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Original Article

Effect of Repeated Public Releases on Cesarean Section Rates

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Objectives: Public release of and feedback (here after public release) on institutional (clinics and hospitals) cesarean section rates has had the effect of reducing cesarean section rates. However, compared to the isolated intervention, there was scant evidence of the effect of repeated public releases (RPR) on cesarean section rates. The objectives of this study were to evaluate the effect of RPR for reducing cesarean section rates.
Methods: From January 2003 to July 2007, the nationwide monthly institutional cesarean section rates data (1 951 303 deliveries at 1194 institutions) were analyzed. We used autoregressive integrated moving average (ARIMA) time-series intervention models to assess the effect of the RPR on cesarean section rates and ordinal logistic regression model to determine the characteristics of the change in cesarean section rates.
Results: Among four RPR, we found that only the first one (August 29, 2005) decreased the cesarean section rate (by 0.81 percent) and continued to have an impact period through the last observation in May 2007. Baseline cesarean section rates (OR, 4.7; 95% CI, 3.1 to 7.1) and annual number of deliveries (OR, 2.8; 95% CI, 1.6 to 4.7) of institutions in the upper third of each category at before first intervention had a significant contribution to the decrease of cesarean section rates.
Conclusions: We could not found the evidence that RPR has had the significant effect of reducing cesarean section rates. Institutions with upper baseline cesarean section rates and annual number of deliveries were more responsive to RPR.

Key words: Economic crisis, Labor regulation, Occupational health and safety, Regulatory change
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INTRODUCTION

The cesarean section rates varied significantly across nations, regions and institutions (clinics and hospitals). In 2007, the cesarean section rates in Korea were two times greater than the lowest of OECD countries, like a Netherlands and Norway [1]. Within Korea, there was also great variation of cesarean section rates between regions and institutions [2]. Although adjusted cesarean section rates were concerning, the variation of cesarean section rates can be showed. A substantial number of this cesarean sections may not be medically appropriate [3,4].

Therefore, many programs institute feedback to providers, quality improvement, financial incentives, and public releases of performance to try to reduce cesarean section rates [5]. A second opinion by an obstetrician, the education of patients and communities, feedback and audit mechanisms, clinical practice guidelines, quality improvement strategies and financial incentives may be effective in reducing cesarean section rates [6-9]. However, lack of information about the quality of services has interrupted the efforts of improvement of quality of care, and for that reason the public release of provider performance has been proposed as a strategy for these failures [10,11].

The public release of institutional cesarean section rates does effectively reduce the rates [12]. Hospitals with a upper baseline cesarean section rate and a large number of deliveries were susceptible to public release (here after public release), which led to the decrease of cesarean section rates. Based on the result, the Health Insurance Review & Assessment Service (HIRA) has repeatedly released to public and institutions the information about institutional cesarean section rate.

However there is little evidence to last the repeated public releases for reducing cesarean section rates. Because of some limitations include the facts that the

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study did not evaluate repeated public releases, did not consider trends of cesarean section rates, did not present the effect size and effect duration, and did not adjust for maternal and fetal risk factors.

To the best of our knowledge, it is unclear what effect repeated public releases (RPR) will have on cesarean section rates and the characteristics of institutions which response [5,12-15]. We aimed to evaluate the effect of RPR for reducing adjusted cesarean section rates and to analyze the characteristics of responsive institution to RPR. The hypothesis of this study was examined that the effect of RPR will be decayed and the cesarean section rates of the institutions with higher cesarean section rates in pre-period of RPR will decrease largely than lowers after RPR.

METHODS

I. Data Sources

We collected monthly data about institutional cesarean section rates and total deliveries from the HIRA National Quality Improvement project database from 2003 through 2007 (52 observations). The HIRA, sponsored by the Korean Ministry for Health, Welfare and Family Affairs, has reimbursement records from all medical institutions in Korea. All study data for deliveries were obtained from the HIRA National Quality Improvement project database. According to the HIRA National Quality Improvement project protocol, institutions with 100 or more deliveries annually were selected (1194); these institutions performed more than 96.7% of the deliveries in Korea in 2008 (1 951 303) [2]. We were provided with an institutional predicted cesarean section rate that was analyzed by a multiple risk-adjustment model.

II. Measures and Variables

In the risk-adjustment model, the HIRA database included maternal demographics, co-morbidities, pregnancy-induced illness, obstetrical conditions, labor-induced illness, and a history of cesarean section, and multiple logistic regression analysis was performed. (c statistic = 0.782, Hosmer-Lemeshow test = 0.2653). The predicted number of cesarean sections was calculated by using multiple regression analysis. Risk-adjusted institutional cesarean section rates were computed by dividing the actual number of cesarean sections by the predicted number of cesarean sections and multiplying by overall cesarean section rates [16].

The characteristics (e.g., institutional type, region, ownership) of eligible institutions were also received from the HIRA database. Region were defined as Capital city (Seoul), Metropolis (Busan, Gwangju, Daejeon, Deagu, Incheon, Ulsan) , Satellite city (city in Gyeonggi province), city, rural. Baseline cesarean section rates were defined before the effect of public release (August 29, 2005) over a one year average rate. Regional market share was defined as the number of deliveries of an institution divided by the total number of regional deliveries, and regional competitiveness was defined as the sum of the squares of the market shares of each individual institution (Herfindahl index). There were four times repeated public releases, which were defined RPR, in the period of observation.

III. Statistical Analysis

A. Intervention analysis

We used time-series autoregressive integrated moving average (ARIMA) analysis to assess the effect of four RPR on cesarean section rates [17,18].

ARIMA time-series intervention analysis is widely used to evaluate the effect of unusual condition, for example of government policy change [19]. And it has more precise predication of times series sequences and evaluation of intervention's impact (e.g. RPR) than generalized linear mixed model.

Monthly cesarean section rates had a downward trend and seasonal variation. At first, a time-series model was necessary to remove the effects of the trend and seasonal variation and other possible irregularities from the data. The general difference and seasonal difference were used to solve the problem. After differencing, we checked for stationarity of the time-series using the augmented Dickey-Fuller test (ADF) and could reject the null hypothesis of non-stationary process (Table 1).

In the second step, we also examined all possible combinations of p, q and P, Q of the ARIMA (p, d, q)(P, D, Q)s pre-RPR model (using by pre-RPR data) the patterns of an autocorrelation function (ACF) and partial autocorrelation function (PACF) [18]. In this model p is the order of the non-seasonal autoregressive (AR) process, d is the order of non-seasonal difference, q is the order of the non-seasonal moving average (MA) process. And the large letters (P, D, Q) have same meaning of seasonal process.

In the third step, we used conditional least squares estimation to calculate the coefficient and *p*-value of

these parameters. Next, a diagnosis was performed to determine the stationarity of residuals by checking the ACF and PACF of residuals and portmanteau test. The ACF and PACF of residuals did not differ from white noise and portmanteau statistic at lag 6, 12, 18 and 24 were not significant.

Finally, RPR variables and data of post-RPR cesarean section rates were added to preliminary model with pre-RPR data. Same steps were repeated as mentioned above. The four times RPR dummy variables were coded with 0 and 1 as a pulse function because of the assumption that the effect would be temporary. The onset and duration of the effect of RPR can be represented detailed type by transfer functions. Transfer function is composed with polynomials, such as denominators and numerators. The numerator means amplitude of effect on initial measurement, and the denominator means the changing pattern and duration of effect.

The impact of RPR was estimated by summation of Yt which was calculated by numerators and denominators and backshift functions (Equation 1). We used the Akaike Information Criterion (AIC) to select most appropriate models. In the last model, insignificant public releases were excluded to measure the more precise effectiveness of RPR [19,20].

B. Ordinal logistic regression analysis

To identify the characteristics of susceptibility of institutions to RPR, we implemented an ordinal logistic regression analysis. Institutions were selected which could be simultaneously observed during a baseline period (August, 2004-July, 2005), before the only effective public release (August 29, 2005), and a total impact period (August, 2005-June, 2007). The dependent variable was the difference between the baseline and impact period average adjusted cesarean section rate. Because of the distribution of the difference was not normal, the difference was graded in one of four categories by quartiles: large decrease, small decrease, small increase, and large increase. The proportional odds model of ordinal logistic regression analysis has odds ratios can be understood same meaningful odds ratios of dichotomous logistic regression [21,22]. After public releases, Cesarean section rates of institutions were influenced by nonmedical factors of provider such as number of hospital beds, ownership, teaching hospital, provider density, number of deliveries, prior cesarean section rates [3,12]. The factors and region are analyzed as independent variables (institutional type, region, ownership, number of deliveries, regional market competition, and regional market share), which are shown in Table 1. A two-sided *p*-value less than 0.05 was regarded statistically significant.

Table 1. Evaluation of null hypothesis of stationarity by augmented Dickey-Fuller test

	t-statistic	*p*-value
Before differencing	-2.31	0.17
After differencing	-4.14	<0.01

$$Yt = \frac{Num1 + Num1,1 \times (B^3) + Num1,2(B^4)}{1 - Den1,1 \times (B) + Den1,2 \times (B^2)} Xt$$

Equation 1. Transfer function equation of RPR.

Yt: cesarean section rates response, Xt: RPR dummy variable, Num: numerator, Den: denominator.
(B): backshift function (e.g. (B)Xt=Xt-1).
RPR: repeated public releases.

RESULTS

There were differences within each group of regions and annual number of deliveries with respect to annual cesarean section rates (Table 2). Institutions in the capital city and rural regions had upper adjusted cesarean section rates than the other regions. Institutions, which had a upper annual number of deliveries, had upper adjusted cesarean section rates than the middle and the lower.

Monthly adjusted cesarean section rates have decreased consistently from 39.3% in January 2003 to 36.8% in June 2007 (Figure 1). There were four public releases and feedback (August 29, 2005; December 30, 2005; July 26, 2006; and December 29, 2006).

Among four RPR, only the first was effective ($p<0.05$) (Table 3). In the initial model (Model 1), all the components of transfer functions of the first RPR were significant, but at least one component of the other RPR was not significant. All the components of the final model were significant.

The effect of first RPR was calculated by transfer function of first RPR of final model. RPR in August 2005 had a reduction effect of 0.8 percent of the monthly national average on cesarean section rates, an effect that continued through the impact period from first RPR to the last observation in May 2007 ($p<0.01$). The components of ACF and transfer functions were statistically meaningful ($p<0.05$) in both model 1 and model 2.

After public releases and feedback, cesarean section rates at institutions in the upper third (OR, 2.8; 95% CI, 1.6 to 4.7) and middle third (OR, 1.9; 95% CI, 1.3 to 2.9)

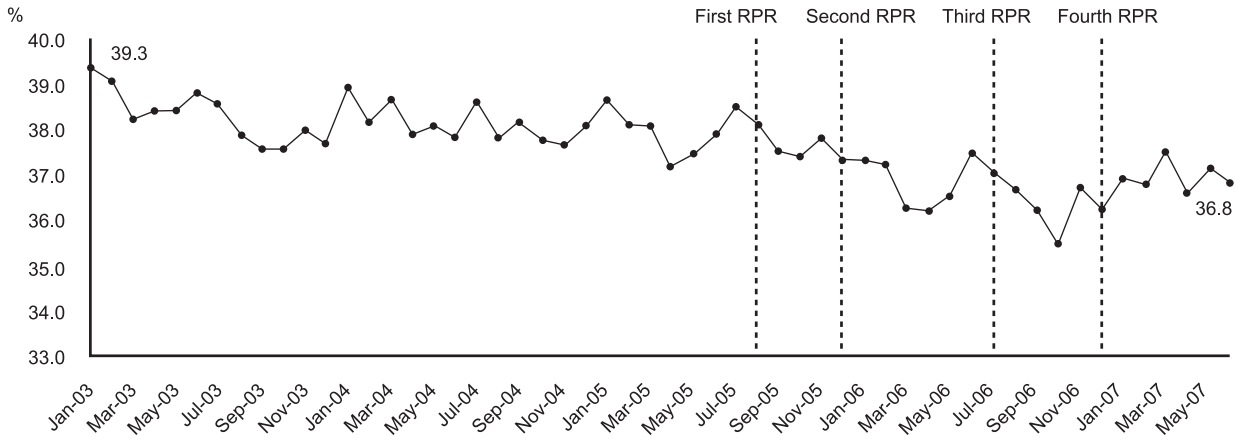

Figure 1. Risk-adjusted institutional cesarean section rates and interventions, January 2003 - May 2007.

RPR: repeated public releases

Table 2. Characteristics of the institutions (n=1194)

Characteristic	Institutions (%)	Adjusted cesarean section rates(%)	*p*-value
Institution type			0.11
Tertiary care hospital	3.6	38.1	
General hospital	13.1	39.2	
Hospital	13.1	36.2	
Clinic	35.4	40.0	
Region			0.003
Capital city	4.9	38.7	
Metropolis	31.7	36.8	
Satellite city	22.5	38.1	
City	24.5	37.4	
Rural	16.3	38.9	
Ownership			0.651
Public	3.2	38.6	
Non-public	96.8	37.6	
No. of deliveries (y)			<0.001
> 700	4.3	36.5	
201 - 700	26.4	37.8	
≤ 200	69.4	40.0	
Regional market competitiveness			0.81
Upper third	26.3	37.3	
Middle third	47.5	38.0	
Lower third	26.2	37.3	
Regional market share			0.19
Upper third	17.1	37.1	
Middle third	37.5	37.8	
Lower third	45.4	39.1	

All the *p*-values are from type 3 Wald test statistic (general estimation equation analysis, working correlation matrix: AR, distribution: normal, link function: identity)

of the annual number of deliveries decreased more than did rates at institutions in the lower third (Table 4). The same upper third (OR, 4.7; 95% CI, 3.1 to 7.1) and middle third (OR, 1.9; 95% CI, 1.3 to 2.5) of institutions had a greater decrease in baseline cesarean section rates.

DISCUSSION

To the best of our knowledge, this study is the first trial to evaluate the effect of RPR in cesarean section rates [5,12-15]. It is clear that RPR were only mildly effective in decreasing the rates of cesarean section. According to a recent systematic review, there is mixed evidence that the public release of provider performance improves practice and performance at the hospital level [22]. However some limitations include the facts that the systematic review did not include a sufficient number of researches about cesarean section rates. Same as the results of earlier studies about the effect of public release on cesarean section rates, our study had been one of the evidences that public release has the effect on reducing of cesarean section rates [12,14].

Although the HIRA repeatedly reported the information of cesarean section rates in the same process, press release, website online confidential feedback, among four public releases and feedback, only the first was effective. It may be because the response of media was different within RPR. The information about institutional cesarean section rates was announced strongly in August 29, 2005 and July 26, 2006 [23]. Public release can improve performance through 2 pathways, which are selection of consumer and self effort of provider to improve [24]. The selection of consumer pathway may be interrupted by the low level of awareness of the information about cesarean section rates [25-27]. Also, consumers' comprehension of the performance data of institutions may be insufficient because of poor presentation quality, making it a barrier to a consumer' s selection [28,29]. In addition, the incentive to sustain the effort of reducing cesarean

Table 3. Effect of repeated public releases on cesarean section rates, January 2003 - December 2007: ARIMA(1, 1, 0)(0, 1,0)$_{12}$

	Model 1 (initial)			Model 2 (final)		
	Estimate	SE	*p*-value	Estimate	SE	*p*-value
August 29, 2005						
Numerator 1	0.332	0.155	0.047	0.664	0.232	0.008
Numerator 1,1	0.963	0.352	0.01	-0.822	0.285	0.007
Numerator 1,2	0.980	0.360	0.02	0.603	0.194	0.004
Denominator 1,1	-1.791	0.244	<0.001	0.829	0.108	<0.001
Denominator 1,2	-1.108	0.171	<0.001	-1.050	0.114	<0.001
December 30, 2005						
Numerator 2	-0.738	0.270	0.01			
Numerator 1,1	0.184	0.513	0.73			
Numerator 1,2	0.440	0.496	0.39			
Denominator 1,1	1.450	0.429	0.004			
Denominator 1,2	-0.703	0.381	0.08			
July 26, 2006						
Numerator 3	-1.982	0.655	0.008			
Numerator 1,1	2.301	0.812	0.011			
Numerator 1,2	0.702	1.284	0.59			
Denominator 1,1	0.547	0.404	0.19			
Denominator 1,2	0.006	0.564	0.99			
December 29, 2006						
Numerator 4	-1.405	2.021	0.50			
Numerator 1,1	0.465	1.282	0.72			
Numerator 1,2	-1.588	1.532	0.32			
Denominator 1,1	0.513	0.560	0.37			
Denominator 1,2	0.557	1.129	0.63			
AR(1)	-0.494	0.212	0.03	-0.664	0.149	<0.001

ARIMA: autoregressive integrated moving average, SE = standard error, AR = autoregressive, AIC = model 1 (60.2), model 2 (-255.8).

section rates was uncertain it may decay the effort of institutions.

The size of effect was 0.8 percentage points, and the duration of the effect included the entire period after first public release. Before 5 years ago the HIRA's public releases and feedback about cesarean section rates, the National Health Insurance corporation (NHIC) publicly reported the information of un-adjusted cesarean section rates in July 7, 2000. The reporting of NHIC had decreased the cesarean section 3.4-4.4% at national level and reversed the trend in increasing of cesarean section rates [12]. Because of the downward trend of cesarean section rates since the reporting of NHIC, it may drive the effect of public releases and feedback of the HIRA to limitation.

Institutions have a upper baseline cesarean section rate and a greater decrease in cesarean section rates when presented with RPR. Just as institutions with upper mortality rates improved after public release of studies about cardiac surgery, institutions with a lower performance of cesarean section rates were more susceptible to public release [29,30].

There were also variations of the effect of RPR within the number of deliveries, the institutions have a upper number of annual total deliveries had a greater decrease in cesarean section rates. Although the upper baseline cesarean section rates drove to the more decreases in cesarean section rates after RPR, the upper third of institutions by delivery numbers had a lower baseline cesarean section rates and be comprised Group practices in obstetric specialty institutions. Additionally, market share and market competition and region (proxy measure of provider density) did not affect the decrease in cesarean section rates. These findings suggest that the concerns about the public image of institutions are more effective than the market situation for decreasing the rates of cesarean sections [12,31]. Public releases may initiate an implicit incentive, such as avoiding damage to a reputation, which allows the releases to create not only a market-dominated system (e.g., the US), but also a government-dominated system (e.g., the UK) [32,33].

Whereas most of the earlier studies examining the effectiveness of public releases about cesarean section rates were performed by simple before-and-after analysis [12-14]. Therefore, they suffer from the limitations of maturation effects and seasonal trend effects. In this case, an interrupted time series design was tested to find the more precise size and duration of the effect on cesarean section rates. Almost all of the deliveries (96.7%) were analyzed, and a consistent administrative

Table 4. Results of multivariate ordinal logistic regression model of the factors affecting repeated public releases of cesarean section rates

	OR	95% CI
Institution type		
Tertiary care hospital	0.5	0.3 - 1.0
General hospital	0.6	0.4 - 1.0
Hospital	0.9	0.6 - 1.5
Clinic	1.0	
Region		
Capital city	1.5	0.6 - 3.6
Metropolis	1.0	0.4 - 2.3
Satellite city	0.9	0.4 - 2.2
City	1.2	0.5 - 2.7
Rural	1.0	
Ownership		
Public	0.8	0.3 - 2.3
Private	1.0	
No. of deliveries (y)		
Upper third	2.8	1.6 - 4.7
Middle third	1.9	1.3 - 2.9
Lower third	1.0	
Baseline cesarean section rates		
Upper third	4.7	3.1 - 7.1
Middle third	1.8	1.3 - 2.5
Lower third	1.0	
Regional market competitiveness		
Upper third	1.5	1.0 - 2.2
Middle third	1.3	0.9 - 1.9
Lower third	1.0	
Regional market share		
Upper third	0.8	0.5 - 1.3
Middle third	0.7	0.4 - 1.0
Lower third	1.0	

OR: odds ratio, CI=confidence interval.

formula was used, allowing this analysis to overcome the risks of selection and instrument bias.

As number of times increased, the effect of RPR has decayed in reducing cesarean section rates. To last the effect of RPR, it is need to improve the presentation method and promote the use of information by mass media. The lower baseline cesarean section rate is higher than the average cesarean section rates across OECD countries. Not institutions with upper cesarean section rates, but the lowers should be supported to decrease the rates. We suggest that not only public release, but also multi-faced strategies are continually used to reduce the cesarean section rates of the both. Complex interventions (education, financial incentives, audit, feedback, public release, identification of barrier to change, clinical practice guidelines, etc.) are more effective than the single in reducing cesarean section rates [5].

Our study has limitations. There was no comparison group to differentiate the net effectiveness of RPR from a history effect. RPR were performed nationwide, and thus it is impossible to perform a group comparison. Many nonclinical factors affect cesarean section rates, including provider factors (institutional characteristics, physician characteristics) and consumer factors [34-37]. However, the factors related to physicians (training/experience, procedure characteristics) and consumers (socioeconomic status, culture) were not investigated in our study. Further research should investigate physicians' and consumers' characteristics, which can affect the response to RPR.

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CONFLICT INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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