In this article, IMV is presented from its historical and clinical application, with special emphasis on its advantages and precautions. The authors present IMV from the perspective of a literature search and review, and also include an updated bibliography for future investigation of the topic by the reader.

The role of the nurse anesthetist has expanded within the past decade as a result of several factors, including the knowledge explosion, newest advances in medicine and surgery, and the medical-legal aspects of the health care practitioner.

To meet these needs and fill the expanded role of practitioner, educator and consultant, the nurse anesthetist’s repertoire of skills and knowledge must also be broadened. These skills must include a working knowledge of respiratory care where intermittent mandatory ventilation (IMV) has become an important mode.

In preparing a literature review of IMV, a diligent search of journals was required since IMV is not listed in the current cumulative indexes. To acquire the publications for this article, it was necessary to scan several journals to locate an article on IMV, then refer to its bibliography as a source of reference for further articles. This technique was carried out on each article to obtain a complete list of current major publications on IMV and related maneuvers. To facilitate further investigation and study by the reader, the authors’ entire list of major references may be found at the end of this article.

History

The early theory, clinical application and investigation of IMV, a period spanning two and one-half years, took place at the University of Florida College of Medicine, Gainesville, Florida. One can conclude from the literature that IMV was an outgrowth of a technique of continuous flow ventilation for infants with respiratory distress syndrome (RDS), described in Kirby, et al, in 1971.

In September, 1973, a new approach to weaning adult patients from mechanical ventilators was introduced by Downs, et al, of Gainesville, Florida. This article described a new pediatric volume ventilator.1 Approximately two years later, in September, 1973, these same authors reintroduced the concept of infant continuous flow ventilation supported by further clinical investigation. This article reported that the technique represented an alternative to patient triggered (assisted) ventilation, and a decreased need for paralytic agents in infants on mechanical ventilators.2

In September, 1973, a new approach to weaning adult patients from mechanical ventilators was introduced by Downs, et al, of Gainesville, Florida. This was the first appearance of the term, intermittent mandatory ven-
tilation (IMV), which was proposed by Klein. The term, IMV, was originally used to describe the characteristics of the baby bird ventilator, and was not applied to a specific technique of adult ventilation.

Prior to the publication of the 1973 articles, IMV had already spread to the west coast, where it was introduced in the Seattle area by Caldwell in December, 1972. Succeeding articles began to appear from other areas of the country dealing with various innovations of the new technique. Margand, et al, of Baltimore, Maryland, reported weaning a 51-year-old woman from artificial (mechanical) ventilation with IMV when conventional methods failed.

Cross, of Jacksonville, Florida, introduced a variation on the assembly of IMV. Gingold, et al, of Hartford, Connecticut, described the successful treatment of a patient with IMV and high levels of PEEP (30 cm H₂O). Brach, et al, of San Diego, California, introduced the concept of creating positive inspiratory pressure (PIP) in the IMV circuit.

The purpose of PIP was to reduce the inspiratory effort of the patient being treated with non-positive inspiratory pressure IMV. Intermittent demand ventilation (IDV), an alternative to IMV, had been reported by Shapiro, et al, of Chicago, Illinois, in June 1976. These authors support IDV as a maneuver that is advantageous in patients with cardiovascular instability.

Equipment and technique

A considerable amount of versatility in the assembly of IMV is possible. Two types of reservoirs, controlled oxygenation or a mixture of oxygen and compressed air, with or without humidification, can be achieved with a minimal amount of equipment. The variety of assemblies falls into two major categories, which include those utilizing ambient reservoirs and those utilizing pressure reservoirs.

To create an IMV assembly, an auxiliary port (T-piece) is coupled with a patient directed unidirectional flow valve and installed in the inspiratory limb of the breathing circuit. A gas reservoir is then added proximal to the unidirectional valve. When the ventilator is in the inspiratory phase, the valve closes and the patient receives the preset tidal volume. When the patient breathes spontaneously, the valve opens, allowing the tidal volume to be drawn from the reservoir.

The ambient gas reservoir is used when the IMV assembly is placed distal to the ventilator humidifier. The ambient gas reservoir is a length of large, bore tubing (flex-tube) placed proximal to the unidirectional valve, and of sufficient length to prevent the entrainment of room air during spontaneous inspiration.

The pressure reservoir consists of an anesthesia bag attached distal to the unidirectional valve. The supply of oxygen is adjusted to allow a sufficient flow to keep the unidirectional valve partially open and the reservoir expanded.

Humidified oxygen and compressed air-oxygen mixture can be delivered by a variety of systems. If oxygenation is not a critical factor, a standard oxygen flowmeter with nebulizer plugged into a 50 psig source, can be used. This system delivers only 40, 70, and 100 per cent oxygen, and must utilize the ambient type reservoir which will preclude the use of PEEP.

There are a number of oxygen blenders available (such as the Bird) which allow a wide variety of oxygen, compressed air mixtures and concentrations. The pressure reservoir system does not preclude the use of PEEP.

Presently, mechanical ventilators have been introduced with the IMV apparatus incorporated as a permanent feature of the instrument.

Clinical application

Once the condition of the mechanically ventilated patient has improved, the primary concern is to return the patient to spontaneous ventilation. There are numerous respiratory and circula-
tory parameters used to predict the success of weaning from mechanical ventilation.8,5,9

Successful weaning often requires subjective judgment and the prolonged technique of trial spontaneous ventilation. During these trial periods however, there is a danger of the patient becoming hypoxic, hypercarbic or both. To eliminate these problems, a special adult technique, comparable to the technique used in treating infants with RDS, was introduced.1,2,8

The technique used to wean adult patients is a relatively simple one, now known as intermittent mandatory ventilation (IMV).8 IMV is the technique whereby a patient on mechanical ventilation breathes spontaneously, bypassing the ventilator, and receives mechanical hyperinflation at a preset rate and volume.8

A one-way valve in the inspiratory limb of the mechanical ventilator’s breathing circuit allows the patient to bypass the machine and breathe spontaneously. The IMV setup and its many variations are adaptable to most ventilators in current use today. However, precautions should be taken, as not all ventilators are capable of the low machine rates required in some situations when IMV is used.

The number of breaths delivered by the ventilator is called the IMV rate. This rate is gradually decreased as weaning progresses and the parameters of respiratory stability are achieved.

While the IMV rate is progressively decreased, the patient is allowed to assume more of the responsibility for the work of breathing. This technique has been successful in weaning mechanically ventilated patients, who failed to meet the criteria for conventional methods. It has also been used in the treatment of patients with COPD,10 and in combination with PEEP up to 30 cm H2O.11

IMV allows the patient to maintain his own “normal” pHa and PaCO2 without compromising arterial oxygenation. This is in contrast with conventional methods of ventilation and weaning, and it could lessen the necessity for ventilatory measurements and frequent determinations of serial blood gas tensions and pH.8,18

IMV appears to be more readily accepted by the anxious patient than the conventional method of trial spontaneous ventilation.5,15 It is interesting to note that patients on IMV have been observed to synchronize spontaneous ventilation with the IMV rate, often waiting for the mechanical inspiration to occur.12

When PEEP of greater than 4-5 cm H2O is used in conjunction with IMV, it becomes necessary to wean the patient from two ventilatory measures rather than one. The patient must now be weaned from PEEP as well as mechanical ventilation. Patients receiving PEEP of 4-5 cm H2O or less may be extubated without dramatic or precipitous change in measured parameters.9,13

Advantages

There appears to be some controversy about the advantages of IMV, but this serves more to encourage reflection and discretion rather than condemnation of the technique. There have been many practical and theoretical advantages to the technique of IMV proposed in the literature.

The predominant value of IMV is that it has been used to decrease the weaning time from mechanical ventilation in both adult and pediatric patients with acute respiratory distress.5,8,10,16,18 Early weaning seems to be a result of maintenance of physiologic blood gas tensions and pH, which is attributed to the patient who gradually assumes more of the responsibility for the work of breathing at his own pace. This differs from the “trial and error” technique of weaning where the patient is periodically challenged to breathe without ventilatory assistance, precipitating dramatic PaCO2, PO2, pHa changes.

It has also been proposed that IMV, when compared to CMV, is less likely to have a negative effect on venous return and subsequent cardiac output.
Further comparisons point out that complications of hypokalemia, cardiac dysrhythmias and seizures associated with acute alkalosis induced by vigorous mechanical ventilation should be less frequent when IMV is employed.

The psychological advantage of minimal ventilator dependency is fostered by IMV. Anxious patients who fear being unable to breathe spontaneously, or those who will not tolerate prolonged trials of spontaneous breathing will be the major beneficiaries.

The remaining positive aspects of IMV centers on its simplicity of design and operation. The system can be applied to most ventilators in current use, necessitating only the addition of a small amount of extra equipment. There is also a minimum of equipment handling, therefore reducing the possibility of contamination, patient infection, and equipment malfunction due to assembly error.13

Downs, et al, supported by Margand, indicates that nursing and respiratory care are simplified by the decreased need to monitor parameters with less frequent blood gas determinations. This is not a call for elimination of monitoring techniques but could result in increased patient tolerance and decrease the use of adjunctive drugs to produce a tranquil state.14

Precautions

A major source of problems for consumers of IMV is a lack of equipment knowledge. The simplicity of the original system has invited modifications and experimentations that may render the final product unworkable, dangerous, or both.15 In conjunction with this, the unidirectional valve which is the focal point of the setup, may stick or become reversed, causing interference with inspiratory flow and subsequent increased resistance to the patient. If a conventional oxygen wall outlet flow meter is used, oxygen concentration must not be a critical factor for the patient, as this unit only delivers 40, 70, and 100 per cent oxygen. When PEEP above 4-5 cm H2O is employed with IMV, care should be exercised to wean the patient from PEEP as well as from mechanical ventilation, and not the latter alone.9 Also, when the method of choice is the trifurcated system, it is important to recognize that additional weight is placed on the endotracheal tube.14

It appears that while IMV is still in a dynamic state of change and experimentation, one should have a clear understanding of the basic concept before attempting to utilize the modifications described in the literature.

Conclusion

IMV has become an integral part of respiratory care. Although it is a simple technique, knowledge, experience, and discretion are prerequisites for its utilization, if disaster is to be avoided. Since nurse anesthetists are often a source of reference, education, and consultation in respiratory care, it behooves them to become knowledgeable about the technique of IMV and its many variations.

REFERENCES

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