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[ ABSTRACT. ]

[From the Pathological Laboratory of the Johns Hopkins Hospital  
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Presented in the Section on Practice of Medicine, at the Forty-eighth  
Annual Meeting of the American Medical Association held at  
Philadelphia, Pa., June 1-4, 1897.

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REPRINTED FROM  
THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,  
JULY 31, 1897.

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AMERICAN MEDICAL ASSOCIATION PRESS.  
1897.

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# The Clinical Symptoms, Bacteriologic Findings and Postmortem Appearances in Cases of Infection of Human Beings with the Bacillus Pyocyaneus.

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THE CLINICAL SYMPTOMS, BACTERIO-  
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THE BACILLUS PYOCYANEUS.

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The literature of the bacillus pyocyaneus with especial reference to its pathogenic effects in human beings was reviewed. Especial reference was made to the experimental work of Charrin on animals and to the human infections reported by Oettinger, Ehlers, Jadkewitch, Neumann, Schaefer, Karlinsky, Ledderhose, Jakowski, Gruber, Martha, Krannhals, Calmette, Monnier, Ernst, Fowler, Adami and Williams, Kossel-Blumer, Williams and Cameron, Lavender, Pes and Gradenigo, and Le Noir. There can no longer be any doubt that in addition to the more or less accidental appearance of blue pus in surgical cases that the bacillus pyocyaneus is capable of entering the human organism and setting up disease processes of variable intensity sometimes of a violence leading to a fatal issue. The writer reported eleven such cases which had come under his personal observation. These eleven cases were independent of the instances in which ordinary blue pus occurred and are examples of infections in which the bacillus pyocyaneus could be held directly responsible for definite lesions. The frequency of such infections may be calculated from the statement that out of some 800 consecutive autopsies made, eleven such occurred. That they were discovered depends upon the fact that a systematic bacteriologic study of all the autopsies made at the Johns Hopkins Hospital is insisted upon by Professor Welch. No detailed description of the autopsies and histologic

lesions was given as they are to be reported in full later. The cases were from the wards of Drs. Osler, Halsted and Kelly. The autopsies were made by Drs. Welch, Flexner, Blumer, Livingood and the writer.

*Case 1.*—Thomas P., white, aged 20; operated upon for acute abdominal symptoms suggesting obstruction. At operation bowels greatly distended, wall of gut paralyzed, deeply congested; small intestine very friable; torn at one spot; death same night. At autopsy (March 10, 1893) general peritonitis, marked distension and hemorrhagic discoloration of intestine; necrosis and ulceration of surface of small gut; acute colitis; very marked enlargement of mesenteric glands with suppurating inflammation in some of them. *Bacillus pyocyaneus* present in enormous numbers (along with *bacillus coli communis*) in the peritoneal exudate and (pure) in the mesenteric lymph glands. Large masses of *bacillus pyocyaneus* on surface of gut.

*Case 2.*—Richard B., negro aged 40, with extensive skin disease resembling acute exfoliative dermatitis. Death from broncho-pneumonia. At autopsy Aug. 14, 1893, hemorrhages and thromboses were found in the neighborhood of the skin lesions. Broncho pneumonia, necrotic foci in the liver, adherent pericardium, heart hypertrophy with fatty degeneration; *bacillus pyocyaneus* in the lung and in the cutaneous lesions. Another bacillus carefully studied, but not identified as any known organism, in the kidney, liver and spleen.

*Case 3.*—E. A. L., middle aged man, dead of peritonitis following operation for appendicitis. At autopsy, Nov. 10, 1893, fibrino-purulent peritonitis; broncho pneumonia; pulmonary edema; most extensive diphtheritic inflammation of esophagus (with necrosis and hemorrhages), stomach and intestine, especially of the small intestine. Paralysis of wall of small gut with dilatation; acute nephritis; fatty degeneration of heart, liver and kidney; *bacillus pyocyaneus* present in enormous numbers on the surface of the esophagus, in almost pure culture. Histological study of sections from the esophagus and alimentary tract showed large masses of the *bacillus pyocyaneus* on the surface over the necrotic areas. Many of the necroses in the esophagus go into the submucosa. Extensive hemorrhages in neighborhood of necroses; thromboses of blood vessels of mucous membrane; hyperplasia of lymphatic apparatus.

*Case 4.*—James L. W. Extensive epithelioma of cheek and neck extending to mouth, lung, pharynx and bone. Metastases in cervical and axillary lymph glands. At autopsy, March 15, 1894, bronchitis, extensive broncho-pneumonia, chronic Bright's disease, congestion and edema of lungs; *bacillus pyocyaneus* in pure culture in broncho-pneumonic exudate.

*Case 5.*—Mary S., autopsy April 12, 1894, large sloughing

and gangrenous spindle celled sarcoma of sacrum; extraperitoneal, filling up pelvis, larger than the head of a child. Cæsarian section had been done about a year before. Linear scar in uterus; hemorrhagic purulent cystitis; ureteritis and pyelonephritis; old peritoneal adhesions; no fresh peritonitis; acute bronchitis; pulmonary emphysema; encapsulated trichinæ in muscles. The bacillus pyocyaneus was obtained in cultures from the gangrenous part of the tumor; also in large numbers from the dilated pelvis of the kidney. Streptococcus pyogenes present in the lung, kidney and spleen, as well as in the sloughing tumor.

*Case 6.*—Lizzie K., white; autopsy May 29, 1894. Unresolved pneumonia with carnification of right lower and part of middle lobe; sub acute pleurisy on right side with organizing exudate; hyperemia and edema of rest of right lung; emphysema, edema and congestion of left lung with multiple areas of consolidation in lower lobe; bronchi congested; mucus and pus in trachea; old pleural adhesions; encapsulated diaphragmatic empyema on right side; subacute suppurative pericarditis (pyopericardium with about 500 c.c. of greenish yellow pus); cloudy swelling of kidneys, slight chronic diffuse nephritis with beginning arterio sclerotic change; liver deformed and fatty; spleen enlarged and rather firm; enteroptosis and gastroptosis; acute cystitis with ecchymosed mucous membrane. On the folds are hemorrhagic reddish black crests capped with a grayish white necrotic layer. One hemorrhoidal mass ulcerated on the surface. Erosion of the cervix of the uterus.

From the necroses in the bladder great numbers of bacillus pyocyaneus were obtained in pure culture. Micrococcus lanceolatus in the unresolved pneumonia, in the pyopericardium and in the empyema.

*Case 7.*—Theresa S. Autopsy June 15, 1894. Chronic pelvic cellulitis and peritonitis (uterus, tubes, ovaries embedded in dense fibrous tissue with old peritoneal pelvic adhesion); left ovarian abscess (greenish yellow burrowing pus); recto-vaginal fistula; ulceration of small and large intestine; perforation size of a dime in lower part of sigmoid flexure; acute peritonitis; marked dilatation of small gut, especially in lower part. On surface of small intestine beginning at a point 130 cm. above the valve shallow ulcerations begin to appear at first involving only the mucous membrane. Many of them have hyperemic bases with tendency to run along the edges of the cross folds of the gut. As the ileo-cecal valve is approached, the ulcers become larger and deeper and some of them measure 2x1.5 cm.; margin slightly undermined with ragged necrotic base. Peritoneal surface corresponding to ulcers, smooth; similar ulcers in cecum and ascending colon; ulcers in still greater numbers in transverse and descending colon; two large ulcers in rectum; mucous membrane of rectum absent for a distance of 6 cm. above the anus. Circular perforation of rectum 2 cm. above the

anus communicating with vagina through posterior wall; mucous membrane of stomach hyperemic and ecchymosed. The ulcers differed from typhoid ulcers in that they were more shallow and were devoid of sloughs and medullary infiltration. Hyperemia and hyperplasia of mesenteric lymph glands; fresh vegetative endocarditis of mitral valve; pulmonary emphysema; purulent bronchitis with bronchiectases; acute fibrino-purulent pleuritis; double hypernephrosis with renal atrophy; elephantiasis vulvæ; amyloid disease of spleen and kidney.

*Bacillus pyocyaneus* present in ovarian abscesses, bronchial exudate, in bladder, on mitral valve, in pelvis of kidney and in large numbers in the intestinal ulcers and in the peritoneal exudate. The *bacillus coli communis* was present in the peritoneal cavity, in the pelvis of the kidney, in the spleen and pleural cavity.

*Case 8.*—B. O., white. Autopsy June 17, 1894. Chronic productive endocarditis of mitral valve; mitral stenosis and insufficiency; calcified nodule in aortic valve; aortic insufficiency; general heart hypertrophy and dilatation; arteriosclerosis; chronic passive congestion; cirrhosis of liver; chronic diffuse nephritis; catarrhal colitis with shallow ulcers; acute sero-fibrinous pleurisy on left side; acute peritonitis; fatty degeneration of the heart and liver; a few shallow ulcerations in large intestine, involving only mucous membrane.

*Bacillus pyocyaneus* in pure culture from the peritoneal cavity. *Bacillus coli communis* and a second unidentified bacillus in the pleural exudate. Cultures from kidney, heart's blood and bile, sterile.

*Case 9.*—T. S., male. Autopsy July, 1894. Extreme dilatation of pelvis of right kidney, containing purulent urine; abnormal opening of right ureter into part of renal pelvis; healed operation for femoral hernia; gallstones; pulmonary emphysema and edema; fatty heart, liver and kidney; chronic diffuse nephritis on right side; superficial erosions in large intestine, cultures from which yield large numbers of *bacillus pyocyaneus*; *bacillus pyocyaneus* also obtained from interior of gallstones.

*Case 10.*—Rosie W. Autopsy April 1, 1895. Diffuse carcinoma of stomach, involving omentum and gastric lymph glands; metastatic carcinoma of liver, kidney and peritoneum; acute broncho-pneumonia; healed tuberculosis; chronic nephritis; sub-acute and chronic pericarditis with a few tubercles in the pericardium. Cultures from pericardial exudate yield many colonies of *bacillus pyocyaneus*. A few colonies of *bacillus pyocyaneus* obtained from the peritoneal cavity and from the kidneys. *Streptococcus pyogenes* in the lungs and in the kidney.

*Case 11.*—Wm. S., white, aged 62 years. Autopsy Dec. 16, 1896. Sloughing and gangrenous ulcerative cancer of neck with extension into the surrounding tissues, including sterno-

cleido-mastoid muscle; pulmonary emphysema; hypostatic pneumonia; tumor metastases in lungs; arterio-sclerosis; fatty degeneration of heart and kidneys. In the pneumonic exudate and heart's blood the bacillus pyocyaneus was present. In addition there was a general streptococcus infection setting out from the sloughing ulcer.

After a recital of the above eleven cases personally met with, the writer proceeded to briefly marshal the evidence thus far available for the view that the bacillus pyocyaneus can be pathogenic for human beings.

It is well known that the pyogenic organisms in general can produce very different sorts of disease processes situated in very different parts of the body. They may cause local infections of one or more of the mucous or serous membranes or may give rise to general infections and intoxications. Some of them are more prone to cause the local processes, others more often are concerned in the production of general infections. Even the same bacterium in different instances according to its virulence or to the varying resistance offered by its host can lead either to local or general processes.

The writer showed that the bacillus pyocyaneus can be concerned in acute local infections of the most various mucous membranes, of the skin, of nearly all the serous membranes of the body, and that it can give rise to general infection, and more often still to instances of general acute intoxication. There is some evidence also that the bacillus pyocyaneus can be the cause of chronic infections and intoxications in human beings.

Of the acute local infections due to it, ovarian abscess has been met with by the writer; three cases of liver abscess are mentioned by Kruse and Pasquale. Jakowski found the bacillus pyocyaneus present as the pathogenic agent in two out of 200 suppurative processes. In the mucous membrane of the alimentary tract superficial and deep inflammations of various sorts are common with this bacillus as an etiologic factor. Thus in the intestine there may be superficial erosion, acute hemorrhagic and necrotic enteritis, shal-

low ulceration or deep ulceration due to the action of this organism. The most remarkable lesions in the esophagus were found in the writer's Case 3. The mucous membrane of the stomach may be involved. Along with these lesions of the alimentary tract it is common to find paralysis of the wall of the gut, hemorrhages, necroses and ulcerations, accompanied by enlargement and sometimes by suppuration of the mesenteric lymph glands.

Suppurative processes in the middle ear (Gruber, Pes and Gradenigo), in the antrum (Kossel) and nasopharynx are not infrequently due in human beings to the bacillus pyocyaneus. Bronchitis and bronchopneumonia may be due to this bacillus (Monnier and the writer). The latter has noticed the tendency to hemorrhages and to paralysis of the smooth muscle of the bronchi in such cases.

Severe hemorrhagic and necrotic cystitis, ureteritis and pyelonephritis with paralysis of the muscular walls have been met with by the writer.

In cutaneous and subcutaneous inflammations, the bacillus pyocyaneus has been met with in human beings. These may consist of gangrenous processes (Fowler and the writer), of suppurative phlegmon (Kraus and Buswell), of vesicular eruptions (Oettinger and Ehlers), or of acute exfoliative processes (the writer). The greatest care, however, should be exercised before making definite statements concerning the pathogenicity of the bacillus in cutaneous lesions.

Of the serous membranes which may be infected may be mentioned: 1. The pericardium, in cases thus far reported in association with the tubercle bacillus (Ernst and the writer). 2. The peritoneum, often in association with the bacillus coli communis (the writer's cases 1, 2, 7 and 8). 3. In meningitis (Kossel, Pesina and Honl). 4. In the endocardium (case 7). 5. In joint surfaces (Schurmayer). It apparently has not yet been met with in pleuritis, but doubtless will be found in this process.

That the bacillus pyocyaneus does enter the blood,

giving rise to a general infection of the organism, there can no longer be any doubt. The cases of Oettinger, Ehlers and Neumann show that it can give rise to a definite general hemorrhagic septicemia, accompanied by a vesicular skin eruption, yielding a clinical picture not unlike typhoid fever. The accidental experimental infection associated first with general symptoms, and later with a subcutaneous phlegmon produced in a human being by Kraus and Buswell is a unique observation and extremely important for the establishment of the pathogenicity of the bacillus pyocyaneus. In the writer's experience, however, the bacilli are very rapidly filtered out of the blood by the organs, and thus the cases in which at autopsy the bacillus pyocyaneus is found in several or even a large series of organs, are explicable (Cf. the writer's Cases 2, 7, 10 and 11).

In the cases in which local infection has occurred, and especially in those in which large surfaces like the mucous membrane of the alimentary tract have been involved the phenomena of *general acute intoxication* are common, giving rise clinically to fever, delirium, albuminuria and meteorism, phenomena which can also be produced experimentally in animals by means of injection of the toxins of the bacillus pyocyaneus. At autopsy one finds the pathologic evidences of intoxication; namely, vasomotor disturbances, hemorrhages, focal necroses, parenchymatous lesions in the heart and liver, spleen and kidneys. A very common phenomenon is paralysis of the smooth muscle of the intestinal wall, of the bronchial wall, and of the urinary bladder.

In view of the remarkable results of experimentation on animals, obtained by Charrin, chronic forms of infection with the bacillus pyocyaneus and intoxication with its products may be expected. Charrin has proven the possibility of producing as a remote effect of infection with this microorganism the most various acute and chronic degenerative processes in the nervous system, not unlike many of the syphilitic

changes to which the nervous system is liable. It is interesting to find a human case reported by Jadkewitsch in which recurrent paralysis and other nervous phenomena existed in association with repeated infections in the same individual with the bacillus pyocyaneus.

It is evident, the writer concluded, from the data at hand, that the bacillus pyocyaneus is definitely pathogenic for human beings and is capable of causing a whole series of lesions, acute and chronic, of very different sorts. He laid particular stress on the cases of general infection and intoxication; on the various forms of intestinal ulceration, which are not at all uncommon; on the broncho-pneumonias; on the infections of the genito-urinary tract, and on the remarkable form of esophagitis which he reported.

Infections with this microorganism are not confined to children, as many authors believe, but are also relatively frequent in adults. The cases of pyocyaneus infection in human beings are in reality probably much more common than have been supposed, for so far the cases which have recovered have for the most part passed unrecognized.

The question of diagnosis during life was referred to. The general course of the disease, especially if associated with diarrhea and paralysis of the wall of the intestine, is important for diagnosis. The cutaneous blebs which sometimes occur are said to contain the bacillus pyocyaneus. It must be remembered, however, that the bacillus pyocyaneus is frequently present in the normal skin, especially in its folds. Bacteriologic cultures from the urine, in suspected cases, will be helpful, as this bacillus has been shown by Le Noir and the writer to be present in the urine in some cases of human infection, and by the latter it was almost constantly found in the urine of animals experimentally inoculated with the bacillus. One difficulty met with in the bacteriologic diagnosis is the fact that the bacillus often grows colorless and may pass unrecognized unless special media favorable

for color production be employed. The bacillus pyocyaneus is motile and serum diagnosis analogous to Widal's test for typhoid fever is applicable.

The cases, if recognized during life, are best treated by anti-pyocyaneus serum. The writer referred to the interesting fact that Bouchard had established the virtue of anti-toxic serum for infections with the bacillus pyocyaneus even before the serum treatment of diphtheria was inaugurated. On account of the rarity of the case and the difficulty of recognition there has been no demand for such a serum and, for the present, cases of pyocyaneus infection even if recognized must be treated simply on general principles. Should these infections, however, prove to be common, and to be easily recognizable during life, doubtless the serum will be provided.





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