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Reprinted from The Journal of The American Medical Association  
February 14, 1959, Vol. 169, pp. 691-695  
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## PROPHYLACTIC TRACHEOSTOMY IN AGED AND POOR RISK GENERAL SURGICAL PATIENTS

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The value of tracheostomy in the postoperative care of certain thoracic and neurosurgical patients has been recognized for some time,<sup>1</sup> but there has not been widespread acceptance of this procedure as an adjunct to therapy for the critically ill general surgical patient. The present report concerns the prophylactic use of tracheostomy in a series of aged and bad risk patients. For each of these patients a major operation was deemed mandatory, but the prognosis for immediate postoperative survival was poor because of debilitation and independent pulmonary or cardiovascular disease. The objectives of tracheostomy were to allow maximum utilization of pulmonary reserve and to prevent postoperative pulmonary complications.

The most common postoperative complications are related to the respiratory system.<sup>2</sup> These complications, which may only be a source of morbidity in younger people, carry serious implications for feeble geriatric or poor risk patients. Preexisting

*The most common postoperative complications are those involving respiration, and they are especially dangerous to patients classified as poor risks because of age or other handicaps. Among the 11 patients whose histories are given, some who were nearly moribund from respiratory difficulties were saved by tracheostomy; others made good recoveries from major surgery under conditions that would have been hopeless without the help afforded by prophylactic tracheostomy. If this possibility is foreseen, an orderly procedure can be carried out in the operating room instead of desperate measures on the ward. Scrupulous care of the tracheostomy is essential; this includes aseptic precautions, humidification of the inhaled air or oxygen, and the systematic but gentle use of suction to aspirate accumulating mucus.*

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pulmonary disease plus loss of the strength necessary for powerful coughing and ventilation have already reduced the respiratory reserve. The additional factors of anesthesia and postoperative pain may lead to a condition in which retained secretions, atelectasis, and pneumonitis are lethal. A pulmonary complication can develop with such subtlety that its presence is not suspected.<sup>1</sup> The resultant anoxia or hypercapnia may be manifest in altered function of the heart, brain, kidney, or other organs in this type of patient. These structures often exhibit such marked pathological changes that compensated function can continue only within a narrow margin of safety and under optimal environmental conditions. The cause of death in these circumstances is frequently designated as coronary occlusion, cerebrovascular accident, renal failure, or other cause, while actually the initiating factor was disruption of a delicately balanced homeostatic state by hypoxia.

It has been our experience with poor risk patients that pulmonary complications can be predicted with a high degree of accuracy on the basis of the preoperative history and physical examination. In the past we have treated these patients by standard methods of preoperative and postoperative bronchopulmonary toilet,<sup>3</sup> only to see problems of hypoxia and/or hypercapnia develop. If a respiratory complication arises in this type of patient, treatment by any means is likely to be unsuccessful.

Postoperative pulmonary difficulties were anticipated in the patients included in the present study. The cases were reviewed with the department of anesthesiology and the decision for prophylactic tracheostomy was usually made well in advance of the proposed operation. Tracheostomy was done in the operating room immediately after completing the primary procedure or during the first few postoperative hours.

It has been our impression that tracheostomy has extended the limits of operability to include certain aged and poor risk patients who could not otherwise have been expected to survive a major surgical procedure. The present report documents the use of this prophylactic measure in one of the general surgical charity services of the Jackson Memorial Hospital during a recent three-month period (January through March, 1958).

#### Report of Cases

**CASE 1.**—This moribund 65-year-old woman was admitted on Jan. 6, 1958, after six days of abdominal pain, vomiting, and distention. Examination showed wet lungs and peritonitis with abdominal distention. X-rays showed bilateral basilar atelectasis, massive pneumoperitoneum, and distention of the small intestine. At celiotomy, a perforated sigmoid diverticulum was found, with fecal peritonitis and adhesive obstruction of the ileum. Treatment consisted of closure of the perforation, transverse colostomy, decompression of the small intestine,

lysis of adhesions, abdominal drainage, and gastrostomy. Digestion was necessary during surgery. Tracheostomy was performed after wound closure. Postoperatively the patient improved steadily for six days, and then had an exsanguinating gastric hemorrhage necessitating rapid replacement with 2,500 cc. of blood and 1,000 cc. of plasma expander. She was reexplored, and a bleeding prepyloric ulcer was found and suture-ligated. Anesthesia was induced through the tracheostomy. Tracheobronchial care, including management of aspirated blood, was facilitated by the tracheostomy. She recovered slowly until bleeding recurred four days later, requiring a transfusion of 3,000 cc. of blood, at which time she was returned to surgery for gastrectomy. Anesthesia was again induced through the tracheostomy and bronchoscopy was performed at the conclusion of the procedure. Her recovery was slow but without further complication. On Feb. 3, radiography showed that the atelectasis which was present at the admission had cleared. The cannula was removed 32 days after admission. She was discharged on Feb. 17 and has remained well since.

*Comment.*—This critically ill patient would probably not have survived any one of the three procedures without a carefully managed tracheostomy. At the time of gastric hemorrhage, blood aspiration was so overwhelming that no other measure would have allowed the consistent maintenance of a patent airway.

**CASE 2.**—This 57-year-old man, with an incompletely obstructing carcinoma of the rectum, was admitted with chills, fever, dyspnea, and diarrhea and had lost 40 lb. (18.1 kg.). His chest was emphysematous with diffuse rales bilaterally. Chest x-ray revealed chronic interstitial fibrosis. He was treated for bronchopneumonia with clinical improvement but without striking change in the x-ray findings. On Feb. 7, 1958, an abdominoperineal resection was done, followed by a prophylactic tracheostomy. The patient's early convalescence was uncomplicated and the tracheostomy was removed on the sixth postoperative day. He developed obstruction of the small intestine eight days after surgery which was unresponsive to intestinal intubation. Lysis of adhesions was carried out three days later and the tracheostomy cannula was replaced through the original incision. Seven days after reexploration he resumed a full diet and the cannula was again removed. He was discharged on March 10 and has been well since.

*Comment.*—In this case tracheostomy was indicated by chronic disabling lung disease with a recent superimposed acute infection.

**CASE 3.**—This 74-year-old man was admitted with a four-month history of pain in the right upper quadrant and had lost 40 lb. (18.1 kg.). There was a palpable mass in the right upper quadrant. For the preceding nine years he had had progressive dyspnea and severe asthma. Examination revealed an emphysematous chest with widespread inspiratory and expiratory wheezes. Chest fluoroscopy showed diffuse air trapping, enlargement of the pulmonary artery, and fixed diaphragms. Electrocardiogram findings suggested coronary insufficiency. At operation on Feb. 7, 1958, he was found to have empyema of the gallbladder and a walled-off subhepatic abscess which contained many stones. The gallbladder and abscess were excised, the common ducts explored, a T-tube was inserted, and tracheostomy was performed. During convalescence the tracheostomy was supplied with room air which had been pumped through Alevaire (sterile aqueous solution of Superinone [oxethylated tertiary octyl-phenol-formaldehyde polymer] in combination with glycerin

and sodium bicarbonate). The use of bronchodilators, which had started a week before surgery, was continued. Postoperative tracheobronchial care was not a problem, even though the patient was disoriented and irrational during the first four days. On the sixth day after surgery the cannula was removed. He was discharged on the 13th day after operation and subsequently has had the T-tube removed in the clinic.

*Comment.*—Prophylactic tracheostomy was done because this patient was a pulmonary cripple. In patients with emphysema the use of pure oxygen should be avoided because of the danger of inducing hypercapnia.

CASE 4.—This 79-year-old man was admitted for treatment for carcinoma of the stomach. He had been followed in the medical clinic for two years with intractable heart failure. On admission he suffered from decompensation, with edema, bilateral massive pleural effusion, rapid atrial fibrillation, and uremia. An abdominal aortic aneurysm was present with peripheral vascular insufficiency (no pulses below the femoral arteries). A radical subtotal gastrectomy was performed on Feb. 7, 1958, after extensive preparation. Prophylactic tracheostomy was done at this time. His immediate postoperative condition was satisfactory, but two days after surgery he developed evidence of cerebral and femoral emboli. A left iliofemoral embolectomy was carried out. Several toes became gangrenous and on Feb. 13 a mid-thigh amputation was done. His condition gradually deteriorated and he developed giant decubiti. Despite the tracheostomy, tracheobronchial care became progressively more difficult. He died one month after surgery, on March 7, 1958. Autopsy findings included extensive old infarct of the left ventricle, recent mural thrombus of the left atrium, multiple renal infarcts, severe generalized arteriosclerosis, bilateral bronchopneumonia, and various pathological signs of cardiac decompensation.

*Comment.*—This was the only patient in the series in whom a pulmonary complication arose after tracheostomy. The development of severe terminal bronchopneumonia must be explained by inadequate tracheostomy care.

CASE 5.—This 83-year-old man was admitted on Feb. 7, 1958. He had been followed for five years in the outpatient department because of hypertension and periodic heart failure. He had been known to have complete left bundle-branch block for this period. Chest x-ray on admission showed bilateral pulmonary congestion. On the day of admission cholecystectomy was performed for gangrene of the gallbladder. Prophylactic tracheostomy was considered at the time of surgery but was not done. Although he recovered promptly from anesthesia, during the next 10 hours he became moribund with irrational and irritable behavior, tachycardia, and wet lungs. Endotracheal suction gave only temporary relief. Tracheostomy was done at this time. Improvement was rapid and after a few days recovery seemed assured. He subsequently developed a subhepatic abscess, which was drained with the patient under local anesthesia. Massive hemorrhage occurred from the depths of the abscess during the third, fourth, and fifth postoperative weeks, necessitating transfusions of 6,000 cc. He developed intractable heart failure and died on March 18, 1958. During his last week of life he required repeated thoracenteses for a right pleural effusion. Serial chest x-rays during the five-week postoperative period showed no evidence of intrapulmonary complication except for atelectasis at the right base of the right lung, which was thought to be secondary to the subhepatic abscess. Permission to perform autopsy was not granted.

*Comment.*—This patient served as his own control in evaluating the role of tracheostomy in the determination of immediate postoperative survival. Prophylactic tracheostomy was considered at the time of surgery and rejected. As a result of this error in judgment the tracheostomy became an urgent measure several hours later, after his condition had deteriorated badly.

CASE 6.—This 85-year-old man was admitted for the treatment of a large carcinoma of the gastric antrum. He had been receiving digitalis since a myocardial infarction 15 years prior to admission, and for one year heart failure had been increasingly difficult to control despite constant bed rest. Physical examination revealed an emphysematous chest with distant breath sounds. He was a very feeble old man. Chest x-ray showed emphysema and slight cardiomegaly. An electrocardiogram revealed a complete left bundle-branch block. On Feb. 18 radical gastrectomy was performed, with removal of 85% of the stomach, and a prophylactic tracheostomy. The tracheostomy was postoperatively supplied with oxygen which had been passed through Alevaire. Although he aroused promptly after anesthesia, he was alternately confused and comatose until the fourth postoperative day, but subsequently improved rapidly. The cannula was removed on the sixth postoperative day and the patient was discharged 13 days after surgery. He has continued to do well and is now living at a convalescent home.

*Comment.*—This octogenarian had not been able to leave bed for one year prior to admission due to severe heart disease complicated by emphysema. The prevention of anoxia during a difficult convalescence was facilitated by the tracheostomy.

CASE 7.—This 75-year-old man was admitted on Feb. 21, 1958, with abdominal pain and jaundice. Chest x-ray revealed bilateral basilar atelectasis. His condition deteriorated rapidly and within four days he developed anuria, hyperpyrexia, and hypotension. On the fifth day after admission, common duct drainage and tracheostomy were performed with the patient under local anesthesia. The patient's temperature then returned to normal, and kidney function was restored. The jaundice deepened, however, and the patient died 28 days after surgery. At autopsy the basilar atelectasis was found to have cleared and the only pulmonary abnormality was congestion of the lungs. Autopsy also revealed far-advanced biliary cirrhosis with multiple intrahepatic stones in both the right and left hepatic ducts.

*Comment.*—Like several other patients in this series this man went into surgery with a previously established respiratory complication. The pulmonary status improved with tracheostomy despite deterioration of his general condition.

CASE 8.—This 49-year-old man had an 11-year history of progressive muscular dystrophy involving both legs and both arms as well as the accessory muscles of respiration. He had one-block exercise tolerance and after prolonged conversation became dyspneic. On Feb. 28, 1958, he underwent cholecystectomy and common duct exploration. Because of his neurological disability a prophylactic tracheostomy was done. Because of feeble respiratory efforts and excessively thick mucus there was great difficulty in keeping the tracheobronchial tree clean postoperatively. He was disoriented for the first two days after surgery and on the second day he aspirated gastric contents and nearly became asphyxiated. Suction was applied immediately and bronchial wash

carried out with saline solution. He showed improvement after this, but a chest x-ray on the fourth postoperative day showed disk atelectasis at both bases. His chest gradually cleared and the tracheostomy cannula was removed 10 days after surgery. He was discharged home two days later.

*Comment.*—Extensive neurological disability made postoperative tracheostomy mandatory in this case. Death from aspiration of gastric contents in the early postoperative period would probably have resulted without this precaution.

CASE 9.—On March 5, 1958, this 74-year-old woman was brought to the emergency room in shock after having been struck by an automobile. She had multiple injuries, including a traumatic amputation of the left leg, extensive soft tissue injury of the right leg, hemothorax, and fractures of the left second to eighth ribs, left scapula, and right superior and inferior pubic rami. After transfusion of 4,000 cc. of blood and plasma she was taken to the operating room for a left supracondylar amputation and débridement of other wounds. Tracheostomy was not done. Fifteen hours after surgery she was irrational, dyspneic, ashen, and clammy. Tracheostomy was performed with immediate benefit. Her condition was critical for many days but improvement was steady. The hemothorax was evacuated with repeated thoracenteses. Despite the serious chest wall injury neither atelectasis nor pneumonitis developed. The tracheostomy tube was removed on the eighth postoperative day. The patient was discharged in good condition on the 22nd postoperative day, and has subsequently returned to her home in New Jersey.

*Comment.*—This is the type of crushed-chest injury for which Carter<sup>4</sup> recommended early tracheostomy. The unnecessary delay in this case nearly cost the patient her life.

CASE 10.—This 71-year-old man had had dyspnea on exertion and severe nocturnal asthma for several years. Chest x-ray and electrocardiogram were normal. The present admission was for unremitting obstructive jaundice. On March 10, 1958, a pancreaticoduodenal resection was performed. Prophylactic tracheostomy was considered because of the patient's history of asthma but was not done. For the first few hours after surgery there were no pulmonary difficulties but after this the patient's condition deteriorated rapidly despite the use of bronchodilators, forced coughing, and endotracheal suction. He developed extreme dyspnea, carphology, hallucinations, tachycardia, and bilateral diffuse rales. His condition was grave 18 hours after surgery. Tracheostomy was performed with removal of profuse thick secretions and the patient showed immediate improvement. Subsequently he developed persistent fever and nine days postoperatively a subhepatic abscess was drained. His condition again improved but on March 28 he developed high intestinal obstruction. He was reexplored on April 2, and jejunal obstruction was found in the wall of the subhepatic abscess. A gastrojejunostomy and feeding jejunostomy were done below this point, after which he gradually and steadily improved. The tracheostomy tube was removed on April 10, one month after the pancreaticoduodenectomy, and the patient was finally discharged on May 8, 1958. Despite his postoperative experiences there was never any evidence of pneumonitis or atelectasis on serial x-rays.

*Comment.*—There will not be unanimity of opinion about the need for prophylactic tracheostomy in some patients. Because of a reluctance to employ tracheostomy unless specifically required, we have allowed a postoperative trial period, in borderline

cases, during which the patient is closely observed for evidence of pulmonary difficulty. If the slightest complication develops, tracheostomy should be done without delay.

CASE 11.—This 65-year-old man was referred from another hospital for treatment of a large chondrosarcoma of the left shoulder. He had had pulmonary tuberculosis in his youth, and 17 years previously had undergone nephrectomy for tuberculous pyelonephritis. He took digitalis daily and had been in heart failure recently. He had dyspneic for 10 years and had needed convalescent home care for the past 2 years. Examination showed cyanosis, kyphosis, markedly emphysematous chest, and diffuse wheezes over both lung fields. Chest x-rays showed bilateral apical scarring and emphysema. Electrocardiogram disclosed complete right bundle-branch block. Maximum breathing capacity was 27 liters per minute. Vital capacity was 2,700 cc. Timed vital capacity showed a 31%, 42%, and 52% expiration in 1, 2, and 3 seconds. The diagnoses were advanced pulmonary emphysema and cor pulmonale. Bronchodilators were used preoperatively and the patient was given positive pressure breathing exercises. On March 19, 1958, left interscapulothoracic amputation and tracheostomy were done. Room air pumped through Alevaire was used postoperatively to supply the tracheostomy cup. Convalescence was uncomplicated and the cannula was removed on the fifth day after surgery. He was discharged on the 12th postoperative day.

*Comment.*—This patient was referred from an outlying hospital for consideration of radiotherapy, since it was thought that his condition precluded extirpative therapy. The use of prophylactic tracheostomy was probably a critical factor in permitting reversal of this decision.

#### Comment

Until the last two decades the indication for tracheostomy was rigidly defined as mechanical upper airway obstruction. The broader utility of this procedure in the treatment of secretional airway obstruction was not realized until Galloway's report<sup>5</sup> on the use of tracheostomy in the treatment of bulbar poliomyelitis. Tracheostomy has subsequently become accepted treatment in a variety of clinical conditions in which mechanical obstruction is not a major factor, including coma from any cause, tetanus, respiratory burns, tracheobronchitis, traumatic chest injuries, and the postoperative state after major thoracic and neurosurgical procedures.<sup>1</sup>

In describing the management of crushed-chest injuries Carter<sup>4</sup> defined the following benefits to be derived from the use of tracheostomy: reduction in the respiratory dead space, decrease in the resistance to air flow, and increase in the ease of management of tracheobronchial secretions in patients who cannot or will not cough. In addition, by diminishing the effort necessary for ventilation, pain is relieved. The advantages of tracheostomy are applicable to the care of geriatric and poor risk patients who have had major abdominal surgery. These people have a respiratory reserve so limited that maximum utilization of pulmonary function is necessary for their postoperative survival. They are

handicapped by an increase in bronchopulmonary dead space,<sup>6</sup> by an emphysematous and fixed chest, and by muscular weakness. The problem is further aggravated by incisional pain with splinting, suppression of coughing, and the consequent accumulation of tracheobronchial secretions. These unfavorable conditions are all at least partially alleviated by tracheostomy. The dead space is reduced, decreasing the tidal volume necessary for the same alveolar ventilation; the elimination of upper airway resistance diminishes the muscular energy expended for respiration and the more effortless ventilation can be performed with less pain; and the management of tracheal secretions is brought under moment-to-moment control. The value of tracheostomy under these circumstances was realized by Baronofsky,<sup>7</sup> who, in addition to having advocated the procedure for crushed-chest injuries prior to Carter's report, has alluded to the systematic use of tracheostomy in aged and debilitated general surgical patients.

If recovery from surgery is uncomplicated, the total period of hospitalization is not significantly increased by the presence of the tracheostomy. After a trial period of occlusion the cannula can usually be withdrawn within the first postoperative week and the patient can be discharged a few days later (cases 3, 6, 9, and 11). When nonrespiratory complications have occurred we have found the presence of the tracheostomy to be a factor on which survival (cases 1, 2, 8, and 10) has often depended.

The necessity for scrupulous care of the tracheostomy is universally recognized but so important as to justify reiteration here. Exclusion of the larynx from the airway has deprived the patient of whatever power he possessed to cough explosively, and he is now at the mercy of those entrusted with the hygiene of his tracheobronchial tree. If suction is not applied at regular intervals he will be in a more indefensible state than if tracheostomy had never been done. It is taught at most nursing centers that the tip of the suction tube should not pass beyond the inner extent of the cannula, but if this practice is carried out secretions will pool beyond the end of the tracheostomy. Nursing personnel must be taught to apply suction deeply, but with frequent rest intervals,<sup>8</sup> with a Y-tube to avoid traumatizing the mucosa. For most of the patients reported here oxygen was furnished to a plastic tracheostomy cup, and for those with severe emphysema compressed air was employed. Humidification was obtained by passage of the gas through a wetting agent (Alevaire). Aseptic precautions must be employed in tracheostomy care, for severe tracheobronchitis can be precipitated by careless handling of the suction catheters.

In the present series an effort was made to anticipate the need for tracheostomy on the basis of preoperative evaluation. Tracheostomy was done in this series only on a group of patients who might otherwise not have been able to undergo major surgery. In three cases elective tracheostomy was considered and rejected, and in these instances what could have been an orderly procedure in the operating room became a desperate measure on the ward. Experiences like these have tended to lower our originally stringent criteria for the performance of prophylactic tracheostomy.

#### Summary

Prophylactic tracheostomy was used postoperatively for aged and debilitated general surgical patients. The objectives were to allow maximum utilization of pulmonary reserve and to prevent postoperative pulmonary complications. In a recent three-month period in one of the general surgical services at Jackson Memorial Hospital, 11 patients underwent this procedure after various major operations. These people constitute a group for which it was thought that extensive surgery would uniformly have been fatal without the postoperative use of tracheostomy. Eight of the patients were completely rehabilitated. The remaining three died of late complications of the primary disease and in only one case did a pulmonary complication materially contribute to death. On the basis of this experience it is suggested that the judicious use of tracheostomy is a means of extending the limits of operability to include certain aged and poor risk patients who might not otherwise be expected to survive a major surgical procedure.

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