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PHYSIOLOGICAL TRESPASS IN ANESTHESIA

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Anesthetic practices more than ever are today striving for patient comfort during surgical intervention. The patient expects that comfort will be safely provided, and the surgeon demands that his need for ideal operating conditions will also be met. A poorly conducted anesthesia will obviously impose departures either from safety, comfort or surgical convenience. Physiological processes will be grossly insulted with poor anesthesia. It is perhaps fortunate that the human body will so often recover, in spite of, rather than because of, specific methods of surgery and medicine.

But what of average properly conducted anesthetics — is there serious physiological trespass in this case? In 1938, Beecher¹ of Harvard Medical School suggested that anesthesia is probably akin to sleep; that anesthesia is *not* a grossly abnormal condition; that it is not a state akin to “shock” or “death”. Today, however, there is evidence that every time we administer an anesthetic (no matter how trivial the intended surgery is to be) we trespass upon body physiology. We disturb normal homeostasis. Renal function is suppressed, hepatic blood flow is reduced; the cerebral function, especially in the geriatric patient, may be altered for hours and days. Important autonomic reflexes are depressed or dangerously activated. Secreting glands are overly active; the heart’s reserve is tested.

One must continually emphasize the “physiological trespass” which occurs even with proper anesthetic administration in order that complacency does not promote another evil — “the trespass of common sense”. When anesthetic inductions are hurried as with a “blitz” technique, we frequently obtain severe depression of all physiological processes. We too often accede to the surgical “dream universal” of relaxation as seen only in the fresh corpse. We underventilate in order to provide the quiet “non-pushing” abdomen or to prevent lungs billowing from the open chest. Too often the blood pressure is regarded with a variety of opinions; if low, it helps reduce surgical bleeding. If *too low* (and this is so variable) a vasopressor will often skyrocket the blood pressure to dizzy cerebral hemorrhage levels. If high, we can use more depressant drugs and if *too high*, there are always available a host of antihypertensive drugs. These physiological trespasses, while relative, stem from a breach of common sense.

The poor and the good surgeon have nearly the same mortality rate; but the poor surgeon has a much greater morbidity rate. So too in anesthesia. What should entice everyone training in anesthesia is not the physiological trespass with which we barely avoid trouble but a reduction in the morbidity in the majority group of patients who thrive despite our efforts; and a saving of lives in the minority group who die or survive dependant upon medical or surgical and anesthesiological skills.

Criticism of these evils is being voiced by thinking leaders in “modern”

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Physiological Trespass in Anesthesia

anesthesia. Our colleagues across the sea are likewise rousing. The following letter appeared in a recent British journal.

“Sir:

Having retired from anesthetic practice some years ago, I was interested when a surgical colleague invited me to an operation, to see the modern anaesthetist at work. The patient was a man of over 80, so far as I could judge from his appearance, reasonably fit. The anaesthetist appeared on the scene with a loaded 20 c. cm. syringe, containing, as he informed me, 1 Gm. Pentothal. This was injected into a vein much quicker than it takes me to describe it. The anaesthetist then disappeared: also, the patient's respirations. I was wondering which would appear first, but the anaesthetist won, with a second syringe, containing, as he explained, 80 mg. Flaxedil. This was injected as quickly as the piston of the syringe could be persuaded to descend. The patient, whose colour had changed through some interesting and picturesque shades of blue into purple and grey, was quickly revived by a few vigorous pumps with the handle of a Mushin absorber and still apnoeic but now pink, was taken into the theatre. Here, cyclopropane was added to the mixture and a diathermy pad applied to a thigh. The anaesthetist must have noticed that I was now getting interested in the other theatre, for he called me back, and was good enough to explain that, as the diathermy machine was at the foot of the table, and we were at the head, “it was quite safe”. I was about to protest, when the anaesthetist disappeared again (the patient still apnoeic) but he reappeared a few moments later with yet another syringe, which was injected as quickly as the other two. This, I was told, was 50 mg. of Pentamethonium. Having heard something of the properties of this drug, I felt a little anxious particularly when I could no longer feel the radial pulse. My anxiety must have been apparent for the anaesthetist said: “Why, he's got a beautiful pulse” (that is not how I would have described it, but then, I am not a modern anaesthetist). The anaesthetist again did his disappearing act, to reappear later with a sphygmomanometer, with which he attempted to measure the blood pressure: “That's very satisfactory, the systolic is just below 60”. . . . Some 90 minutes later, the surgeon asked me over coffee whether I did not think that was a wonderful anaesthetic. My reply, I am afraid, was couched in such terms as I am sure you, Mr. Editor, would consider unprintable.”²

This happily is a rarity or a non-entity in this locality. It does highlight the physiological digression possible in anesthesia. It likewise raises a question about the validity of present “balanced anesthesia”, a method capable of just the opposite and which often perpetrates insults. Lundy³ proposed in 1926 that several drugs, each used to a minimal degree, with selection based upon specific requirements would produce less physiological trespass. This led to Pentothal for sleep, nitrous oxide for pain relief, curare for relaxation, meperidine to potentiate the nitrous oxide analgesia, a narcotic antagonist to undo the respiratory depressant action of the narcotic and an anticurare drug to undo the effect of the muscle relaxant. The theory is probably excellent. In practice, it can lead to serious physiological trespass. For even with the concomitant use of ventilators, EEG, ECG, and other monitoring devices on every patient, the aberrations seen are probably little different than a single potent agent carried to plane 3 — such as with ether or cyclopropane.

Statistics all too often are an author's own device but do indicate a trend, and as seen in Beecher's⁴ well documented report covering ten leading university centers there is a relationship where deaths are related to anesthesia as follows:

- One in 880 with ether
- One in 1100 with nitrous oxide
- One in 1800 with spinal
- One in 370 when curare was used.

These data have been criticized sharply and many of us feel the data are misleading, especially where curare is concerned. None the less, we are confronted with several unanswerable questions:

1. Are clinicians correct in relating a higher incidence of cardiac arrests to use of multiple agents?

2. Is it the agent or the skill of the anesthetist? Which is the paramount problem? All the facts are not currently known. One fact we need to know for example is whether a patient is benefited by light anesthesia and the preservation of potent reflexes even though these reflexes may initiate bronchospasm, vasospasm, cardiac arrhythmias, etc. Until an adequate reappraisal is completed, we must consider balanced anesthesia as capable of producing physiological trespass.

TRESPASS TO CIRCULATION

If we administer an anesthetic with a resultant stable blood pressure, some adduce a skillful use of technique and the use of trouble free agents. This often is not so. The ancient Riva Rocci method often does detect deviations. But blood pressure recordings can seldom be taken as often as required to note changes. The anesthetist often is too busy performing an intubation, applying a mask, adjusting an I.V., fastening drapes and carrying out a host of other chores to note these deviations. When the blood pressure is then taken, body homeostasis has often compensated for smaller derangements and a low pressure may have been restored to an artificially "normal" blood pressure. Even if we did employ routine continuous intra-arterial recording, the blood pressure is but a small facet. A pressure can remain relatively constant with:

- a) Peripheral resistance constant and slow pulse.
- b) Peripheral resistance decreased and increased pulse rate — all dependent on cardiac output; or output can vary and by compensation of heart rate and resistance the pressure can again remain constant. Hence, a "normal" blood pressure is little evidence that a serious trespass upon circulation has not occurred. It is important because we are never certain, when a plunger of a syringe is pushed or flow rate of gas increased, that we might be dealing with a member of that group whose lives depend upon such knowledge. Certain surmizes are possible. The geriatric or pediatric patient, the one debilitated by virtue of weight loss, hepatic, cardiac, renal or cerebral disease, the overly premedicated patient, the one with depleted blood volumes or electrolyte depletion will all be likely candidates for physiological aberrations which approach pathological concern, even when careful anesthesia is obtained. Emphasis is needed that Pentothal produces more than sleep; curare, ether and cyclopropane do more than "relax" and produce sleep with "a whiff". They are also poisons. It says so on the bottle.

Physiological Trespass in Anesthesia

TRESPASS TO RESPIRATION

Carbon dioxide early was recommended for resuscitation to promote deeper breathing. More recently some have argued that with normal arterial tensions of carbon dioxide, respiration must be adequate. What has long been suspect, namely, the degree of responsiveness of the respiratory center to a normal stimulus of carbon dioxide is the more important factor. Hence, if the center is depressed, as it always is with pre-anesthetic sedation, inhalation and I.V. anesthetic agents, the center requires a greater stimulus of carbon dioxide for "normal" respiration to occur. If carbon dioxide levels are kept normal, the respiration is depressed under these conditions. If carbon dioxide tensions are permitted to rise this can lead to acidosis. The point is that nearly all our agents for sedation and anesthesia depress the respiratory center. The consensus of opinion is that all anesthetized patients need assistance to respiration. At the opposite end of the scale, some investigators have found that particularly in hypothermic patients with assisted respirations, carbon dioxide may actually be lost and an alkalosis may ensue. The same is said to occur with over-use of ventilators. Whether a fall of the arterial carbon dioxide tensions as we see it is detrimental is not as yet fully understood. Certain it is that this is a trespass of normal respiratory physiology.

DELIBERATE TRESPASS TO CIRCULATION, RESPIRATION AND THERMAL MECHANISMS

With the advent of more radical surgery for congenital defects and for cancer, the surgeon sought help in decreasing blood loss. This was important not only to facilitate surgical dissection but to spare the patient the hazard of repeated transfusions which when in excess of 2500 cc. may be implicated in blood clotting disorders. Since the essential feature of circulation is blood flow rather than just systolic level, it was determined that systolic pressure in most patients could be reduced to 70 mm. Hg. with little difficulty provided blood volume remained stable and vital organs were in dependant positions perfused with blood of high oxygen tensions. While neurosurgeons had previously used arteriotomy for this purpose, it seemed more feasible to lower the perfusion pressure by interruption of autonomic impulses and vasodilatation. Deliberate hypotensive techniques are useful but to a lesser degree than proposed originally since the morbidity and mortality is increased. Little⁵, reviewing the first 27,000 cases of deliberate hypotension in the world, found that the death rate was one in 291 and the morbidity rate was one in every 31 cases performed. This was the form of anesthetic technique which caused Gillies⁶ first to use the term "physiological trespass".

But we trespass on. Man is a nonhibernating animal. If we lower his temperature, he will assume the temperature of his environment and will not spontaneously rewarm himself as does the woodchuck. Man is most sensitive to changes in excess of 4°F. either side of 98.6°F. Neurosurgeons and cardiovascular surgeons have frequent need to interrupt circulation to vital areas, such as brain, liver, heart etc. for the prevention and control of hemorrhage as well as better direct surgical approach in relatively bloodless fields. Hypothermia is another means of deliberate hypotension. In fact,

both may be combined deliberately and/or co-incidentally. Hypothermia further aids in decreasing tissue oxygen requirements.

When one begins to cool the average adult, shivering occurs and body temperature is raised. So we anesthetize or block autonomic and neuromuscular response. Then the patient will cool. At about 34° to 35° C. if all sources of cooling are removed, in a room at 70° F., his body temperature continues to drop, often to 28-29° C. If rewarming is not done at this time, he continues to cool with eventual death. Rewarming at this point is often a serious problem since with decrease in temperature, the blood pressure falls, the heart rate slows and the blood becomes more viscid. This state prevents rapidity in rewarming. Not infrequently at 30 degrees C., one feels no pulse, hears no blood pressure and respiratory activity ceases. With the help of the EKG, cardiac activity can be monitored; respirations are controlled. This is a physiological response but bordering on a pathological state.

Somewhat germane to this discussion yet not at the wish of the anesthetist is induced (deliberate) cardiac arrest and extracorporeal circulation. Volumes have been written and much is yet to amaze us. The most undefinable but definite changes in tissue oxygen, carbon dioxide, K+, and other electrolytes are enough to cause unexplained deaths in the postoperative period. These later procedures are spectacular and vitally necessary, attendant with much care and deliberation. They are more transgressions than trespass, however.

It may be emphasized that variations of a rather wide range are compatible with life in matters of temperature, cardiac rate, circulatory pressures and respiratory activity. Many patients are even benefited by a selective use of apnea and controlled respirations, the deliberate lowering of blood pressure and rapid autonomic or neuromuscular depression.

These successful accomplishments should not be adopted by us as "routine" or even "physiological" since normal homo sapiens physiologically must remain within very strict confines of temperature, carbon dioxide tension, pH and circulatory performance. Deviations though often successful are physiological trespass.

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