

SEVERE RESPIRATORY INSUFFICIENCY - METHODS OF MANAGEMENT

THE GENERAL AVAILABILITY OF IMPROVED TECHNIQUES FOR THE TREATMENT OF SEVERE VENTILATORY INSUFFICIENCY MAKES IT EXPEDIENT FOR ALL PHYSICIANS TO BE MORE FAMILIAR WITH THE INDICATIONS FOR THE USE OF THESE METHODS AS WELL AS THE SPECIFIC DETAILS FOR THE UTILIZATION OF THESE METHODS.

THE CONDITIONS WITH WHICH WE WILL BE MORE CONCERNED MAY BE GENERALLY DIVIDED INTO TWO CATEGORIES: A. THOSE IN WHICH THE CAUSE OF VENTILATORY INSUFFICIENCY IS PERIPHERAL IN ORIGIN; AND B. THE SITUATIONS IN WHICH VENTILATORY INSUFFICIENCY IS CENTRAL IN ORIGIN.

EXAMPLES OF PERIPHERAL RESPIRATORY FAILURE ARE:

1. SEVERE INTERSTITIAL PNEUMONIA
2. SEVERE PULMONARY EDEMA
3. CRUSH INJURY OF THE CHEST OR FLAIL CHEST
4. SEVERE STATUS ASTHMATICUS
5. PULMONARY EMPHYSEMA OR OTHER OBSTRUCTIVE DISEASE WITH CARBON DIOXIDE RETENTION
6. ACUTE UPPER AIRWAY OBSTRUCTION
7. TETANUS
8. POLIOMYELITIS
9. OTHER FORMS OF NEUROMUSCULAR FAILURE
10. POST OPERATIVE CONDITIONS CAUSING PAIN OF THE CHEST OR ABDOMEN

EXAMPLES OF CENTRAL RESPIRATORY FAILURE ARE:

1. DRUG DEPRESSION ASSOCIATED WITH ANESTHESIA OR SUICIDAL ATTEMPTS WITH NARCOTICS OR BARBITURATES
2. HEAD INJURIES
3. CEREBROVASCULAR ACCIDENTS OR OTHER FORMS OF CENTRAL NERVOUS SYSTEM DISEASE

FREQUENTLY THE PRESENCE OF ONE OF THESE CONDITIONS IS OBSCURED BY THE PATIENT'S UNDERLYING CONDITION WHICH TENDS TO OCCUPY THE PHYSICIAN'S ATTENTION. THIS IS PERHAPS MOST OFTEN TRUE IN THE CASE OF PULMONARY EDEMA, WHICH CAN OCCUR AS A CONSEQUENCE OF SO MANY DIFFERENT DISTURBANCES. SEVERE VENTILATORY INSUFFICIENCY OFTEN PRODUCES PHYSIOLOGIC ALTERATIONS WHICH MAY AGGRAVATE THE UNDERLYING CONDITION AS WELL AS PERPETUATE THE PULMONARY EDEMA ITSELF.

THE INDICATIONS FOR RESPIRATORY ASSISTANCE MAY GENERALLY BE AS FOLLOWS:

1. HYPOXIA DUE TO SEVERE DISTRIBUTION DEFECTS RESULTING FROM DIFFUSE MECHANICAL DISTURBANCES OF THE LUNGS OR THORAX,
2. ALVEOLAR UNDER-VENTILATION WITH CARBON DIOXIDE RETENTION,
3. SITUATIONS IN WHICH THE WORK OF BREATHING IS PROFOUNDLY INCREASED OWING TO MECHANICAL ALTERATIONS IN THE AIRWAYS, LUNG PARENCHYMA OR THORAX.

THE PARTICULAR APPARATUS OR METHODS EMPLOYED FOR PROVIDING EITHER SIMPLE ASSISTED RESPIRATION OR ASSISTED VENTILATION WITH OXYGEN DEPEND ON THE PARTICULAR CIRCUMSTANCES SURROUNDING EACH CASE AS WELL AS THE GENERAL AVAILABILITY OF APPARATUS. CERTAIN BASIC PRINCIPLES, HOWEVER, SHOULD BE CONSIDERED. ONE OF THE FIRST CONSIDERATIONS IS WHETHER RESPIRATION NEEDS TO BE CONTROLLED OR MERELY ASSISTED. GENERALLY SPEAKING, IF A PATIENT HAS ADEQUATE RESPIRATORY DRIVE OF HIS OWN, RESPIRATION SHOULD BE ASSISTED RATHER THAN CONTROLLED, IN WHICH CASE A DEVICE SUCH AS THE INTERMITTENT POSITIVE PRESSURE BREATHING APPARATUSES, WHICH ALLOW THE PATIENT TO ESTABLISH HIS OWN RATE OF BREATHING, ARE MOST SATISFACTORY. WHERE THE PATIENT'S ABILITY TO INITIATE A RESPIRATORY RHYTHM IS HAMPERED OR ABSENT, SUCH DEVICES AS RESPIRATORY PUMPS, COMMONLY USED BY SURGEONS AND ANESTHESIOLOGISTS, CAN BE UTILIZED. ON THE OTHER HAND, MOST IPPB DEVICES ARE NOW PROVIDED WITH RATE CONTROL DEVICES WHICH MAKE IT POSSIBLE TO TAKE OVER A PATIENT'S BREATHING RHYTHM AT ANY TIME WHEN THE BREATHING RATE IS EITHER INADEQUATE OR ABSENT.

THE NEXT IMPORTANT CONSIDERATION IS WHETHER OR NOT THE PATIENT HAS AN ADEQUATE AIRWAY. NO FORM OF ASSISTED VENTILATION WILL BE EFFECTIVE UNLESS ADEQUATE CONTROL OF THE AIRWAY CAN BE OBTAINED. ALSO, THE PRACTICAL USEFULNESS OF CERTAIN APPARATUSES IS GREATLY LIMITED UNLESS COMPLETE CONTROL OF THE AIRWAY CAN BE OBTAINED. AS A GENERAL RULE, ANY PATIENT WHO IS UNCONSCIOUS OR IN WHOM THE SWALLOWING MECHANISM IS IMPAIRED, THE ONLY SATISFACTORY METHOD WHEREBY ASSISTED VENTILATION CAN BE GIVEN IS THROUGH A TRACHEOSTOMY. IN THOSE CIRCUMSTANCES WHERE THE PATIENT'S COMPLETE INCAPACITY IS CONSIDERED TO BE TEMPORARY, THAT IS, LESS THAN 48 HOURS, COMPLETE CONTROL OF THE AIRWAY CAN BE GAINED THROUGH AN ENDOTRACHEAL TUBE. IN RECENT YEARS THERE HAS BEEN SOME CONTROVERSY ABOUT WHETHER CUFFED OR UNCUFFED TUBES SHOULD BE UTILIZED. WHEN INTERMITTENT POSITIVE PRESSURE DEVICES ARE USED, CUFFED TUBES MUST BE UTILIZED, SINCE THESE DEVICES ARE PRESSURE-LIMITING AND WILL NOT FUNCTION PROPERLY EXCEPT WITH A COMPLETELY CLOSED SYSTEM. WITH THE PISTON-TYPE PUMPS, HOWEVER, UNCUFFED TUBES CAN BE UTILIZED BUT IT BECOMES VERY DIFFICULT TO MEASURE AND CONTROL VENTILATION WITH AN UNCUFFED TUBE. THOSE PEOPLE WHO HAVE BEEN USING UNCUFFED TUBES GENERALLY PAY LITTLE ATTENTION TO THE CONTROL OF THE LEVEL OF VENTILATION AND, AS A RESULT, USUALLY HYPERVENTILATE THEIR PATIENTS IN ORDER TO INSURE ADEQUATE VENTILATION. IN ORDER TO USE

UNCUFFED TUBES, SPECIAL APPARATUSES WHICH CAN DELIVER LARGE VOLUMES OF AIR ARE REQUIRED. WITH SUCH HIGH AIR FLOW RATES, THE PROBLEM OF HUMIDIFICATION BECOMES FURTHER COMPLICATED. ONE OF THE IMPORTANT CRITICISMS OF THE USE OF THE CUFFED TUBE IS THE DANGER OF PRODUCING TRACHEAL NECROSIS. WHEN CUFFS ARE USED PROPERLY, THIS IS NEVER A DANGER. ONLY THAT AMOUNT OF PRESSURE WHICH IS NECESSARY TO PREVENT A SERIOUS LEAK AROUND THE TUBE SHOULD BE UTILIZED. THIS RARELY REQUIRES MORE THAN 3-5 CC. OF AIR IN THE CUFF, DEPENDING ON THE SIZE OF THE PATIENT'S TRACHEA AFTER THE TUBE IS IN PLACE. IN ANY EVENT, THE AMOUNT OF PRESSURE ON THE CUFF NEVER NEED EXCEED CAPILLARY PRESSURE AND THUS NECROSIS WOULD NOT OCCUR.

THE NEXT CONSIDERATION IS THE AMOUNT OF PRESSURE THAT SHOULD BE UTILIZED. IN THIS REGARD, THE AIM SHOULD BE TO PROVIDE ADEQUATE RESPIRATORY ASSISTANCE. AS A GENERAL GUIDE, THAT AMOUNT OF PRESSURE WHICH IS NECESSARY TO RELIEVE DYSPNEA EFFECTIVELY SHOULD BE USED, REGARDLESS OF WHETHER THAT AMOUNT IS AS HIGH AS 45 CM. OF WATER. MORE PRECISELY, THAT AMOUNT OF PRESSURE SHOULD BE UTILIZED TO INSURE ADEQUATE VENTILATION AS JUDGED BY MEASUREMENTS OF TIDAL VOLUME OR BLOOD GAS LEVELS. HOWEVER, IN CERTAIN CIRCUMSTANCES, PARTICULARLY WHEN PULMONARY INFECTION OR AN INEFFECTIVE COUGH IS PRESENT, LARGER THAN NORMAL TIDAL VOLUMES ARE INDICATED TO ACHIEVE OPTIMAL DISTRIBUTION OF VENTILATION. IN THESE CASES, IT MAY BE NECESSARY TO ADD DEAD SPACE TO PREVENT EXCESSIVE CO₂ LOSS. WHEN A PATIENT FUNCTIONS WITH HIS OWN RESPIRATORY RATE, IT IS NECESSARY TO COACH HIM TO A SLOW, EFFECTIVE BREATHING PATTERN AND THIS OFTEN REQUIRES CONSIDERABLE EDUCATION AND REASSURANCE. OTHERWISE THERE IS A TENDENCY FOR THE PATIENTS TO BREATHE TOO RAPIDLY AND TO ACTUALLY WORK AT BREATHING, THEREBY NEGATING A SIGNIFICANT FUNCTION OF THE ASSISTANCE.

A FINAL CONSIDERATION IN REGARD TO THE METHODS EMPLOYED IS THE ADEQUATE HUMIDIFICATION OF THE INSPIRED AIR. WHEN ASSISTANCE IS APPLIED IN SUCH A WAY SO THAT AIR PASSES THROUGH THE NOSE AND PHARYNX, ASSISTANCE CAN BE GIVEN FOR SHORT PERIODS OF TIME, NOT TO EXCEED AN HOUR OR TWO, WITH THE CONVENTIONAL MEAGER METHODS OF HUMIDIFICATION. HOWEVER, IT SHOULD BE NOTED THAT FOR LONGER TERM ASSISTANCE, SPECIAL METHODS OF HUMIDIFICATION OF THE INSPIRED AIR ARE NECESSARY. MAIN-STREAM COLD-MIST NEBULIZERS WILL BE ADEQUATE WHEN THE UPPER AIRWAY IS KEPT INTACT. HOWEVER, WHEN THE PATIENT IS VENTILATED DIRECTLY VIA THE TRACHEA, IT BECOMES NECESSARY TO USE HEATED MIST IN ORDER TO PROVIDE HUMIDITY OF THE INSPIRED AIR WHICH WILL PREVENT INSPISSATION AND CRUSTING OF TRACHEOBRONCHIAL SECRETIONS. AN EXAMINATION OF AVAILABLE PSYCHOMETRIC CHARTS READILY DEMONSTRATES THE FACT THAT ADEQUATE HUMIDIFICATION CAN ONLY BE ACCOMPLISHED BY HEATING THE SOLUTIONS. EVEN SO, IN THOSE PATIENTS IN WHOM COPIOUS AMOUNTS OF TRACHEOBRONCHIAL SECRETIONS ARE PRESENT, IT BECOMES, IN ADDITION, NECESSARY TO UTILIZE FREQUENT INSTILLATION OF MIXTURES OF WARM SALINE AND WETTING AGENT SOLUTIONS IN ORDER TO ASSIST IN THE EVACUATION OF THESE SECRETIONS.

AN ADDITIONAL PROBLEM THAT ARISES IN THOSE PATIENTS IN WHOM A VIGOROUS COUGH CANNOT BE PRODUCED BY STIMULATION OF THE TRACHEOBRONCHIAL TREE WITH A SUCTION CATHETER IS THE ACCUMULATION OF SECRETIONS IN THE PERIPHERAL BRONCHI. UNDER THESE CIRCUMSTANCES, MECHANICAL METHODS OF COUGHING ARE NECESSARY IN ORDER TO AID IN THE EVACUATION OF SUCH MATERIAL AND PREVENT ITS ACCUMULATION WHICH MIGHT WELL LEAD TO THE DEVELOPMENT OF PULMONARY INFECTION OF ATELECTASIS. THIS IS BEST ACCOMPLISHED WITH MECHANICAL COUGHING APPARATUSES SUCH AS THE COFLATOR.

IN ORDER TO ILLUSTRATE THE USEFULNESS OF THESE METHODS, A NUMBER OF CASES WILL BE PRESENTED BRIEFLY.

CASE 1. ■■■■■, A 57-YEAR-OLD COLORED MALE, KNOWN ASTHMATIC OF 30 YEARS' DURATION, WAS ADMITTED TO THE HOSPITAL WITH A 3-DAY HISTORY OF CRAMPY ABDOMINAL PAIN, VOMITING, DIARRHEA AND ABDOMINAL DISTENSION, WHICH HAD BEEN PRECEDED BY THREE MONTHS OF ANOREXIA AND A 15-POUND WEIGHT LOSS. THE PHYSICAL EXAMINATION REVEALED TEMPERATURE 102, THE ABDOMEN WAS MARKEDLY DISTENDED, TENDER, AND THERE WAS EVIDENCE OF A MARKED EXTRACELLULAR FLUID DEFICIT. THE AP DIAMETER OF THE CHEST WAS MARKEDLY INCREASED AND THORACIC EXCURSIONS WERE LIMITED. THERE WERE DIFFUSE SIBILANT RALES, OCCASIONAL RHONCHI AND WHEEZES NOTED. RESPIRATORY RATE WAS 30 PER MINUTE AND THE PATIENT APPEARED TO BE MILDLY DYSPNEIC. THE X-RAY WAS COMPATIBLE WITH PULMONARY EMPHYSEMA AND FIBROSIS. BUN WAS 75, CO₂ 29, AND CHLORIDES 86. FOR THE NEXT THREE DAYS, THERAPY CONSISTED ONLY OF THE ADMINISTRATION OF INTRAVENOUS FLUIDS AND MILD SEDATION. ON THE THIRD HOSPITAL DAY, AN EXPLORATORY LAPAROTOMY WAS PERFORMED ON THE BASIS OF A PRESUMPTIVE DIAGNOSIS OF SMALL BOWEL OBSTRUCTION. A PARTIAL BOWEL RESECTION AND AN ANASTOMOSIS WAS PERFORMED AND DURING SURGERY MARKED OBSTRUCTIVE BREATHING AND HYPOTENSION APPEARED WHICH, HOWEVER, WERE TRANSIENT IN NATURE AND BELIEVED TO BE DUE TO MANIPULATION OF THE BOWEL. HOWEVER ONE HOUR POSTOPERATIVELY, THE PATIENT WAS IN SHOCK AND CYANOTIC WITH SEVERE GENERALIZED OBSTRUCTIVE BREATHING. OXYGEN BY MASK, LEVOPHED, AND A TRACHEOSTOMY FAILED TO IMPROVE THE PATIENT'S CONDITION AND HE APPEARED TO BE TERMINAL. AT THIS TIME THE BUN WAS 92, CO₂ WAS 34, CHLORIDES 96, AND PH 7.18. AT THIS POINT, INTERMITTENT POSITIVE PRESSURE BREATHING WITH 70% HELIUM AND 30% OXYGEN HUMIDIFIED VIA A MAINSTREAM WARM MIST NEBULIZER AND INTRAVENOUS AMINOPHYLLINE WERE STARTED. AFTER EIGHT HOURS OF THIS REGIMEN, ACCOMPANIED BY THE SUCTIONING AND ASPIRATION OF LARGE AMOUNTS OF MUCOUS PLUGS, THE PATIENT BECAME RESPONSIVE. TWO HOURS AFTER THE START OF THIS REGIMEN, LEVOPHED WAS DISCONTINUED BECAUSE THE BLOOD PRESSURE HAD STABILIZED. COMPLETE RECOVERY FOLLOWED AND THE TRACHEOSTOMY WAS REMOVED SEVERAL DAYS LATER.

THIS CASE IS AN EXAMPLE OF THE CONSEQUENCES OF INADEQUATE PREPARATION PRIOR TO GENERAL SURGERY IN A PATIENT WITH CHRONIC BRONCHOPULMONARY DISEASE. WHEREAS THE TREATMENT RENDERED APPEARED TO BE

LIFE SAVING, ALL OF THIS COULD PROBABLY HAVE BEEN PREVENTED BY PROPER PREPARATION. BECAUSE OF THE EVIDENCE OF MARKED AIRWAY OBSTRUCTION AND PROFOUND RESPIRATORY ACIDOSIS, IT WAS FELT THAT BETTER VENTILATION COULD BE ACHIEVED IN THIS PATIENT BY THE USE OF HELIUM AND OXYGEN RATHER THAN STRAIGHT OXYGEN.

CASE 2. ■■■, A 42-YEAR-OLD WHITE FEMALE, WAS ADMITTED TO THE HOSPITAL TWELVE DAYS POST SEPTIC ABORTION. THE FIRST FIVE DAYS AFTER ADMISSION, SHE DEVELOPED PROGRESSIVE DYSPNEA ACCOMPANIED BY INTENSE CYANOSIS, SHOCK, OLIGURIA, PROFOUND AZOTEMIA, WHICH FAILED TO RESPOND TO THE ADMINISTRATION OF 100% OXYGEN BY MASK AND LEVEPHED INTRAVENOUSLY. AT THIS TIME, HER RESPIRATORY RATE WAS 60 PER MINUTE, PULSE RATE 120, TEMPERATURE 104; HER RESPIRATORY EFFORTS WERE INTENSE, BUT THE LUNGS WERE CLEAR AND BREATH SOUNDS WERE HARSH. THE X-RAY REVEALED EVIDENCE OF A DIFFUSE INTERSTITIAL INFILTRATE. THE BASIS OF THIS PATIENT'S DIFFICULTY WAS FELT TO BE MILIARY EMBOLIZATION OF THE LUNGS WITH DIFFUSE INTERSTITIAL EDEMA. INTERMITTENT POSITIVE PRESSURE BREATHING WITH OXYGEN WAS STARTED AT 20 CM. WATER PRESSURE. THIS, HOWEVER, DID NOT ALLEVIATE THE PATIENT'S DYSPNEA. IT WAS NOT UNTIL 40 CM. WATER PRESSURE WAS UTILIZED THAT DYSPNEA SIGNIFICANTLY DIMINISHED. AT THIS TIME THE RESPIRATORY RATE HAD SLOWED TO 30 PER MINUTE AND THE BLOOD PRESSURE ROSE TO 60/40 WITHIN FIVE MINUTES AFTER THE INSTITUTION OF EFFECTIVE PRESSURES, AND TO 100/60 TWENTY MINUTES AFTER THE INSTITUTION OF THE TREATMENT. WHEN INTERMITTENT POSITIVE PRESSURE OXYGEN WAS DISCONTINUED, PROFOUND CYANOSIS AND HYPOTENSION REAPPEARED WITHIN MOMENTS. CONTINUED ASSISTANCE WAS NECESSARY ON THIS PATIENT WITH GRADUALLY DIMINISHING PRESSURES OVER A PERIOD OF THE NEXT THREE WEEKS. THE OXYGEN STREAM WAS HUMIDIFIED AGAIN BY WAY OF A MAINSTREAM WARM MIST NEBULIZER. AFTER THREE WEEKS GRADUAL DIMINUTION IN THE PERIODS OF ASSISTANCE WERE STARTED. AFTER FOUR ADDITIONAL WEEKS, IT WAS NO LONGER NECESSARY TO GIVE THE PATIENT PERIODS OF ASSISTED BREATHING. DURING THIS SAME TIME, TREATMENT FOR SEPTIC PELVIC THROMBOPHLEBITIS CONSISTED OF MASSIVE ANTIBIOTIC THERAPY AND SUBSEQUENTLY INFERIOR VENA CAVAL LIGATION. RECOVERY IN THIS PATIENT WAS ULTIMATELY COMPLETE.

THIS CASE IS AN EXAMPLE OF THE PROLONGED ADMINISTRATION OF 100% OXYGEN WHICH WAS NECESSARY IN ORDER TO PROVIDE ADEQUATE OXYGENATION. THE ANOXIC DEFEAT HERE WAS LARGELY A RESULT OF PROFOUND INTRAPULMONARY SHUNTING THROUGH NON-VENTILATED SEGMENTS OF LUNG. SUCH SHUNTING IS ALWAYS MOST SEVERE IN CASES SUCH AS THIS WHERE PULMONARY HYPERTENSION WAS MARKED. THE SUBSEQUENT TABLE IS A TYPICAL EXAMPLE OF PHYSIOLOGICAL STUDIES OBTAINED FROM A SIMILAR PATIENT, ILLUSTRATING THE ROLE OF PRESSURE BREATHING WITH OXYGEN.

TABLE 5
GAS EXCHANGE STUDIES IN PATIENT WITH PULMONARY EDEMA

	ROOM AIR	100% O ₂ 40 MIN.	IPPB O ₂ 15 MIN. 25 CM. H ₂ O	IPPB-O ₂ 45 MIN. 25 CM. H ₂ O	IPPB-O ₂ 30 MIN. 45 CM. H ₂ O
ARTERIAL BLOOD					
O ₂ SATURATION (PER CENT)	50	75	82	82	92
P _O 2 (MM. HG)	30	50	60	62	80
P _C O ₂ (MM. HG)	26	30	25	26	24
PH	7.10	7.11	7.17	7.20	7.22
ALVEOLAR P _O 2 (MM. HG)	115	670	690	690	695
A-A P _O 2 DIFFERENCE (MM. HG)	85	620	630	628	615
VENTILATION (LITERS/MIN.)	18.2	17.5	24.4	25.8	33
RESPIRATORY RATE	60	55	32	32	30
TIDAL VOLUME (ML.) (BTPS)	300	318	762	805	1,100
CO ₂ PRODUCTION (ML.) (STPD)	250	262	289	290	300
O ₂ CONSUMPTION (ML.) (STPD)	264	276	320	325	340
ARTERIAL PRESSURE (MM. HG)	50/20	60/40	85/50	90/60	90/60

CASE 3. [REDACTED], A 48-YEAR-OLD WHITE MALE KNOWN ASTHMATIC SINCE 1943 WHO GAVE A 35-YEAR HISTORY OF NASAL ALLERGY. IN THE THREE YEARS PRECEDING THIS ADMISSION, PROGRESSIVE RESPIRATORY SYMPTOMS MADE IT IMPOSSIBLE FOR HIM TO WORK MOST OF THE TIME AND 36 HOURS PRIOR TO ADMISSION HE WAS IN VIRTUAL STATUS ASTHMATICUS. AT THE TIME OF ADMISSION, HE EXHIBITED SEVERE OBSTRUCTIVE RESPIRATORY DISTRESS, HE WAS PERSPIRING PROFUSELY. SHORTLY AFTER ADMISSION, IN SPITE OF INTRAVENOUS AMINO-PHYLLINE, NEBULIZED BRONCHODILATOR AND WETTING AGENT DRUGS BY OXYGEN WITH AN OEM MASK, HE BECAME SEMI-COMATOSE, HYPOTENSIVE, CYANOTIC; CO₂ COMBINING POWER WAS 36 MEQ, PH 7.20; RESPIRATIONS WERE VERY RAPID, SHALLOW AND LABORED. AT THIS TIME CONTINUOUS INTERMITTENT POSITIVE PRESSURE BREATHING OXYGEN WITH WARM MIST MAINSTREAM NEBULIZATION OF TERGEMIST WAS STARTED BY MASK. ISUPREL WAS ADMINISTERED BY A SMALL SIDEARM NEBULIZER EVERY TWO HOURS. ONE HOUR AFTER THE START OF THIS THERAPY, HE WAS MORE ALERT, RESPIRATIONS WERE MUCH SLOWER; 14 HOURS LATER CO₂ COMBINING POWER WAS DOWN TO 29 MEQ BUT RESPIRATION STILL BECAME DIFFICULT WITHOUT INTERMITTENT POSITIVE PRESSURE BREATHING ASSISTANCE. THEREFORE CONTINUOUS ASSISTANCE WAS GIVEN MOST OF THE TIME FOR THE NEXT THREE DAYS. IN THE MEANTIME, STEROID THERAPY WAS ALSO INSTITUTED. IMPROVEMENT WAS STEADY AND LATER RESPIRATORY ASSISTANCE WAS ONLY USED ON AN INTERMITTENT BASIS. TEN DAYS AFTER ADMISSION THE PATIENT

WAS DISCHARGED WITH NORMAL BREATHING. CO₂ COMBINING POWER WAS 22 MEQ. DURING THE INTERIM, HUGE AMOUNTS OF MUCOID SPUTUM WITH DENSE PLUGS HAD BEEN EVACUATED. THE FOLLOWING TABLE EXHIBITS A COMPARISON BETWEEN PULMONARY FUNCTION STUDIES DONE 11 DAYS PRIOR TO ADMISSION TO THE HOSPITAL AND THE DAY OF DISCHARGE FROM THE HOSPITAL.

	5 - 9 - 57		5 - 30 - 57	
	BBD	ABD	BBD	ABD
0.5 Sec EC	500	800	2500	2700
VC	2800	3500	4700	5200

THE IMPORTANT POINT IN THIS CASE IS THAT ASSISTED BREATHING CORRECTED AND LATER PREVENTED CO₂ NARCOSIS WHILE ADEQUATE OXYGENATION WAS MAINTAINED. RESPIRATION WAS MAINTAINED TOLERABLY COMFORTABLE WHEREAS WITHOUT ASSISTANCE, THE PATIENT WAS CONTINUOUSLY IN DISTRESS.

REFERENCES

1. HICKAM, J.B., SIEKER, H.O., PRYOR, W.W., AND FRAYSER, R.: THE USE OF MECHANICAL RESPIRATORS IN PATIENTS WITH A HIGH AIRWAY RESISTANCE. ANN. NEW YORK ACAD. SCI. 66:866-878 (APRIL 2), 1957.
2. PLUM, F., AND SWANSON, A.G.: BARBITURATE POISONING TREATED BY PHYSIOLOGICAL METHODS. J. A. M. A. 163:827-835 (MARCH 9), 1957.
3. AVERY, E.E., MORCH, E.T., AND BENSON, D.W.: CRITICALLY CRUSHED CHESTS. J. THORACIC SURG. 32:291-311 (SEPT.), 1956.
4. RADFORD, E.P., FERRIS, B.G., JR., AND BERTRAND, C.K.: CLINICAL USE OF A NOMOGRAM TO ESTIMATE PROPER VENTILATION DURING ARTIFICIAL RESPIRATION. NEW ENGLAND J. MED. 251:877-884 (NOV. 25), 1954.
5. MALONEY, J.V., JR., AND WHITTENBERGER, J.L.: CLINICAL IMPLICATIONS OF PRESSURES USED IN THE BODY RESPIRATOR. AM. J. MED. SCI. 221:425-430 (APRIL), 1951.
6. MORGAN, W.L., JR., BINION, J.T., AND SARNOFF, S.J.: CIRCULATORY DEPRESSION INDUCED BY HIGH LEVELS OF POSITIVE PRESSURE BREATHING COUNTERACTED BY METARAMINOL (ARAMINE). J. APPL. PHYSIOL. 10:26-30 (JAN.), 1957.
7. KENT, H.: WHAT PHYSICIANS SHOULD KNOW ABOUT RESPIRATORS. SO. M. J. 50:1497-1503 (DEC.), 1957.
8. AFFELDT, J.E., COLLIER, C.R., CRANE, M.G., AND FARR, A.F.: VENTILATORY ASPECTS OF POLIOMYELITIS. CURRENT RES. IN ANESTH. & ANALGESIA 34:41-53 (JAN.-FEB.), 1955.
9. BECK, G.J., AND BARACH, A.L.: VALUE OF MECHANICAL AIDS IN THE MANAGEMENT OF A PATIENT WITH POLIOMYELITIS. ANN. INT. MED. 40:1081-1094 (JUNE), 1954.
10. BICKERMAN, H.A.: EXSUFFLATION WITH NEGATIVE PRESSURE (E.W.N.P.). A.M.A. ARCH. INT. MED. 93:698-704 (MAY), 1954.
11. CHERNIACK, R.M., GORDON, C.A., AND DRIMMER, F.: PHYSIOLOGICAL EFFECTS OF MECHANICAL EXSUFFLATION ON EXPERIMENTAL OBSTRUCTIVE BREATHING IN HUMAN SUBJECTS. J. CLIN. INVEST. 31:1028-1035 (DEC.), 1952.
12. CHERNIACK, R.M.: THE EFFECT OF MECHANICAL EXSUFFLATION ON RESPIRATORY GAS EXCHANGE IN CHRONIC PULMONARY EMPHYSEMA. J. CLIN. INVEST. 32:1192-1196 (NOV.), 1953.
13. MILLER, W.F., CADE, J.R., CUSHING, I.E.: PREOPERATIVE RECOGNITION AND TREATMENT OF BRONCHOPULMONARY DISEASE. ANESTHESIOLOGY 18:483-497 (MAY-JUNE), 1957.