The Routine Autopsy

Most patients who die in accidents or under questionable circumstances undergo autopsy. When an autopsy is requested, it is either by the medical examiner legally mandating it, the attending physician or the patient's family. After the patient is pronounced dead by a physician, the body is wrapped in a sheet or shroud and transported to the morgue, where it is held in a refrigeration unit until the autopsy. Autopsies are rarely performed at night, but they are typically performed between 8 am and 4 pm every day, including weekends and holidays.

Immediately before the autopsy, the body is removed from the cooler by a morgue attendant who will help with the autopsy. This individual is called a diener (DEE-nur), which is German for "servant." Dieners are not formally trained, but many have some background of employment in the funeral industry. The other individual directly involved in the autopsy is the prosector. This is the individual who is in charge of the actual dissection. The prosector is a Board-certified pathologist, an MD or DO (osteopath) who has undergone a four- or five- year residency in the specialty of pathology, specifically anatomic pathology. The "PA" is typically a graduate of a masters or baccalaureate program which provides training in several areas of pathology, especially those that involve "hands-on" activities, such as autopsy dissections, dissections of specimens removed at surgery, specimen photography, and video applications. Other individuals may be present at the autopsy, usually for educational opportunities. These may include the attending or consulting physicians, residents, medical students, nurses, respiratory therapists, and others involved in patient care. The prosector and diener wear fairly simple protective equipment, including shields. Some facilities have sealed-environment "space suits."

THE EXTERNAL EXAMINATION

The body is taken from the cooler by the diener and is placed on the autopsy table. Experienced dieners, even those of slight build, can transfer even obese bodies from the carriage to the table without assistance. Since the comfort of the patient is no longer a consideration, this transfer is accomplished with what appears to the uninitiated a rather brutal combination of pulls and shoves, not unlike the way a thug might manhandle a mugging victim. The body is then measured. Large facilities may have total-body scales, so that a weight can be obtained. The autopsy table is a waist-high aluminum fixture that is plumbed for running water and has several faucets and spigots to facilitate washing away all the blood that is released during the procedure. The autopsy table is basically a slanted tray (for drainage) with raised edges (to keep blood and fluids from flowing onto the floor). After the body is positioned, the diener places a "body block" under the patients back. This rubber or plastic brick-like appliance causes the chest to protrude outward and the arms and neck to fall back, thus allowing the maximum exposure of the trunk for the incisions. The prosector checks to make sure that the body is that of the patient named on the permit by checking the toe tag or patient wristband ID. Abnormalities of the external body surfaces are then noted and described, either by talking into a voice recorder or making notes on a diagram and/or checklist.

OPENING THE TRUNK

The diener takes a large scalpel and makes the incision in the trunk. This is a "Y" shaped incision. The arms of the "Y" extend from the front of each shoulder to the bottom end of the breast bone (called the xiphoid process of the sternum). In women, these incisions are diverted beneath the

breasts, so that the “Y” has curved, rather than straight, arms. The tail of the “Y” extends from the xiphoid process to the pubic bone and typically makes a slight deviation to avoid the umbilicus (navel). The incision is very deep, extending to the rib cage on the chest, and completely through the abdominal wall below that. With the “Y” incision made, the next task is to peel the skin, muscle, and soft tissues off the chest wall. This is done with a scalpel. When complete, the chest flap is pulled upward over the patient’s face, and the front of the rib cage and the strap muscles of the front of the neck lie exposed. At this point of the autopsy, the smells are otherwise very faint. An electric saw or bone cutter (which looks a lot like curved pruning shears) is used to open the rib cage. One cut is made up each side of the front of the rib cage, so that the chest plate, consisting of the sternum and the ribs that connect to it, are no longer attached to the rest of the skeleton. The chest plate is pulled back and peeled off with a little help of the scalpel, which is used to dissect the adherent soft tissues stuck to the to the back of the chest plate. After the chest plate has been removed, the organs of the chest (heart and lungs) are exposed (the heart is actually covered by the pericardial sac). Before disturbing the organs further, the prosector cuts open the pericardial sac, then the pulmonary artery where it exits the heart. He sticks his finger into the whole in the pulmonary artery and feels around for any thromboembolus (a blood clot which has dislodged from a vein elsewhere in the body, traveled through the heart to the pulmonary artery, lodged there, and caused sudden death. This is a common cause of death in hospitalized patients). The abdomen is further opened by dissecting the abdominal muscle away from the bottom of the rib cage and diaphragm. The flaps of abdominal wall fall off to either side, and the abdominal organs are now exposed.

REMOVING THE ORGANS OF THE TRUNK

The most typical method of organ removal is called the “Rokitansky Method.” This is not unlike field dressing a deer. The dissection begins at the neck and proceeds downward, so that eventually all the organs of the trunk are removed in one bloc. The first thing the diener does is to identify the carotid and subclavin arteries in the neck and upper chest. He ties a long string to each and then cuts them off, so that the ties are left in the body. This allows the mortician to more easily find the arteries for injection of the embalming fluids. A cut is then made above the larynx, detaching the larynx and esophagus from the pharynx. The larynx and trachea are then pulled downward, and the scalpel is used to free up the remainder of the chest organs from their attachment at the spine. The diaphragm is cut away from the body wall, and the abdominal organs are pulled out and down. Finally, all of the organs are attached to the body only by the pelvic ligaments, bladder, and rectum. A single slash with the scalpel divides this connection, and all of the organs are now free in one bloc. The diener hands this organ bloc to the prosector. The prosector takes the organ bloc to a dissecting table (which is often mounted over the patient’s legs) and dissects it. Meanwhile, the diener proceeds to remove the brain.

REMOVING THE BRAIN

The diener takes the body block out form under the patient’s back and places it under the back of the head. This elevates the head so that it is positioned as if it were on a very thick, stiff pillow. The diener uses a scalpel to cut from behind one ear, over the crown of the head, to behind the other ear. Like with the trunk incisions. This one is deep, all the way to the skull. The skin and soft tissues are now divided into a front flap and a rear flap. The front flap is pulled (this takes some strength) forward (like being “scalped”) over the patient’s face, thus exposing the top and front of

the skull. The back flap is pulled backwards over the nape of the neck. The whole top hemisphere of the skull is now exposed. The diener takes an electric saw (typically known as the “Stryker saw”) and makes cuts around the equator of the cranium. This cut must be deep enough to cut all the way through the skull, but not so deep that the brain is cut (this takes some skill). Typically, the cut is not totally straight but has a notch so that the skull top (calvarium) will not slide off the bottom half of the skull after everything is sewn back up. After this cut, the calvarium is removed and set aside. As the calvarium is lifted off, there is a very characteristic sound that is a combination of a sucking sound and the sound of rubbing two halves of a coconut together. The outer layer of the meninges (the coverings of the brain), called the dura, stays with the calvarium, so that the top of the brain is now fully exposed. After the chore of getting to it, it is a relatively easy matter to get the brain out. The spinal cord and the dural reflections that go between the cerebellum and cerebrum (called the tentorium) are cut. The brain is then easily lifted out. Since the brain is very soft and easily deformable, it is not manipulated at the time of the autopsy. Instead, it is hung up by string in a large jar of formalin (a 10% solution of formaldehyde gas in buffered water) for two weeks or longer. The action of formaldehyde is to “fix” the tissue, not only preserving it from decay, but also causing it to become much firmer and easier to handle without deforming it. The reason that it is suspended by string is to prevent it from having a flattened side from lying in the bottom of the jar (the brain is heavier than water and therefore sinks).

EXAMNIATION OF THE ORGANS OF THE TRUNK

At the dissection table, the prosector typically dissects and isolates the esophagus from the rest of the chest organs. This is usually done simply by pulling it away without the help of a blade (a technique called “blunt dissection”). The chest organs are then cut away from the abdominal organs and esophagus with scissors. The lungs are cut away from the heart and trachea and weighed, then sliced like loaves of bread into slices about one centimeter thick. A long (12”- 18”), sharp knife, called a “bread knife” is used for this. The heart is weighed and opened along the pathway of normal blood flow using the bread knife or scissors. The coronary arteries are examined by making numerous crosscuts with a scalpel. The larynx and trachea are opened longitudinally from the rear and the interior examined. The thyroid gland is dissected away from the trachea with scissors, weighed, and examined in thin slices. Sometimes the parathyroid glands are easy to find, other times impossible. The bloc containing the abdominal organs is turned over so that the back side is up. The adrenal glands are located in the fatty tissue over the kidneys (they are sometimes difficult to find) and are removed, weighed, sliced, and examined by the prosector. The liver is removed with scissors from the rest of the abdominal organs, weighed, sliced with a bread knife, and examined. The spleen is similarly treated. The intestines are stripped from the mesentery using scissors or bread knife. The intestines are then opened over a sink under running water, so that all the feces and undigested food flow out. As one might imagine, this step is extremely malodorous. The resultant material in the sink smells like a combination of feces and vomit. The internal (mucosal) surface of the bowel is washed off with water and examined. The stomach is then opened along its greater curvature. The pancreas is removed from the duodenum, weighed sliced and examined. The duodenum is opened longitudinally, washed out, and examined internally. The esophagus is similarly treated. The kidneys are removed, weighed, cut lengthwise in half, and examined. The urinary bladder is opened and examined internally. In the female patient, the ovaries are removed, cut in half, and examined. The uterus is opened along either side (bivalved) and examined. In the male, the testes are typically not removed if they are not enlarged. If it is necessary to remove them, they can be pulled up into the abdomen by traction on the

spermatic cord, cut off, cut in half, and examined. The aorta and its major abdominal/pelvic branches (the renal, celiac, mesenteric, and iliac arteries) are opened longitudinally and examined. Most of the organs mentioned above are sampled for microscopic examination. Sections of the organs are cut with a bread knife or scalpel and placed in labeled plastic cassettes. Each section is the size of a postage stamp or smaller and optimally about three millimeters in thickness. The cassettes are placed in a small jar of formalin for fixation. They are then "processed" in a machine that overnight removes all the water from the specimens and replaces it with paraffin wax. Permanent microscopic sections (five microns, or one two-hundredth of a millimeter thick) can be cut from these paraffin sections, mounted on glass slides, stained, coverslipped, and examined microscopically. The permanent slides are usually kept indefinitely, but must be kept for twenty years minimum. Additional small slices of the major organs are kept in a "save jar," typically a one-quart or one-pint jar filled with formalin. Labs keep the save jar for a variable length of time, but at least until the case is "signed out" (i.e., the final written report is prepared). Some labs keep the save jar for years. All tissues that are disposed of are done so by incineration. All of the above procedures are done with only four simple instruments—a scalpel, the bread knife, scissors, and forceps. The more handy the prosector, the more he relies of the bread knife, sometimes making amazingly delicate cuts with this long, unwieldy-looking blade. The best prosectors are able to make every cut with one long slicing action. To saw back and forth with the blade leaves irregularities on the cut surface which are often distracting on specimen photographs. So the idea is to use an extremely sharp, long blade that can get through a 2000-gram liver in one graceful slice. Note the appearance of the autopsy suite: Toward the end of the autopsy procedure, the room is not a pretty sight. Prosectors vary markedly in how neat they keep the dissection area while doing the procedure. Usually, the autopsy table around the patient is covered with blood, and it is very difficult not to get some blood on the floor. We try to keep blood on the floor to a minimum, because this is a slippery substance that can lead to falls. The hanging meat scales used to weigh the organs are usually covered with or dripping with blood. The chalk that is used to write organ weights on the chalkboard is also smeared with blood, as may be the chalkboard itself.

CLOSING UP AND RELEASING THE BODY

After all the above procedures are performed, the body is now an empty shell, with no larynx, chest organs, abdominal organs, pelvic organs, or brain. The front of the rib cage is also missing. The scalp is pulled down over the face, and the whole top of the head is gone. Obviously, this is not optimal for lying in state in public view. The diener remedies this problem. First, the calvarium is placed back on the skull (the brain is not replaced), the scalp pulled back over the calvarium, and the wound sewn up with thick twine using the type of stitch used to cover baseballs. The wound is now a line that goes from behind the ears over the back of the skull, so that when the head rests on a pillow in the casket, the wound is not visible. The empty trunk looks like the hull of a ship under construction, the prominent ribs resembling the corresponding structural members of the ship. In many institutions, the sliced organs are just poured back into the open body cavity. In other places, the organs are not replaced but just incinerated at the facility. In either case, the chest plate is placed back in the chest, and the body wall is sewn back up with baseball stitches, so that the final wound resembles a "Y." The diener rinses the body off with a hose and sponge, covers it with a sheet, and calls the funeral home for pick-up. As one might imagine, if the organs had not been put back in the body, the whole trunk appears collapsed, especially the chest (since the chest plate was not firmly reattached to the ribs). The mortician must then remedy this by placing filler in the body cavity to re-expand the body to roughly normal contours. Ultimately, what is buried/cremated

is either 1) the body without a brain and without any chest, abdominal, or pelvic organs, or 2) the body without a brain but with a hodgepodge of other organ parts in the body cavity.

FINISHING UP

After the funeral home has been called, the diener cleans up the autopsy suite with a mop and bucket, and the prosector finishes up the notes and/or dictation concerning the findings of the "gross exam" (the part of the examination done with the naked eye and not the microscopic; this use of the term "gross" is not a value judgment but a direct German translation of "big" as opposed to "microscopic"). The whole procedure in experienced hands, assuming a fairly straightforward case and no interruptions, has taken about two hours. Complicated cases requiring detailed explorations and special dissections (e.g., exploring the bile ducts, removing the eyes or spinal cord) may take up to four hours.

AFTER THE AUTOPSY

Days to weeks later, the processed microscopic slides are examined by the attending pathologist, who renders the final diagnoses and dictates the report. Only the pathologist can formally issue the report, even if he or she was not the prosector (i.e., the prosector was a resident, PA, or med student). The report is of variable length but almost always runs at least three pages. It may be illustrated with diagrams that the prosector draws from scratch or fills in on standard forms with anatomical drawings. The College of American Pathologists, which certifies medical laboratories, requires that the report be issued within thirty days of the actual autopsy.

THE BRAIN CUTTING

Remember the brain? We left it suspended in a big jar of formalin for a few weeks. After the brain is "fixed," it has the consistency and firmness of a ripe avocado. Before fixation, the consistency is not unlike that of three-day-old refrigerated, uncovered Jell-O. Infant brains can be much softer than that before fixation, even as soft as flan dessert warmed to room temperature, or worse, custard pie filling. Such a brain may be difficult or impossible to hold together and can fall apart as one attempts to remove it from the cranium. Assuming good fixation of an adult brain, it is removed from the formalin and rinsed in a running tap water bath for several hours to try to cut down on the discomforting, eye-irritating, possibly carcinogenic formalin vapors. The cerebrum is severed from the rest of the brain (brainstem and cerebellum) be the prosector with a scalpel. The cerebellum is severed from the brainstem, and each is sliced perpendicularly to its long axis and laid out to be examined. Sections for microscopic processing are taken, as from the other organs, and a few slices are held in "save jars." The remainder of the brain slices is incinerated.

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