
In his discussion of sudden cardiac death, he concludes, "Finally there remains a group of patients in which the patient dies of sudden heart failure but no satisfactory cause can be found at autopsy. Such cases may be put down to shock, Status Thymolymphaticus, or a Visitation from God."

In the lay press, sudden death in infants without verification by autopsy is attributed to suffocation; to fulminating infection in children; to rupture of cerebral aneurysms in young adults; to myocardial infarction or pulmonary embolism in the middle-aged; and to cerebrovascular accidents in the elderly. Medically speaking, these categories frequently are fallacious.

On the other hand, an entirely different situation prevails once a patient reaches the hospital, and especially the operating theater. Here, any sudden instance of cardiovascular collapse automatically becomes a "cardiac arrest." This term was readily accepted by surgeons and anesthetists alike because it offered something better than just "death under anesthesia," "death in the operating room," or "anesthetic death." "Cardiac arrest" became more firmly entrenched in medical terminology as more and more cases of successful resuscitation of cardiac standstill or ventricular fibrillation were reported.

A review of the literature of the late 1940's and early 1950's certainly afforded no valid conclusions as to the etiology or incidence of cardiac standstill or circulatory collapse, because each author established his own criteria for the inclusion or exclusion.

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of certain cases. Stephenson began to collect extensive data through his "Cardiac Arrest Registry," and culminated this research with the publication, *Cardiac Arrest and Resuscitation.* This could have easily dispensed with the problem, but he concluded that "Acute cardiac arrest is not a wastebasket term in any sense." It represents a sudden, abrupt and immediate failure of the heart to maintain an output adequate to provide continuing function of the vital centers. It does not refer to that group of patients with a gradually deteriorating cardiovascular system occurring over an hour or even several minutes.

Natof and Sadove tried to clarify the matter with the publication of *Cardiovascular Collapse in the Operating Room,* but one entire chapter is devoted to "Cardiac Arrest Data." There is little wonder that many surgeons and physicians accepted the premise that sudden cardiovascular collapse, either cardiac standstill or ventricular fibrillation, is a totally preventable condition. A review of the literature, and also some of the comments in the *Anesthesiology News Letter,* indicates that more often than not cardiovascular collapse in the operating room must be due to errors of omission or commission on the part of the surgeon, or, most frequently, the anesthesiologist or anesthetist.

In 1959, I had the privilege of hearing the following statement: "If hypoxia is prevented and carbon dioxide remains within normal limits, if reflex stimuli are prevented and electrolyte and fluid volumes controlled, cardiac arrest will not occur." How true, but how often unknown!

In the late 1950's, many additional articles were published which brought about a change of thought concerning the problem. Cardiac massage became a part of the armamentarium of all physicians, and successful resuscitation was accomplished in medical wards, in emergency rooms, in ambulances, and even in homes on patients with diagnoses of acute respiratory obstruction, drowning, or even electrocution. None of these cases could possibly have fitted into the previously mentioned concept of acute cardiac arrest.

This prompted us to review the records of our hospital, covering a period from 1948 to the present. All types of surgery are performed, with the exception of cardiac surgery. Hypothermia is not utilized. All surgery is performed by board or board-qualified men, and for this reason we feel that their remarks or notes reflect the thinking of a majority of surgeons in practice today. Some cases will be presented in varied detail to establish the original premise of this paper — "Cardiac Arrest: Fact or Fallacy."

**CASES INVOLVING "CARDIAC ARREST"**

The first case involves a ninety-three year old man with gangrene of the left lower extremity due to arterial occlusion. Patient was irrational, fibrillating, and had Cheyne-Stokes Respirations upon arrival to O.R. Amputation was performed under tourniquet control for one hour and five minutes. Shortly after release of the tourniquet, pulse and heart sounds disappeared. No resuscitation was attempted, no autopsy was requested. Chart was signed out as "death during anesthesia." (October 1948.)
A forty-eight year old male was brought to O.R. for open reduction of tibia. The patient's blood pressure was 130/80. Laboratory findings were within normal limits. He received an induction dose of sodium pentothal (250 mg.), suddenly gasped, and all vital signs disappeared. The chest was opened and the heart massaged for one hour, to no avail. Autopsy was requested and revealed a massive pulmonary embolism. This chart was signed out with pulmonary embolism as cause of death. Cardiac arrest was not mentioned, except in the operative note (1956). Both of the preceding cases were patients of the same surgeon—note the different diagnosis.

A seventy-one year old female was admitted to O.R. for a D & C and exploratory laparotomy. The patient was induced with a small amount of pentothal (125 mgms.), followed by nitrous oxide, oxygen, and ether. Operation consisted of D & C, exploration of abdomen, and appendectomy. During closure of the abdomen, pressure gradually fell from 140/90 to 80/50, and finally disappeared. The patient was given 1,500 cc. blood intra-arterially, with excellent response. EKG was negative. The operation was completed, but pulse was thready and respirations shallow. She was taken back to her room, received 1,000 more cc. blood, and was placed in a respirator where she expired. Autopsy was requested and a massive hemo-peritoneum secondary to rupture of spleen was found! Cardiac arrest was mentioned in the operative note but not included in the final diagnosis.

A fifty-seven year old man was admitted for repair of aortic aneurysm. A portion of the operating note is self explanatory: “When the patient was turned, his pulse disappeared and it was thought the patient suffered a cardiac arrest; the chest was reopened and found to be full of blood. There was a rent in the posterior portion of the resected sac.” No further resuscitation was attempted. The cause of death was ruptured aortic aneurysm.

A sixty-eight year old man was admitted to surgery for resection of lung due to carcinoma with involvement of esophagus. Again the operative note: “I attempted to remove the lower lobe; however, we got into bleeding on the atrial surface when some of the malignant and necrotic tissue broke free; the bleeding was stopped with clamps, but the heart went into standstill and we were unable to revive the patient from this condition.” Autopsy was not requested. The chart was signed out with, “complication: Cardiac Arrest.” COMMENT: It would certainly be most interesting to obtain a definition of cardiac arrest from the three surgeons involved in these cases.

A twenty-seven month old boy was to be operated upon for left inguinal hernia. Physical status one, and in apparent good health upon arrival to O.R. Pulse was 126 per minute. Premedication consisted of atropine gr. 1/300. Induction was with open drop vinethene followed by open drop ether. After some twenty minutes, he became apneic, respiration became jerky after artificial respiration for some three minutes, and was followed by disappearance of pulse. The chest was opened and the heart massaged. The patient was intubated, and after some forty minutes, respirations were 36 and pulse rate returned to 110.
The child was returned to his room with the endotracheal tube in place, but he expired some seven hours later. Upon removal of the endotracheal tube, it was found that a piece of peach had adhered to the end. Evidently, the child had vomited and aspirated this foreign body. The chart was signed out "Cardiac Arrest"! No autopsy was requested, but it is obvious the cause of the demise was tracheal obstruction due to aspiration of a foreign body, with subsequent asphyxia.

A fifty-four year old man was operated upon for carcinoma of the mandible with metastases to lymph nodes of the neck. The operation performed was hemi-mandibulectomy and a radical neck dissection. This patient withstood a three and one-half hour operation very well. The anesthesia was sodium pentothal, followed by ether and oxygen. The only complication was a rapid and sustained rise of blood pressure from an initial 140/60 to 180/90. The pulse did not vary a great deal (100-110 throughout the entire procedure). At the completion of the procedure, the B/P was 180/90, the pulse was 96; a very tight and all-composing head and neck dressing was applied, and the patient was extubated because he was bucking on the tube. He rapidly became cyanotic, and the cyanosis did not respond to vigorous oxygen therapy. Blood pressure became unobtainable, a carotid pulse was palpable, but finally disappeared. The chest was opened, and it was noted the left lung could be inflated only with difficulty. Partial withdrawal of the tube did not alter the situation. After several minutes of massage the heart began to beat again, and the blood pressure gradually returned to 90/60. X-ray of the chest taken the following day revealed some infiltration of the left lobe. This was still present three days later, but had disappeared in 14 days. The patient made an uneventful recovery. A thorough examination of the patient's chart revealed that, four days prior to her emergency, she had suddenly complained of pain in the chest, and coughed up some bright red blood. The pain and
cough subsided within several hours and no further workup was performed. We are confronted with these questions: Did this patient receive too much anesthesia in view of her rather heavy medication, did she have inadequate ventilation, did she have reflex standstill upon manipulation of the endotracheal tube due to absence of belladonna drugs in the premedication, or did she have a pulmonary embolus? Any one of the four could have caused the condition—but the chart reveals: “complications—Cardiac Arrest.”

A fifty-five year old man had complete cardiovascular collapse at the end of a three hour operation for reduction of facial bones. Cardiac massage was to no avail. Autopsy revealed: (1) Myocardial infarction, recent, anterior wall left ventricle, (2) Myocardial Hypertrophy, and (3) Atherosclerosis severe, anterior descending coronary artery. Complication was listed as “Cardiac Arrest.” Res ipsa loquitur.

A sixty-four year old male had a pneumonectomy for carcinoma of the right lung. As the patient was turned from the lateral to the supine position, he developed cardiovascular collapse. The right chest, which had been closed without drainage, was reopened and a leak was closed in the bronchial stump. The left chest was opened and the heart was successfully massaged. The operative note indicated that the patient had developed a tension pneumothorax with mediastinal shift. The final summary sheet listed as “complications—Cardiac Arrest.” No mention was made of the actual cause. Incidentally, this patient had a myocardial infarction on the fifth postoperative day, but was ultimately discharged with no neurological sequelae.

There were four other cases signed out as fatal cardiac arrest in patients with moderate to severe pre-existing cardiovascular disease, who had relatively minor surgery and local anesthesia, and two cases of fatal arrest in moribund patients during induction of anesthesia. Autopsies were not obtained in any of these, and for that reason it would be necessary to incriminate either the anesthesia or the pre-existing heart disease, or both.

There was one seventy-four year old woman who had cardiac standstill when the anesthesiologist pushed the amount of Fluothane. Open chest massage was successful, and the patient was discharged without any evidence of neurological complications.

A twenty-one year old boy, who had been severely injured in an automobile accident five days before, was admitted to surgery for manipulation and fixation of bilateral severely comminuted fractures of both femurs and application of body spica. After one and one-half hours of deep general anesthesia (sodium pentothal, nitrous oxide, and ether) the anesthesia was discontinued and the patient allowed to breathe room air. Respirations were satisfactory, seemed unobstructed, and were closely observed for some twenty minutes. The patient suddenly began to breathe irregularly and became cyanotic. He was then rapidly intubated and given oxygen. Pulse was bounding and 96 per minute, blood pressure 90/60. Within a minute, his pulse and respiration ceased. The body cast was cut and the chest opened. The heart was found to be in standstill. After four or five massages the heart resumed its normal rhythm, but the cyanosis did not immediately disappear. Within the hour with an IV of neosynephrin, pressure could be main-
tained at 90-100/60, respirations 26-30. Within two hours the patient began to have athetoid movements and carpal spasm. Neurological consultation was obtained and a diagnosis of severe, deep-seated brain damage was made. A tracheotomy was recommended as the neurosurgeon felt that recovery was very doubtful. A urinalysis the following day was strongly positive for fat! This patient never regained consciousness, but survived for seven weeks. Autopsy, in addition to extreme emaciation, revealed: focal cerebral infarction, old healing, .7 cm. in diameter in the region of the calcarine fissure on the left, and a few smaller infarcts of similar nature in both parietal lobes. Examination for fat was negative, but this was not surprising in view of the delay in death. The overall picture of both gross and microscopic findings indicated extensive multiple infarction, most likely fat.

A twelve year old girl, who was admitted to our hospital in a coma, had had a "Cardiac Arrest" 48 hours previously at another hospital. History revealed the patient had developed severe uterine bleeding during her first menstrual period. Her Hg. was 48%. She was given 1,000 cc. blood and taken to O.R. for a D & C. Spinal anesthesia was administered (Pontocaine 10 mg.), and she was placed into position to be prepared. Suddenly she gasped and had no blood pressure. Oxygen was administered and adrenalin was injected into her heart. Gradually her color improved and the pulse could be obtained; she then developed pulmonary edema which was treated by Digoxin intravenously. Shortly thereafter she began to have convulsions, which were treated by barbiturates and dilantin. She was transferred to our hospital where she expired. A postmortem showed evidence of: (1) Fat embolus, small, of coronary vessel with necrosis of adjacent heart muscle, (2) cerebral edema, marked, and (3) multiple duodenal ulcers with terminal perforation.

This case demonstrates that an autopsy is necessary before any discussion of a given catastrophe can be considered. I am certain that, prior to the autopsy findings, every anesthesiologist in this country would have indicated that this was the classic picture of an overdose of spinal anesthetic agent with the development of high spinal anesthesia. However, even the purest fundamentalist could not explain how a spinal could produce a fat embolus in the coronary artery, especially in a 12 year old.

During the past year, we have had two cases of cardiac standstill in patients undergoing carotid angiography. One, a sixty-eight year old male, occurred immediately after insertion of the needle into the vessel. The patient had a pentothal induction with succinylcholine, and easy intubation. Open chest massage was necessary. Two weeks later the procedure was repeated, but the carotid area was thoroughly infiltrated with 1% procaine. Induction was completed and the same dosage utilized. The examination was completed without difficulty.

The second (58 year old female) occurred, after manipulation of the head, in a patient receiving nitrous oxide and Fluothane. The patient was resuscitated by external cardiac massage and made an uneventful recovery.
Finally, a brief report on a thirty-eight year old moribund patient who was operated upon for acute intestinal obstruction. Upon admission to O.R. her pulse was 160, respirations 30, blood pressure 60/? . The EKG on the cardiac monitor indicated a ventricular tachycardia. She was intubated awake. Shortly after this her blood pressure disappeared, and cyanosis developed despite vigorous positive pressure on the breathing bag. She was given Digoxin and the amount of levophed was increased. The monitor still indicated a rate of 160—under nitrous oxide 2 liters flow—2 liters oxygen and a succinylcholine drip. The abdomen was opened and the terminal ileum was found to be gangrenous. Upon manipulation of the intestines, all evidence of cardiac activity ceased. The heart was massaged through the diaphragm; after two minutes, a regular rhythm developed, and the rate had slowed to 120. No blood pressure was audible. The surgeon rapidly removed the gangrenous ileum and did an ileotransversecolostomy. All cardiac activity again ceased after 40 minutes operating time. Massage was continued for thirty-five minutes, to no avail. The surgeon began to close the abdomen with through and through sutures. The anesthesia apparatus was disconnected. As the last stitch was placed, the monitor began to indicate cardiac activity. The patient was rapidly reintubated and, much to our surprise, her color gradually improved. She was returned to the recovery room with a heart rate of 120. Respiration became active, but jerky. She survived for an additional twelve hours. facetiously, this brings us back to “Cardiac Arrest: Fact or Fallacy.”

A review of all our cases demonstrated that, in almost every instance, we were able to ascertain the cause of the demise. More often than not, an autopsy revealed an actual organic reason, as pointed out by Boyd, to be the cause.

Collins, in an excellent article, made a partial list of precipitating factors of cardiocirculatory collapse.\(^5\)

<table>
<thead>
<tr>
<th>INDIRECT</th>
<th>Moribundity</th>
<th>Anesthetic Agents</th>
</tr>
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<tbody>
<tr>
<td>Hypoxia</td>
<td>CO(_2) retention</td>
<td>Blood loss</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Reflexes-Vagal</td>
<td>Diminished venous return</td>
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<tr>
<td>Pooling of blood after mobilization of tumors</td>
<td>Drugs—including blood and electronarcosis</td>
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<tr>
<th>DIRECT</th>
<th>Trauma to the heart</th>
<th>Surgical contact</th>
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<tbody>
<tr>
<td>Torsion of heart</td>
<td>Effusion</td>
<td>Pericarditis</td>
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<tr>
<td>Cardiac catheters</td>
<td>Electroconvulsive therapy</td>
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</tbody>
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In addition we must add adrenocortical failure, reaction to antihypertensive drugs, amniotic fluid embolism, excess potassium due to massive transfusions, and undue cooling of the heart caused by the administration of massive amounts of cold blood.

**CONCLUSION**

Sudden death can and does occur in all areas, ages, and walks of life. Under given circumstances, certain individuals with seemingly fatal conditions can be resuscitated successfully. Resuscitations of this nature should not necessitate the creation of a new bit of medical terminology, but rather should instigate increased zeal on the part of all concerned to arrive at and record an accurate diagnosis.

*(Continued on page 296)*
Rubin
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The THIRTY-EIGHTH QUALIFYING EXAMINATION for membership in the American Association of Nurse Anesthetists will be conducted on November 9, 1963. The deadline for accepting completed applications including the transcripts is October 1. Notice of eligibility will be mailed about October 7.

Applications should be forwarded early enough to allow time to request transcripts and have them returned to the Executive Office before the deadline date.

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GRACE ALUMNI—DETROIT
The Alumni Association of Grace Hospital School of Anesthesia, Detroit, Michigan, will hold its annual breakfast at the Statler Hilton Hotel, New York City, on August 27, 1963, at 7:30 A.M. Check the hotel bulletin board or contact Mabel E. Courtney for dining room location.

BARNES ALUMNI—ST. LOUIS
The Alumni Association of Barnes Hospital School of Anesthesia, St. Louis, Missouri, will hold a breakfast meeting at the Statler Hilton Hotel, New York City, on August 27, 1963, at 7:30 A.M. The breakfast will be a Dutch affair. The location of the dining room will be posted. New officers will be elected. Please contact Mary L. Carpenter or Virginia A. Edwards at the hotel or at 70 Westerly Way, Marietta, Georgia, for reservations.