for the understanding of the cause and treatment of the many human ailments which are peculiarly related to season.

**SUMMARY**

Estimation at monthly intervals of the water-content of the trachea, the alveolar portion of the lung and the bronchial portion of the lung of 105 albino rats, 115 guinea-pigs, 146 rabbits, 90 cats, 146 white mice and 11 cases of human autopsy material revealed that a statistically significant drying occurs in one or more of these portions of the respiratory tract over a varying interval during the winter months in this locality of southeastern Ontario.

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**REFERENCES**

3. Idem.: Seasonal variation in the water-content of the respiratory tract of birds and mammals.

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**THE INDICATIONS FOR COMMON DUCT EXPLORATION**

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One who studies, or is even interested in, diseases of the biliary system soon becomes impressed with the all-important rôle played by the extra-hepatic ductal system. One will also be equally impressed at both the absolute and relative neglect which this system receives. The gallbladder is too often considered to be a "North Star" of all biliary pain or indigestion, which will lead to the cause and the cure of all suggestive symptoms. If this were true, biliary disease would present one of the simplest of all conditions found in medicine, from the preventive as well as the curative viewpoint. But it is not so. Instead, it presents one of the most complex situations. There are few other conditions which have so high an incidence of frequency and give as unsatisfactory end-results in general practice.

The biliary system begins in the smallest radicles in the liver and consists of the liver as a whole and the individual liver cell as the basic functioning unit, the intrahepatic bile channels, the hepatic ducts, the cystic duct and its sphincter-like mechanism, the gallbladder, the common duct, the pancreas and its excretory system, the sphincter of Oddi, the ampulla of Vater and its physical mechanism, the duodenum with all its mechanical and functional intricacies, as well as the lymphatic circulation of the whole area. Truly this is a large and extensive system, which functions normally only when the physiological, anatomical, and neuromuscular segments are working in perfect co-ordination, and it is reasonable to believe that, as in any large piece of machinery, the breakdown of any one part will affect any or all of the remaining parts.

Because of these facts it is obvious that the removal of a gallbladder may have little or no effect on biliary disease in general, or on the separate basic symptom-producing factors. The doctor who sees many cases of gallbladder disease will sooner or later learn that the patient who has had a cholecystectomy, particularly if there is no preoperative treatment or postoperative supervision, will come back to him, or more often go to someone else, because operation did not remove, let alone cure, the symptoms for which operation was done. One of the chief reasons for this is residual disease in the ductal system.

A fundamental point is this: *biliary disease is progressive* and the resulting complications and associated conditions, both in and out of the ductal system, may in time become more serious and dangerous than the original disease. Such complications include liver and kidney deficiencies, infection of the biliary channels in and out of the liver, and obstructing pancreatitis. Therefore the mortality associated with secondary operations is obviously much higher than it is with the primary. The causative factor in the majority of secondary operations on the biliary system is, as just mentioned, residual disease of the common duct. Therefore it must be emphasized that every primary operation on a patient with gallbladder disease is a potential common duct exploration, particularly if bladder calculi have been diagnosed preoperatively. Because common-duct stones are so often overlooked at the time of cholecystectomy, the author drains the cystic duct through a small catheter.
after the removal of the gallbladder if the common duct is not opened. This is done as a routine and it performs the same principal functions as a T-tube drain of the choledochus, namely, it allows perfusion and cholangiography. If cholangiographs are made by this method, in every case in which the common duct is not drained, the incidence of overlooked common-duct calculi will be reduced to a minimum, and, of course, the incidence of symptoms following cholecystectomy will also be reduced. It is obvious, too, that the mortality resultant upon secondary operations will also be markedly lessened, because the calculi will be removed before longstanding and intermittent obstruction has damaged the liver and upset the normal physiochemical balance.

Every operator who subjects a patient to cholecystectomy (so often sadly called "simple") should, of course, be able to recognize additional pathological changes and be able to successfully perform any procedure which is indicated by such unexpected findings.

**INDICATIONS FOR EXPLORATION**

It therefore seems proper to discuss generally, but briefly, the indications for opening, exploring and perfusing the common duct, and the relationship of the ductus choledochus to the biliary system as a unit. The indications for choledochotomy, or at any rate the conditions which demand serious consideration, can be grouped as: (a) those determined before operation, and (b) those determined at operation.

(a) **Those as determined before operation:**

1. A history of jaundice, particularly if repeated;
2. Involuntary attacks of vomiting with the attacks of colic;
3. An increasing frequency of attacks;
4. Charcot's so-called syndrome of colic, fever, chills and jaundice (clinical history of cholangitis);
5. Persistence of a biliary fistula following operation;
6. When symptoms following cholecystectomy demand operation;
7. Chronic non-calculous cholecystitis.

(b) **Those as determined at operation:**

1. The presence of lesions which necessitate perfusion (pancreatitis, hepatitis);
2. The palpation of stones in the common duct;
3. A distended or thickened duct;
4. A small fibrosed gallbladder, particularly if the cystic duct is dilated;
5. The presence of many small bladder stones;
6. Aspirated bile from the common duct showing a cloudy or hazy appearance;
7. An enlarged or otherwise pathological pancreas;
8. A pathological liver.

Independently or in combination the above conditions must be considered seriously. At this point it should be emphasized that the history must be thoroughly studied and completely understood before the operation is started. Unless this is always done the surgeon will some day make a serious mistake. Such mistakes are not always unavoidable but they should be reduced to a minimum.

There is no added danger if a normal duct is opened, provided this is well done, and, if it is diseased the danger of exploration at the first operation is much less than it would be at a second operation.

(a) **As determined before operation**

1. Repeated attacks of jaundice, particularly if preceded by colic, indicate intermittent obstruction of the common bile duct. The most common cause of this is one or more stones. In this respect it is wise to remember the widely proved axiom that "the common things occur the most often," i.e., that jaundice appearing in known or suspected biliary disease is the result of calculus and inflammation more often than not. Pancreatitis usually gives slowly progressive obstruction and rarely is it severe enough to produce progressive jaundice, unless it be malignant. It produces obstructive symptoms early, but few signs until late. Pancreatic icterus usually occurs slowly. The changes are not rapid and quick as they usually are with stones. Anyway, such pancreatic disease is so often associated with advanced biliary disease that either one demands that the common duct be explored and, maybe, perfused. Repeated or fluctuating icterus is, therefore, one of the strongest indications for choledochotomy, even though non-calculous cholecystitis may sometimes produce the same findings. (Acute hepatitis. It is really the conditions associated with non-calculus cholecystitis.) A stone must be diligently searched for, particularly if any of the other indications, as outlined above, are present. The finding of one stone should not mean the end of the search. Every effort must be made to make sure that none remain.

On the other hand an absence of jaundice does not mean an absence of common-duct stones. An average of only 65 to 75% of pa-
tients with calculi in this passageway produce enough rise in the bilirubin to show a visible jaundice, but an icteric index is easily performed and repeated determinations will often show small changes (latent jaundice) before visible jaundice appears. This should be done in every suspected case and it may indicate the presence of common-duct stones before clinical jaundice is seen. It is well to remember this fact, namely, that approximately one out of every four patients with common-duct calculi will show no visible jaundice. Mid-epigastric colic or pain is thought to be a more constant and more important finding than jaundice, although statistics say that one in five patients with proved common-duct stones have no colic (pain). Both colic and jaundice are end-results of the obstruction, and theoretically colic or suggestive pain should be more frequent because ductal distension due to back pressure must be present before such back pressure is high enough to produce jaundice.

2. It has been shown experimentally and clinically that distension, or merely mild back pressure, in the common duct will produce reflex vomiting. This is involuntary and will occur even in anesthetized dogs. Balloons placed in the common duct of patients, and inflated days and weeks later consistently produce attacks of vomiting. Therefore, attacks of frequent and involuntary vomiting, especially if accompanied by colic, pain, or merely epigastric distress, particularly in the presence of known biliary disease, are presumptive evidence of common duct stone. Distension of the gallbladder does not always produce vomiting, even if the peritoneum is involved, and is much less likely to do so under any conditions.

3. When attacks of pain or colic, with or without vomiting, occur more than twice a month (approximately) or, more particularly, when attacks become more frequent and last longer than they originally did, the presence of common-duct stones should be suspected. Although this applies to any case, it is more applicable to those patients with mid-epigastric pain, jaundice and vomiting than it is to patients with right sub-costal pain, less jaundice and little vomiting.

At this point a word should be said about "biliary colic". Clinical biliary colic is not "colicky". It is a severe pain which increases in severity until it reaches a climax, and it does not disappear until the cause has been relieved or drugs administered. Also, common-duct pain is usually mid-epigastric in location rather than right sub-costal and is more likely to radiate directly through to the mid back. Indeed, many authorities open the common duct on this finding alone, i.e., repeated epigastric crampy-like pain, particularly if this pain radiates straight through to the back. Colic and jaundice, however, are proof of biliary disease, and although this may be produced by cholecystic disease in the presence of a normal ductal system, choledochlolithiasis is a much more common cause and must always be carefully ruled out. It should be appreciated, too, that functional changes can simulate organic disease even to the point of colic and jaundice.

Cystic-duct colic (obstruction) produces changes in the size of the gallbladder, if non-fibrotic, which in turn produces varying amounts of peritoneal irritation with resultant right sub-costal pain. Hence a difference, in many cases, in the location of ductal colic and gallbladder colic. The former is also more commonly associated with involuntary vomiting.

4. The syndrome of colic, jaundice, chills and fever has long been associated with choledocho-lithiasis, and for practical purposes it is pathognomonic of common-duct calculi. Fortunately, the incidence of this combination (Charcot's syndrome) is not as common as it formerly was because preventive surgery is practised more today than it was in the days of less understood biliary physiology and pathology. It is a serious danger signal and diagnosis should be made before this stage has been reached. It indicates a relatively poor prognosis, because liver involvement is always moderate and often advanced. To compare the incidence of chills and fever with colic and jaundice we find, approximately, that out of 100 patients with common-duct calculi, 20 will have no colic, 25 will have no jaundice, and 65 will have no chills and fever. In other words, only 4 in 5 will have colic, only 3 in 4 will have jaundice, and only 1 in 3 will have chills and/or fever. The finding of either chills or fever with colic and/or jaundice is of the greatest diagnostic importance, and has more clinical significance than the appearance of colic or jaundice, either alone or in combination.

Even an apparently normal ductal system would not be a contraindication to exploration, if enough of these indications are present. It would indicate, however, that the obstruction
was, in all probability, above the junction of the hepatic and cystic ducts. The removal of calculi in this location may involve the most difficult and potentially dangerous of all surgical procedures. The chills and fever are a result of an obstructive and infective lymphangitis along the intra-hepatic bile ducts (hepatitis and cholangitis) and the resulting bacteremia. These findings therefore indicate long standing or severe disease with a minimum of liver reserve. So-called infected bile seldom produces a hepatitis, because actually bile is seldom infected. Infection travels by the lymphatics, not through the bile stream.

A clinical axiom of the greatest importance is that "a patient with a rising bilirubin figure should never be subjected to operation". Operation should be postponed until the icteric index has fallen to normal, or at least until it is stationary. This is, however, not an infallible rule. To operate in the presence of a rising icteric index is to ask for trouble, and trouble comes often enough without an invitation. There is one notable exception to this, namely, the presence of increasing infection which must be drained from the biliary system as it is drained elsewhere in the body. A two-stage procedure is the one of choice in such patients. It may also be of value in certain patients with inflammatory obstructive jaundice. The decision may well mean the difference between life and death for the patient.

5. A persistent fistula draining bile from the common duct is proof of major or minor obstruction to the ductal flow of bile, usually at the point of the former operative work, or between this point and the outlet. Such a case must be explored and the obstructing barrier repaired. This will also, in the majority of cases, demand the maximum of experience and surgical handiwork. A stricture or remaining stones are the common causes of fistula.

6. When symptoms, such as pain, colic, dyspepsia, vomiting, etc., follow gallbladder removal the law of averages favours: (a) that the diagnosis was wrong and the symptoms are due to other disease, particularly if the common duct was explored at the first operation; (b) that common duct stones were missed at the first operation; (c) that there is a stricture of the common duct; (d) that pancreatitis is present. However, a not uncommon cause of post-cholecystectomy symptoms is the failure of the patient to follow a diet. Hence, if a thorough examination rules out other disease processes, and if medical treatment fails to give relief, re-operation for common duct exploration is definitely indicated, especially if careful studies show changes in the level of the blood bilirubin. Cholangiography, in those patients who have a T-tube in the common duct or a small catheter in the cystic duct, following the first operation, or a drainage tube in the gallbladder, will often prove the absence or presence of stones and may, furthermore, show a chronic pancreatitis. The latter may occasionally simulate common-duct stone even to the point of jaundice, chills and fever. Other causes of post-cholecystectomy symptoms are: functional changes, partial duodenal obstruction and malignancy. For obvious reasons cancer must always be kept in mind.

7. It is a well-known fact that better results follow cholecystectomy for stones than for non-calculous cholecystitis. When stones are removed, the causative factor, or at least one of the principal causative factors, is removed, but this is not so in the case of the non-calculous bladder. In the latter instance only one small segment of a diffuse area of disease is removed, and there remain variable amounts of disease throughout the liver, pancreas and the ducts. The presence of stones means obstruction of, and often progressive infection in, the gallbladder. In other words, the calculous bladder has a greater degree of disease and infection than the non-calculous bladder. The latter is rarely associated with choledocholithiasis, but I believe that it is always part and parcel of diffuse biliary disease, which must be treated, and that it is not treated directly by cholecystectomy. It can be treated and attacked directly by ductal perfusion coupled with properly supervised medical treatment. Non-calculous cholecystitis is therefore a considered indication for cholecystotomy with cholecystectomy, and for postoperative perfusion, because, if symptoms and disability are severe enough to demand the removal of a non-calculous gallbladder, the symptom-producing disease must frequently be present in the remainder of the system, and, to repeat, this is not always affected, or cured, by removing the gallbladder.

(b) AS DETERMINED AT OPERATION

1. The disease which necessitates perfusion may be in any part of the biliary system. Part of this system can be seen and examined; part
cannot. T-tube drainage of the common duct or catheter drainage of the cystic duct does not always clean the intra- and extra-hepatic ductal system as thoroughly as does the internal lavage which is induced by perfusion. The application of heat is also most beneficial and can be applied to the actual seat of the disease. The indications for opening the common duct are also indications for drainage and therefore for perfusion. Future work may show that perfusion is of value as a preventive as well as a therapeutic agent, in those cases which do not now show indications for exploration. (See Section (s) number 7.)

2. The palpation of stones in the common duct is, of course, the most definite indication for exploration. These cases should be all drained and perfused. It may at times be difficult to differentiate hard portal lymph nodes from stones, and indeed it may be impossible to palpate even large calculi, particularly if they are in the distal end of the duct. Calculi move in the long axis of the duct whereas lymph nodes are movable in all directions. Usually the latter are not as hard and resistant (unless malignant) as a calculus. It should be remembered that stones may rarely be present in the common duct even though none are present in the bladder, and they can often be present without any of the more usual findings.

3. A dilated or thickened duct is proof positive of the presence of disease. This usually is a stone (or stones) which has produced an incomplete or transitory obstruction with infection. The stone is not always palpable. Such a condition is most often found associated with a past history of pain and vomiting and often jaundice. However, a diseased duct may also result from a direct extension of the infection from the gallbladder wall along the cystic duct. When this happens the dilatation is not so great as it is when obstruction has been present, and the presence of infection may be indicated only by thickening. It is obvious, of course, that a dilated, thickened or otherwise diseased duct, cannot be seen unless a definite effort is made to look for it. In other words every cholecystectomy demands a thorough visual examination of the ductal system. Indeed, even if the gallbladder is found normal, the common and hepatic ducts must nevertheless be examined if the history indicates, or even suggests, obstructive biliary disease.

4. A small, fibrosed gallbladder indicates long standing and progressive inflammatory disease, and experience has shown that many of these cases have associated common-duct disease, whether or not stones can be palpated, and exploration is always indicated. A normal duct is a rare operative finding with such a bladder. A dilated cystic duct indicates increased ductal pressure and is an added indication. Any evidence of increased pressure means intermittent, semi-permanent, or transient obstruction.

5. When large numbers of small stones are found in the gallbladder it is easily understood how one of these might have passed through a large cystic duct into the common duct. When this condition is found the common duct should be explored regardless of its size, consistency, or normal palpability, and drainage should be instituted through either the cystic or common ducts. Abnormal bile will practically always be present if the duct contains stones. A combination of a fibrotic bladder containing many small stones and a dilated cystic duct is evidence that always demands exploration.

6. When any doubt exists about opening the duct a small hypodermic needle should be used to withdraw some bile. The needle should be inserted at an angle so that leaking will be minimum if the duct is not later opened. The location of the hepatic artery and portal vein must be known. This procedure is also a test, and sometimes a vital one, to differentiate the common duct and the portal vein. This is not a theoretical difficulty, particularly in long standing and active disease. If the aspirated bile is held in front of a bright light any flecks, cloudiness, or debris, can easily be seen. If these are found it indicates common duct stagnation or, at least, an absence of a normal flow, and it is a definite indication for exploration. On the other hand, clean and transparent bile usually indicates a normal system. However, the writer has seen three cases of common-duct stone associated with clear bile, one of which had a negative culture. A microscopic study of aspirated bile undoubtedly gives more information than visual examination.

7. The presence of a large pancreas usually indicates extensive disease in the biliary tract (pancreatitis is a complication) and in many cases it produces a partial, and sometimes a complete, common duct obstruction. It is a not uncommon cause of post-cholecystectomy
symptoms and, if present, therefore, is usually an indication for drainage and for perfusion, because, if the enlargement is due to a chronic inflammatory process heat by perfusion is a logical therapeutic measure. If, on the other hand, ductal infection is still present, whether or not partial obstruction is a factor, perfusion with increasing pressure is indicated, both for cleansing the duct and for dilatation of the sphincter. Obstruction of the common duct is never present for any length of time without infection being added.

8. A diseased liver, especially if large, is a definite indication for prolonged drainage and internal hepatic lavage by means of perfusion.

**ACUTE CHOLECYSTITIS AND CHOLEDOCHOTOMY**

The question of medical or surgical treatment for acute cholecystitis is a debatable one and although many surgeons are beginning to favour conservative treatment, particularly if the cases are not seen early, radical treatment has very much in its favour but the decision must always be an individual one. (Early and late cases should refer to the pathological, and not to the clinical, age.) It is certain that one of the better arguments against radical surgical treatment during the acute attack is the fact that the common duct cannot be explored with maximum ease and safety, or the optimum thoroughness, while the acute disease is prevailing. (Surgical treatment may be conservative, i.e., the two-stage procedure.) It is often impossible to palpate common-duct stones when they are present in the chronic stages (non-acute cases), and it is obvious that this difficulty is greatly increased by the presence of edema, congestion, swelling and other acute manifestations. However, there are occasions when the common duct can be explored during cholecystectomy for acute disease, but expert surgical technique and great clinical acumen are imperative prerequisites.

The writer has advocated a two-stage procedure for certain cases of acute cholecystitis. The first stage (simple and quick drainage) prevents the dangers consequent upon the acute phase (empyema, necrosis, gangrene, pericholecystitis, fistula formation, perforation) which are more common than was formerly thought, and it also allows the serious and dangerous secondary operation (removal and, probably, ductal surgery) to be done with greater technical safety. The normal physiochemical balance will also have become restored.

**CONCLUSIONS**

Successful gallbladder surgery often depends upon successful common-duct surgery, and this ranks high among that group of surgical procedures which requires the best in the technique and judgment of the surgeon. This is true of either preventive or curative treatment. It is impossible to place too much emphasis on the preventive aspect of choledochus disease at the time of cholecystectomy. In no sphere of surgery is the axiom 'prevention is better than cure' more true than it is in this condition. It is not possible to give reliable statistics regarding the incidence of patients whose suffering following operation is preventable because all such figures are founded on large teaching hospital and clinical records, whereas the greater number of patients with common-duct disease are seen, and treated, for the first time in general practice. However, it can be said with no hesitation that an unnecessarily large number of these cases are preventable, and because many are eventually fatal it follows that many deaths are preventable.

**SUMMARY**

The principal clinical indications for exploring and perfusing the common duct are discussed.

The principal indications for cholecystotomy (with individual reservations) are noted as those which can be determined before operation and those which have to be determined at operation.

Each condition is discussed as a potential indication for common duct incision, exploration and perfusion. Also, the relation of residual common duct disease to persistent and progressive changes in the biliary system and to post-cholecystectomy symptoms, is stressed.

*Be the blood vessels. A branch of the gastro-duodenal artery or superior pancreatico-duodenal artery, and sometimes of the cystic artery, as well as veins, which lie in the peritoneal covering of the common duct can give troublesome and serious bleeding if the vessels are not identified and controlled during opening the peritoneum in the hepato-duodenal ligament, and if the duct is not clearly and cleanly exposed. Uncontrolled bleeding is, with the probable exception of exposure, the most important single factor which predisposes to the difficulties and dangers of gallbladder surgery. It obscures the field, prevents good vision, causes trauma in the wound and abdominal viscera, predisposes to big and promiscuous bites of tissue and therefore to strictures.
ADDENDUM

Since this paper was submitted the writer has operated upon a case worthy of mention. Two previous operations had been performed elsewhere—one for drainage and one for removal of gallbladder. Symptoms (jaundice, chill, fever, high mid-line pain, vomiting, loss of weight, general health decreased) increased and jaundice fluctuated. Diagnosis: (1) common duct calculi; (2) strictures (inflammatory). All evidence greatly in favour of calculus. Cholangiogram performed on operating table revealed no negative or positive shadows. Catheter and large sounds passed easily into the duodenum but because the clinical history said a stone was present the duodenum was freely mobilized and the duct followed to its termination. A soft cholesterol stone was discovered. Moral: the clinical history must weigh the balance of diagnostic facts.

BIBLIOGRAPHY


UNILATERAL PYELONEPHRITIS AND HYPERTENSION

By I. J. Patton, M.D.

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The case herewith reported may be of interest in view of the lack of data on the frequency of this syndrome.

Mr. E.G., aged 49 years, was admitted in coma, to the Homoeopathic Hospital, of Montreal, May 26, 1942. His history gave no clue to the cause, except that six months previously he had been discharged from the army on account of hypertension.

He himself had felt perfectly well, and until the day of his final illness had been doing heavy manual work. On returning home at 6 p.m., May 25, he complained of not feeling well, and of a bubbling sensation at the back of his chest, and went to bed. Soon after, his wife found him unconscious, breathing stertorously, and soaked with perspiration. The respiration soon took on a Cheyne-Stokes character, and neurological signs developed in the form of moderate irritability on the left side, and mild hemiplegia on the right.

On admission, the patient was in deep coma, and incontinent. Moist, bubbling râles were heard throughout the chest, thick white mucus was dribbling from the corners of the mouth, and there were bubbling râles in the trachea. The skin was cold, with profuse sweating. For a great part of the time, the patient appeared to be almost in a state of decerebrate rigidity, with pupils fixed and eyeballs rolling. Reflexes were diminished in both lower extremities, but increased in the upper. There was a bilateral Babinski reflex, and the tongue protruded to the left. Blood pressure 200/100; temperature 104°; pulse 140; respirations 40.

Lumbar puncture yielded a normal spinal fluid, with no evidence of increased pressure or block. A faint fruity odor to the breath suggested diabetes. Blood-sugar was 204.1 mgm. %, but the urine was sugar-free. Unfortunately, in spite of 1+ albumin, a microscopic examination was not done, nor was a blood non-protein nitrogen.

On the clinical picture and the history a provisional diagnosis was made both by the family physician and the hospital staff of cerebral hemorrhage. Therapy was continuous oxygen, coramine, and insulin. The patient died, without recovering consciousness, on May 28, 30 hours after admission.

At autopsy, no pathological changes were found in brain or pancreas. The significant features were purulent bronchitis, with evidence of chronic passive congestion; hypertrophic gastritis, with free blood in the stomach; an extensive exudative and proliferative pyelonephritis.