The Lewin Group

HEALTH CARE AND HUMAN SERVICES POLICY, RESEARCH, AND CONSULTING—WITH REAL-WORLD PERSPECTIVE.

Update of Cost Effectiveness of Anesthesia Providers

Final Report

Prepared for: **American Association of Nurse Anesthetists**

Submitted by: **The Lewin Group, Inc.**

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I. INTRODUCTION AND BACKGROUND

Anesthesia services, in the United States, are predominantly provided by two types of providers: Certified Registered Nurse Anesthetists (CRNAs) and Anesthesiologists. CRNAs are advanced practice nurses who have earned a baccalaureate degree, practiced at least one year as an acute care nurse, and have successfully completed a graduate-level nurse anesthetist program. Anesthesiologists are physicians who have completed medical school, a clinical base year residency, and three years of residency in an anesthesia program.

Both types of providers are critical to the safe, efficient provision of anesthesia services, but are subject to different regulations. For example, anesthesiologists are licensed to practice independently in 50 states plus the District of Columbia. CRNAs, in contrast, are subject to state law requirements. Many states do not require CRNAs to be supervised by a physician. Some states require CRNAs to practice in collaboration or cooperation with a physician, or do not specifically require physician involvement. States that require CRNAs to be physician supervised do not require that the physician be an anesthesiologist. In all situations, CRNAs are responsible for their clinical decisions concerning the provision of anesthesia.

As a result, anesthesia services can be delivered in a variety of delivery models that vary by the degree of autonomy in which CRNAs may deliver anesthesia, as well as economic considerations. At one end of the spectrum, the CRNA may provide and bill for anesthesia services alone. At the other end, anesthesiologists may be the only providers administering and billing for anesthesia services in a particular practice setting. In between the two extremes, CRNAs may provide anesthesia services under physician oversight (i.e., medical direction or supervision) as determined by anesthesia provider ratios. Delivery models may vary by practice setting based on the preferences and beliefs of the particular hospital or other setting, and because of state-specific and federal laws and regulations regarding the delivery and billing for services.

In this paper, we refer to CRNAs who provide anesthesia for a patient under the care of an operating practitioner, but are neither supervised nor medically directed, as "independent." CRNAs who provide anesthesia under physician oversight are either medically directed or supervised. These terms are used in the context of anesthesia staffing models and costs, not in terms of clinical decisions.

The costs of delivery services will vary across delivery setting and across delivery models within a setting. A cost simulation model developed in Hogan et al. (2010) is used to evaluate both differences across delivery models and potential costs savings associated with a change in the delivery model distribution. The simulation model highlights recent updates to the parameters used in the model. A summary of the cost and revenue implications of different delivery model types is presented.

II. SIMULATION MODEL

In cost effectiveness analysis, the output or product of the delivery model, including its quality as well as quantity, is held approximately constant.[1] The total cost needed to provide the required anesthesia services is then compared across delivery models. The most cost-effective approach is the one that produces the output or service at the lowest cost while maintaining quality. An economically viable model is one where the revenue generated exceeds the costs.

The cost effectiveness of anesthesia delivery services is largely assessed in a context of simulation analyses (e.g., Hogan et al. 2010, Quintana et al. 2009).[2] The purpose of the simulation model is to simulate costs and revenue that would likely occur under various anesthesia delivery models and settings. A total of seven different delivery models are considered:

1. Certified Registered Nurse Anesthetist (CRNA) practicing without an anesthesiologist involved in anesthesia delivery;
2. An anesthesiologist practicing alone;
3. Four medical direction model variants consisting of one anesthesiologist directing 1, 2, 3 or 4 CRNAs;
4. A supervisory model where one anesthesiologist supervises more than 4 CRNAs.

A key distinction between a medical direction model and a supervisory model is that in the direction models an anesthesiologist must fulfill the seven requirements established by the *Tax Equity and Fiscal Responsibility Act of 1982* (TEFRA) to medically direct a CRNA, while in the supervisory model the anesthesiologist is immediately available. These differences are captured in the simulation model along with differences across delivery settings.

Although cost effectiveness assessment relies on simulation of costs, the model also simulates revenue. Calculation of costs is straightforward and is based on the salary of CRNAs and anesthesiologists and the delivery model used to administer the service. Intuitively, in an anesthesiologist acting alone model, the cost of providing a given anesthesia procedure is the implied cost of the anesthesiologist's time. However, if demand in a given day is unexpectedly low so that the anesthesiologist has idle time and completes fewer procedures, the implied cost per procedure will be greater. Reimbursement or revenue for the procedure depends on the type of delivery model as well as the type of payer. The reimbursement rules (i.e., the billing rules) vary across payer types. In particular, the billing rules for Medicare Part B used in the simulations are:

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[1] Evidence that the quality of anesthesia care does not vary across delivery model types is presented in Negrusa et al (2016), forthcoming.

[2] See a literature review in Hogan et al. 2010.

Table 1. Medicare Billing Rules

Delivery Model	CRNA	Anesthesiologist
Anesthesiologist alone		(Base units+Time units)*Conversion Factor
CRNA alone	(Base units+Time units)*Conversion Factor	
Medical direction	(Base units+Time units)*Conversion Factor*.5	(Base units+Time units)*Conversion Factor*.5
Supervisory	(Base units+Time units)*Conversion Factor*.5	4 units

Note: Centers for Medicare & Medicaid Services (CMS).

Additionally, the set-up for a simulation requires specifying a number of parameters that are taken into account during the simulations. Key variables include the following:

- Demand. This is the number of patients seeking an operation in a given day.

- Payer distribution. The user also specifies the proportion of patients by payer type. These include Medicare, Medicaid, private payer, and self-pay. The latter is unreimbursed.

- Characteristics of the anesthesia procedure: base units and time units. The number of base units represented by the procedure is a measure of complexity. The number of time units correspond to the duration of the procedure. Both base units and time units are essential in determining the reimbursement amount for the procedure.

The model is stochastic. That is, one specifies a distribution for demand, base units, time units and so forth, rather than a single number for each. This means that the exact procedures, defined by base units and time units, that the setting conducts in a period will fluctuate around a specified mean, but potentially differ from day to day. One can simulate different settings, including inpatient, ambulatory surgery center (ACS), by specifying the distribution of demand, base units and time units. We use empirically observed median values for time and base units to distinguish among the different settings. Typical inpatient surgery procedures generally has greater time units and base units per procedure than an outpatient facility. For a given simulation, each delivery model faces the same set of realized values of patient demand, base and time units. That is, these parameters are constant in calculations of the costs and revenue.

A number of simulations across practice settings was conducted. The set-up for these simulations was the same and is shown in Table 2.

Table 2. Key Parameters Held Constant in Simulations

	Medicare	Medicaid	Private	Self-pay
Payer Proportions [a]	.33	.14	.46	.07
Conversion Factors	$22.61 [b]	$18.06 [c]	$68.00 [d]	0
		Costs		
Anesthesiologist	$350,000/yr.	CRNA	$170,000/yr.	

Note: [a] The payer proportions are obtained from the Medical Expenditure Panel Survey (the 2013 Hospital Inpatient Stays file and the 2013 Outpatient Visits file). The proportions reported are conditional on patients having an operation or surgery event. [b] The 2015 national conversion factor for Medicare. Retrieved from the website of Center for Medicare & Medicaid Services. [c] The average Medicaid reimbursement conversion factor based on data from 39 states. [d] The national median in 2015 (Stead and Merrick, 2015).

Similar to Hogan et al. (2010), the practice settings are defined by the characteristics of the procedures. Table 3 shows the median values for the number of base units per procedure and the number of time units per procedure obtained from the Optum Corporation's research database of de-identified Normative Health Insurance (dNHI) claims for 2011-2012.[3]

Table 3. Median Values for Procedures by Setting

Setting	Base units	Time units
Inpatient	6.0	8.3
Outpatient Surgery	5.0	3.7
Ambulatory Surgery Center	5.0	2.1

Note: Outpatient setting excludes procedures performed in Ambulatory Surgical Centers, which are reported separately.

For each simulated scenario, we first used facility-level data to define the types and volume of anesthesia services provided at a typical facility assuming typical hours and days of operation. Then, we modeled the total cost to provide anesthesia services under each of the delivery models.

Efficiencies, under some delivery models, will vary depending on how many patients simultaneously receive anesthesia as well as how many patients receive anesthesia in a setting in a year. The simulation model will be able to analyze the effect of different patient workload demands on the costs associated with the model. This is potentially important because the cost associated with a delivery model must be analyzed in the context of a patient workload and the distribution of this patient workload. For example, if the delivery model consists of an anesthesiologist in a supervisory role for up to four nurse anesthetists, the average cost of providing anesthesia will vary depending upon whether there is actual patient workload demand to support the model. If patient demand is such that the anesthesiologist is actually supervising the administration of anesthesia by four CRNAs simultaneously only 30% of the time, the costs will be higher than if there were patients to support full utilization.

[3] Observed means are generally higher due to outliers in the data that skew the distribution to the right. Medians that more closely align with typical units observed in a setting (based on the feedback from the Technical Expert Panel), therefore, are preferred.

The first scenario compares the results from the seven delivery models in an inpatient setting. For comparison purposes, we assume each delivery model operates at a facility with 12 distinct locations (i.e., stations). Hence, in a medical direction 1:4 model, three anesthesiologists would be directing a total of 12 CRNAs. The results are calculated at the annual basis assuming typical hours and days of operation.

Table 4 presents the results from simulating the delivery models in an inpatient setting operating for a year under ideal conditions. The flow of patients is sufficient to conduct four procedures per day, on average, at each station. The results indicate the CRNA acting independently model is the least costly per procedure and produces the greatest net revenue.

Table 4. Inpatient Simulations with Average Demand (12 Stations)*

	Yearly Total Revenue	Yearly Total Costs	Revenue Minus Costs
Anesthesiologist alone (4 Per Station Per Day)	6,531,454	4,200,000	2,331,454
CRNA alone (4 Per Station Per Day)	6,531,454	2,040,000	4,491,454
Medical direction 1:1 (4 Per Station Per Day)	7,051,885	6,240,000	811,885
Medical direction 1:2 (4 Per Station Per Day)	7,051,885	4,140,000	2,911,885
Medical direction 1:3 (4 Per Station Per Day)	7,051,885	3,440,000	3,611,885
Medical direction 1:4 (4 Per Station Per Day)	7,051,885	3,090,000	3,961,885
Supervisory 1:6 (4 Per Station Per Day)	5,030,207	2,740,000	2,290,207

Note: *4 per station per day is defined as 4 anesthetics per anesthetizing location per day. Demand four procedures per day, on average, at each station over the course of a year.

Table 5 presents the same results, except on per procedure or per patient basis.

Table 5. Per Procedure Results for Inpatient Setting with Average Demand (12 Stations)*

	Revenue per Procedure	Costs per Procedure	Revenue Minus Costs per Procedure
Anesthesiologist alone (4 Per Station Per Day)	623.33	400.76	222.57
CRNA alone (4 Per Station Per Day)	623.33	194.66	428.67
Medical direction 1:1 (4 Per Station Per Day)	672.97	595.42	77.55
Medical direction 1:2 (4 Per Station Per Day)	672.97	395.04	277.93
Medical direction 1:3 (4 Per Station Per Day)	672.97	328.24	344.72
Medical direction 1:4 (4 Per Station Per Day)	672.97	294.85	378.12
Supervisory 1:6 (4 Per Station Per Day)	479.92	261.40	218.52

The next scenario considers what may happen in an outpatient setting. Given substantially lower values of the median time units for this type of facility, the average demand for this setting defined as seven procedures per day, on average, at each station. The results of outpatient surgery are shown in Table 6 and Table 7, respectively for total revenue and costs and per procedure basis. The qualitative results are similar to the inpatient case.

Table 6. Outpatient Simulations with Average Demand

	Yearly Total Revenue (12 Stations)	Yearly Total Costs (12 Stations)	Revenue Minus Costs (12 Stations)
Anesthesiologist alone (7 Per Station Per Day)	8,289,881	4,200,000	4,089,881
CRNA alone (7 Per Station Per Day)	8,289,881	2,040,000	6,249,881
Medical direction 1:1 (7 Per Station Per Day)	8,947,992	6,240,000	2,707,992
Medical direction 1:2 (7 Per Station Per Day)	8,947,992	4,140,000	4,807,992
Medical direction 1:3 (7 Per Station Per Day)	8,947,992	3,440,000	5,507,992
Medical direction 1:4 (7 Per Station Per Day)	8,947,992	3,090,000	5,857,992
Supervisory 1:6 (7 Per Station Per Day)	7,355,574	2,740,000	4,615,574

Note: Demand seven procedures per day, on average, at each station over the course of a year.

Table 7. Per Procedure Results for Outpatient Setting with Average Demand

	Revenue per Procedure	Costs per Procedure	Revenue Minus Costs per Procedure
Anesthesiologist alone (7 Per Station Per Day)	425.76	215.73	210.02
CRNA alone (7 Per Station Per Day)	425.76	104.78	320.97
Medical direction 1:1 (7 Per Station Per Day)	459.53	320.52	139.01
Medical direction 1:2 (7 Per Station Per Day)	459.53	212.65	246.88
Medical direction 1:3 (7 Per Station Per Day)	459.53	176.70	282.83
Medical direction 1:4 (7 Per Station Per Day)	459.53	158.72	300.81
Supervisory 1:6 (7 Per Station Per Day)	377.80	140.75	237.05

Note: Demand seven procedures per day, on average, at each station over the course of a year.

Table 8 and Table 9 show results for ASC, where demand is also defined as seven procedures per day, on average, at each station.

Table 8. Ambulatory Surgery Center (ASC) Simulations with Average Demand

	Yearly Total Revenue (12 Stations)	Yearly Total Costs (12 Stations)	Revenue Minus Costs (12 Stations)
Anesthesiologist alone (7 Per Station Per Day)	7,592,188	4,200,000	3,392,188
CRNA alone (7 Per Station Per Day)	7,592,188	2,040,000	5,552,188
Medical direction 1:1 (7 Per Station Per Day)	8,182,095	6,240,000	1,942,095
Medical direction 1:2 (7 Per Station Per Day)	8,182,095	4,140,000	4,042,095
Medical direction 1:3 (7 Per Station Per Day)	8,182,095	3,440,000	4,742,095
Medical direction 1:4 (7 Per Station Per Day)	8,182,095	3,090,000	5,092,095
Supervisory 1:6 (7 Per Station Per Day)	4,236,001	2,740,000	1,496,001

Note: Demand seven procedures per day, on average, at each station over the course of a year.

Table 9. Per Procedure Results for Ambulatory Surgery Center (ASC) with Average Demand

	Revenue per Procedure	Costs per Procedure	Revenue Minus Costs per Procedure
Anesthesiologist alone (7 Per Station Per Day)	358.55	198.35	160.20
CRNA alone (7 Per Station Per Day)	358.55	96.34	262.21
Medical direction 1:1 (7 Per Station Per Day)	386.40	294.69	91.71
Medical direction 1:2 (7 Per Station Per Day)	386.40	195.52	190.89
Medical direction 1:3 (7 Per Station Per Day)	386.40	162.46	223.94
Medical direction 1:4 (7 Per Station Per Day)	386.40	145.93	240.47
Supervisory 1:6 (7 Per Station Per Day)	350.65	226.82	123.83

Note: Demand seven procedures per day, on average, at each station over the course of a year.

III. DISCUSSION

We simulate costs and revenue of anesthesia service provision by setting and anesthesia delivery model. A current limitation of the study is that the empirical distributions used in the analyses are based on the 2011-2012 national commercial claims data. Since a similar set of billing rules applied to both "Anesthesiologist alone" and "CRNA alone" delivery models, the simulated revenue are the same for each setting. In our analysis, we assume that the same service is reimbursed at the same rate, according to the CMS billing rules.

For the inpatient setting, the results indicate the CRNA acting independently model is the least costly per procedure and produces the greatest net revenue. The supervisory model is the second lowest cost but reimbursement policies limit its profitability. Among the medical direction models, the 1:4 model does the best in terms of net revenue. Similar to the inpatient setting, CRNAs acting independently in both the outpatient and ASC settings resulted in the lowest cost delivery model and the largest net revenue.

In summary, potential cost saving strategies for anesthesia procedures would be to increase the number of procedures performed by CRNAs alone or to increase the proportion of procedures under the supervisory model.

IV. REFERENCES

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