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SYSTEMS-LEVEL QUALITY IMPROVEMENT

A System-Wide Approach to Physician Efficiency and Utilization Rates for Non-Operating Room Anesthesia Sites

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Abstract There has been little in the development or application of operating room (OR) management metrics to non-operating room anesthesia (NORA) sites. This is in contrast to the well-developed management framework for the OR management. We hypothesized that by adopting the concept of physician efficiency, we could determine the applicability of this clinical productivity benchmark for physicians providing services for NORA cases at a tertiary care center. We conducted a retrospective data analysis of NORA sites at an academic, rural hospital, including both adult and pediatric patients. Using the time stamps from WiseOR® (Palo Alto, CA), we calculated site utilization and physician efficiency for each day. We defined scheduling efficiency (SE) as the number of staffed anesthesiologists divided by the number of staffed sites and stratified the data into three categories (SE < 1, SE = 1, and SE >1). The mean physician efficiency was 0.293 (95% CI, [0.281, 0.305]), and the mean site utilization was 0.328 (95% CI, [0.314, 0.343]). When days were stratified by scheduling efficiency (SE < 1, =1, or >1), we found differences between physician efficiency and site utilization. On days where scheduling efficiency was less than 1, that is, there are more sites than physicians, mean physician efficiency (95% CI, [0.326, 0.402]) was higher than mean site utilization (95% CI, [0.250, 0.296]). We demonstrate that scheduling efficiency *vis-à-vis* physician efficiency as an OR management metric diverge when anesthesiologists travel between NORA sites. When the opportunity to scale operational efficiencies is limited, increasing scheduling efficiency by incorporating different NORA sites into a "block" allocation on any given day may be the only suitable tactical alternative.

Keywords Non-operating room anesthesia · Efficiency · Billable hours · Utilization; scheduling

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Introduction

In the United States, non-operating room anesthesia (NORA) case volumes continues to grow as demand for anesthesia services increases [1]. For clinical directors, the tactical and operational decisions used to manage NORA services are borrowed from the operating room management literature. For instance, Dexter et al. had argued that staffing for NORA cases should provide open access with a reasonable release time, aim to reduce over-utilized time, and schedule cases sequentially [2, 3]. Tactically, these policies supposedly allow anesthesiology groups to appropriately fill the available NORA time or condense any unused block time. Further, there has been little in the development or application of operating room management metrics to NORA case lists. Gabriel et al. [4] created an OR metrics score card for individualized feedback, and in 2006, Macario published a dashboard of operating room management benchmarks. A similar

dashboard optimizing the staffing and scheduling for NORA sites is lacking. Finally, the tactical planning for NORA services with low utilization rates is similar to surgeons who do not operate on a daily basis. For example, a weekly NORA block allocation may be assigned to interventional cardiology for 3 days, to gastroenterology for 1 day, and to pediatric sedation on the last day.

The operationalization of NORA services has direct implications for anesthesiologists. Abouleish et al. have established a set of individual and group productivity benchmarks for anesthesiology departments [5, 6]. These metrics provide a structural basis to compare different anesthesiology groups and individuals within the same group. Hudson argued that there are a myriad of reasons that anesthesiologists differ in productivity measures [7]. He categorized the factors as follows: billable hour efficiency, staffing efficiency, and organizational and caseload management factors. He also defined billable efficiency as the minutes billed divided by the minutes staffed in an effort to understand operating room efficiency across a large, multi-hospital system. Underlying both sets of benchmarks is a common denominator, a site (or block allocation) or an anesthesia provider.

For many NORA sites, an individual anesthesia health care team member may staff several sites in one day. For instance, an anesthesiologist may start the day in interventional radiology for an aneurysm coiling, move to endoscopy for several procedures, and finish the day in the interventional pulmonary suite. Using Abouleish's methodology, the application of the site for NORA case lists becomes difficult when an anesthesiologist staffs more than one location in a given day. Therefore, we adopted the concept of physician efficiency, minutes utilized divided by minutes staffed, using Hudson's definition of billable efficiency. In this study, we tested the hypothesis that physician efficiency and site utilization, an OR management metric, diverge when anesthesiologists travel between NORA sites.

Methods

We extracted the daily operational schedules from OpenTempo® (Williston, VT) for all NORA cases at our institution between January 1st, 2015 and December 31st, 2015, and compared them to the daily sedation list which had been published in OR Manager (OPTUM, Eden Prairie, WI). Cases that were scheduled, but not completed were identified by the lack of a recorded start time and/or attending anesthesiologist and removed. We also excluded cases performed on the weekends and holidays. ECT and obstetric cases were extracted, but were not included in the final analysis. Also, cases staffed by residents supervised by an anesthesiologist or cases staffed by per diem physicians were not included in analysis. Cases with multiple anesthesiologists listed were investigated using PICIS Anesthesia Manager in order to determine the time each listed physician spent on a case.

Using the time stamps from WiseOR® (Palo Alto, CA), we calculated site utilization and physician efficiency for each day using Microsoft Excel (Microsoft Corp., Redmond, WA). We used a 10-h (600 min) day for the denominator except for Thursdays (540 min). Previously, Abouleish et al. established the concept of FTE/site and tASA/FTE to generate benchmarks to compare anesthesiology groups and physicians within anesthesiology groups [5, 6]. For this study, we defined FTE/site as scheduling efficiency (SE). We calculated this ratio and stratified the data to the following groups: SE < 1, SE = 1, or SE >1. Confidence intervals (CIs) for each stratified, daily case list were calculated using Microsoft Excel (Redmond, WA).

Results

We calculated physician efficiency and site utilization for 256 separate days. There were 1278 separate events for physician efficiency and 1140 separate events for site utilization. We attributed the difference in the number of events to a physician being relieved or a physician working in multiple sites throughout the day. Table 1 summarizes the calculated values of physician efficiency and site utilization. The mean physician efficiency was 0.293 (95% CI, [0.281, 0.305]), and the mean site utilization was 0.328 (95% CI, [0.314, 0.343]). When days were stratified by scheduling efficiency (SE < 1, =1, or >1), we found differences between physician efficiency and site utilization (Table 2). On days where scheduling efficiency was less than 1, that is there are more sites than physicians, mean physician efficiency (95% CI, [0.326, 0.402]) was higher than mean site utilization (95% CI, [0.250, 0.296]). When scheduling efficiency was greater than 1 (i.e., more physicians than sites), mean site utilization (95% CI, [0.360, 0.402]) was greater than mean physician efficiency (95% CI, [0.257, 0.281]). When the same number of anesthesiologists and sites are staffed (SE = 1), there is no difference between physician efficiency and site utilization.

Discussion

In the U.S., the proportion of NORA cases have significantly increased in parallel with the progression of outpatient procedures over the past two decades [1, 8, 9]. Using statistics from the National Anesthesia Clinical Outcomes Registry (NACOR), Nagrebetsky et al. [1] revealed that NORA care increased in both hospital and non-hospital settings from 28.3% to 35.9% of all anesthetics between 2010 and 2014. Although the recent growth of NORA care indicates the increasing importance of understanding NORA efficiency [1],

Table 1 Distances between anesthesia sites at the University of Vermont Medical Center

A									
	IR [1]	IC [3]	MRI [L]	CT [1]	PET [1]	EP [1]	TAVR [1]	MPU [3]	RO [L]
PACU [3]*	118.6	50.5	203.3	199.9	132.4	173.2	156.8	35.4	389.8
B									
	PACU* [3]	GI* [4]	CSC* [4]	IVF* [4]					
GI* [4]	80.5	X	141.9	45.3					
CSC* [4]	183.4	144.0	X	109.6					
IVF* [4]	76.5	44.2	111.6	X					
IR [1]	194.5	126.7	305.9	188.4					
IC [3]	54.5	80.8	185.7	95.9					
MRI [L]	228.4	250.4	358.0	272.3					
CT [1]	212.6	177.9	279.1	192.5					
PET [1]	184.6	159.5	294.0	176.5					
EP [1]	220.4	199.3	321.4	214.3					
TAVR [1]	176.3	187.0	308.6	199.8					
MPU [3]	34.5	58.9	166.1	76.8					
RO [L]	196.7	173.7	79.4	129.2					

Distances (in meters) between NORA sites at the University of Vermont Medical Center. Columns represent starting locations for an anesthesiologist and rows signify the final destination. Two distances in a cell indicates two possible routes between locations. Asterisks (*) indicate sites where anesthesiologists leave patients for recovery. Brackets show the floor each site is on. (A) shows the distance between sites from which anesthesiologists must return to the PACU with patients. (B) shows the distance to sites an anesthesiologists may venture to after a procedure at a site where the patient remains for recovery. PACU = post anesthesia care unit. GI = endoscopy. CSC = child specialty center. IVF = in vitro fertilization. IR = interventional radiology. IC = internal control. MRI = magnetic resonance imaging. CT = computed tomography. PET = positron emission tomography. EP = electrophysiology. TAVR = cardiac catheterization lab. MPU = minor procedures units. RO = radiation oncology. [L] = lobby. [1] = 1st floor. [3] = 3rd floor. [4] = 4th floor

benchmarks to measure productivity of these cases are poorly defined. Currently, the tactical and operational aspects of NORA rely predominantly on the application of metrics established in OR management literature.

At many hospitals and freestanding surgical centers, anesthesia and ancillary staffing are adjusted to maximize OR efficiency [10–14] which is imperative to increasing anesthesia group productivity [15]. Mcintosh et al. [15] established that the most crucial step in maximizing OR efficiency is appropriate allocation of OR time. Therefore, many studies have developed methods to calculate optimal OR allocation, whether surgery dates are chosen by the surgeon and patient [10–14, 16] or whether they are fixed within a specified time period [13, 17–20]. If too little or too much OR time is allocated, OR efficiency is reduced due to increased overutilized or underutilized time, respectively [10, 16]. Tactical staffing should be scheduled to avoid scenarios where services fill their allocated OR time and have another case to schedule [10, 12, 13, 21]. In situations where this is inevitable, OR efficiency can still be enhanced by scheduling the case into an allocated OR time of the service anticipated to have the greatest underutilized OR time on the day of surgery, assuming the surgeon and necessary resources are available [12]. Ultimately, tactical OR allocation and operational decisions on the day of surgery both aim to minimize the weighted sum of underutilized and overutilized OR time [15]. Hence, OR utilization is a universally used criterion in determining whether more or less block time is allocated to a surgical service.

Table 2 – Physician Efficiency and Site Utilization stratified by Scheduling Efficiency

	SE < 1 (n = 53)		SE = 1 (n = 91)		SE > 1 (n = 125)	
	PE	SU	PE	SU	PE	SU
Mean	0.364	0.273	0.293	0.293	0.269	0.381
StDev	0.141	0.084	0.102	0.102	0.069	0.123
95% CI	[0.326, 0.402]	[0.250, 0.296]	[0.272, 0.314]	[0.272, 0.314]	[0.257, 0.281]	[0.360, 0.402]

Table 2 shows the means, standard deviations, and 95% confidence intervals for physician efficiency and site utilization when days are stratified by scheduling efficiency. Scheduling efficiency is calculated for each day as the number of physicians divided by the number of sites utilized. Physician efficiency and site utilization are equal on days when the scheduling efficiency is 1. On days where the scheduling efficiency is less than 1, physician efficiency is greater than site utilization. When scheduling efficiency is greater than one, site utilization is greater than physician efficiency. Counts (i.e., n) are of days. SE = scheduling efficiency. PE = physician efficiency. SU = site utilization

In 1998, our institution started "open access" NORA block allocations for clinical services that requested anesthesia for their patients on a first-come, first serve basis. As case volumes grew for individual service lines (Figs. 1 and 2), the department expanded the number of NORA block allocations using strategies based on OR management literature. Although some services resemble their operating room counterparts in terms of productivity, several services remain poorly utilized and highly variable. These discrepancies highlight the fundamental differences between NORA and OR cases [2]: NORA locations are not as interchangeable as operating rooms [2, 22–24], NORA workload variation is inherently larger due to a smaller service size and NORA turnover times are significantly longer. All of which support the claim that utilization as an exclusive metric cannot guide block allocation [25–33] and that NORA management methods need to differ from that in OR management literature to avoid unsustainably large staffing costs [2].

With the goal to enhance NORA management, our study attempted to determine the applicability of physician efficiency as a clinical productivity benchmark for physicians providing NORA services. We found that regardless of concurrency, our institution's physician efficiency and utilization rates were roughly 35%. More importantly, our results revealed a diverging relationship between physician efficiency and site utilization with modifications in scheduling efficiency. This uncovers the opportunity that physician efficiency can be used as an additional point of reference in regards to block allocations and further reaffirms the assertion that block utilization alone is not a sufficient metric for tactical decisions. Understanding the relationship of these parameters can guide hospital administrators and anesthesia leaders in efficiently managing the expansion of NORA services. When resources to scale operational efficiencies are limited, the optimization of scheduling efficiency may be a suitable tactical alternative. Ideally, anesthesiologists and program managers should appropriate staff for NORA sites in a way that maximizes both physician efficiency and site utilization.

There are several limitations to this study. First, our study draws conclusions from the experience of a single, small, academic hospital in a rural health care setting. Second, our data show that our physician efficiency metrics are slightly lower than our site utilization rates across a case list. This most likely is a result of a physician relieving another physician of their clinical responsibilities at the end of the day. Third, we have not measured the previous metrics (e.g. time units, cases, total ASA units billed) created for individual and group benchmarks. Future studies should examine the differences along different service lines. Finally, we have made certain assumptions about our staffing models for NORA sites. Our department typically staffs NORA sites with a sole anesthesiologist. At times, an anesthesiologist may supervise an anesthesiology resident rotating on the NORA service. However, it is rare that an anesthesiologist supervises more than one NORA site. This factor limits the concurrency calculations and may invalidate the framework for institutions with different staffing models.

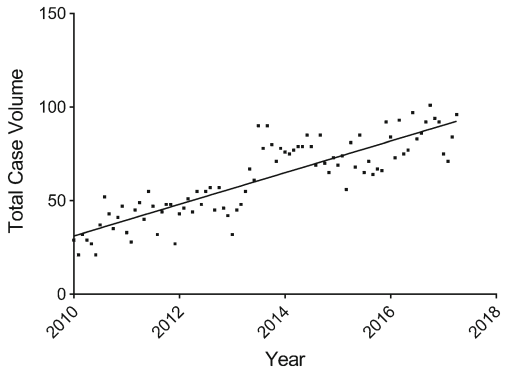

Fig. 1 Interventional cardiology monthly case volume since January 2010

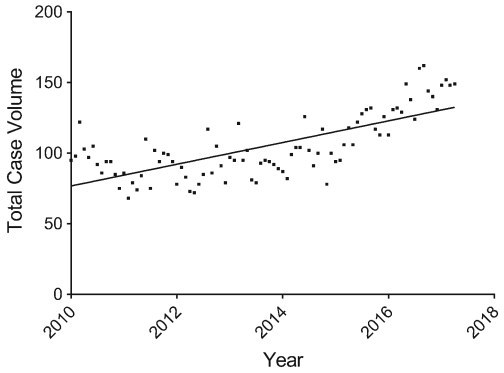

Fig. 2 Endoscopy monthly case volumes since January 2010

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Contribution: this author helped design and prepare the manuscript.
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Jesse M. Ehrenfeld, MD, MPH
Contribution: this author provided critical edits to the manuscript.
Richard D. Urman, MD, MBA
Contribution: this author helped design and prepare the manuscript.

Compliance with Ethical Standards

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Ethical Approval This article does not contain any studies with human participants performed by any of the authors.

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