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To Study Importance of Cost in Healthcare and to Analyze Break-Even Point for Spirometry in Pediatric Department

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Abstract

For providing high quality services in the hospital at an optimum cost it has become essential to understand the concepts of costs and the way they behave in different situations. Cost is the sacrifice made in order to obtain a goods and services. There are mainly three elements of costs

1. Material
2. Labour
3. expenses

Cost-Benefit Analysis in health care is the analysis of health care resource expenditures relative to possible medical benefit. This analysis may be helpful and necessary in setting priorities when choices must be made in the face of limited resources. This analysis is used in determining the degree of access to, or benefits of, health care to be provided.

Key words Cost, Healthcare, Services, Benefit.

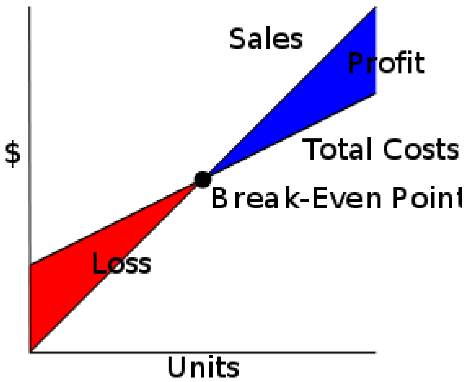
Introduction:

All indirect costs are called overheads Costs can be classified into fixed and variable costs, direct and indirect costs, and capital and indirect costs; each classification has its own significance in management decisions.

Cost Volume profit analysis is valuable tool for profit planning. It profit for planning. It forecasts the level of profit quite accurately. It is also popularly known as break-even analysis.

The break-even point

BEP in economics, business, and specifically cost accounting, is the point at which total cost and total revenue are equal: there is no net loss or gain, and one has "broken even." A profit or a loss has not been made, although opportunity costs have been "paid", and capital has received the risk-adjusted, expected return. In short, all costs that need to be paid are paid by the firm but the profit is equal to 0.



The break-even point (BEP) or break-even level represents the sales amount—in either unit (quantity) or revenue (sales) terms—that is required to cover total costs, consisting of both fixed and variable costs to the company. Total profit at the break-even point is zero. It is only possible for a firm to Break-even, if the dollar value of sales is higher than the variable cost per unit. This means that the selling price of the good needs to be higher than what the company purchased the good, or components of the good for, in order for them to cover the initial price they paid (variable costs). Once the break-even price has been surpassed, the company can start making a profit.

The break-even point is one of the most commonly used concepts of financial analysis and is not only limited to economic use, but can also be utilized by entrepreneurs, accountants, financial planners, managers and even marketers. Break-even points can be useful to all avenues of a business, as it allows employees to identify required outputs and work towards meeting these.

The Breakeven value is not a generic value and will vary dependent on the individual business. Some businesses may have a higher or lower breakeven point, however it is important that each business develop a break-even point calculation, as this will enable them to see the number of units they need to sell to cover their variable costs. Each sale will also make a contribution to the payment of fixed costs as well.

For example, a business that sells tables needs to make annual sales of 200 tables to break-even. At present the company is selling less than 200 tables and is therefore operating at a loss. As a business, they need to consider increasing the amount of tables that they are selling annually in order to make enough money to pay both their fixed and variable costs.

If the business does not think that they can sell the required amount of units, in order to ensure their future viability, they could consider doing the following options:

1. Reduce the fixed costs that they face. This could be done through a number or negotiations, such as reductions in rent, or through better management of bills or other costs faced by the business;

2. Reduce variable costs, for example, finding a new supplier that sells tables thus reducing the amount paid for tables;

3. Increase the quantity of tables that they are selling.

Any of these options have the potential to reduce the break-even point. This means that the business would not need to sell as many tables as before, and would still be able to pay their fixed costs.

The main purpose of break-even analysis is to determine the minimum output that must be exceeded in order for a business to make profit. It also is a rough cator of the earnings impact of a marketing activity. A firm is able to analyze their ideal levels of output and therefore be knowledgeable on the amount of sales and revenue they need to generate in order to meet and surpass the break-even point and ensure the survival of the business. If this level is not met, it often becomes difficult for the business to continue to operate and thus they may have to shut down their operations.

The break-even point is one of the simplest, yet least utilized analytical tools by a business's management team. Identifying a breakeven point helps to provide a dynamic view of the relationships between sales, costs, and profits made. For example, expressing break-even sales as a percentage of actual sales can give managers a chance to understand when to expect to break even (by linking the percent to when in the week/month this percent of sales might occur).

The break-even point is a special case of Target Income Sales, where Target Income is 0 (breaking even). This is very important for financial analysis. Any sales made past the breakeven point can be considered profit (after all initial costs have been paid)

Break-even analysis can also provide data that can be useful to the marketing department of a business as well, as it provides financial goals to the business which can be passed down to marketers in order to try and increase sales.

Not only is the break-even analysis beneficial to the financial side of the business, but it can also provide a chance for operating businesses to see where they could re-structure or cut costs and get the optimum results out of the resources that they have. This may in the long term help the business become more effective and achieve higher returns. In many cases, if an entrepreneurial venture is seeking to get off of the ground and enter into a market it is advised that they formulate a break-even analysis to suggest to potential financial backers that the business has the potential to be viable and at what points.

Margin of safety

Margin of safety represents the strength of the business. It enables a business to know what is the exact amount it has gained or lost and whether they are over or below the break-even point. In break-even analysis, margin of safety is the extent by which actual or projected sales exceed the break-even sales.

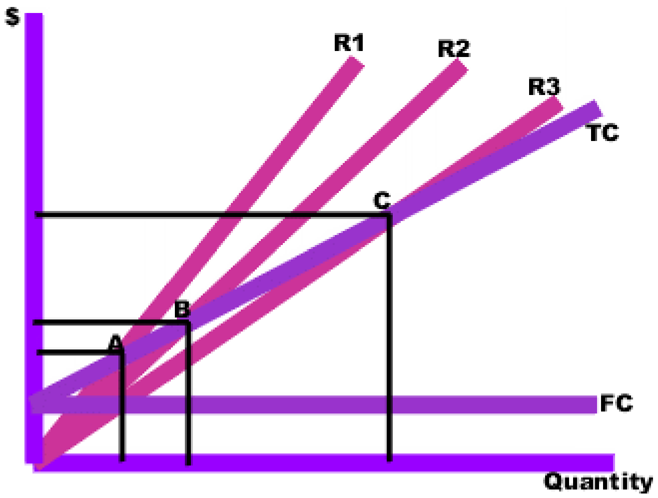
Margin of safety = (current output - breakeven output)

Margin of safety% = (current output - breakeven output)/current output × 100

When dealing with budgets you would instead replace "Current output" with "Budgeted output." If P/V ratio is given then profit/PV ratio.

Break-even analysis

By inserting different prices into the formula, you will obtain a number of break-even points, one for each possible price charged. If the firm changes the selling price for its product, from $2 to $2.30, in the example above, then it would have to sell only 1000/(2.3 - 0.6)= 589 units to break even, rather than 715.



To make the results clearer, they can be graphed. To do this, you draw the total cost curve (TC in the diagram) which shows the total cost associated with each possible level of output, the fixed cost curve (FC) which shows the costs that do not vary with output level, and finally the various total revenue lines (R1, R2, and R3) which show the total amount of revenue received at each output level, given the price you will be charging.

The break-even points (A,B,C) are the points of intersection between the total cost curve (TC) and a total revenue curve (R1, R2, or R3). The break-even quantity at each selling price can be read off the horizontal axis and the break-even price at each selling price can be read off the vertical axis. The total cost, total revenue, and fixed cost curves can each be constructed with simple formula. For example, the total revenue curve is simply the product of selling price times quantity for each output quantity. The data used in these formula come either from accounting records or from various estimation techniques such as regression analysis.

Limitations

- Break-even analysis is only a supply-side (i.e., costs only) analysis, as it tells you nothing about what sales are actually likely to be for the product at these various prices.
- It assumes that fixed costs (FC) are constant. Although this is true in the short run, an increase in the scale of production is likely to cause fixed costs to rise.
- It assumes average variable costs are constant per unit of output, at least in the range of likely quantities of sales. (i.e., linearity).
- It assumes that the quantity of goods produced is equal to the quantity of goods sold (i.e., there is no change in the quantity of goods held in inventory at the beginning of the period and the quantity of goods held in inventory at the end of the period).
- In multi-product companies, it assumes that the relative proportions of each product sold and produced are constant (i.e., the sales mix is constant).

Break-Even Analysis in Healthcare

Introduction:

Break-even analysis is the use of a simple mathematical formula to determine the sales level at which the business is neither incurring a loss nor making a profit. In other words, when the firm's total expenses equal its net sales revenue that is the break-even point for the operation.

The break-even point (BEP) is, in general, the point at which the gains equal the losses. A BEP defines when an investment will generate a positive return or also the point where total costs equal total revenues. There is no profit made or loss incurred at the break-even point. This is important for anyone who manages a business, since the BEP is the lower limit of profit when prices are set and margins are determined.

Break-even analysis, sometimes called cost-volume-profit analysis, is an important analytical technique used to study relations among costs, revenues and profits. Both graphic and algebraic methods are employed. For simple problems, simple graphic methods work best. In more complex situations, analytic methods, possibly involving spreadsheet software programs are preferable.

Defining the break-even point in mathematical terms is simply the point where:

Total expenses = Net sales revenue

The amount of sales revenue should be readily available on income as 'Net Sales'. Net sales revenue is all sales revenue (often called gross revenue) less any sales returns and allowances or sales discounts.

The break-even point represents the level of revenue that equals the total of the variable and fixed costs for a given volume of output service at a particular capacity use rate. Other things being equal, the lower the break-even point, the higher the surplus and the less the operating risk. The BEP also provides nonprofit managers with insights into surplus/deficit planning.

The following case studies will elucidate the concept of break-even analysis.

Case Reports

Case 1

A hospital is offering laparoscopic cholecystectomy at a package deal with a selling price ` 30,000/- per operation and the variable cost per operation comes out to be 20,000/-. The annual fixed cost is ` 60,00,000/-. How many laparoscopic operation the hospital must do to come at BEP.

Solution

Total fixed cost = ` 60,00,000

Unit selling price = ` 30,000

Unit variable cost = ` 20,000

Unit contribution = unit selling price-unit variable = 30,000 – 20000 = 10,000

Therefore, BEP (units) = 60,00,000/10,000 = 600 numbers of laparoscopic operation.

Thus, a minimum number of 600 operations must be done so that the hospital achieves breaks-even point.

Case 2

An X-ray center has priced its X-ray test and report for 200/- each. The variable cost is ` 100/- per test. The annual fixed cost is ` 2,00,000/-. Find out the number of X-ray tests to be performed per year for BEP to be achieved.

Solution

Total fixed cost = ` 2,00,000

Unit selling price = ` 200

Unit variable cost = ` 100

Therefore, BEP (units) = 200,000/(200-100) = 2000.

Thus, a minimum of 2000 X-ray tests must be carried out so that the X-ray center breaks even.

Thus, break even analysis in an institution leads to a point where there is no profit or loss, i.e. where revenue and expenditure match. In public sector hospitals this sort of analysis is usually not done as there is no such pressing requirement. In private hospitals this has to be made. Otherwise the hospitals will not know whether that the hospital is making a profit or going in loss.

Break-even analysis attempts to study the revenue and costs in relation to sales volume of a business unit and to determine that point where sales revenue just equals to total costs. The level of activity is generally termed as break-even point (BEP). At this point of activity (production/sales), a producer neither earns any profit nor incurs any loss. That is why it is also called as 'No Profit, No Loss Point', or 'Zero Profit and Zero Loss Point'. If sales exceed Break-even point, profit arises and if sales fall below break-even point, loss emerges. Thus break-even point is also known as point at which loss ceases and above which profit begins.

Break-even analysis assists the provider in predicting the volume of services that must be provided (and for which payment must be received) in order for the cost of providing the services to be equally matched by the payment received, yielding neither a profit nor a loss.

For the purpose of this analysis, the various costs are divided in two parts, i.e. fixed costs and the variable costs. The fixed costs are the costs that cannot be avoided and are essential for the business. These remain fixed irrespective of the changes in the volume, i.e. the numbers of units of goods produced such as rent, insurance, etc. Variable costs are costs that vary directly with the number of products produced. The difference between selling price per unit and variable cost per unit is called contribution per unit or simply unit contribution. The sum total of all unit contribution is called 'Total Contribution'. In BEP, the total contribution is equal to the fixed cost. Thus at breakeven point, the fixed cost has been overcome by the contribution and any further activity would have additional contribution to generate profit. In a break even analysis we would determine this point BEP.

Break -even analysis determines the service output at which total revenue will equal the total costs of an organization.

Assuming that the output of services is 'x' and the price is 'p', then total revenue is 'xp'. If fixed costs are 'a', and 'b' is the variable cost per unit of service then the total costs are 'a + bx'. The algebraic expression of the break-even condition (total costs equal total revenues) will then be:

$$xp = a + bx \qquad (1)$$

And, the BEP, i.e. the service output at which costs and revenues are equal, can be determined as:

$$x = a/(p - b) \qquad (2)$$

Equations (1) and (2) hold true within the service output range for which the fixed costs and unit variable costs remain constant.

As long as 'p' is somewhat bigger than 'b' (i.e. the price is higher than the variable unit cost), so that at least some element of fixed costs is being covered, then, with each additional unit of service, the hospital makes a step toward its BEP. It will take the sale of a certain number of units of service to recover fixed costs. Beyond that number, each additional unit of service sold will generate a surplus of revenue over cost. Figure 1 provides a graphical illustration of the breakeven condition and point.[2,3]

Many organizations sell a combination of different products or services. The sales mix is the roportion of different products or services that an organization sells.

Most of the hospitals or clinics have more than one service. It may be possible to identify the specifiic fiixed costs associated with each service, and so calculate each service's BEP. However, there would still be a core of fiixed costs, such as the rent for the buildings and the salary costs of senior management, which cannot be allocated to individual service. If we are to discover the BEP for the whole fiirm we need to be able to:

- Combine all the fiixed costs into a single pool.
- Obtain a surrogate for the contribution per unit that is used to calculate the BEP for a single service.

It will not be possible to use an average contribution per unit in those fiirms that produce service which are very different from each other. The calculation of a weighted average contribution per unit is time consuming so a surrogate is useful. Hospital is a service industries do not have tangible products, but the units of output can be identified which are connected to selling prices. A multi product/service organisation like hospital can compute its break-even point using the following formula:

$$\text{Break-even point} = \frac{\text{Total fixed expenses}}{\text{Weighted average selling price} - \text{weighted average variable expenses}}$$

For computing BEP of a company with two or more products/service, we must know the sales percentage of individual products/service in the total sales mix. This information is used in computing weighted average selling price and weighted average variable expenses.

In the above formula, the weighted average selling price is worked out as follows:

Sale price of product/service A × sales percentage of product/service A + sale price of product/service B × sale percentage of product/service B + Sale price of product/ service C ×

sales percentage of product/service C + … and the weighted average variable expenses are worked out as follows:

Variable expenses of product/service A × sales percentage of product/service A + Variable expenses of product/service B × variable expenses of product/service B

+variable expenses of product/service C × sales percentage of product/service C + …When weighted average variable expenses per unit are subtracted from the weighted average selling price per unit, we get weighted average contribution margin per unit. Therefore, the above formula can also be written as follows:

$$\frac{\text{Total fixed expenses}}{\text{Weighted average contribution margin per unit}}$$

The hospital is a multiproduct/ service organization. Sustainable performance above the BEP depends on the sum of performances across many services and cost centers. Decline in the output of services in one clinical department will cause a shortfall of revenue that throws the facility left of the BEP and into deficit (Figure 1). The hospital will have to close the gap either by increasing reimbursable or budgeted activities in other revenue-earning cost centers, or by reducing costs in the intermediate cost centers (taking care not to jeopardize the quality of patient care). The break-even analysis shows the percent by which price and outputs should be increased in each final cost center (or costs should be reduced in each intermediate cost center) in order to restore the hospital to its BEP, for each percent revenue shortfall in a given revenue-earning cost center.

A basic break-even analysis chart composed of a firm's total cost and total revenue curves is depicted in Figure 1. Volume of output is measured on the horizontal axis; revenue and cost are shown on the vertical axis. Fixed costs are constant regardless of the output produced and are indicated by a horizontal line. Variable costs at each output level are measured by the distance between the total cost curve and the constant fixed costs. The total revenue curve indicates the price/demand relation for the firm's product; profits or losses at each output are shown by the distance between total revenue and total cost curves.

Advantages of the break even chart

1. It serves as a useful tool of planning and control.
2. It is useful tool to study the feasibility of acquiring the equipment.

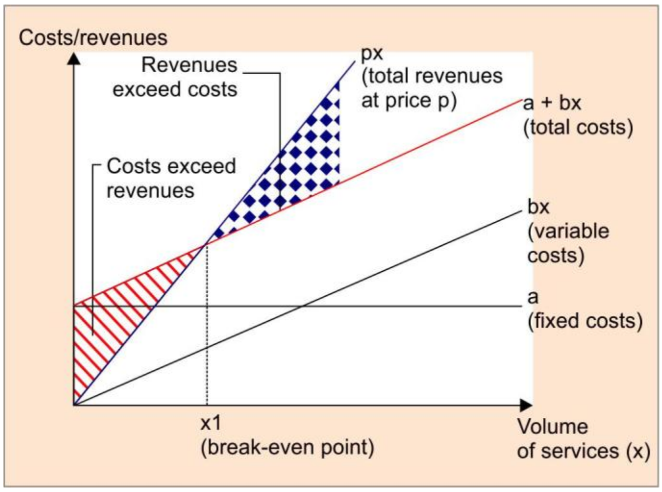


Fig. 1: Break-even analysis

3. It helps to explain relations among volume, prices and costs. It is also useful for pricing, cost control and other financial decisions.

4. Its practical implications are profit estimation at the different levels of activity, ascertaining turnover for desired profit.

5. The main advantage of break-even analysis is that it explains the relationship between cost, production volume and returns. It can be extended to show how changes in fixed cost-variable cost relationships, in commodity prices, or in revenues, will affect profit levels and BEP.

6. Break-even analysis is most useful when used with partial budgeting or capital budgeting techniques.

7. The major benefit to using break-even analysis is that it indicates the lowest amount of business activity necessary to prevent losses.

Limitations of Break-Even Analysis

1. It is best suited to the analysis of one product at a time.

2. It may be difficult to classify a cost as all variable or all fixed.

3. There may be a tendency to continue to use a break-even analysis after the cost and income functions have changed.

4. It ignores the price and technology changes and efficiency.

Spirometry is indicated for the following reasons:

- to diagnose or manage asthma
- to detect respiratory disease in patients presenting with symptoms of breathlessness, and to distinguish respiratory from cardiac disease as the cause
- to measure bronchial responsiveness in patients suspected of having asthma
- to diagnose and differentiate between obstructive lung disease and restrictive lung disease
- to follow the natural history of disease in respiratory conditions
- to assess of impairment from occupational asthma
- to identify those at risk from pulmonary barotraumas while scuba diving[4]
- to conduct pre-operative risk assessment before anaesthesia or cardiothoracic surgery
- to measure response to treatment of conditions which spirometry detects
- to diagnose the vocal cord dysfunction.

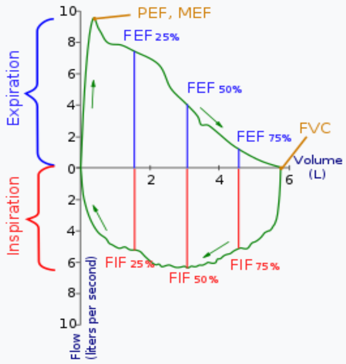
Contraindications

Forced expiratory maneuvers may aggravate some medical conditions.[5] Spirometry should not be performed when the individual presents with:

- Hemoptysis of unknown origin
- Pneumothorax
- Unstable cardiovascular status (angina, recent myocardial infarction, etc.)
- Thoracic, abdominal, or cerebral aneurysms
- Cataracts or recent eye surgery

- Recent thoracic or abdominal surgery
- Nausea, vomiting, or acute illness
- Recent or current viral infection

Diagnostics



Flow-Volume loop showing successful FVC maneuver. Positive values represent expiration, negative values represent inspiration. At the start of the test both flow and volume are equal to zero (representing the volume in the spirometer rather than the lung). The trace moves clockwise for expiration followed by inspiration. After the starting point the curve rapidly mounts to a peak (the peak expiratory flow). (Note the FEV_1 value is arbitrary in this graph and just shown for illustrative purposes; these values must be calculated as part of the procedure).

MeSH	D013147
OPS-301 code	1-712

Another major limitation is the fact that many intermittent or mild asthmatics have normal spirometry between acute exacerbation, limiting spirometry's usefulness as a diagnostic. It is more useful as a monitoring tool: a sudden decrease in FEV1 or other spirometric measure in the same patient can signal worsening control, even if the raw value is still normal. Patients are encouraged to record their personal best measures.

Related tests

Spirometry can also be part of a bronchial challenge test, used to determine bronchial hyper responsiveness to either rigorous exercise, inhalation of cold/dry air, or with a pharmaceutical agent such as methacholine or histamine.

Sometimes, to assess the reversibility of a particular condition, a bronchodilator is administered before performing another round of tests for comparison. This is commonly referred to as a reversibility test, or a post bronchodilator test (Post BD), and is an important part in diagnosing asthma versus COPD. Other complementary lung functions tests include plethysmography and nitrogen washout From Wikipedia, the free encyclopedia

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Limitations of the Tests

The maneuver is highly dependent on patient cooperation and effort, and is normally repeated at least three times to ensure reproducibility. Since results are dependent on patient cooperation, FVC can only be underestimated, never overestimated.

Due to the patient cooperation required, spirometry can only be used on children old enough to comprehend and follow the instructions given (6 years old or more), and only on patients who are able to understand and follow instructions — thus, this test is not suitable for patie

who are unconscious, heavily sedated, or have limitations that would interfere with vigorous respiratory efforts. Other types of lung function tests are available for infants and unconscious persons.

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Spirometry in children

Respiratory disorders are responsible for considerable morbidity and mortality in children. Spirometry is a useful investigation for diagnosing and monitoring a variety of paediatric respiratory diseases, but it is underused by primary care physicians and paediatricians treating children with respiratory disease. We now have a better understanding of respiratory physiology in children, and newer computerised spirometry equipment is available with updated regional reference values for the paediatric age group. This review evaluates the current literature for indications, test procedures, quality assessment, and interpretation of spirometry results in children. Spirometry may be useful for asthma, cystic fibrosis, congenital or acquired airway malformations and many other respiratory diseases in children. The technique for performing spirometry in children is crucial and is discussed in detail. Most children, including preschool children, can perform acceptable spirometry. Steps for interpreting spirometry results include identification of common errors during the test by applying acceptability and repeatability criteria and then comparing test parameters with reference standards. Spirometry results depict only the pattern of ventilation, which may be normal, obstructive, restrictive, or mixed. The diagnosis should be based on both clinical features and spirometry results. There is a need to encourage primary care physicians and paediatricians treating respiratory diseases in children to use spirometry after adequate training.

Respiratory diseases account for the majority of all paediatric hospital visits and hospitalisations all over the world, with significant morbidity and mortality. Spirometry is a procedure that measures the rate of changing lung volumes during forced breathing manoeuvres and it is used to diagnose, manage, and monitor patients with a variety of respiratory diseases. Children have a dynamic developmental phase during which lung volume size and airway size change with increasing age. Spirometry parameters are influenced by weight, height, age, sex, environmental factors, ethnicity, prematurity, patient cooperation and effort, and technical factors. Spirometry is frequently used in adults while managing respiratory conditions. Although it is not difficult to perform spirometry in children in the primary care office setting, it is frequently underused in the paediatric age group. Dombkowski et al. conducted a survey to assess the use of spirometry by physicians in paediatric primary care who were treating children with asthma and found that only half of them were using spirometry and nearly half did not interpret the spirometry results correctly.

In the past, spirometry was considered difficult to perform in children of preschool age (2–6 years) as they are not able to perform voluntary breathing manoeuvres as efficiently as older children and adults. However, in the current era with the availability of better spirometry equipment with incentives and modified criteria for acceptability and repeatability, it is possible to perform reliable spirometry tests even in preschool children by trained personnel. A variety of methods other than spirometry have also been adopted to assess lung function in infants and young children, such as the interrupter technique, the forced oscillation technique, gas washout techniques, tidal breathing techniques, and the rapid thoracoabdominal compression manoeuvre. Some of these manoeuvres may require sedation and are usually performed in advanced respiratory laboratories. These will not be discussed in this review.

Spirometry has been found to be safe with regard to inducing cardiac arrhythmias in both children and adults. It is therefore prudent for primary care physicians and paediatricians who treat respiratory diseases in children to consider the role of spirometry in this age group and the issues of underutilisation and incorrect interpretation of spirometry tests.

This review aims to summarise the current literature regarding indications, test procedure, quality assessment, and interpretation of spirometry results in children.

Types of spirometery

A variety of spirometers are available on the market. The basic handheld spirometers provide forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) values that can be compared manually with available predicted normal values. The next generation of spirometers provide graphs (usually volume-time curves) visually with or without printouts. The most recent electronic spirometers calculate the percentage of the predicted normal values based on reference values already programmed after entering patient details and performing the test. Most of these recent spirometers have built-in printers and can also be connected to a computer. When selecting a spirometer it is desirable that the equipment fulfils American Thoracic Society/European Respiratory Society (ATS/ERS) recommendations for spirometry (which are regularly updated). As the volume of air is affected by the environment, the spirometry parameters should be presented at body temperature and ambient pressure saturated with water vapour (BTPS). The calibration, maintenance, and infection control measures (e.g. use of disposal mouthpiece or use of filters) should be implemented in accordance with the recommendations of the manufacturer of the equipment. Many newer generation spirometers do not require calibration daily or after a certain number of tests, as used to be the case. The respiratory technician or physician performing the spirometry tests requires training. It is suggested that at least five tests a week (20/month) are required to maintain competency in a person with initial competency.

Indications for spirometry in children

Spirometry is commonly indicated for children with chronic cough, persistent wheezing, and for the diagnosis and monitoring of asthma and cystic fibrosis. It must be included as a necessary component in reviewing asthma control and disease activity in cystic fibrosis in children as well as in adults. It is also frequently used to measure lung function in a number of diseases that affect the lungs including haematological disorders such as transfusion-dependent thalassaemia major and sickle cell anaemia,[21] haemato-oncology conditions, connective tissue disorders, ataxia telangiectasia, and chest deformities such as pectus excavatum. Spirometry is helpful in ascertaining preoperative lung function in flaccid neuromuscular scoliosis (e.g. muscular dystrophy, spinal muscular atrophy, and cerebral palsy).[24] Constant et al.[15] used field spirometry as a measure to screen schoolchildren for respiratory diseases. The role of spirometry during an acute exacerbation of asthma in children is not well established. In a study by Schneider et al., many children presenting to the emergency department with an acute moderate to severe exacerbation of asthma were unable to perform acceptable spirometry tests, whereas in a study by Langhan et al., most children performed acceptable spirometry tests during an acute exacerbation. In both studies, correlation was not good between clinical severity and spirometry measurements. Uchida reported three cases of double aortic arch in children who were initially misdiagnosed as having asthma and a correct diagnosis was made based on spirometry findings. Many research studies on asthma and cystic fibrosis in children had spirometry

who are unconscious, heavily sedated, or have limitations that would interfere with vigorous respiratory efforts. Other types of lung function tests are available for infants and unconscious persons.

Another major limitation is the fact that many intermittent or mild asthmatics have normal spirometry between acute exacerbation, limiting spirometry's usefulness as a diagnostic. It is more useful as a monitoring tool: a sudden decrease in FEV1 or other spirometric measure in the same patient can signal worsening control, even if the raw value is still normal. Patients are encouraged to record their personal best measures.

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Respiratory disorders are responsible for considerable morbidity and mortality in children. Spirometry is a useful investigation for diagnosing and monitoring a variety of paediatric respiratory diseases, but it is underused by primary care physicians and paediatricians treating children with respiratory disease. We now have a better understanding of respiratory physiology in children, and newer computerised spirometry equipment is available with updated regional reference values for the paediatric age group. This review evaluates the current literature for indications, test procedures, quality assessment, and interpretation of spirometry results in children. Spirometry may be useful for asthma, cystic fibrosis, congenital or acquired airway malformations and many other respiratory diseases in children. The technique for performing spirometry in children is crucial and is discussed in detail. Most children, including preschool children, can perform acceptable spirometry. Steps for interpreting spirometry results include identification of common errors during the test by applying acceptability and repeatability criteria and then comparing test parameters with reference standards. Spirometry results depict only the pattern of ventilation, which may be normal, obstructive, restrictive, or mixed. The diagnosis should be based on both clinical features and spirometry results. There is a need to encourage primary care physicians and paediatricians treating respiratory diseases in children to use spirometry after adequate training.

Respiratory diseases account for the majority of all paediatric hospital visits and hospitalisations all over the world, with significant morbidity and mortality. Spirometry is a procedure that measures the rate of changing lung volumes during forced breathing manoeuvres and it is used to diagnose, manage, and monitor patients with a variety of respiratory diseases. Children have a dynamic developmental phase during which lung volume size and airway size change with increasing age. Spirometry parameters are influenced by weight, height, age, sex, environmental factors, ethnicity, prematurity, patient cooperation and effort, and technical factors. Spirometry is frequently used in adults while managing respiratory conditions. Although it is not difficult to perform spirometry in children in the primary care office setting, it is frequently underused in the paediatric age group. Dombkowski et al. conducted a survey to assess the use of spirometry by physicians in paediatric primary care who were treating children with asthma and found that only half of them were using spirometry and nearly half did not interpret the spirometry results correctly.

In the past, spirometry was considered difficult to perform in children of preschool age (2–6 years) as they are not able to perform voluntary breathing manoeuvres as efficiently as older children and adults. However, in the current era with the availability of better spirometry equipment with incentives and modified criteria for acceptability and repeatability, it is possible to perform reliable spirometry tests even in preschool children by trained personnel. A variety of methods other than spirometry have also been adopted to assess lung function in infants and young children, such as the interrupter technique, the forced oscillation technique, gas washout techniques, tidal breathing techniques, and the rapid thoracoabdominal compression manoeuvre. Some of these manoeuvres may require sedation and are usually performed in advanced respiratory laboratories. These will not be discussed in this review.

Spirometry has been found to be safe with regard to inducing cardiac arrhythmias in both children and adults. It is therefore prudent for primary care physicians and paediatricians who treat respiratory diseases in children to consider the role of spirometry in this age group and the issues of underutilisation and incorrect interpretation of spirometry tests.

This review aims to summarise the current literature regarding indications, test procedure, quality assessment, and interpretation of spirometry results in children.

Types of spirometery

A variety of spirometers are available on the market. The basic handheld spirometers provide forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) values that can be compared manually with available predicted normal values. The next generation of spirometers provide graphs (usually volume-time curves) visually with or without printouts. The most recent electronic spirometers calculate the percentage of the predicted normal values based on reference values already programmed after entering patient details and performing the test. Most of these recent spirometers have built-in printers and can also be connected to a computer. When selecting a spirometer it is desirable that the equipment fulfils American Thoracic Society/European Respiratory Society (ATS/ERS) recommendations for spirometry (which are regularly updated). As the volume of air is affected by the environment, the spirometry parameters should be presented at body temperature and ambient pressure saturated with water vapour (BTPS). The calibration, maintenance, and infection control measures (e.g. use of disposal mouthpiece or use of filters) should be implemented in accordance with the recommendations of the manufacturer of the equipment. Many newer generation spirometers do not require calibration daily or after a certain number of tests, as used to be the case. The respiratory technician or physician performing the spirometry tests requires training. It is suggested that at least five tests a week (20/month) are required to maintain competency in a person with initial competency.

Indications for spirometry in children

Spirometry is commonly indicated for children with chronic cough, persistent wheezing, and for the diagnosis and monitoring of asthma and cystic fibrosis. It must be included as a necessary component in reviewing asthma control and disease activity in cystic fibrosis in children as well as in adults. It is also frequently used to measure lung function in a number of diseases that affect the lungs including haematological disorders such as transfusion-dependent thalassaemia major and sickle cell anaemia, haemato-oncology conditions, connective tissue disorders, ataxia telangiectasia, and chest deformities such as pectus excavatum. Spirometry is helpful in ascertaining preoperative lung function in flaccid neuromuscular scoliosis (e.g. muscular dystrophy, spinal muscular atrophy, and cerebral palsy).[24] Constant et al.[15] used field spirometry as a measure to screen schoolchildren for respiratory diseases. The role of spirometry during an acute exacerbation of asthma in children is not well established. In a study by Schneider et al., many children presenting to the emergency department with an acute moderate to severe exacerbation of asthma were unable to perform acceptable spirometry tests, whereas in a study by Langhan et al., most children performed acceptable spirometry tests during an acute exacerbation. In both studies, correlation was not good between clinical severity and spirometry measurements. Uchida reported three cases of double aortic arch in children who were initially misdiagnosed as having asthma and a correct diagnosis was made based on spirometry findings. Many research studies on asthma and cystic fibrosis in children had spirometry parameters

Contraindications to spirometry

Although there is no absolute contraindication for spirometry, the following conditions are considered relative contraindications: presence of respiratory tract infection (e.g. influenza), haemoptysis of unknown origin, pneumothorax, aneurysm, uncontrolled hypertension, recent thoracic, abdominal or eye surgery, nausea, vomiting or pain, and confusion or dementia.

BEP (Break Even Point): Calculation of newly purchased spirometer in pediatric department

Fixed cost = Rs.1,37,000

Variable cost = Rs.70

Selling cost = Rs.400

$$BEP = \frac{\text{Fixed Cost}}{\text{Selling price} - \text{Variable cost}}$$

$$\frac{1{,}37{,}000}{400 - 70} = 450$$

Nearly 900 tests of spirometry taking in to consideration average 3/ day for 300 days in a year (i.e. excluding Sundays and Holidays out of 360 300 days are calculated).

BEP possibility for year time as to be fixed for Rs.450/900 tests / 300 days.

As tests of spirometry increases cost will come down with the variable cost as Rs.70.

Conclusion

Break-even analysis is a simple tool for financial analysis so as to make a right decision in business proposals when more than one alternative is available. The break-even analysis is most commonly used to do the cost volume profit analysis. It indicates the level of sales at which the total revenues are equal to the total costs. For every unit of goods produced the sale/activity generates revenue and the difference of the price minus variable cost is called unit contribution. It is an efficient and effective method of financial reporting and planning and easily understood by the senior executives when compared to accounting data.

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