A Controlled Study Using Routine Intermittent Positive Pressure Breathing in the Post-Surgical Patient

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Intermittent positive pressure breathing with oxygen (hereinafter referred to as I.P.P.B.) has rapidly gained wide clinical use in a variety of cardio-pulmonary diseases. Well established as of value in treating some of these patients in the pre- and post-operative state, its "routine" use in the post-operative patient has also been advocated by some as a measure to prevent pulmonary complications.[1,2] The purpose of this controlled study was to evaluate the "routine" use of I.P.P.B. in the patient subjected to upper-abdominal surgery in an effort to clarify its true value in reducing post-operative complications. It was also hoped to determine if I.P.P.B. reduces discomfort and pain by increasing confidence in deep breathing, secondarily affecting ambulation time and total hospital stay.

Method

Because Inter-Community Hospital is a private practice hospital, the cooperation of the doctors was enlisted for the entirety of the study. Only patients who were admitted for upper-abdominal surgery were included in the study irrespective of complications or presence or absence of cardio-pulmonary disease. Every other case on admission was placed in the treatment group and the alternate cases in the controlled group, independent of the specific surgery contemplated. Cases selected were limited to upper-abdominal surgery in order to eliminate the type of surgery as a variable. With this method, 42 cases comprised the treatment group and 42 cases the controlled group. Seventeen cases were dropped, primarily because of lack of cooperation. In a few cases, the private doctor requested that they be dropped from the study because of his desire to use I.P.P.B. on his own in the post-operative period.

On admission to the hospital, each patient was given a pre-operative PA chest roentgenogram, a spirogram, (consisting basically of a maximum breathing capacity, vital capacity, and a three second timed vital capacity), and a cardio-respiratory evaluation by one of the research doctors. An effort was made whenever possible to determine the clinical presence or absence of pulmonary disease pre-operatively. No detailed studies were made, however, other than the history, physical examination spirogram, and chest x-ray film. Patients who reported smoking, but who were asymptomatic and had no pulmonary abnormality on examination, were considered as having no pulmonary disease for study purposes. These data were recorded on a research sheet, which also included age, sex, weight, body build, type of surgery, length of surgery, pre-operative medication, post-operative sedation, ambulation day, and total hospital stay. Each research doctor saw his assigned patients daily, and recorded symptoms, state of comfort, and physical findings. Our department of

TABLE 1—ROENTGENOGRAPHIC COMPLICATIONS IN 84 PATIENTS IN THE POST-OPERATIVE PERIOD

X-ray film change	Treated	Control
Pneumonia or atelectasis (major changes)	6	5
Zonal atelectasis (minor changes)	11	10
No X-ray film change	25	27
Total Cases	42	42

inhalation therapy performed daily vital capacity and three second timed vital capacity tests for five post-operative days. The daily values were expressed as a per cent of their pre-operative recordings taken as 100 per cent. The maximum breathing capacity was impossible to perform in the usual post-operative state. One chest x-ray film was taken on the second or third day post-operatively and again on the fifth day. The x-ray films were taken on the same day on all patients whenever possible. X-ray film evidence of complications was divided arbitrarily into three groups: those with completely normal post-operative x-ray films; those with "minor" x-ray film changes (consisting of platelike atelectasis or apparent uneven aeration); and those with major complications (consisting of pneumonia or atelectasis). The x-ray films were interpreted by two roentgenologists (W. E. Quinn, M.D., and D. Stewart, M.D.) who had no prior knowledge as to which patients were in the treated or in the controlled group.

Treatments

In all cases I.P.P.B. treatments performed by the department of inhalation therapy were started in the recovery room, usually within the first hour post-surgically. Tergemist was used routinely, but no antibiotic or bronchodilator. The latter two were not used as we were dealing basically with healthy individuals without pulmonary disease and the use of these substances would add two more variables difficult to evaluate. Forty per cent oxygen was administered and a pressure of 15 centimeters of water. Treatments were given ten minutes of every hour for three hours; ten minutes of every two hours for the next nine hours; ten minutes of every four hours for the next 12 hours; then four times a day for two more days. In all cases the therapist was in constant attendance during the treatments and urged the patient to make the maximum respiratory

TABLE 2—CORRELATION OF PRE-OPERATIVE CLINIC PULMONARY DISEASE WITH ABNORMAL ROENTGENOGRAPHIC FINDINGS

	Treated Group			Control Group		
C-R Disease	Neg. X-ray	Zonal atelectasis	Pneumonia or atelectasis	Neg. X-ray	Zonal atelectasis	Pneumonia or atelectasis
No Pulmonary Disease	18	7	5	26	6	2
Chronic bronchitis, bronchiectasis, and Smoker's Syndrome	3	3	1	0	1	2
History of Pulmonary disease	4	0	0	1	1	0
Heart Disease	0	1	0	2	1	1

TABLE 3—RELATIONSHIP BODY BUILD AND ABNORMAL ROENTGENOGRAMS

Body Build Type	Abnormal Roentgenograms	
	Treated Group	Control Group
Endomorph	9	9
Mesomorph and Ectomorph	8	6
Total	17	15

effort in both depth and length. This was unsuccessful in many instances due to pain.

Results

Post-operative Roentgenographic Complications (Tables 1 and 2)

The post-operative roentgenogram was the cornerstone of our objective evaluation. Table 1 shows that I.P.P.B. did not prevent post-operative pulmonary complications. Seventeen patients in the treated group were interpreted as having complications, six major (pneumonia or atelectasis) and 11 minor (zonal atelectasis). In the control group, five of the 15 patients had major complications and ten had minor complications.

Table 2 summarizes the relationship between the presence or absence of pre-operative clinical pulmonary or cardiac diseases and post-operative x-ray film changes. The number of patients with pre-operative pulmonary disease was too small to evaluate as a separate group, although pulmonary complications were found in both series irrespective of I.P.P.B. treatments.

Correlation of Abnormal Roentgenograms with other Factors (Table 3)

Body Build

It is well recognized that the elderly obese patient is more prone to have pulmonary complications post-operatively. Review of Table 3 shows that, even though the endomorph has a higher percentage of post-operative complications, I.P.P.B., as used, did not prevent these complications. There were 18 endomorphs in each group studied, nine in each developing post-operative complications. Analyzing only patients with major complications, (Table 9) the endomorph tended again to predominate.

Age and Sex (Tables 4 and 5)

Post-operative pulmonary complications were noted in all age groups. Here again, no significant protection could be attributed to I.P.P.B. treatments in preventing complications in any of these age groups. No correlation was found in this study between the sex of the individual patients, their tendency to develop post-operative complications, or protection from the use of I.P.P.B.

TABLE 4—RELATION BETWEEN AGE AND ABNORMAL ROENTGENOGRAMS

Decade	Treated Group	Control Group
3rd	2	1
4th	4	4
5th	4	5
6th	1	4
7th	3	1
8th	3	0
Total	17	15

TABLE 5
RELATIONSHIP BETWEEN SEX AND ABNORMAL ROENTGENOGRAMS

Sex	Treated Group	Control Group
Female	10	9
Male	7	6

Type of Surgery (Table 6)

Patients having gastric-resections had a higher per cent of complications than those having cholecystectomies and, here again, I.P.P.B. afforded no protection from pulmonary complications.

Spirographic Results (Tables 7 and 8)

A review of the spirographic data demonstrates that I.P.P.B. had no beneficial effect in hastening the return towards normal of the vital capacity. The timed vital capacity data was also comparable in the two groups.

Only a small number of patients had abnormal spirograms pre-operatively. The number is too few to draw any conclusions, although the number of major complications was zero in the treated as compared to two in the control group.

Analysis of Major Complications (Table 9)

Analysis of patients with major complications alone shows no significant variation or difference in the various categories studied as compared to the patients having major and minor complications combined. The overall incidence of major complications was approximately the same in the treated and controlled groups despite the fact that, if anything, more pulmonary disease was present in the treated group.

Miscellaneous Data

No difference in the day ambulated or total days hospitalized was found in comparing the controlled and treated groups.

As an overwhelming number of patients had general anesthesia, this factor was not evaluated. Post-operative analgesics is extremely difficult to evaluate on a comparative basis, but only an occasional patient was found to have "heavy" post-operative sedation, which statistically was not considered significant.

Discussion

I.P.P.B. as used in this control did not prevent post-operative complications even in those few patients with pre-operative pulmonary diseases, abnormal pre-operative spirograms, and the obese. The ability of I.P.P.B. to prevent complications in the post-operative patient, even without cardio-pulmonary disease, would necessarily be based on the following observations: I.P.P.B. increases pulmonary ventilation and tidal

TABLE 6—RELATIONSHIP OF TYPE SURGERY AND ABNORMAL ROENTGENOGRAMS*

Surgery	Number Abnormal	Total Cases
Gastric Resection	9	17
Cholecystectomy	23	67

*Of the four major pulmonary complications in patients with gastric resection, three were in the treated group. Of the eight major complications in those with cholecystectomies, three were in the treated group.

TABLE 7—DAILY AVERAGE SPIROGRAPHIC IMPROVEMENT IN POST-OPERATIVE PERIOD

	Treated Group		Control Group	
Day	V.C.	T.V.C. (3 sec.)	V.C.	T.V.C. (3 sec.)
1st	36 per cent	98 per cent	42 per cent	97 per cent
2nd	48 per cent	97 per cent	53 per cent	94 per cent
3rd	61 per cent	100 per cent	63 per cent	93 per cent
4th	77 per cent	93 per cent	76 per cent	93 per cent
5th	79 per cent	93 per cent	76 per cent	93 per cent
Pre-Op.		89 per cent		91 per cent

volume, increases respiratory depth, causing more uniform alveolar ventilation, and improves bronchial drainage during exhalation because of the high velocity expiratory rate. These effects might be considered generally to maintain ventilation in the post-operative patients, to enhance the elimination of secretions, and thereby to prevent atelectasis.

In trying to explain our negative results, it is possible that the positive pressure used, and the length and depth of each individual respiration was inadequate to produce the desired effects, and that the tidal volume was not increased to the point of therapeutic benefit. This is borne out by the lack of I.P.P.B. to hasten the rate to normal of vital capacity performed in the post-operative period. These findings occurred despite constant urgings by competently trained inhalation therapists to the patients to make maximum respiratory efforts in both depth and length. Each treatment was personally supervised by an inhalation therapist, a condition that would exist in few hospitals today. This emphasizes even more forcibly the danger of leaving the work of stimulating the post-operative patient to breathe to a "machine" even when supervised. Elevating the pressure might help force the issue making it more difficult for the patient to voluntarily stop inspiration. The recognition of these facts compromise the real value of this study. The I.P.P.B. machine, as used in this study, cannot replace the bedside work of the post-operative surgical team.

Further observations bear mention. The research team was unanimous in noting that treated patients complained of "more mucus" than in the control group, and that I.P.P.B. although effective in mobilizing the mucus was not simulating the cough reflex. These patients were actually then unable to raise the loosened secretions, so that retained secretions remained the major problem in both groups. Perhaps use of the cofflator would be a more logical approach to the post-operative patient for this reason.

I.P.P.B. did not seem to reduce post-operative discomfort, did not hasten ambulation time, and did not reduce total hospital stay. These are expected observations when it was shown the post-operative pulmonary complications were not prevented.

Patients treated with I.P.P.B. did not have a more rapid return to normal of the vital capacity in the five day post-operative observation period. This tends to substantiate our impression that with the methods used little improvement was made in overall ventilation.

Nine of 13 "major" complications were not demonstrated clinically during our daily bedside pre-operative examinations. The post-operative patient is, at best, difficult to examine, is loathe to turn, sit up, and to perform deep breathing. These reasons undoubtedly account for the research team's missing the pulmonary abnormalities in such a high percentage of patients. This lends even greater importance to the roentgenogram as being the corner stone of the evaluation of the post-operative patient. This undoubtedly is a frequent occurrence where routine x-ray films are not taken.

There was not a sufficient number of patients with substantiated pulmonary disease or abnormal pre-operative spirograms to analyze their results with I.P.P.B. separately. Although well established in the treatment of some of these patients in the pre- and post-operative period, the indications should be clear-cut, and the indiscriminate use of I.P.P.B. should be discouraged. Further controlled studies employing a larger number of these patients using I.P.P.B. treatment post-operatively is indicated.

CONCLUSION

1. Intermittent Positive Pressure Breathing, as used in this controlled study by a competent inhalation therapy department, did not prevent post-operative pulmonary

TABLE 8—ABNORMAL PRE-OPERATIVE SPIROGRAM AND ROENTGENOGRAPHIC CHANGE

Abnormal Spirograms	X-Ray Change
Treated Group (6 Cases)	3 minor 0 major
Control Group (9 Cases)	3 minor 2 major

TABLE 9—ANALYSIS OF MAJOR PULMONARY COMPLICATIONS—11 CASES

Factors Aanlyzed	Treated Group (6 cases)	Control Group (5 cases)
Average Age	62 (age 33-80)	45 (age 28-53)
Sex	2 male 4 female	1 male 4 female
Body Build	Endomorph — 3 Mesomorps — 1 Ectomorph — 2	Endomorph — 3 Mesomorph — 0 Ectomorph — 2
Abnormal Pre-Operative Spirogram	0	2
Pre-Operative Pulmonary Disease	1	2 (1 Pulmonary) (1 Coronary)

complications in patients subjected to upper-abdominal surgery. These patients for the most part did not have cardiopulmonary disease.

2. The I.P.P.B. machine as used in this study cannot replace the bedside work of the post-operative surgical team.

3. Although well established in the treatment of some patients with cardio-pulmonary disease in the pre- and post-operative period, the indications should be clear-cut and the indiscriminate use of I.P.P.B. discouraged.

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CONCLUSIONES

1. El uso de la respiración a presión positiva intermitente como método en estudio controlado por un departamento de terapia de inhalación competente, no previno las complicaciones pulmonares postoperatorias en los enfermos sujetos a cirugía abdominal alta. Estos enfermos en su mayoría no tenían enfermedad cardiopulmonar.

2. La máquina de IPPB como se usó en este estudio, no puede substituir al trabajo a la cabecera del enfermo que desarrolla el grupo de trabajo postoperatorio.

3. Aunque el uso del aparato de IPPB está bien justificado en algunos pacientes con enfermedad cardiopulmonar en el período pre y postoperatorio, sus indicaciones deben ser bien determinadas y su uso indiscriminado debe desalentarse.

RESUMÉ

1. La respiration en pression positive intermittente, utilisée dans cette étude par le service compétent de traitement par inhalations, n'empêcha pas les complications pulmonaires post-opératoires chez les malades soumis à une chirurgie sus-diaphragmatique. Ces malades n'avaient pas d'affection cardiopulmonaire pour la plupart.

2. L'appareil servant à la respiration en pression positive intermittente, utilisé dans cette étude, ne peut pas remplacer le travail au chevet du malade fait par l'équipe chirurgicale post-opératoire.

3. Bien que les indications soient bien établies dans le traitement de quelques malades atteints d'affection cardio-pulmonaire dans la période pré- et post-opératoire, elles devraient être très claires et l'utilisation indiscriminée de la respiration en pression positive intermittente découragée.

SCHLUSSFOLGERUNG

1. Die intermittierende positive Druckatmung, wie sie bei dieser beschränkten Untersuchung durch eine leistungsfähige Abteilung für Inhalationstherapie angewandt wurde, war nicht imstande, postoperative Lungenkomplikationen bei Kranken zu verhindern, die chirurgischen Eingriffen im Oberbauch unterzogen worden waren. Meistenteils hatten diese Patienten keine cardio-pulmonalen Erkrakungen.

2. Die Apparatur zur intermittierenden positiven Druckatmung, wie sie bei dieser Untersuchung benutzt wurde, vermag die Arbeit des Teams zur postoperativen chirurgischen Versorgung am Krankenbett nicht zu ersetzen.

3. Wenngleich klare Indikationen zur Behandlung gewisser Kranken mit Herz-Lungen-Krankheiten durch intermittierende positive Druckatmung während ihrer prä- und postoperativen Periode aufgestellt sind, müssen sie gut abgegrenzt un die wahllose Verwendung dieser Druckatmung verhindert werden.

REFERENCES

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