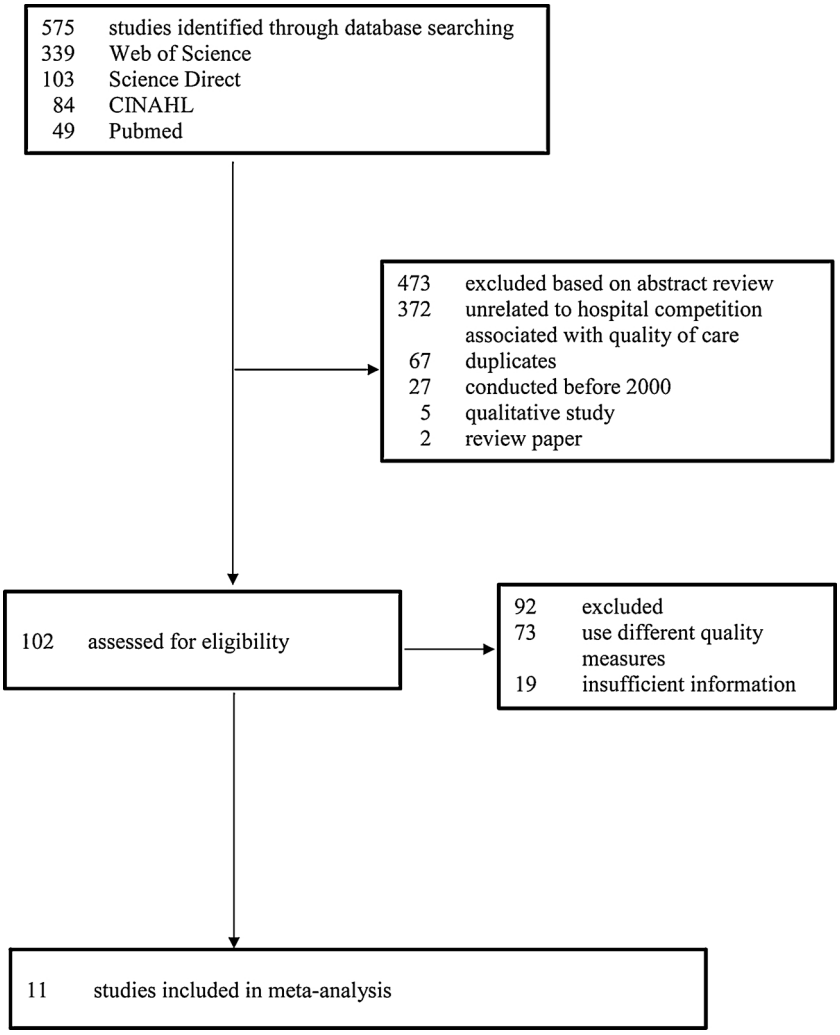

Fig. 1. Flow chart of meta-analysis procedure.

Burgess, and Gossage, (2008) used administrative data of 145 acute hospitals in the English National Health Service (NHS) from 1991 to 1999 and found competition eventually varied over time due to policy changes and suggested that competition reduced measures less visible, such as 30-day mortality of acute myocardial infarction (AMI), while well published measures such as waiting lists for treatment were improved. Another Australian study showed similar findings that competition increased mortality but reduced unplanned readmission (Palankaraya & Yong, 2013), and the adverse effects of competition on mortality were similar for both private and public hospitals while the positive effect of unplanned admissions was significantly higher for public hospitals.

It has been reported that AMI patients in the least competitive areas had higher mortality rates and lower treatment costs than most competitive areas before 1991; however, AMI treatment costs substantially increased in least-competitive areas without corresponding improvement of mortality rates than competitive areas after 1991 (Kessler & McClellan, 2000). A previous study investigated the impacts of hospital competition on quality of care for all non-rural elderly with AMI, which showed that patients in the least competitive areas have higher 1-year mortality rates than the in the most competitive ones (Kessler & Geppert, 2005). Moreover, low-risk patients in competitive areas obtained less intensive treatment, but their health outcomes remained similar. However, high-risk patients in competitive areas obtained more intensive treatment, yet they achieved significantly better outcomes (Kessler & Geppert, 2005). Cooper, Gibbons, Jones, and McGuire, (2011) found that hospital competition enhanced quality of care becaue the 30-day mortality rates reduced faster in more competitive fixed-priced areas after the introduction of patient choice. These findings were also supported by other studies (Bloom, Propper, Seiler, & reenen, 2010; Gaynor, Moreno-Serra, & Propper, 2010). On the contrary, price competition and reduced subsidies may significantly jeopardize quality of care among uninsured patients with AMI (Volpp et al., 2003). An US-based study showed that hospital competition reduced hospital quality for Medicare patients, but it improved quality for HMO patients (Gowrisankaran & Town, 2003). Similarly, Propper, Burgess, and Green, (2004) found that hospital competition reduced quality of care following the NHS reforms in the 1990s that lead to payer-driven competition among hospitals.

Based on the inconsistent results from previous studies, the associations between hospital competition and quality of care remained controversial. The inconsistence of these studies may come from differences in study design, methodology, sample size, patient groups, and locations. Therefore, the study aims to perform a meta-analysis to investigate the underlying impact of hospital competition, using summary data of the studies identified in the literature search.

2. Methods

2.1. Study identification

This study was a systematic review and adopted meta-analysis to

Table 1
Summary data of the included studies.

Study	Time perioda	Geographic Area	Quality measure	Competition measure	Competition effect on quality
Bijlsma, Koning, Shestalova, and Aouragh (2010)	2004-2008	Netherlands	18 quality indicators including 30-day AMI mortality rates	Number of competitors, HHI	Mixed effect
Bloom et al. (2010)	2005-2006	U.K.	28-day AMI mortality rates	Number of competitors	Increased quality
Cooper et al. (2011)	2002-2008	U.K.	30-day AMI mortality rates	HHI	Increased quality
Gaynor et al. (2010)	2003-2007	U.K.	4 mortality rates including 30-day AMI mortality rates	HHI	Increased quality
Gowrisankaran and Town (2003)	1989-1993	California, U.S.	30-day AMI Mortality rates (HMO)	HHI	Increased quality
Gowrisankaran and Town (2003)	1989-1993	California, U.S.	30-day AMI Mortality rates (Medicare)	HHI	Reduced quality
Mutter et al. (2008)	1997	All states in U.S.	38 quality indicators, 30-day AMI mortality rates	12 competition measures including number of hospitals and HHI	Mixed effect but decreased quality for AMI patients
Palankaraya and Yong (2013)	2000-2005	Australia	30-day AMI mortality rates	HHI and the number of hospitals	Mixed effect but reduced quality for AMI patients
Propper et al. (2004)	1991-2000	U.K.	30-day AMI Mortality rates	Number of competitors	Reduced quality
Propper et al. (2004)	1995-1998	U.K.	30-day AMI Mortality rates	Number of competitors	Reduced quality
Propper et al. (2008)	1991-2000	U.K.	30-day AMI Mortality rates	Number of competitors	Mixed effect but decreased quality for AMI patients

combine results from various studies to obtain an overall outcome. For the preliminary research, computer-assisted research was conducted through PubMed, using keywords such as *hospital competition* or *quality* or *hospital competition and quality* or *competition and quality of care*. Boolean operators (NOT, AND, and OR) were also used in the search process (McGrath, Brown, & Samra, 2012; Pan, 2013). Google search was also used to identify unpublished studies. Moreover, unpublished research unavailable on a particular website was obtained by directly contacting the relevant organization such as U.S Department of Justice. Furthermore, the references lists in the retrieved research reports were examined and then a computerized search through the databases was conducted to obtain relevant papers not found in the initial search. The titles and abstracts of the studies generated from the preliminary research were examined to determine their relevance. The majority of the studies were published in journals, while some of them are unpublished studies, working, or discussion papers from professional associations such as CPB Netherlands Bureau for Economic Policy Analysis, Centre for Economic Performance (CEP) in London School of Economics and Political Science, the Centre for Market and Public Organization (CMPO) in Bristol Institute of Public Affairs, and National Bureau of Economic Research (NBER). The second stage review included analyzing research questions and aims, data, methodology, and results of the studies identified in the preliminary search to determine suitability.

2.2. Selection criteria

The studies selected from the search were based on a variety of criteria. First, the research includes published and unpublished studies written in English. Second, studies were excluded if their topics are unrelated to hospital competition associated with quality of care. Third, studies which were descriptive, did not use multivariate analysis to control for confounding factors, or did not provide sufficient information such as methodology and data are excluded. Fourth, types of competition other than hospital competition were excluded. Fifth, because the 30-day AMI mortality rate was the mostly commonly used quality measure, this meta-analysis employed this indicator to measure the quality of care and thus studies that did not use this quality measure were excluded. As the meta-analysis aimed to provide updated observations based on recent studies, studies conducted before the year 2000 were excluded. In addition, data and information from all studies selected are independently reviewed and extracted.

2.3. Evaluation of effect

Comprehensive Meta-Analysis version 2.0 was used to conduct meta-analysis (Borenstein, 2005). Measure of effect size, I^2 test, meta-regression to find sources of heterogeneity, tests for publication bias, sensitivity analysis and cumulative analysis are performed. The mean effect size was estimated by coefficient and standard error with P values less than 0.05 was considered statistically significant. A negative coefficient indicated that hospital competition resulted in a reduction in 30-day AMI inpatient mortality rates, suggesting competition led to better quality of care, and vice versa. To test for heterogeneity, both the fixed effect and random effects models were used. While the fixed effect model assumed that the real effect size was the same for all studies, the random effects model assumes that the real effect size differed across studies (Borenstein, 2005). According to Borenstein (2005), selection of the fixed effect model should be based on two conditions: variables that can impact the outcome are identical across the studies and the goal of the meta-analysis is to obtain one common effect size for the population defined (Borenstein, 2005). However, if the goal of the meta-analysis was to assess the mean effect in various studies, the random effects model should be used (Borenstein, 2005). Furthermore, as there was heterogeneity among the studies, the random effects model was employed to assess the pooled effect.

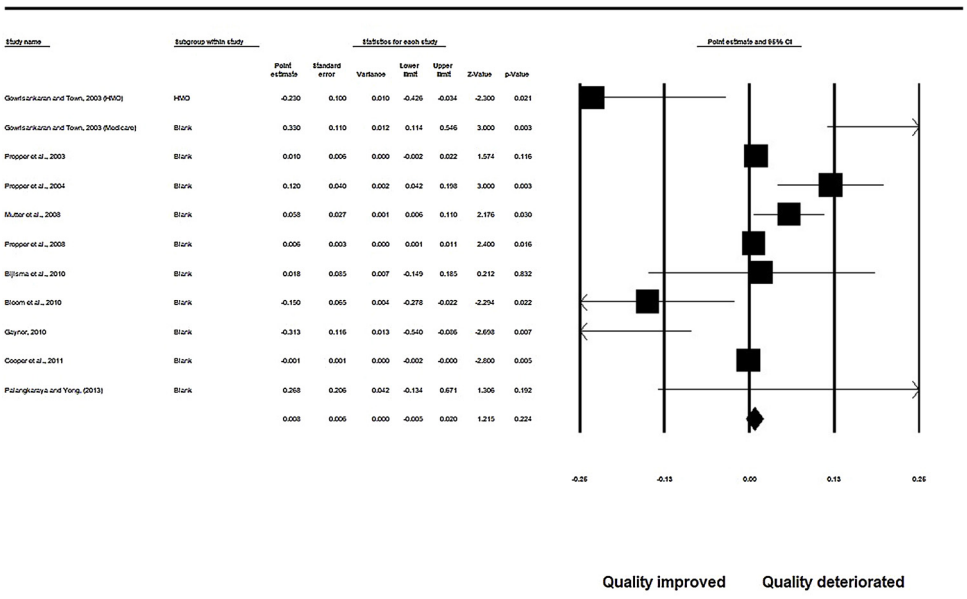

Fig. 2. Forest Plots of the effect of hospital competition on quality of care.

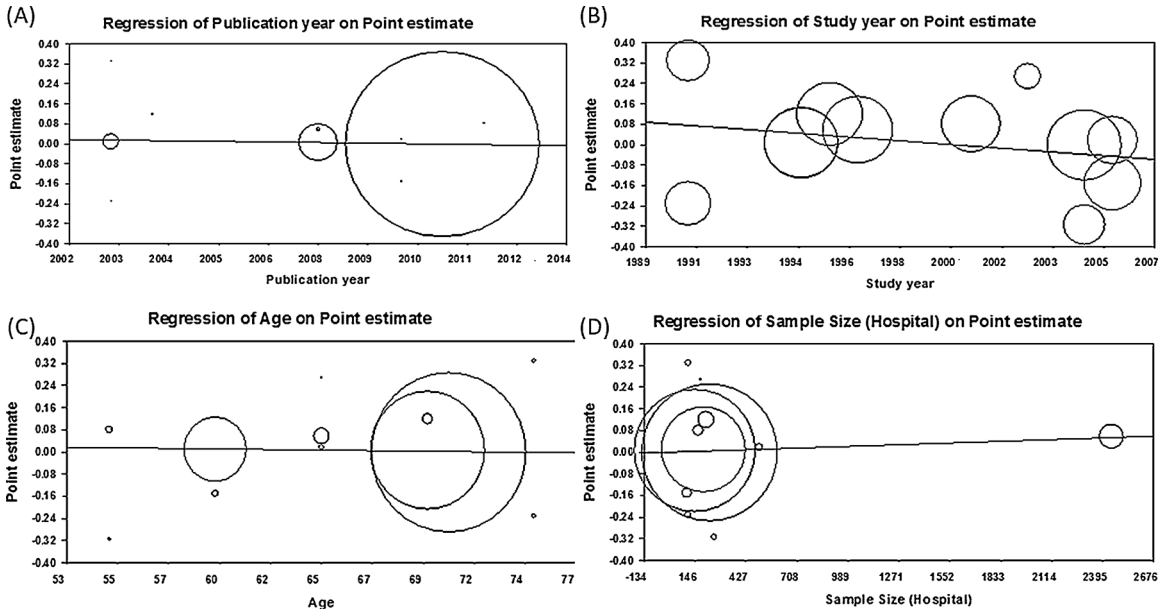

Fig. 3. Meta-regression for heterogeneity of included studies (A: publication year; B: study year; C: age; D: sample size).

2.4. Evaluation of heterogeneity and sources

In this study, heterogeneity was measured by Cochran's Q-statistics and the I^2 test. Cochran's Q-statistics was calculated as the weighted sum of squared differences between each study's effect estimate and the overall effect estimate (Huedo-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006; StatsDirect Limited, 2016). A p-value of 0.05 was determined as a cut-off for significance; however, Cochran's Q-statistics has low power at detecting heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). This study also applied I^2 statistic to test for heterogeneity. The I^2 statistic estimates the percentage of total variation across studies that is due to heterogeneity rather than chance (Fletcher, 2007; Higgins et al., 2003; MedCalc, 2016). A result of 0% from the I^2 test depicted non-existence of heterogeneity while a result of 100% indicated the highest level of heterogeneity (Li et al., 2016). The I^2 test above 50% suggested that the total observed variation was a result of heterogeneity (Li et al., 2016; Warrier, Chee, Smith, Chakrabarti, & Baron-Cohen, 2015). The potential sources of heterogeneity or moderators in CMA 2.0, were assessed by meta-regression analysis. The meta-regression method applied regression analysis to investigate the impact of selected variables on the effect size (Haidich, 2010). Age of patients, sample size of hospitals, study year, and year of publication were identified as potential sources of heterogeneity. As study period length varied from study to study, the median year was used for each study in the meta-regression.

2.5. Evaluation of publication bias, sensitivity analysis, cumulative analysis

To examine publication bias in the meta-analysis, a funnel plot, the Rosenthal fail-safe N method, Begg and Mazumdar Rank Correlation Test and Egger's regression test were used. Publication bias may arise when research with significant results were likely to be published

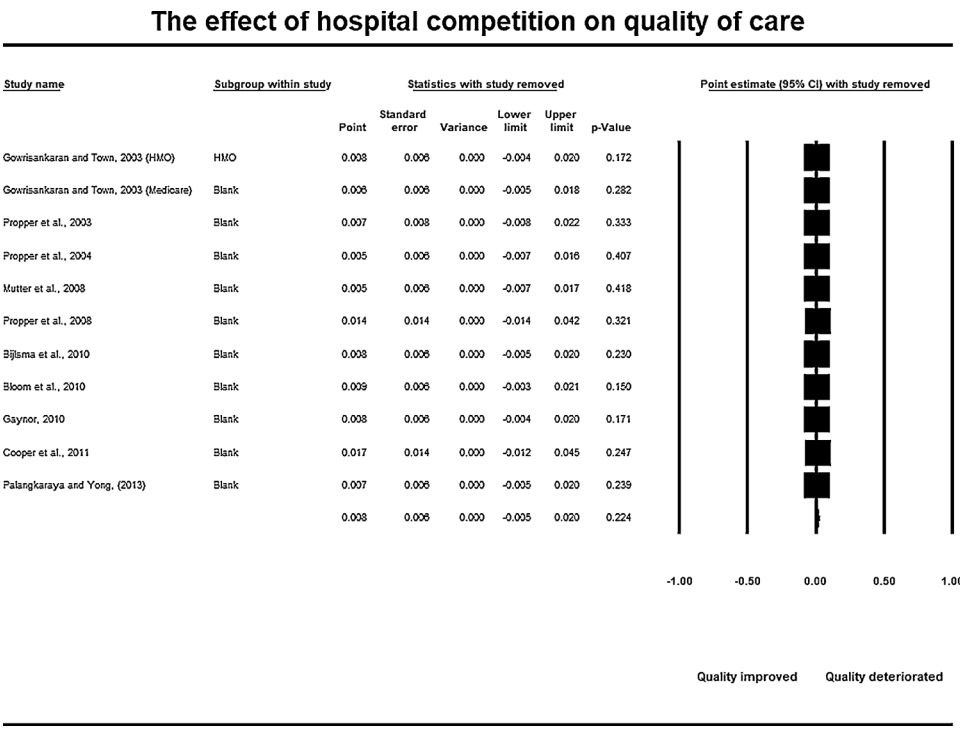

Fig. 4. Sensitivity analysis of included studies.

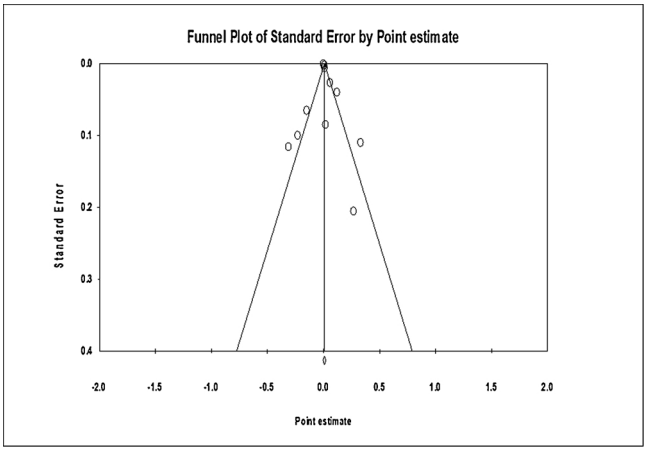

Fig. 5. Publication bias of included studies.

(Gordis, 2009). The funnel plot which was used for detecting publication bias or heterogeneity, was a scatter plot of the effect estimate against a measure of study size (Anzures-Cabrera & Higgins, 2010). Moreover, the Rosenthal fail-safe N method computed a combined p-value for all studies in the meta-analysis and then found the number of additional unpublished studies with null results to make the results of a meta-analysis statistically insignificant (Borenstein, 2005; Cochrane Handbook, 2016). The Begg and Mazumdar Rank Correlation test computed the inverse correlation between study size and effect size to test for publication bias (Cochrane Handbook, 2016). Furthermore, Egger's test used a simple linear regression to predict y (the actual values of the effect size of each study divided by its standard error) by using their precision (the inverse of the standard error) to test that the intercept that captures the bias was significantly different from zero (Thornton & Lee, 2000).

Sensitivity analysis tests were performed by deleting each study one by one to examine if any studies have a significant effect on the pooled outcome (Warrier et al., 2015). The studies were sorted chronologically based on publication year, and a cumulative analysis is conducted to investigate how the estimated effect size may have changed over time (Borenstein, 2005). It depicted the stability or instability of the effect over time (Tanner-Smith, 2013).

3. Results

3.1. Included studies

Overall, 575 studies were located from databases and of these, 102 were identified for further screening as their titles or abstracts seem to meet the selection criteria. An additional 10 papers were identified from the references. Based on the selection criteria, only 11 studies were included for this meta-analysis (Fig. 1). One study (Gowrisankaran & Town, 2003) used two different populations to examine the identical effect and provides separate results for the two populations, the two results of this study were treated as two separate studies. As such, 11 studies are included in the meta-analysis (Table 1).

3.2. Association of hospital competition with quality of care

3.2.1. Pooled effect

The pooled effect of hospital competition on quality of care was shown by all of the 11 studies that were included in the analysis (Fig. 2). The results of the meta-analysis suggested that hospital competition reduced quality of care, but the overall effect was relatively insignificant from a statistical perspective (Point estimate = 0.008, 95% CI = -0.004 ˜ 0.020, $P >$ 0.05). It showed that the point estimates of the correlation coefficient range from -0.313 to 0.330 and the 95% confidence intervals include 0.

3.2.2. Individual studies

If the 95% confidence interval for the estimated difference among the groups did not include 0, then the effect was a statistically significant one ($P <$ 0.05) (Lang & Secic, 2006). Among the 11 studies selected in this meta-analysis, 8 studies indicated a statistically significant association between hospital competition and quality of care

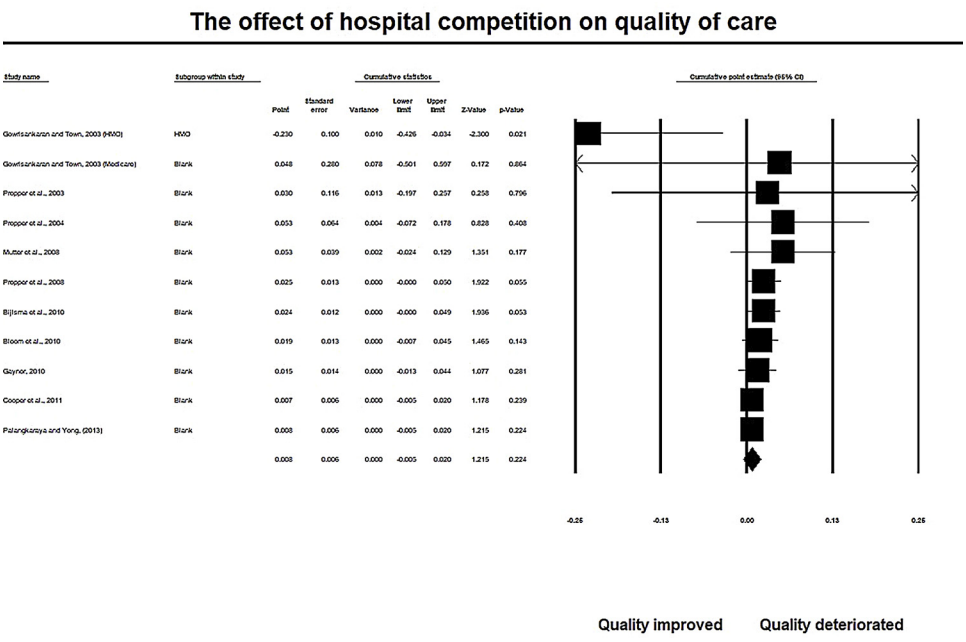

Fig. 6. Cumulative analysis of included studies.

(P < 0.05) (Fig. 1). Among these 8 studies, 4 studies demonstrated that hospital competition lowered AMI mortality rates, i.e. Bloom et al., 2010; Cooper et al., 2011; Gaynor et al., 2010; Gowrisankaran & Town, 2003 (HMO), whereas the others indicated the opposite effect, i.e. Gowrisankaran & Town, 2003 (Medicare), Mutter et al., 2008; Propper et al., 2004, 2008.

3.3. Heterogeneity and meta-regression

To measure heterogeneity statistically, the I^2 statistic was performed, which indicated a percentage of 81.50%, suggesting high heterogeneity (I^2 = 81.50%) (Fig. 1). As the studies varied and there was evidence of heterogeneity (Point estimate = 0.008, 95% CI = -0.004 ˜ 0.020, *P > 0.05)*, the random-effects model was used in this meta-analysis (Fig. 1). Meta-regression was performed to investigate potential sources of heterogeneity such as year of publication, age, sample size, and study year and each source's relationship with the outcome. The results of meta-regression indicated that after adjusting for the three potential sources of heterogeneity, only year of publication appeared to be the crucial factor of heterogeneity (Slope = -0.00207, Intercept = 4.13648, $P < 0.05$) (Fig. 3), while age, study year, and sample size do not show significant results (Age: Slope = -0.00074, Intercept = 0.05428, $P > 0.05$; Study year: Slope = -0.00888, Intercept = 17.75239, $P > 0.05$; Sample size: Slope = 0.00002, Intercept = -0.00079, $P > 0.05$) (Fig. 3). The meta-regression results indicated that studies that were published more recently depicted better quality of care (or lower AMI mortality rates) (Fig. 2). Such result indeed reflected the current situation in the healthcare market where medical technology has become more advanced compared to the past. Therefore, mortality rates were likely to be lower because of the improved quality of care resulted from the continuous advancement in medical practices, technology, and prevention techniques over time. In addition to improvement in medical technology and prevention techniques, policy reforms that help improve healthcare quality may have also improved hospital quality (Propper et al., 2008).

3.4. Sensitivity analysis

The sensitivity analysis was conducted to determine if any study has impact on the pooled effect (Lang & Secic, 2006). The result of sensitivity analysis indicates that no particular study has significant impact on the pooled association of hospital competition and quality of care (Fig. 4).

3.5. Publication bias

Publication bias is not presented as determined through visual inspection of the funnel plot, which is symmetrical (Fig. 5). Also, the Classic fail-safe N tests indicate that there is no significant publication bias (P > 0.05); the Begg and Mazumdar rank correlation test depicted insignificant results (Kendall's tau = -0.09091, 1 tailed P > 0.05, 2-tailed P > 0.05). Moreover, the Egger's regression further confirms non-existence of publication bias (Intercept = 0.68047, 95% CI = -0.81279 ˜ 2.30324, 1-tailed and 2 tailed $P > 0.05$).

3.6. Cumulative meta-analysis

Cumulative meta-analysis was performed by sorting the studies chronologically based on year of publication from the earliest to the most recent to identify how the evidence on the effect of hospital competition on quality of care has shifted over time. Fig. 6 illustrated that the first study on HMO patients done by Gowrisankaran and Town (2003) depicted statistically significant evidence on the association of hospital competition and quality of care ($P < 0.05$). It was the first and the only study among the studies selected that suggested a positive effect of hospital competition on reducing mortality rates. After adding their study on Medicare patients, the point increased substantially and changed to the opposite direction, suggesting that hospital competition increased mortality rates. The studies that were conducted afterwards all demonstrate the opposite effect of hospital competition on mortality rates with statistically insignificant results (P > 0.05). However, the magnitude of the impact of hospital competition on mortality rates decreased over time. The precision of the estimated outcome improved since the 95% confidence intervals become narrower as the data

accumulated. Overall, the impact of hospital competition on mortality rates became less detrimental over time which may possibly be due to differences in methodologies between the studies included and the improvement in medical technology which helps decrease mortality rates as illustrated in the section on heterogeneity and meta-regression.

4. Discussion

In this meta-analysis, the examination of the pooled effect of hospital competition on quality of care was based on the selected studies in the context of Western countries. The results from the meta-analysis random-effects calculation suggested that hospital competition relatively increased AMI mortality rates, but this association was statistically insignificant. Overall, 8 out of the 11 selected studies depicted a statistically significant association between hospital competition and quality of care. Among them, half of the studies (one U.S. and three UK studies) indicated that hospital competition may result in better quality (lower mortality rates), but the other half (two UK and two U.S. studies) showed different results. Due to the variety of contexts, the mixed results from the meta-analysis on the association between hospital competition and quality of care may be anticipated. The results from the studies in markets where firms set prices have been predicted by the economic theory that competition in these markets leads to either improved or decreased quality (Gaynor, 2006). However, the results of studies done for regulated markets were not consistent with the economic theory for fixed-price markets. Gowrisankaran and Town's study (2003) finds that hospital competition increased the 30-day AMI mortality rates for Medicare patients, and the negative impact of hospital competition on quality of care may be related to either the low margins of Medicare patients or hospitals' deviation from profit-maximizing behavior. However, due to the complicated nature of the health care market, the economic theory on the association between competition and quality may not be applicable as it is not clearly evident in the healthcare sector (Glick et al., 2015).

There was a number of reasons for the mixed results on the association between hospital competition and quality of care more distinctly. First, the variation in study methodology may have contributed to the inconsistent results on the association between hospital competition and quality of care (Bevan & Skellern, 2011; Glick et al., 2015). The studies employed various methods to compare the predicated flow of patients and the actual flow of patients, the number of hospitals, or the distance to the closest competitors as illustrated in the literature review section. However, these approaches may not accurately captured the market size of a hospital. Hospital quality could be associated with market size and distance to another hospital, so there can be differences between urban and rural areas (Cooper et al., 2011). Second, the nature of hospital management was too complicated to use one single quality measure to assess the overall quality of care of a hospital. As one single quality indicator may only relate to a particular condition, other aspects of quality in a hospital may be overlooked (Gaynor, 2006). As such, when sufficient data and research become available, future meta-analysis focusing on other quality and competition measures to estimate the pooled effect of hospital competition on hospital quality will be beneficial.

A recent study in China showed the hospital competition reduced 30-day AMI mortality rate, but increased inpatient pneumonia mortality, which also echoed results of previous studies (Lin et al., 2018). However, pneumonia has gradually become an important cause of deaths for older patients that may potentially suggest the poorer quality of care for older patients with multiple complex conditions (Lu, Lee, Chen, & Hsiao, 2015; Chou et al., 2019). In consideration of the possible limitations of this study, it was important to recognize that because of the limited availability of studies employing identical quality measures, only eleven studies were examined. This can be seen to limit its representativeness. Future research to include more studies would help substantiate the results find in this study.

In conclusion, the differences in study design and methodology of studies on the association of hospital competition and quality of care may account for the inconsistent findings. This study showed that hospital competition slightly increased AMI mortality rates, but not statistically significant. However, such negative impact can be expected to lessen over time as medical technology, practices, and techniques continue to improve. Indeed, this downward trend was consistent to the findings in prior research. Furthermore, in view of the complicated nature of the healthcare market, when assessing the effect of hospital competition on quality of care, different measures for market structure and quality should be taken into account.

Conflict of interest

All authors declare no conflicts of interest

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