Development of a Resource-Based Relative Value Scale and Fee of Advanced Nursing Practices by Nurse Anesthetists in South Korea

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Abstract

Purpose: This study was aimed to develop fee and a resource-based relative value scale (RBRVS) advanced nursing practices done by nurse anesthetists under the national health insurance. Methods: The classification of practices in Nurse Anesthetists was performed by clinical panel and then the RBRVS of nurse anesthetists for 16 advanced nursing practices was calculated by magnitude estimation method, based on their workload and working time survey in the context of the national health insurance. A cost analysis including direct labor cost and indirect cost for advanced nursing practice was performed to estimate the conversion factor (unit price) for the RBRVS of nurse anesthetists. The share of nurse anesthetists' contribution to the feefor-service was also analyzed. Results: Calculation of the RBRVS for the 16 advanced nursing practices showed a range of points from 100 to 305.2 with an average of 175.3 points. The relevant conversion factor for advanced nursing practices of nurse anesthetists was estimated at $14.9 \sim 19.4$ Korean won. The nursing fee for 16 advanced nursing practice was calculated by multiplying the RBRVS of the each practice and the conversion factor. The contribution rate for advanced nursing practices of nurse anesthetists using the relative value scale of the national health insurance was estimated at $9.3\% \sim 100.0\%$ (indirect cost 10%) with the rate varying widely. **Conclusion**: In order to address the shortage of anesthetic staffs, the employment of nurses specializing in anesthesia is thought to bring the national interests. In addition, we believe the Nurse Anesthetist system is an effective way to prevent a shortage of anesthetic care providers in South Korea.

Keywords: Nurse Anesthetists, Advanced nursing practice, Resource based relative value scales (RBRVS), Nursing fee

1. Introduction

There were a total of 1,657,000 cases of major surgical patients in 2011, with an increase of 20.8% compared to the 1,372,000 cases in 2006 [1]. Further increases in surgical patients is expected due to the rapid advance of modern medical science and a rise in a life expectancy in Korea [2] (Korean Statistical Information Service, 2010). The revised surgical procedures require surgeons as well as anesthetic care providers. In

the near future in Korea, there will be a shortage of nurse anesthetists and anesthesiologists by 2015 [3]. This shortage of anesthetic care providers could result in a delay or cancellation of surgery. This is why the government needs to introduce a measure that will reverse this trend so that there will be enough anesthetic care providers in the future.

The educational program for Korean Nurse Anesthetists (KNAs), which was founded at hospitals for the first time in 1973, was initiated to solve the shortage of anesthesiologists [4]. However, in 2003, the educational program for KNAs was transferred from hospitals to higher educational institutions, *i.e.*, master's degree level [5]. Since 1973, 550 KNAs have been trained with the support of the Ministry of Health, Welfare and Family Affairs, and currently 240 KNAs are practicing as anesthetic care providers as of April 2013 [6]. Bai & Yoon (2013) reported that KNAs perform preanesthetic assessments, implement anesthetic care, and monitor the patient's physiological conditions during anesthesia under the supervision of a surgeon or anesthesiologist [7]. Although KNAs do contribute to the actual demands found in clinical settings and considering that there is a shortage of anesthesiologists in Korea, they are not given credit for their anesthetic practices.

Although the nurse practitioner system contributes by providing high quality care and decreasing medical expenses, it is treated unfairly. Certified Registered Nurse Anesthetists in the United States are paid the cost for their anesthetic practice [8], but KNAs do not warrant the cost of anesthetic care in Korea. In order to improve the nurse practitioner system in anesthetic practices, it is imperative to enact legislation that implements cost policies for high quality anesthetic nursing care. Although KNAs have been providing anesthetic care since 1976, there has been no research on the cost of anesthetic practices of KNAs. Therefore, we performed an economic analysis and cost development using the relative value scale of anesthetic practices for KNAs.

2. Definition of Terms

2.1. Resource-Based Relative Value Scale (RBRVS)

Resource-based relative value scale (RBRVS) introduced by Hsiao et al (1988) is the relative value scale of medical services taking into consideration the amount of input resources like workload, time spent on working, and degree of risk for medical services provided. In this study, RBRVS was estimated by the work time of the nurses, physical skill and efforts, mental effort, and stress, excluding the degree of risk [9].

2.2. Conversion Factor

Conversion factor is the price for one unit of the resource-based relative value scale and it is usually calculated with the cost analysis method based on the personnel expenses of nurses and indirect costs, the revenue-expense index model method and the SGR (sustainable growth rate) method. In this study, a cost analysis including direct labor cost and indirect cost related to advanced nursing practice was performed to estimate the conversion factor for advanced nursing practices of nurse anesthetists.

2.3. Nursing Fee

Nursing fee for each practice is calculated by multiplying the RBRVS of the each practice and the common conversion factor: nursing fee for practice(i) =RBRVS(i) * conversion factor.

3. Research Method

3.1. Research Design and Procedure

In the National Health Insurance (NHI) system, the medical fee is calculated by multiplying the relative value scale by the conversion factor. To develop a nursing fee, this study estimated the resource-based relative value scale and conversion factor for advanced nursing practices done by nurse anesthetists so that their contribution rate could be analyzed.

First, a clinical panel was organized to classify the advanced nursing practices of nurse anesthetists. And the researchers requested a health insurance review specialist to review the EDI (Electronic Data Interchange) code and name of the classified practices in the context of the NHI system. After that, the working time measurement based on one-on-one observations and frequency and resource based relative value scale survey were conducted by nurse anesthetists. The relative value scale and conversion factor of each practice were estimated to develop a nursing fee. Lastly, the contribution rate of nurse anesthetists was calculated by using the adjusted relative value scale for advanced nursing practices of nurse anesthetists.



Figure 1. Fee Development Process using the Relative Value Scale for the Practices of NAs

3.2. Data Collection and Analysis

To make a list of advanced nursing practices of nurse anesthetists, a telephone survey of all 43 tertiary hospitals was used to find the appropriate hospitals. Nurse anesthetists from 4 tertiary hospitals in which nurse anesthetists have a separate job description and additional allowances compared to general nurses were recruited for the study. Their job responsibilities were classified as advanced nursing practices of nurse anesthetists and they described the content of these practices. Then, a clinical panel reviewed the actuality and significance of these practices and excluded some of them making a list of 22 practices finally. The clinical panel, which was composed of 4 nurse anesthetists and one professor from a college of nursing, majored in adult nursing and were highly experienced in policy for the advancement of nursing practices. After comparing these practices with the fee code from the NHI, 16 practices were classified as advanced nursing practices of nurse anesthetists.

A survey on the relative value of advanced nursing practices and working time was completed by nurse anesthetists with five or more years of experience in the operating room under the guidance of the researchers.

3.2.1. Nursing Workload

A relative value scale for nursing workload was estimated using relative physical skill and effort, mental effort and stress from each practice and working time. Except for the working time measurement, it was evaluated by the self-administration method using the magnitude estimation method with "consciousness level monitoring" as a standard nursing practice. A practice that had a relatively low workload, high frequency, and relatively small deviation was chosen as a standard nursing practice.

The working time measurement was done by nurse anesthetists during working hours $(09:00 \sim 17:00)$ over 7 days from February 1 to February 7, 2013. Through one-on-one observations, working time was measured by dividing it into preparation time, practice time and retrospective time measured in units of seconds.

Among the surveyed relative value scale, the extreme scale of both ends was adjusted according to the method of the 3% Winsorized mean. The Cronbach's alpha of the relative value scale was 0.92.

3.2.2. Frequency

To estimate the frequency of the advanced nursing practices, statistical data, a report on the practices of nurse anesthetists, and the treatment materials of the targeted hospitals from January 2012 to June 2012 were used.

3.2.3. Direct Personnel Expenses and Indirect Cost.

The personnel expenses of nurse anesthetists were estimated using the average wage of nurses for 10 years of experience in the 33 tertiary hospitals investigated by the Korean Nurses Association in 2008. It is 41,296,840 Korean won (KRW). But considering an annual increase rate of 3.47% for the head nurse's wage in the years 2008 and 2011 according to the survey from the Korean Hospital Nurses Association [10], 42,729,840 KRW was used as direct personnel expenses. The indirect cost was estimated according to a scenario based on a rate of 0%, 10%, 20%, and 30% of the direct personnel expenses. The ratio of indirect cost to direct labot cost in the production of nursing services has been less than 30% in the Korean hospital industry [10].

3.2.4. Development of the Resource -Based Relative Value Scale

The resource-based relative value scale for advanced nursing practices of nurse anesthetists was developed using a method suggested by a previous study on fees for nursing services [11]. It was actually applied to calculate the NHI fee in Korea.

First, the average (U_i) for physical effort, mental effort and stress from advanced nursing practices was calculated from the survey. U_i is the arithmetic mean of α_i , β_i , and δ_i , which are the three elements of RBRVS. Second, when compared to the standard practice as a basis, the RBRVS (V_i) of each of the 16 practices was derived taking into considering the working time.

 $U_i = (\alpha_i + \beta_i + \delta_i)/3$

where U_i : average relative value of advanced nursing practice

 α_i = relative value of technical and physical effort

 β_i = relative value of mental effort

 δ_i = relative value of stress

 $V_i = (U_i T_i / U_0 T_0) * 100$

where V_i : average relative value compared to standard practice

U_i = relative workload of nursing practice(i)

 T_i = input time to nursing practice(i)

 U_0 = relative workload of standard nursing practice (100)

 T_{0} = input time to standard nursing practice

3.2.5. Conversion Factor

The conversion factor can be estimated from the equation used to calculate the nursing cost by multiplying the relative value scale (V_i), frequency (Q_i) and conversion factor (F) of the practice, in which the unknown is the conversion factor, and the nursing cost is calculated by dividing the direct personnel expenses and indirect cost of nursing (C_{NP}) by the rate of time (k) input for the 16 advanced nursing practices among the working hours of the nurse anesthetists.

The left side of the equation indicates the reimbursement (revenue) for providing nursing services in the national health insurance and the right side means total cost required to produce the nursing services. Therefore, the equation indicates a break-even condition in providing the nursing services, from which the conversion factor is derived. In this study, nursing cost includes only personnel expenses and indirect costs (0~30% rate of the personnel expenses) to prevent overestimation of the nursing cost.

 $\sum V_i * F * Q_i * (1+m) = C_{NP} * k$

 \therefore F = (C_{NP} * k)/{ $\sum V_i * F * Q_i * (1+m)$ }

where $k = \sum T_{i*}Q_i$ / 9hour*60minute*22day*12month

k: The rate of time input for the advanced nursing practices among the working

hours of advanced nursing practitioners

m: The added-ratio of tertiary hospital

3.2.6. Nursing Fee

Since price system in market economy is defined as the product of relative price and numeraire, nursing fee in RBRVS payment system also consists of RBRVS and conversion factor. After the RBRVS(V_i) of the each practice and the conversion factor(F) are derived, the nursing fee (P_i) is calculated by multiplying the V_i , F, and the added-ratio of the tertiary hospitals(m), which was 30% in the NHI.

 $P_i = V_i * F * (1+.3)$

3.2.7. Contribution Rate of Advanced Nursing Practices

In the NHI, a medical fee is comprised of man power expenses that include nurses, interns, doctors and others, so there is a portion of the contribution from the nurses' workload in the NHI RBRVS though the exact rate is not known. Accordingly, to identify the contribution rate of the advanced nursing practices for the RBRVS in the current NHI, the researchers calculated the adjusted relative value scale (AV_i) using the current conversion factor of 66.0 from the NHI. The contribution rate is estimated as a percentage of the adjusted RBRVS (AV_i) of the RBRVS presented in the current NHI.

 $AV_i = V_i * F / 66.0$

Contribution rate = $(AV_i / RBRVS \text{ presented in the current NHI}) * 100$

where AV_i indicates adjusted resource-based relative value scale

3.3. Ethical Considerations

Data collection proceeded with prior approval (No. 2012-44) from the Institutional Review Board of Seoul National University College of Nursing. Before the survey, consent was received from the participants and they were notified that they could withdraw from the study at any time. Access to the data was strictly limited to the researchers.

4. Results

4.1. Classified Anesthetic Nursing Practices

There were 63 nurse anesthetists that completed the survey and there were 4 men (6.3%) and 58 women (92.1%) and the average age was 30.1 years (30.1 ± 6.90) . The marital status of the subjects was as follows: 39 unmarried nurses (61.9%), 20 married nurse (31.8%), and the other subject 4(8.3%). In addition, the average working career of the nurses was seven years.

For the anesthetic nursing practices, 16 acts were finally classified. The practices were consciousness level monitoring, blood pressure monitoring by an A-line, preanesthetic assessment during general anesthesia, setting up anesthetic equipment, endotracheal intubation and extubation, natural drainage and care after operation, arterial catheter insertion, arterial puncture and reading of ABGA, epidural anesthesia, spinal anesthesia, brachial plexus block, PAR score evaluation, Pulse O_2 saturation monitoring, and expiration end CO_2 monitoring.

4.2. Resource Based Relative Value Scale, Frequency and Conversion Factor

Calculation of the RBRVS for the 16 advanced nursing practices had a range of points from 100 to 305.2 with an average of 175.3 points. The relevant conversion factor for the

advanced nursing practices of nurse anesthetists was estimated at 14.9~19.4 KRW with an indirect cost rate of 0%, 10%, 20%, and 30%. The workload time included brachial plexus block 5709.4 s, epidural block 3301.6 s, and arterial catheter insertion 3750.2 s. These procedures were high level skills in the workload. They were practiced for a long time because a brachial plexus block takes 33 minutes 13 seconds. The frequency of monitoring blood pressure with an A-line, Pulse O₂ saturation, and expiration end CO₂ was high; thus, these were the most commonly performed tasks of a nurse anesthetist (Table1).

	Relative Value Scale			Time		Corrected		
Advanced practice	Technical Skill	Mental effort	Stress	Mean	(minute :second)	(RBRVS*T)	RBRVS ³⁾	Frequency ⁴⁾
Monitoring Consciousness level ¹⁾	100	100	100	100	9:05	905.0	100.0	528
Monitoring blood pressure with an A-line ¹⁾	100.1	100.2	150.4	116.9	18.00	2104.2	232.5	2030
preanesthetic assessment	100.5	200.0	200.2	166.9	4:09	682.6	75.4	405
Setting up anesthetic equipments	150.1	200.2	200.1	183.5	9:37	1719.1	190.0	310
Endotracheal intubation ²⁾	200.2	249.7	289.1	246.3	13:21	3254.1	359.6	256
Endotracheal extubation ²⁾	189.0	192.0	399.5	260.2	8:03	2089.1	230.8	231
Nasogastric tube insertion	143.8	188.5	190.9	174.4	10:32	1799.8	198.9	32
Sampling and Irrigation from Tube	143.5	150.2	198.1	163.9	10:58	1734.4	191.6	215
Arterial catheter Insertion	203.1	310.2	402.3	305.2	12:29	3750.9	414.5	76
Care related Blood gas study	148.2	189.1	211.1	182.8	6:42	1173.6	129.7	410
Epidural anesthesia ²⁾	188.1	138.2	162.1	162.8	20:28	3301.6	364.8	0.6
Spinal anesthesia ²⁾	212.1	154.3	135.1	167.2	20:01	45.0	369.6	76
Brachial plexus block ²⁾	220.4	143.5	153.1	172.3	33:13	5709.4	630.9	2.3
Assessing PAR score	112.0	170.2	235.2	172.5	2:18	371.0	41.5	390
Pulse O ₂ Saturation Monitoring	97.0	103.5	143.2	114.6	10:00	1145.7	126.6	2036
Monitoring end- tidal CO ₂	102.2	99.4	144.2	115.3	10:00	1152.7	127.4	2036
Mean	150.6	168.1	207.1	175.3	12:31	2140.2	236.5	565
	Proportion of indirect cost in NA's total cost							
Conversion factor	0%)	10	%		20%		30%

Table 1. RBRVS, Time and Frequency in Nurse Anesthetists

10% 0% 16.4

17.9

1) estimate as the mean of one operation by general anesthesia

14.9

2) intervention under supervision of medical doctor

3) average relative value compared with standard practice

4) frequency done by one nurse anesthetist during one year

19.4

4.3. Fee by RBRVS

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For nursing practices in anesthesia, most belonged to the category of less than 10,000 KRW except for some practices. For an indirect cost of 30%, Brachial plexus block was 15,910 KRW, and Arterial catheter insertion was 10,452 KRW. PAR score evaluation, pulse oximetry, CO_2 monitoring of expiration end, and preanesthetic assessment had lower fees than that of the other practices.

Table 2. Costs of	Advanced	Nursing	Practice in	n Nurse	Anesthetists
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Advanced practice	Health insurance	Health Insurance	Cost by indirect cost rate				
		fee	0%	10%	20%	30%	
Monitoring Consciousness level ¹⁾	involved general anesthetic fee		1937.0	2132.0	2327.0	2522.0	
Monitoring blood pressure with an A-line ¹⁾	involved general anesthetic fee		4503.7	4957.1	5410.5	5863.9	
Preanesthetic assessment	involved general anesthetic fee		1461.0	1608.1	1755.2	1902.3	
Setting up anesthetic equipments	involved general anesthetic fee		3679.4	4049.8	4420.2	4790.6	
Endotracheal intubation	-	24055	6964.4	7665.9	8367.1	9068.2	
Endotracheal extubation	-		4471.4	4921.6	5371.7	5821.9	
Nasogastric tube insertion	Nasogastric tube insertion	14494	3852.2	4240.0	4627.8	5015.6	
Sampling and irrigation from tube	Natural drainage and care after operation (per day)	4082	3712.2	4085.9	4459.6	4833.4	
Arterial catheter Insertion	-		8028.2	8836.4	9644.6	10452.8	
Arterial puncture and reading of ABGA	Blood Gas study	11544	2511.2	2764.7	3017.6	3270.5	
Epidural anesthesia	Epidural anesthesia	78668	7066.5	7777.9	8489.3	9200.7	
Spinal anesthesia	Spinal anesthesia	84637	7159.4	7880.2	8600.9	9321.7	
Brachial plexus block	Brachial plexus block	95275	12220.0	13450.2	14680.4	15910.6	
Assessing PAR score	-		804.7	885.7	966.7	1047.8	
Pulse O ₂ Saturation Monitoring	-		2452.1	2699.0	2945.8	3192.7	
Monitoring end-tidal CO ₂	Involved admission care		2467.1	2715.5	2963.8	3212.2	

* Foreign exchange rate: 1 USD = 1087.2 KRW (2013.5.8)

4.4. Contribution Rate of Advanced Nursing Practices

When the practices were compared to the fees of the National Health Insurance Corporation of Korea, it was possible to compare seven practices. This was because a different classification criteria was used in our study. For an indirect cost of 10%, the contribution rate of endotracheal intubation was 31.9%, while Arterial puncture and reading of ABGA was 24.0%. The contribution rate for advanced nursing practices of nurse anesthetists using the relative value scale of the national health insurance was estimated at $9.3\% \sim 100.1\%$ (indirect cost 10%) with the rate varying widely.

		Health Insurance RBRVS	Adjusted RBRVS of Nr. Anesthetist				
Advanced practice	Health insurance		0%(cr)	10%(cr)	20%(cr)	30%(cr)	
Monitoring Consciousness level ¹⁾	involved anesthetic fee	-	22.6	24.8	27.1	29.4	
Blood pressure monitoring with an A-line	involved anesthetic fee	-	52.5	57.8	63.1	68.3	
Preanesthetic assessment	involved anesthetic fee	-	17.0	18.7	20.5	22.2	
Setting up anesthetic equipments	involved anesthetic fee	-	42.9	47.2	51.5	55.8	
Endotracheal intubation	-	280.36	81.2 (29.0)	89.3 (31.9)	97.5 (34.8)	105.7 (37.7)	
Endotracheal extubation	-	-	52.1	57.4	62.6	67.9	
Nasogastric tube insertion	-	168.93	44.9 (26.6)	49.4 (29.3)	53.9 (31.9)	58.5 (34.6)	
Natural drainage and care after operation (per day)	Natural drainage and care after operation (per day)	47.57	43.3 (91.0)	47.6 (100.1)	52.0 (109.3)	56.3 (118.4)	
Arterial catheter Insertion	-	-	93.6	103.0	112.4	121.8	
Arterial puncture and reading of ABGA	Blood Gas study	134.54	29.3 (21.8)	32.2 (24.0)	35.2 (26.1)	38.1 (28.3)	
Epidural anesthesia	Epidural anesthesia	916.88	82.4 (9.0)	90.7 (9.9)	98.9 (10.8)	107.2 (11.7)	
Spinal anesthesia	Spinal anesthesia	986.45	83.4 (8.5)	91.8 (9.3)	100.2 (10.2)	108.6 (11.0)	
Brachial plexus block	Brachial plexus block	1110.43	142.4 (12.8)	156.8 (14.1)	171.1 (15.4)	185.4 (16.7)	
Assessing PAR score	involved admission care	-	9.4	10.3	11.3	12.2	
Pulse O ₂ Saturation Monitor	involved anesthetic fee	-	28.6	31.5	34.3	37.2	
Monitoring end-tidal CO ₂	involved anesthetic fee	-	28.8	31.6	34.5	37.4	
Mean			53.4	58.8	64.1	69.5	

Table 3. Contribution Rate of Advanced Nursing Practice RBRVS

cr: contribution rate

5. Discussion

O'Brien (2003) has pointed out that the recognition of advanced practices of nurses within the health care system is very important [12]. For services not covered by health insurance, they cannot be performed in hospitals, so it is difficult to provide those services to individuals.

In South Korea, to improve the current system, nurses must prove the effectiveness of advanced nursing care. In addition, economic evaluation will prove that advanced nursing care is beneficial to the public health system. We classified 16 anesthetic nursing practices before the economic evaluation. Nurses' tasks focus primarily on the role of monitor such as conscious level, blood pressure, pulse O2 saturation, expiration end CO2 under general anesthesia. And they have to perform the tasks associated with anesthesia under doctor's supervision, such as epidural, spinal anesthesia, brachial plexus block, etc. In this study, assuming the ratio of indirect cost to direct labor cost 10%, the contribution rate of nurse anesthetists was estimated to 9.3%~100.0% and its range was very various.

In South Korea, quality assurance policy of nursing services in the current health care system is implemented through nursing manpower grade system in which nursing fee schedule is proportional to the number of nursing practioners in the admission care. However, the effects of the nursing manpower grade system on nurse employment is very limited since there is weak penalty or low discount rate of nursing fee for the hospitals where nurse staffing level is below the legal requirements. In other words, there is no separate compensation for nursing services, and hospital charge covers the cost of most nursing services.

The practices of nurse anesthetists are not compensated separately and its reimbursement is usually included in physician fee. Therefore, we estimated an independent fee related to anesthetic nursing services and showed the contribution rate of nurse anesthetists to total revenue. This analysis confirmed the contribution performed by nurse anesthetists. It suggests that nurse anesthetists be considered as an alternative to the lack of physician supply in anesthesia.

We think the Nurse Anesthetist system is an effective way to prevent a shortage of anesthetic care providers. From the 36,000 Certified Registered Nurse Anesthetists (CRNAs) and 42,330 anesthesiologists registered as anesthetic care providers in the United States in 2007, approximately 65% of the CRNAs practice in collaboration with anesthesiologists. Such use of the CRNA system in the United States seems to be attributed to the reimbursement of CRNA care [8]. Therefore, measuring the economic value of anesthetic care by nurse anesthetists will be the basis for establishing a reimbursement system for nurse anesthetists and using the Korean Nurse Anesthetist System. Furthermore, a Korean Nurse Anesthetist System seems to be crucial to containing rising medical costs while maintaining high quality anesthetic care.

The difference in the contribution rate and current medical cost is the economic benefits(medical savings). In addition, If practices were performed entirely by a nurse anesthetists instead of doctors, difference of the relative value scales of anesthetic nursing practice and national health insurance will be national benefits. In addition, in order to address the shortage of anesthetic staffs, the employment of nurses specializing in anesthesia is thought to bring the national interests.

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