Issue Paper

Determining the Value-Efficiency of Respiratory Care

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Abstract:

In preparation for future editions of the AARC Uniform Reporting Manual, the respiratory care profession needs to position itself to capture and report both time and value standards that can be applied in justifying respiratory care resources. To do this, we propose a new metric called Value-Efficiency, defined as the product of activity value and activity efficiency. Activity efficiency is defined, conventionally, as activity hours (product of activity volume and standard time) divided by worked hours. Activity value is a new concept. It is assigned according to the degree to which any given respiratory care activity contributes to the general patient care goals of safety, comfort, or liberation. The rubric is to score each activity on a scale of 0 to 2 for five categories of value: evidence, utility, indications for use, and goals served. The value ratings for all activities of a given respiratory care department can be established using expert opinion, discussion, and literature review. Significant challenges are facing the respiratory care profession and a focus on "Value-Efficiency" is a direction the profession must pursue. This approach is a practical response to the increasing demands of payers, administrators, consultants, and patients.

DETERMINING THE VALUE-EFFICIENCY OF RESPIRATORY CARE

The efficiency of Respiratory Care has traditionally been calculated as the ratio of standard time allotted for patient care procedures to the actual labor hours expended performing those procedures. Since its inception, the American Association for Respiratory Care (AARC) Uniform Reporting Manual (URM) has provided guidelines and methods to quantify labor hours required in the provision of Respiratory Care.[1] It had always been the intent of the URM to serve as a valid source for individual times associated with providing respiratory care procedures. By applying these "URM Time Standards" to procedure counts, labor hours required could be determined in the process of making patient care assignments and reporting productivity. While defining the number of labor hours required remains important, it is no longer enough. Payers now mandate that respiratory therapists clearly demonstrate value. Just as time standards for the 6th edition URM were obtained through a survey process and subsequent statistical analysis, therapists must also look ahead to developing standards and methods to better define the value in the provision of respiratory care.

It is time to shift the thinking of the respiratory care community to include the concept of value. Discussions within respiratory care leadership forums indicate that a handful of departments have incorporated the delivery of value in their staffing plans and operations, while others are looking at where to start.[2,3] Assuming departments adopt such approaches, the AARC hopes to survey and report more than just time standards for future editions of the URM.

Looking ahead to future editions of the AARC URM, the profession needs to position itself to capture and report both time and value standards that can be applied in justifying respiratory care resources. What follows below is an explanation of the importance of a value-driven approach along with ideas on getting started.

COULD THE US HEALTH SYSTEM SURVIVE WITHOUT RESPIRATORY THERAPISTS?

What would happen if all respiratory therapists vanished from hospitals tomorrow morning? Certainly, chaos would be the first response. However, the truth is that nothing respiratory therapists do cannot be done by someone else in the healthcare system. Given proper training and competency testing for other healthcare workers, the system would fill the gap. The proof resides in data reported by the World Health Organization. While the US spends significantly more on healthcare than other countries, its overall performance continues to rank well below that of other industrialized nations.[4] A manager that recognizes that the US health system could indeed survive without respiratory therapists (as most countries do) is a leader more likely to generate ideas that will sustain the practice of respiratory care based on unique and unquestionable value.[5]

The profession of Respiratory Care was formed during the 1960s. During the same era, Medicare, Medicaid, and the first healthcare reimbursement systems were created. The profession evolved to take advantage of the fact that the government, and others, would pay for anything that could be invented as a therapy for pulmonary patients. What once kindled the creation and growth of respiratory care, eventually became a threat. In 1983, the creation of Diagnostic Related Groupings (DRGs) as a capitated reimbursement model shifted respiratory care practice from being revenue-generating centers to cost centers.[6] Payment systems continue to focus on capitated payment and other fixed reimbursement programs. The shift in methods of payment has greatly increased focus on cost reduction. As a result, Respiratory Care departments are frequently the subject of workforce reductions. While efficient and productive use of labor has helped justify the expense of a respiratory therapist as caregiver, the advent of the Patient Protection and Affordable Care Act (ACA) expanded the focus to value, patient outcomes, and a variety of performance metrics that now drive reimbursement for the provision of care.[7]

No one argues against the idea that healthcare payers are now demanding value for their dollars. Administrators and consultants increasingly view the Respiratory Care profession, like many other allied health specialties, with suspicion due to scant amount of hard evidence that value is being delivered. Consultants are digging deeper into the cost vs value issue as it relates to the minute details of daily professional activities. With the advancement of "big data",[8] "data mining/predictive analytics"[9] and "deep learning artificial intelligence software",[10] these activities will become easier, faster, and more accessible to the average hospital administrator. This environment mandates a "call to action" and a new focus to rationalize the existence of respiratory care based on value. This is not just the perception of value, but the ability to quantify that value in terms of reducing cost, improving outcomes, and performance-based programs that improve margins.

THE LEGACY OF PRODUCTIVITY TRACKING IN RESPIRATORY CARE

The profession has survived systematic critical scrutiny in the past. The Respiratory Care profession lived through the "reengineering in health care delivery" initiatives of the early 1990s when whole departments were downsized, and in some cases eliminated.[11] Even today, there continues to be a rising tide of consultants recommending staffing cuts. They often apply data from national benchmarking firms that may not accurately identify the resources required to adequately deliver respiratory care. Benchmarking is the process of comparing the performance of an entity against a group of similar entities (or a single entity with itself over time) to improve performance. The idea is to define common metrics (measurable variables reflecting performance) and then compare their values among members of a "compare group" to identify "best performers." While the goal of benchmarking is simply to describe and emulate the "best practices" that are identified, defining

the metrics is difficult. Considering that quality is difficult to define, respiratory care managers focused more on tracking "productivity", or more accurately, efficiency. Efficiency is commonly defined as the ratio of actual output to actual input, whereas productivity is usually defined as output compared to some standard expected output. Defined this way, efficiency is usually less than 100% due to unavoidable operational activities that do not contribute to the desired output (i.e., inefficiencies) while productivity (especially in Respiratory Care departments) is often reported as well above 100%.

Unlike most manufacturing businesses, health care organizations have grown under the paradigm that created Medicare and Medicaid in the 1960s, namely that everything health care professionals do is important to patient care and the more tasks that are done the more the organization should be reimbursed. As a result, health care organizations have developed the infrastructure that is designed for tracking billable activities but provides no means for tracking or even adequately defining efficiency. Thus, attempts by consultants to quantify efficiency have been based almost exclusively on billing data. A common efficiency metric has been the number of billed procedures divided by the labor hours required to deliver those procedures.

As a metric, billed procedure counts are very imprecise because not all respiratory care procedures generate charges and not all procedures take the same amount of time. Quantifying output as a simple count of procedures gives all procedures the same weight. Thus, a department that spends time doing complex, time-consuming procedures will likely appear to have a lower efficiency than one that does many less labor-intensive procedures. Counting each procedure as a '1' does not address the intensity of services (i.e., as measured by time required to complete each procedure). This is the fundamental difference between reporting systems based on a valid metric and those that merely use one facet (i.e., procedures with charges).

The URM should serve as the gold standard in identifying both billable, non-billable activities and the time required to perform those activities. Through the application of procedure duration time standards and calculating the actual time spent doing activities that relate to the worked hours of personnel assigned to perform those activities, the URM provides a solution for more accurately assessing labor efficiency or productivity. Benchmarking should be done using a similar approach. However, the procedures included in a benchmarking program should be limited to only those activities that are common to all departments. This is the baseline principle upon which the AARC Benchmarking Project was designed.[12]

By applying weighted time standard for each procedure, often referred to as Relative Value Units (RVUs) one can derive Variable Clinical Hours Required, (also known as Activity Hours) as a common metric to assess the output achieved by a workforce.

The number of procedures performed is part of the routinely tracked billing data and is closely monitored in all hospitals. Standard times per respiratory care procedure are well documented in the AARC's URM. With this view, the highest departmental efficiency comes from the highest aggregate procedural time performed with the leanest organizational structure, meaning the fewest full-time equivalents (FTEs) required.

FLAWS IN THE PARADIGM

In health care, all activities are important by assumption. However, only a small fraction of all medical activities (or respiratory care activities) are convincingly supported by high-level evidence (e.g., randomized controlled trials). Even when evidence is available, it is poorly assimilated into actual practice. While the application of procedure time standards may assist in quantifying the efficient use of labor, if that labor completes activities that have little or no clinical value, then "effective productivity" suffers.

Most would agree that investing in resources to perform a service that is not needed is illogical.[13] Then why do some respiratory care departments continue to provide treatments for which there may be no medical indications, no guidelines, no evidence, or no demonstrated change in outcomes for a specific condition? In contrast, why is there evidence for noninvasive ventilation, techniques for liberation from mechanical ventilation, or how to avoid ventilator-acquired conditions, yet they are not incorporated into treatment protocols or policies? Why is it that departments are short-staffed, with increasing workloads, while at the same time they continue to perform unnecessary care that will make no difference to patient outcome? Managers must examine those issues that serve as barriers to delivering value in their settings. Subsequently, they must also develop strategies to implement systems that justify resources based on the value provided.

If labor efficiency is being measured through the application of procedure time standards, procedure counts, billable procedures, or patient days, none of these metrics reflect a clear understanding of the value the interventions provide. Ensuring hospital resources are only consumed in the provision of medically necessary interventions can be achieved through protocol programs, or by systems that avoid interventions that have no scientific basis.[14] The challenge is then how to build such value into a productivity system.

A NEW PARADIGM: VALUE-EFFICIENCY

Doing the wrong things (i.e., no evidence of effectiveness) the right way (i.e., efficiently) is a paradigm that no longer supports Respiratory Care's survival as a health care profession. W. Edwards Deming, a pioneer of quality control and adviser to some of the most influential international corporations, stated that "efficiency means doing things right, while effectiveness means doing the right things."[15] Obviously, both are important, so we could say that the elusive "quality" we seek in healthcare is simply a metric of efficiency combined with effectiveness or "value-efficiency".

In general terms, the value-efficiency is more difficult to define than a simple cost/benefit ratio. Several important questions arise to define benefit: What value does the respiratory care department add to the health care organization? What difference does it make that a respiratory therapist is performing a specific intervention as compared to another health care provider? Who is the most appropriate provider regarding cost efficiency and desired patient outcomes? Historically, the Respiratory Care profession has grown by relentlessly increasing its scope of practice without answering such questions. It is time to re-examine this assumption.

To incorporate value-efficiency as a mechanism to define the number and type of caregivers required, there are three key considerations:

1. What value does respiratory care add to the health care organization?
2. Are the interventions provided necessary and of clinical value?
3. What is the value of the respiratory therapist in the delivery of these services?

The ACA signed into law by President Obama on March 23, 2010, aimed at ensuring health-care quality while managing costs. The ACA intended to provide new options and opportunities for affordable health-care coverage. Although the ACA retains the capitated payment models of earlier reforms, it also provides a new focus on quality. Incentives exist in which hospital payment is also dependent on quality indicators inclusive of patient satisfaction and avoidance of readmissions. A prime example of where the Respiratory Therapist can add unique value is the ACA Hospital Readmissions Reduction Program. The program administers penalties for hospitals with higher-than-average unplanned readmission rates for a limited number of diagnosis codes, of which COPD and pneumonia are included.[16] If the reforms of the past 30 years have not been an adequate incentive for the respiratory care community to fully adopt a protocol-driven care model, then perhaps the ongoing reforms in health care serve as a call for action. The safety, quality, and value metrics linked to reimbursement and avoidance of penalties provide a template to drive respiratory care staffing. Table 1 provides examples of safety, quality, and cost-related outcomes that demonstrate value, many of which are part of the ACA:

Table 1. Desired System/Patient Outcomes

Reduce readmission rates
Improve patient satisfaction
Improve interventions associated with smoking cessation
Improve vaccination compliance
Decrease hospital stay
Decrease time on ventilators
Decrease time in the ICU
Decrease infections
Decrease Ventilator Associated Events
Adopt roles to enable more effective use of nursing
Adopt roles to enable physicians to manage cases effectively and efficiently

Purchasers will continue to express a desire for more value for their dollar. Simple efficiency (input/output) is no longer adequate. The performance of any intervention, and the individual providing the intervention, must demonstrate both value and efficiency.[17] If managers can demonstrate that employing a respiratory therapist improves value-efficiency, then it is likely the administrator will continue to invest resources to maintain that role. In cases where the role of the respiratory therapist is justified using a focus on value, simple metrics like "units of services" will be less important in justifying resources. Management, support staff, and special roles that do not produce "units of service" can only be justified in terms of value, although this is usually implicit. Another approach is to clearly define the loss of value or adverse impact if the respiratory therapist or respiratory department is not engaged in the provision of a service.

CALCULATING VALUE-EFFICIENCY

Using the methodology described in the URM, worked hours required in performing respiratory care activities are determined by calculating total activity hours. Activity hours are derived from the number of activities performed and the application of a time standard for each activity.

$$\text{Activity Hours} = \text{Activity Volume} \times \text{Activity Time Standard} \quad (1)$$

It is the sum of these activity hours that defines the total worked hours required. The relationship between activity hours and worked hours is used to report the efficiency (aka, productivity) of staff performing those activities

$$\text{Activity Efficiency} = \frac{\text{Activity Hours}}{\text{Worked Hours}} \quad (2)$$

URM procedure time standards have been the primary source to determine activity hours and worked hours required. In a general value efficiency model, activity value is applied to the equation to determine activity value efficiency.

$$\text{Activity Value Efficiency} = \text{Activity Value} \times \text{Activity Efficiency} \quad (3)$$

Equation 3 defines the concept of value efficiency. In order to calculate Value Efficiency, a measure of Activity Value must be applied. Incorporating activity value requires a process to determine a factor or score that represents the value contribution of each activity.

Assigning Value to Activities

This new paradigm includes not only defining the impact of caregivers in achieving desired hospital or system outcomes but the demonstration that procedures performed by the caregiver are of value. Can we define the value of individual patient care activities? Is the activity considered appropriate, given the patient's condition? Does the intervention represent best practice? Does benefit correlate with desired patient outcomes? Does the activity represent the least costly approach to achieving desired outcomes? What evidence can we obtain that shows patient care activities do indeed deliver value? This last question is particularly difficult because, as mentioned above, only a small percentage of current medical services (let alone respiratory care) is based on irrefutable scientific evidence. That is not to say there is no basis for assigning value. Indeed, we can develop a practical system for respiratory care that is analogous to the way that the evidence is graded for published research. To assign value to respiratory care activities, we must link them to some standard, such as the mission/vision of the organization, medical theory/consensus, achieving benefit, etc. Determining to what degree a procedure contributes to complying with such standards can be used to determine an activity value.

Health care organizations often espouse three general activities: to care (treatments and patient services), to discover (biomedical and operational research), and to teach (patient and provider education). At the level of the individual patient, we can simply define quality, or "high value" activities that serve the goals of safety, comfort, and liberation. Safety means keeping the patient alive without doing more harm than good. Comfort means to alleviate physical and mental suffering. Liberation means to free the patient from disease and ultimately, from care. It is possible to define a value score for individual patient care activities. By simply examining to what degree any given procedure contributes to safety, comfort, or liberation represents one approach to determining a value score. Examples are provided in Table 2.

Table 2. Examples of, but not all inclusive, Respiratory Care activities that serve patient care goals and could be applied to determine their relative weight in contributing to value and used to derive a value score.

Safety
Life support (CPR, mechanical ventilation, oxygen therapy, transport)
Therapeutics (drug delivery by aerosol, airway clearance)
Prophylaxis (tracheostomy tube changes)
Surveillance (ICU monitoring, consulting services)
Diagnosis (pulmonary function testing, desaturation studies, hematologic interpretation)
Comfort
Anxiolytic (maximizing patient-ventilator synchrony, airway care)
Pharmacologic (nebulized opioid or lidocaine therapy)
Liberation
Testing (timely spontaneous breathing trials)
Patient education (inhaled medication instruction)
Discharge planning
Disease management
Rehabilitation

The actual weights may be arbitrary but could be determined by a consensus of expert opinion until there is wider adoption that would provide a means to validate such scores. Deriving an activity value can be as simple as assigning a 0 for interventions in which there is no or little perceived value while assigning a 1 for procedures in which evidence/indications exist that demonstrate the procedure is of value.

The following model provides an example of key elements of a system to identify activity value efficiency. These are concepts developed by the authors from their experience and discussions with respiratory care leaders. The model is intended to present key considerations and concepts so others might begin to develop value-efficient approaches to staffing in their departments.

The Model

The first step is to develop a general set of categories to function as a rubric for defining value. In Table 3 we have listed four categories. For each of those categories, we have identified a set of specific metrics associated with value ratings. The rating represents the benefit of achieving the stated metric.

Table 3. Value rating rubric based on categories of vale for respiratory care activities.

Evidence	Score	Utility	Score
Research-based	2	Most cost-effective	2
Theory or consensus-based	1	Unknown cost-effectiveness	1
No evidence	0	Cost is avoidable	0
Indications	**Score**	**Goals (Safety-Comfort-Liberation)**	**Score**
Measurable	2	Serves at least 2 goals	2
Subjective	1	Serves 1 goal	1
No defined indications	0	No goals served	0

The value rating for each respiratory care activity can be established by means of expert opinion, discussion, and literature review. While every activity of a department could be listed and ratings assigned, we have selected only a few procedures as examples. Table 4 includes nitric oxide, incentive spirometry, IPPB, weaning assessment, oximeter checks, and patient/vent assessment.

Table 4. Examples of how activity values might be calculated.

Nitric Oxide Therapy	Score	Incentive Spirometry	Score
Categories		Categories	
Evidence	2	Evidence	0
Utility	1	Utility	0
Indications	2	Indications	0
Goals	1	Goals	0
Total Score	6	Total Score	0
Activity Value	**0.75**	**Activity Value**	**0.0**
IPPB	**Score**	**Weaning Assessment**	**Score**
Categories		Categories	
Evidence	0	Evidence	2
Utility	1	Utility	2
Indications	0	Indications	2
Goals	0	Goals	2
Total Score	1	Total Score	8
Activity Value	**0.13**	**Activity Value**	**1.0**

Table 4. Examples of how activity values might be calculated. (Continued)			
Oximeter Check	**Score**	**Ventilator Management**	**Score**
Categories		**Categories**	
Evidence	1	Evidence	2
Utility	2	Utility	2
Indications	1	Indications	2
Goals	1	Goals	2
Total Score	5	Total Score	8
Activity Value	**0.63**	**Activity Value**	**1.0**

The procedure would be to identify an activity and then assign a rating for each of the value categories according to Table 3. Consider nitric oxide therapy as an example. In the Evidence category, assign a rating of 2 because research-based data exists to support the activity. In the Utility category, assign a rating of 1 because the cost-effectiveness of this therapy is unknown. (Note that cost-effectiveness data for most medical procedures is unknown due to lack of research. Thus, a subjective rating must be assigned based on expert opinion. Rational methods for achieving such consensus might be borrowed from other disciplines, such as economics and perhaps the use of the analytic hierarchy process.) In the Indications category, we assign a rating of 2 because the indications for nitric oxide therapy are well described in the literature, and are practical and measurable. Finally, in the Goals category, assign a rating of 1 because NO therapy only serves the immediate goal of safety (i.e., promoting oxygenation adequate to sustain life).

The ratings are summed to a total score that is then expressed as a fraction of the maximum score. In this case, the sum of the ratings for NO therapy is 6. Value is then calculated as the total value score for an activity divided by 8, which is the maximum score (i.e., Evidence = 2, Utility = 2, Indications = 2, Goals = 2). In this example, NO therapy is assigned an activity value of 0.75.

Activity values are then used to calculate value efficiency. Substituting Equation 2 into Equation 3 and rearranging we get:

$$\text{Activity Value Efficiency} = \frac{\text{Activity Value} \times \text{Activity Hours}}{\text{Worked Hours}} = \frac{\text{Value Hours}}{\text{Worked Hours}} \quad (4)$$

What is needed now is the total of the value hours summed across all activities. Here is the procedure for a simple spreadsheet analysis:

Step 1: List all the procedures performed by the department.

Step 2: Associate each procedure with a standard time. The AARC URM can be used for this (or a department can conduct its own time & motion studies).

Step 3: Enter the specific procedure count for the period

Step 4: Based on the URM time standard and procedure counts, the spreadsheet should be configured to calculate Activity Time (Time Standard x Count)

Step 5: Enter the value score from the standards worksheet

Step 6: The Value % is an indicator that represents the % of the assigned value score in relation to the maximum value score. In this model, the maximum value score is 8, thus an assigned value score of 6 represents 75% of the maximum. The spreadsheet should be configured with the formula (Value Score/Max Value Score).

Step 7: By multiplying the Value % by the Total Time, the Activity Value Hours are determined
(Activity Time x Value % = Activity Value Hours)

Sample data are shown in Table 5.

Table 5. Calculating Activity Value Hours					
Activity	**Standard Minutes**	**Count**	**Activity Hours**	**Activity Value**	**Hours**
Nitric Oxide Assessment	36	49	29.4	0.75	22.1
Incentive Spirometry	12	356	71.2	0	0
IPPB	19	35	11.1	0.13	1.4
Weaning Assessment	32	219	116.8	1.00	116.8
Oximetry Assessment	10	1050	175.0	0.50	87.5
Patient-Vent Assessment	21	1900	665.0	1.00	665.0
Total		**3,609**	**1,069.5**		**892.7**

The results in Table 5 indicate the direct variable labor time spent in the provision of each procedure. They also show the hours spent in providing what we have identified as activity Value Hours (i.e., activity hours × activity value). In this example, there are a total of 6,4109 minutes, or 1,068 hours of direct variable labor. However, this labor resulted in only 892.7 Activity Value Hours.

Value Efficiency is calculated for the department by inserting the total worked hours (direct and indirect variable plus fixed) into Equation 4. For example, assume the department was comprised of 10 FTEs who worked 1,373 hours in the same period for which Activity Value was calculated. Then:

$$\text{Activity Value Efficiency} = \frac{\text{Value Hours}}{\text{Worked Hours}} = \frac{892.7}{1373} = 0.65$$

This indicates that the value efficiency of the department is a disappointing 65%. However, now we know where to look to improve efficiency. In this example, the department is spending 71.2 hours on an activity with little/no clinical value (e.g., incentive spirometry). If those hours were eliminated from the activity hours, and if there was a practical way to translate that into reduced worked hours, then the Value Efficiency would increase to 68%. Therefore, a complete analysis of a real department would yield many more opportunities to decrease low-value activity hours either by improving the activity protocol and decreasing the standard time or by decreasing the count and thereby improve department efficiency. Upon close examination, you might find that the worked hours can be decreased by decreasing the indirect variable hours or fixed hours.

It would stand to reason that an acceptable result for Value Efficiency represents a strong argument to justify the labor hours being paid. Through protocols and policies that help ensure only medically essential and high-value interventions are provided, the Value Hours will rise and improv Value Efficiency. Higher Value Efficiency then becomes a new benchmark related to how labor is directed and how effective the department is in achieving the standards identified in the provision of care. By developing such systems that incorporate both time and value standards, respiratory therapists can ensure patients, payers, and those that make decisions regarding the budgeted staff understanding the value being delivered by respiratory care.

FINAL THOUGHTS

Significant challenges are facing the respiratory care profession and a focus on Value Efficiency is a direction the profession must pursue. These concepts support a practical response to the increasing demands of payers, administrators, consultants, and patients. They embody the rational essence of survival in an environment of harsh natural selection.

While the URM provides an essential tool to quantify labor, we urge Respiratory Care Leaders to consider Value and Value Efficiency in their staffing plans and care delivery. This supplement to the 6th Edition URM is included to generate ideas, systems, and approaches to incorporating such value in clinical operations. It is essential that we pivot from a qualitative definition of value to one based on a system that quantifies value to expand the current focus on efficiency and busyness to a holistic one encompassing value and efficiency in all clinical services.

References

1. American Association for Respiratory Care Uniform Reporting Manual
https://www.aarc.org/resources/tools-software/standards-development/
2. Kollef MH. Evaluating the value of the respiratory therapist: Where is the Evidence? Respir Care 2017; 62(12): 1602-1610.
3. Stoller JK. Are respiratory therapist effective? assessing the evidence. Respir Care 2001;46(1):56-66.
4. World Health Organization Global Health Care Expenditure Database. November 2020
https://apps.who.int/nha/database/country_profile/Index/en
5. Kauffman, GK. Can respiratory care survive as a profession? AARC Times April 2019:18-23.
6. Becker EA. Utilizing respiratory therapist to reduce cost. Respir Care 2018; 63(1):102-117.
7. HeatlhCare.gov, Affordable Care Act (ACA, PPACA)
https://www.healthcare.gov/glossary/affordable-care-act/
8. Milton CL. The ethics of big data and nursing science. Nurs Sci Q 2017; 30(4):300-302.
9. Hernandez I, Zhang Y. Using predictive analytics and big data to optimize pharmaceutical outcomes. Am Health Syst Pharm 2017; 74(18):1494-1500.
10. Liang Z, Zhang G, Huang JX, et al. Deep learning for healthcare decision making with EMRs. 2014 IEEE International Conference on Bioinformatics and Biomedicine
http://download.xuebalib.com/xuebalib.com.2797.pdf. Last accessed 9/26/17
11. Revin RC. Nurses, doctors decry respiratory staff cuts. Los Angeles Times July 27, 1986.
https://www.latimes.com/archives/la-xpm-1986-07-27-me-1563-story.html
12. American Association for Respiratory Care Benchmarking System
(https://www.aarc.org/resources/tools-software/benchmarking/).
13. Stoller JK. The effectiveness of respiratory care protocols. Respir Care 2004; 49(7):761-765.
14. Modrykamien AM, Stoller JK. The scientific basis for protocol-directed respiratory care. Respir Care 2013; 58(10):1662-1668.
15. The Deming Institute. Avoid doing the wrong things righter. July 2020.
https://deming.org/avoid-doing-the-wrong-things-righter-but-by-what-method/
16. Kauffman GW. Can a respiratory therapist impact COPD readmission and cost? Respir Care 2016; 61(9):1267-1269.
17. Frazer I, Encinosa W, Glied S. Improving efficiency and value in health care: introduction. Health Serv Res 2008; 43(5):1781-1786.