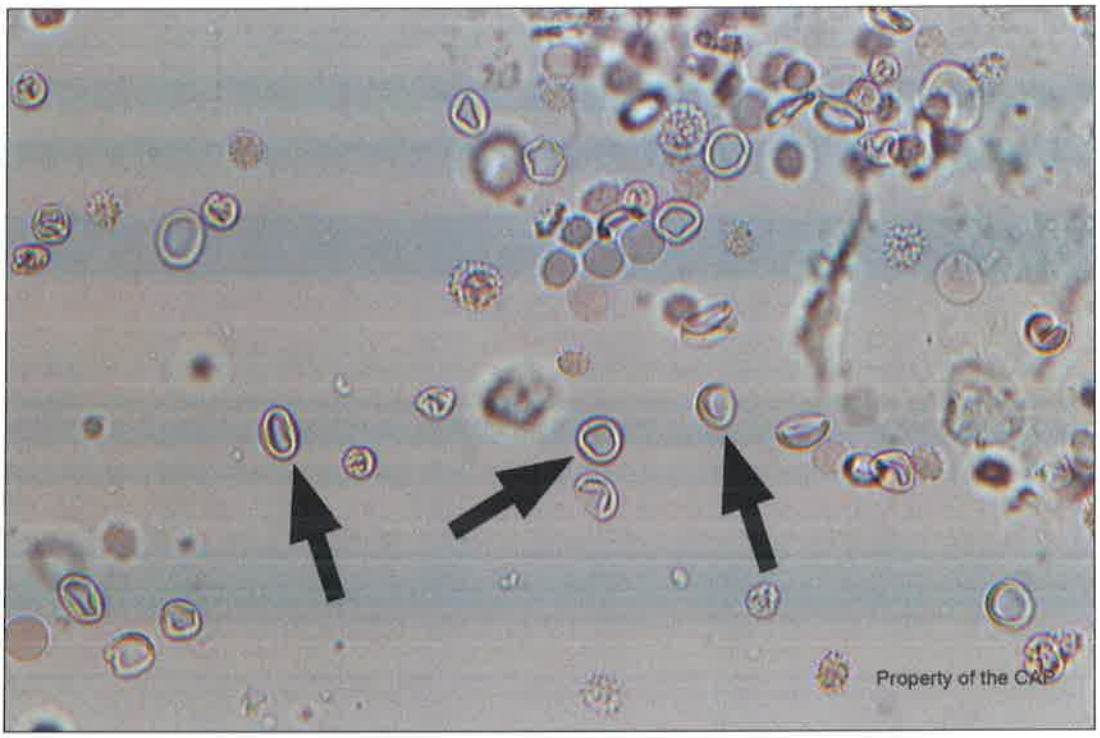
Urine Sediment Photographs

Case History CMP-04 through CMP-07

The patient is a 25-year-old man seen in the emergency room (ER) for acute tubular necrosis due to synthetic cannabinoid overdose. He presents with agitation, hallucinations, and hyperthermia. Supportive treatment was given. Four days later, urinalysis was obtained due to decreased urine output. Laboratory data include: Specific gravity = 1.022; pH = 6.5; blood, protein, and leukocyte esterase = positive; glucose, ketones, and nitrite = negative.

CMP-04



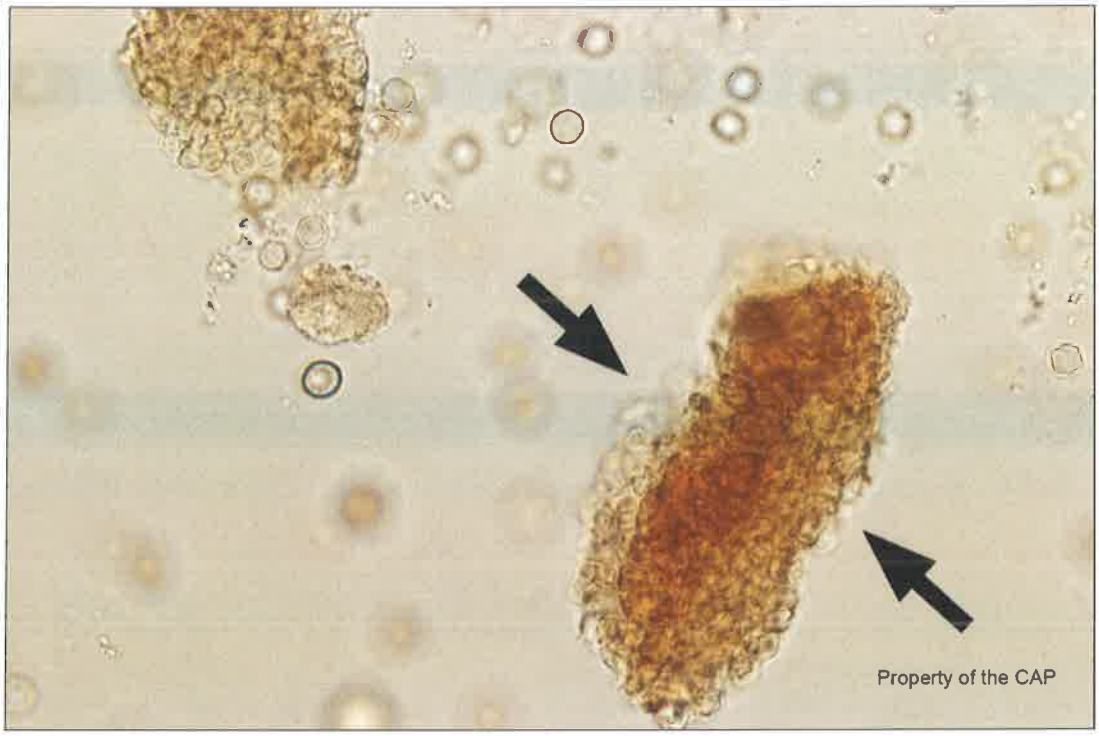
(URINE, UNSTAINED, HIGH POWER)

Identification	CMP Participants No.	%	Performance Evaluation
Erythrocyte	5741	94.5	Good

The arrowed objects are erythrocytes or red blood cells, as correctly identified by 94.5% of participants. They are recognized by their uniform size and biconcave disc shape. Hemoglobin contained within the erythrocytes may cause a yellow-orange color. Crenation may occur with old or hypertonic urine. If the urine is hypotonic, the erythrocytes may swell and become colorless. Occasional red blood cells in urine are normal. Increased numbers are associated with infection, trauma, glomerular diseases, anticoagulants, tumors and urinary tract stones. Erythrocytes may be confused with fat droplets or yeast. Fat droplets vary in size, are not pigmented, are not biconcave and have a refractive margin. Yeast forms are round and oval, are not biconcave, may show budding and lack hemoglobin pigmentation.

Urine Sediment Photographs

CMP-05



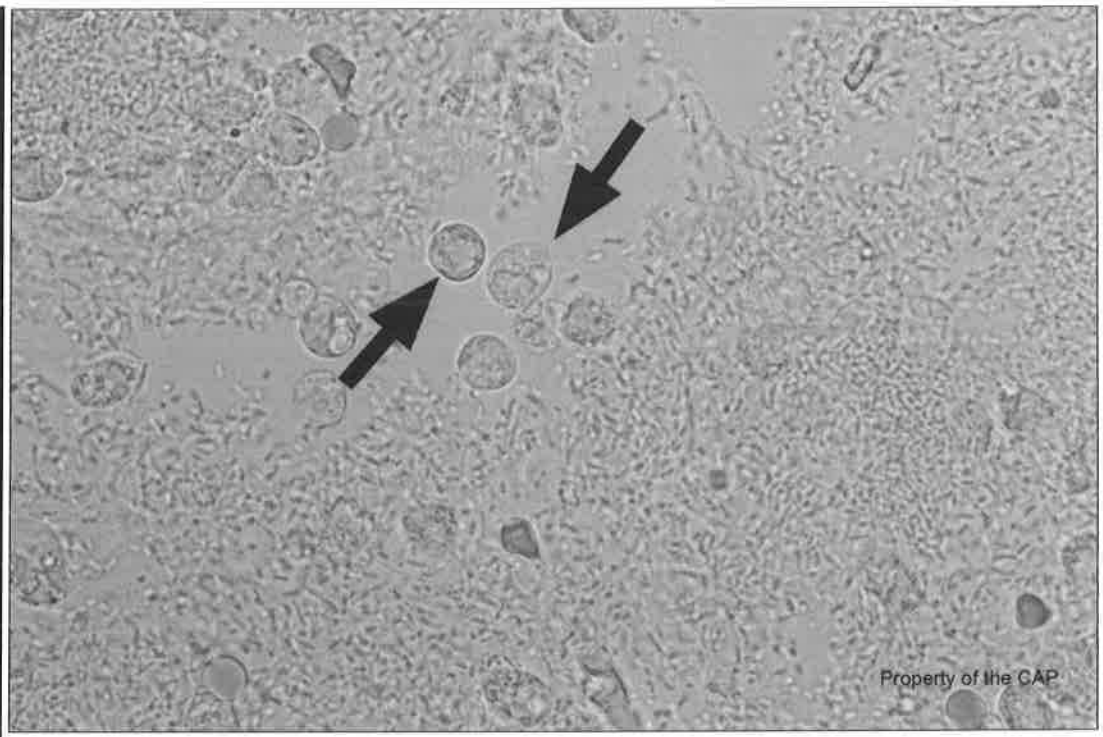
(URINE, UNSTAINED, HIGH POWER)

Identification	CMP Participants No.	%	Performance Evaluation
RBC/muddy brown cast	5841	96.0	Good

The arrowed object is a red blood cell/muddy brown cast, as correctly identified by 96.0% of participants. Red blood cell/muddy brown casts are uncommon and always indicate renal disease, most commonly glomerulonephritis. Red blood cell/muddy brown casts are fragile and easily fragment. Variable numbers of red blood cells adhere to the surface of a hyaline cast by thin strands of Tamm-Horsfall protein. Red blood cell/muddy brown casts vary in length and diameter and tend to have tapered ends. The entire red cell cast is reddish due to hemoglobin in both intact and disrupted red blood cells. The pigmentation and recognizable red blood cells differentiate red blood cell/muddy brown casts from fatty casts and other cellular casts.

Urine Sediment Photographs

CMP-06



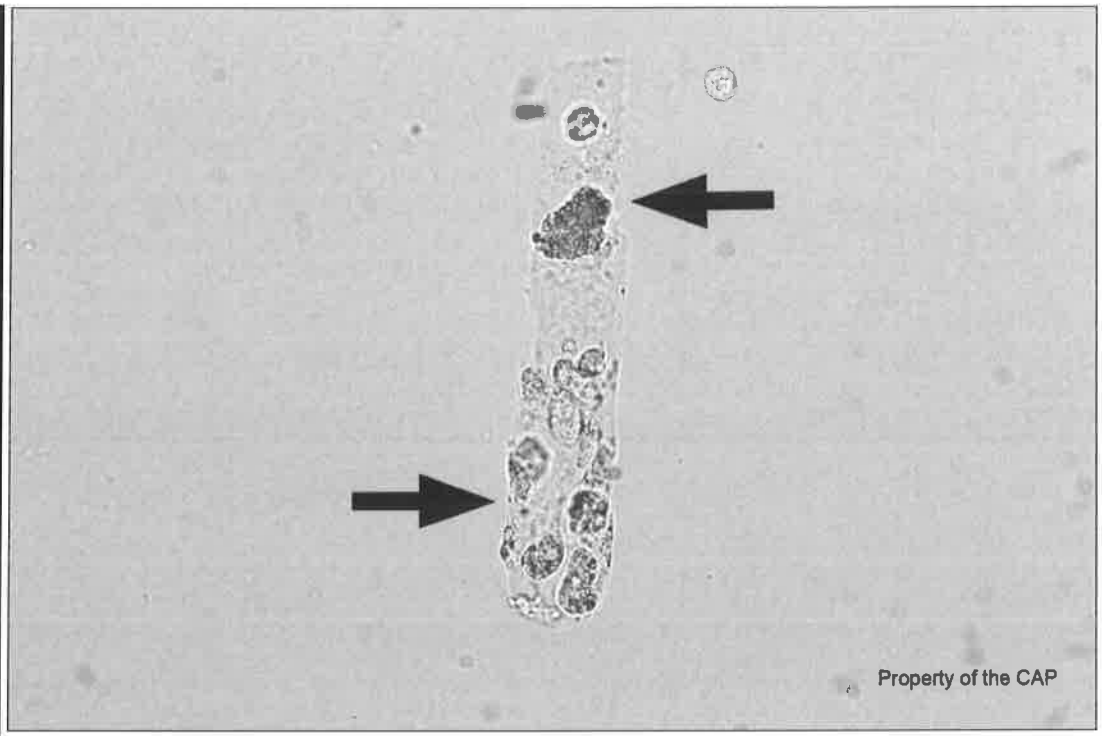
(URINE, UNSTAINED, HIGH POWER)

Identification	CMP Participants No.	%	Performance Evaluation
Leukocyte (neutrophil, eosinophil, lymphocyte)	5921	97.4	Good

The arrowed objects are leukocytes, as correctly identified by 97.4% of participants. Neutrophils are the most common leukocyte in urine. Leukocytes in urine are 10-12 microns in diameter, round, oval or amoeboid, with a segmented or lobulated nucleus. The cytoplasm is granular in fresh specimens. Normal urine may contain up to five leukocytes per high power field. Increased leukocytes indicate bacterial infection, nephritis, tumors or may be associated with kidney or bladder stones.

Urine Sediment Photographs

CMP-07



(URINE, UNSTAINED, HIGH POWER)

Identification	CMP Participants No.	%	Performance Evaluation
Cellular cast (neutrophil and/or RTE)	5801	95.4	Good

The arrowed object is a cellular cast, as correctly identified by 95.4% of participants. Cellular casts are always pathologic. Cellular casts composed of renal tubular epithelial cells indicate damage to the renal tubules. Cellular casts vary in length and width and tend to be short. Cellular casts are characterized by a matrix encrusted with intact or partially disrupted cells. A large central nucleus and cell membrane help identify renal tubular cells. Other cellular casts are composed of mixed cells or cells that cannot be identified with certainty, such as degenerating leukocytes. These mixed cellular casts are included in the category of cellular casts but the cell types should be identified as specifically as possible.

Roberta L. Zimmerman, MD, FCAP
Hematology and Clinical Microscopy Resource Committee

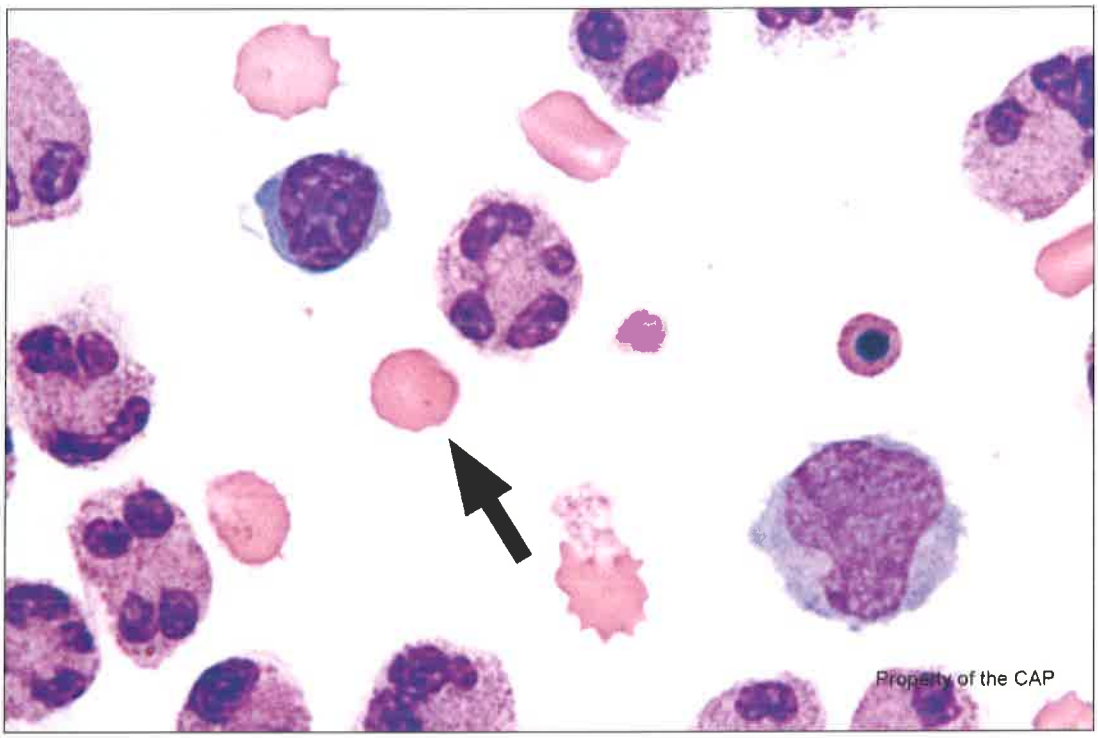
Body Fluid Photographs

Case History CMP-08 through CMP-13

This patient is an 8-month-old infant boy admitted to the hospital because of decreased appetite and vomiting. He was lethargic with a temperature of 101°F (38.3°C). Kernig's sign* was positive. Cerebrospinal fluid (CSF) sample laboratory findings include: WBC = 1131/µL (1.131 x 10E3/µL); RBC = 1/µL (0.001 x 10E3/µL). CSF protein was 291 mg/dL (reference range, 20-40 mg/dL) and CSF glucose of 6 mg/dL (reference range of 45-80 mg/dL). Blood cultures were positive for *Listeria monocytogenes (Listeria)*.

*Kernig's sign is a diagnostic sign for meningitis. Pain in the lower back and resistance to straightening the leg constitutes a positive Kernig's sign.

CMP-08



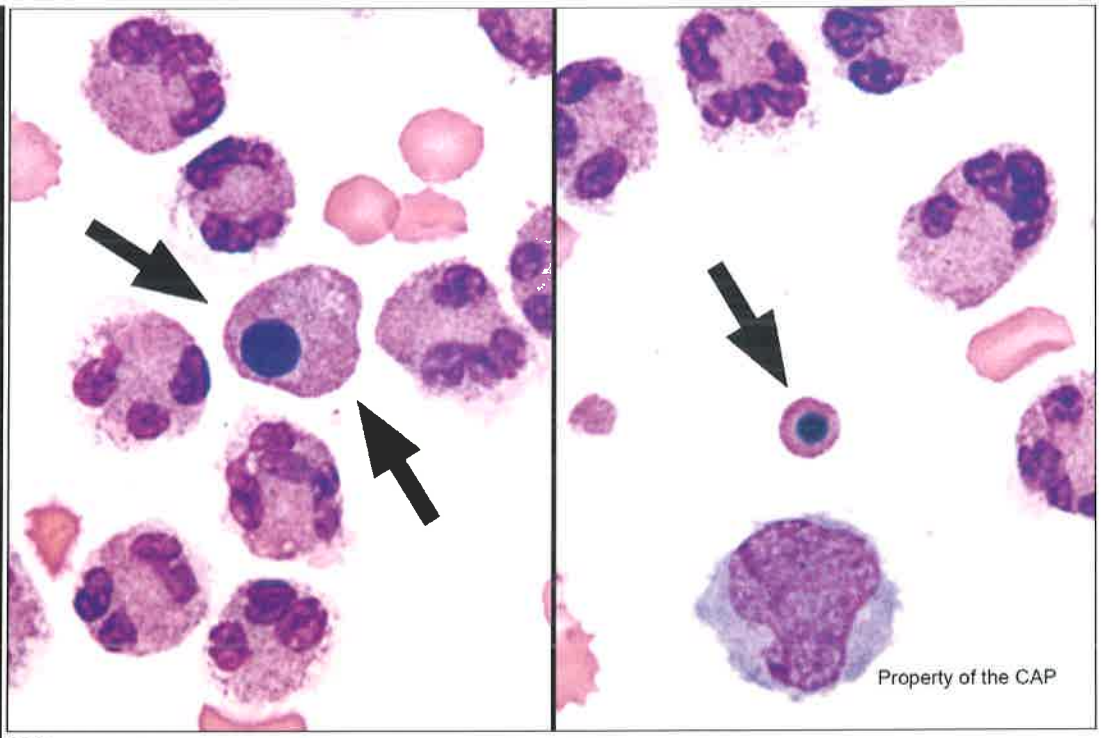
(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Identification	CMP Participants No.	%	Performance Evaluation
Erythrocyte	3537	99.9	Good

The arrowed object is an erythrocyte, as correctly identified by 99.9% of participants. Erythrocytes, or red blood cells, are round with no nucleus. Some erythrocytes may be crenated, but that is not clinically significant. Erythrocytes are not a normal finding in cerebrospinal fluid and indicate contamination due to a traumatic spinal tap or hemorrhage.

Body Fluid Photographs

CMP-09



(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

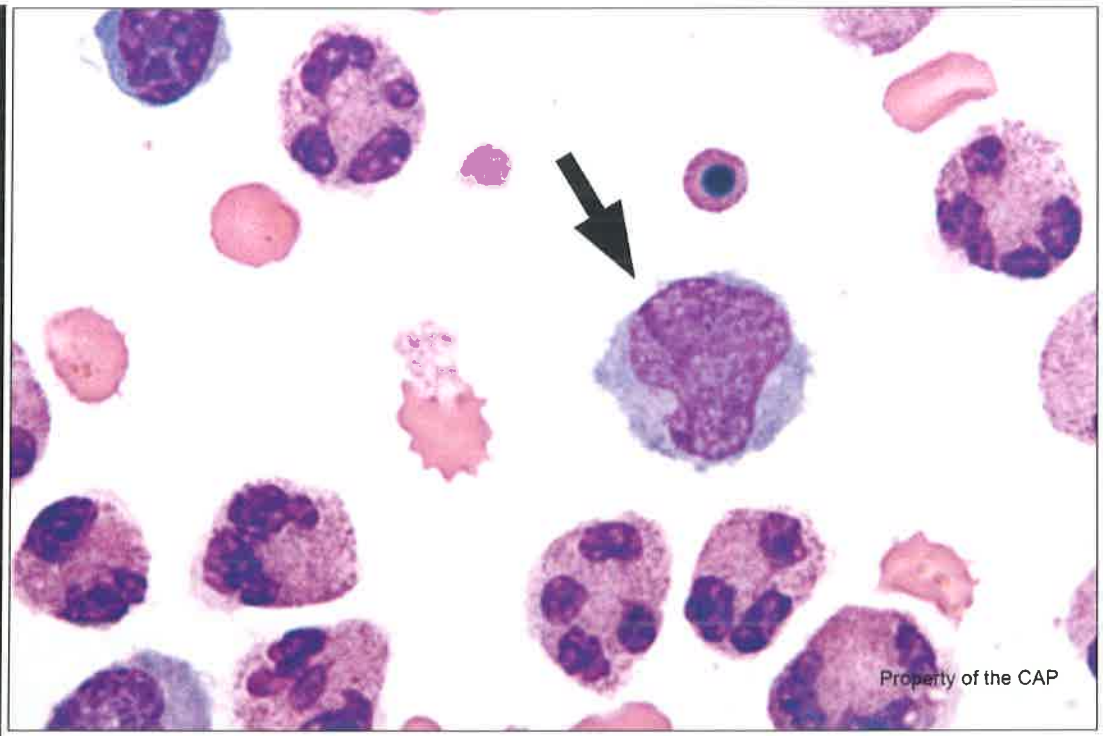
Identification	CMP Referees No.	CMP Referees %	CMP Participants No.	CMP Participants %	Performance Evaluation
Erythrocyte, nucleated	20	66.7	2125	60.1	Educational
Degenerating cell, NOS	9	30.0	1328	37.5	Educational
Plasma cell, normal/abnormal	1	3.3	17	0.5	Educational

The arrowed objects are degenerating cells, as correctly identified by 37.5% of participants. Degenerating cells are characterized by pyknotic condensed nuclei and frayed cytoplasmic borders. If the nucleus autolyzes completely, it may appear as a pale purple inclusion. Cytoplasmic granules in degenerating neutrophils are retained. Actively dividing cells such as malignant cells or reactive lymphocytes are more prone to degeneration. Prolonged storage will increase the number of degenerating cells in a fluid.

There are several characteristics that help differentiate the arrowed cells from nucleated red blood cells. The arrowed cells vary widely in size, whereas nucleated red blood cells tend to be much more uniform in size. The larger arrowed cell is larger than a nucleated red blood cell and has frayed cytoplasmic margins. Nucleated red blood cells will have smooth cytoplasmic margins. Additionally, nucleated red blood cells are only rarely found in body fluids. When present, they are derived from either peripheral blood contamination or accidental aspiration of bone marrow, particularly in infants or adults with osteoporosis and would be associated with the presence of other immature bone marrow cells, including immature myeloid cells. Nucleated red blood cells originating in peripheral blood are usually orthochromatophilic normoblasts and show evidence of hemoglobin formation in their cytoplasm although nucleated red blood cells originating in bone marrow may be an earlier stage such as a polychromatophilic or basophilic normoblast. Careful examination of the arrowed cell's cytoplasm fails to show evidence of hemoglobin, which should be prominent in a nucleated red cell with this degree of nuclear condensation.

Body Fluid Photographs

CMP-10



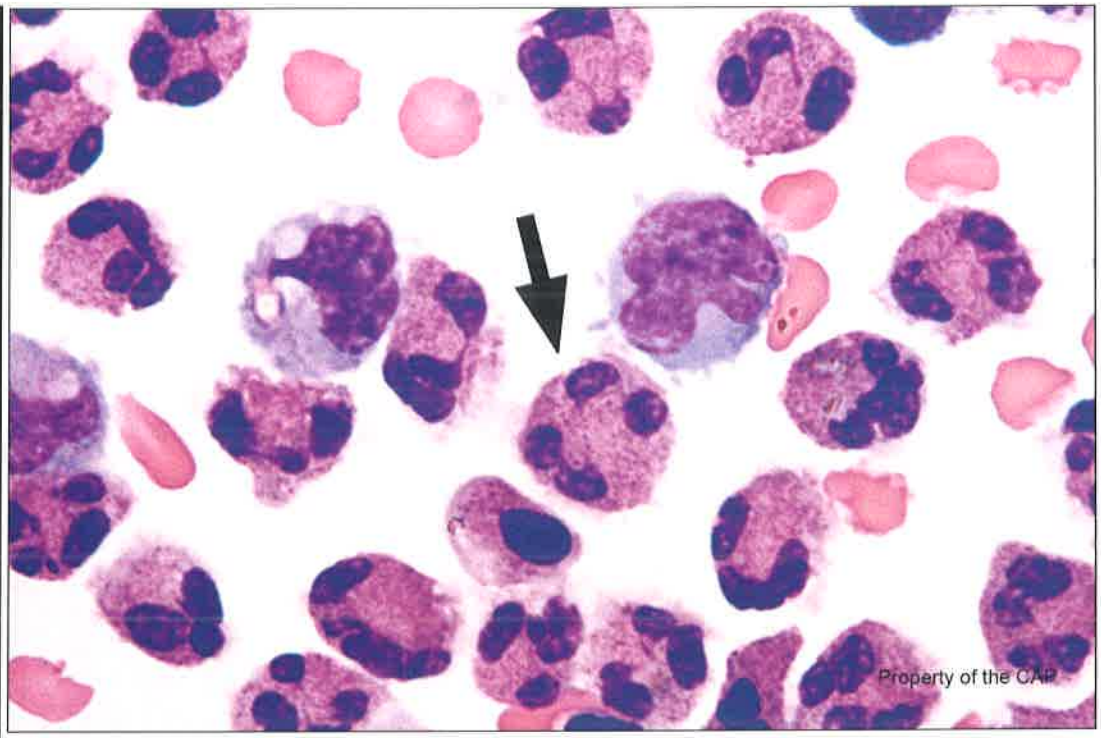
(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Identification	CMP Participants No.	%	Performance Evaluation
Monocyte/macrophage	3479	98.3	Good

The arrowed object is monocyte/macrophage, as correctly identified by 98.3% of participants. Marrow-derived monocytes circulate in the blood. Macrophages are the tissue phase of monocytes. Macrophage morphology in fluids varies widely. The macrophages tend to be large with abundant cytoplasm and one or two rounded or lobulated nuclei and occasionally prominent nucleoli. Macrophages are actively phagocytic and may contain debris and vacuoles in the cytoplasm.

Body Fluid Photographs

CMP-11



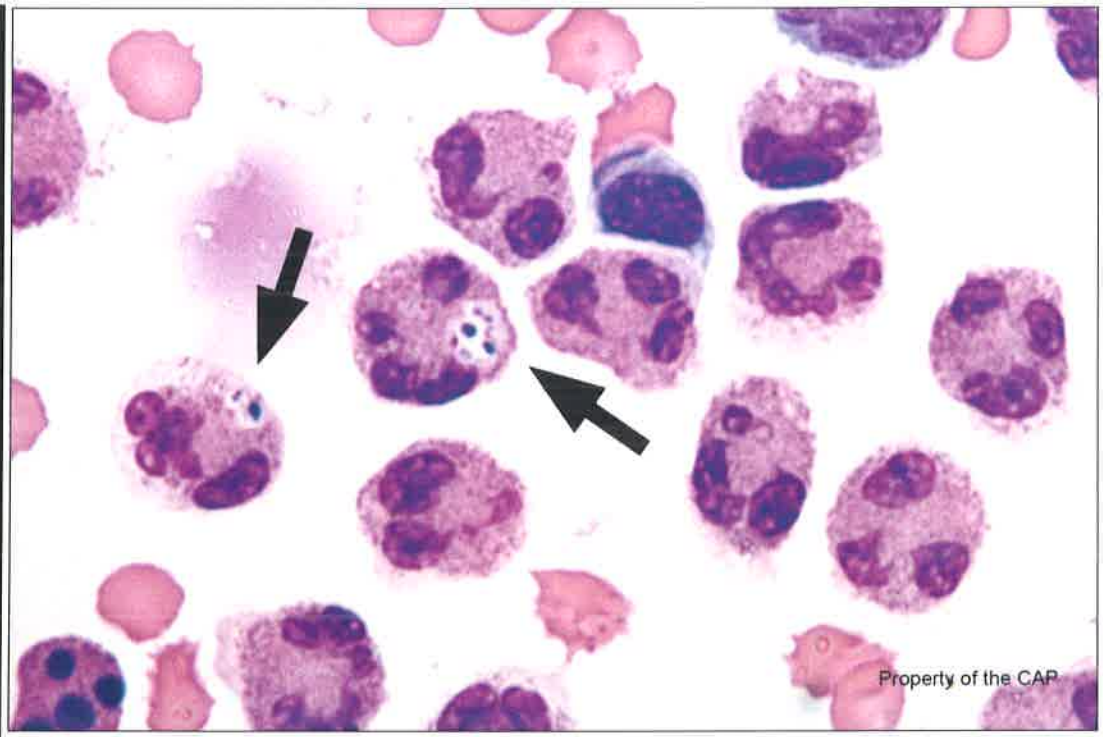
(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Identification	CMP Participants No.	%	Performance Evaluation
Neutrophil, segmented or band	3512	99.2	Good

The arrowed object is a neutrophil, segmented or band, as correctly identified by 99.2% of participants. Neutrophils have fairly condensed chromatin and segmented or band-like nuclei. Small numbers of azurophilic granules are present in the cytoplasm. If the fluid has been centrifuged, the nucleus may be eccentric.

Body Fluid Photographs

CMP-12



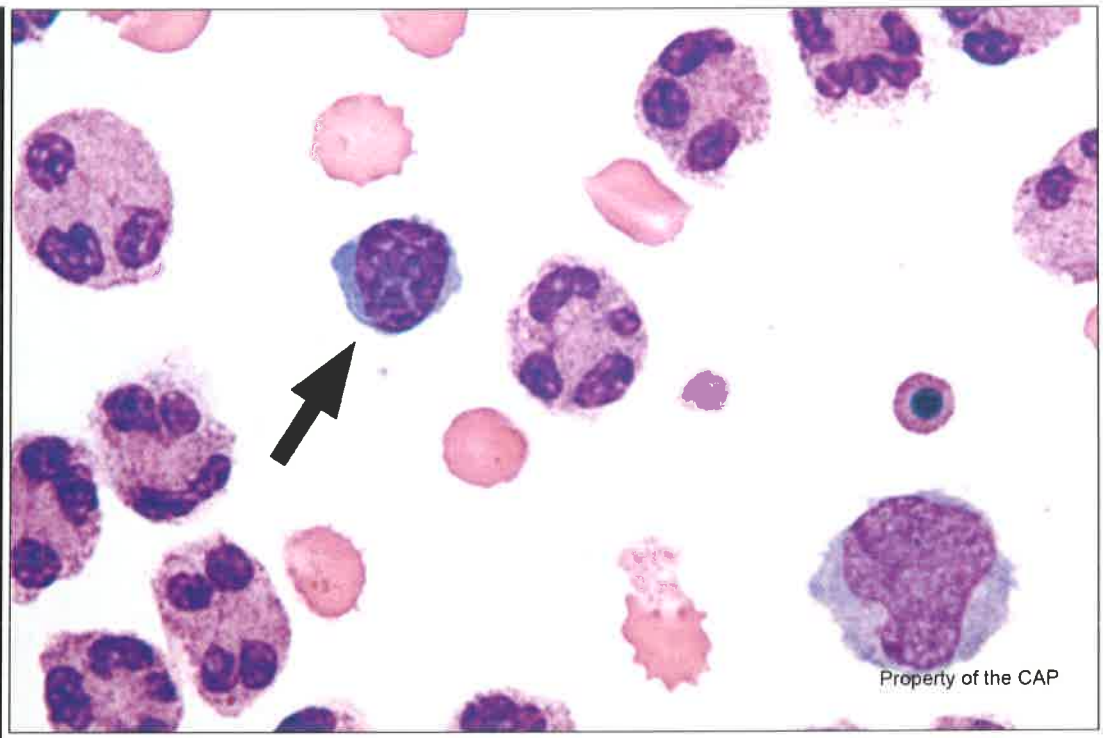
(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Identification	CMP Participants No.	%	Performance Evaluation
Neutrophil/macrophage containing bacteria	3389	95.8	Educational

The arrowed objects are neutrophils with phagocytosed bacteria, as correctly identified by 95.8% of participants. Bacteria within a neutrophil appear as dark-staining, small uniform structures. The bacteria may be recognizable as rods, cocci, diplococci or cocci in chains. There may be additional bacteria present outside the neutrophils.

Body Fluid Photographs

CMP-13



(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Identification	CMP Participants No.	%	Performance Evaluation
Lymphocyte	3389	95.8	Good

The arrowed object is a lymphocyte, as correctly identified by 95.8% of participants. Lymphocytes that have been centrifuged may have small nucleoli, cytoplasmic spreading, nuclear convolutions and a few azurophilic granules. Normal lymphocytes can be differentiated from lymphoma cells by a normal chromatin pattern, a smooth nuclear membrane and lack of large nucleoli.

Roberta L. Zimmerman, MD, FCAP
Hematology and Clinical Microscopy Resource Committee

Case Presentation:
This patient is an 8-month-old infant boy admitted to the hospital because of decreased appetite and vomiting. He was lethargic with a temperature of 101° F (38.3° C). Kernig's sign was positive. Cerebrospinal fluid (CSF) sample laboratory findings include: WBC = 1131/µL (1.131 × 10E3/µL); RBC = 1/µL (0.001 × 10E3/µL). CSF protein was 291 mg/dL (reference range, 20-40 mg/dL) and CSF glucose of 6 mg/dL (reference range of 45-80 mg/dL). Blood cultures were positive for Listeria monocytogenes (listeria).

(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

Case Discussion: Bacterial Meningitis

Meningitis is an inflammation of the thin protective membranes covering the brain and spinal cord. According to the Centers for Disease Control there were 4100 cases per year of meningitis in the United States between the years 2000-2007 with 500 deaths occurring each year. The possible causes include infections with viruses, bacteria, amoeba or parasites, or noninfectious causes such as injury, cancer, drugs, lupus or surgery.

Viruses that may cause meningitis include enteroviruses, arboviruses and herpes simplex. The amoeba *Naegleria fowleri* causes a rare and devastating meningitis acquired from swimming in stagnant water. Parasites implicated in cases of meningitis include *Aniostrongylus cantonensis* from snails, *Baylisasearis procyonis* from raccoon feces and *Gnathostoma spinigerum* from fish or eels. *Cryptococcus* and *Histoplasma* cause fungal meningitis.

Bacterial meningitis is the most common type of meningitis. The most common type of bacteria causing bacterial meningitis varies by age group. Newborns with meningitis most commonly have Group B *Streptococcus*, *Streptococcus pneumoniae, Escherichia coli* and *Listeria monocytogenes* as causative organisms. Bacterial meningitis in infants and children is most commonly caused by *S. pneumoniae, Neisseria meningitides*, *Haemophilus influenza* and Group B *Streptococcus.* Cultures from adolescents and young adults with meningitis most often yield *Neisseria meningitides*, or *S. pneumoniae.* Older adults with meningitis are most often infected with *S. pneumoniae, N. meningitides, H. influenza,* Group B *Streptococcus,* or *L. monocytogenes.*

Bacterial meningitis is spread by person-to-person contact, generally via the respiratory route. The exception is *L. monocytogenes* that is passed through contaminated food. Risk factors for bacterial meningitis include the newborn period, living in close quarters with large groups of people (eg, college dorms, army barracks), recent brain or spine surgery, immunosuppression, alcohol abuse, the post-splenectomy state, working with pathogens as a microbiologist and travel to sub-Saharan Africa, the so-called "meningitis belt," during the dry season.

The three classic signs and symptoms of meningitis are fever, headache and a stiff neck. Patients may also suffer from nausea, vomiting, diarrhea, sensitivity to light or confusion. Late signs include seizures and coma. Infants with meningitis are slow and irritable with poor feeding, abnormal reflexes and a bulging fontanelle, or "soft spot," on the top of the head in infants and young children.

Diagnosis involves sampling and culturing of cerebrospinal fluid (CSF) obtained by lumbar puncture and blood. Antibiotic sensitivity studies should always be performed on the bacteria grown in culture. Protein levels, glucose levels, gram stains and cell counts should also be obtained on CSF. CSF studies in bacterial meningitis generally show a glucose <40 mg/dL, CSF to serum glucose ratio of < or = to 0.4, protein >200 mg/dL and a white blood count >1000 per microliter. Neutrophils are the main cell type. However, there is a wide spectrum of values and a significant overlap with CSF findings in bacterial meningitis with the other types of infectious meningitis.

Treatment of bacterial meningitis requires intravenous antibiotics administered as quickly as possible. The disease is a medical emergency and can be rapidly fatal if not treated quickly. The overall death rate is 10%. Mortality increases over age 65. *S. pneumoniae* is associated with the highest numbers of complications and highest mortality. In some cases, death occurred within 2-3 hours of the onset of symptoms. Anyone showing

signs and symptoms of bacterial meningitis should be evaluated as soon as possible. Empiric antibiotic treatment should be initiated immediately after the lumbar puncture, ideally within 2 hours of admission. A common empiric intravenous antibiotic regimen for an adult over age 50 with no additional risk factors includes a third generation cephalosporin (eg. cefotaxime or ceftriaxone), vancomycin and ampicillin. Complications of bacterial meningitis include seizures, hearing loss, stroke, paralysis and brain damage.

The best method of prevention of bacterial meningitis is vaccination. Vaccines are available for *N. meningitides, S. pneumoniae* and *H. influenza.*

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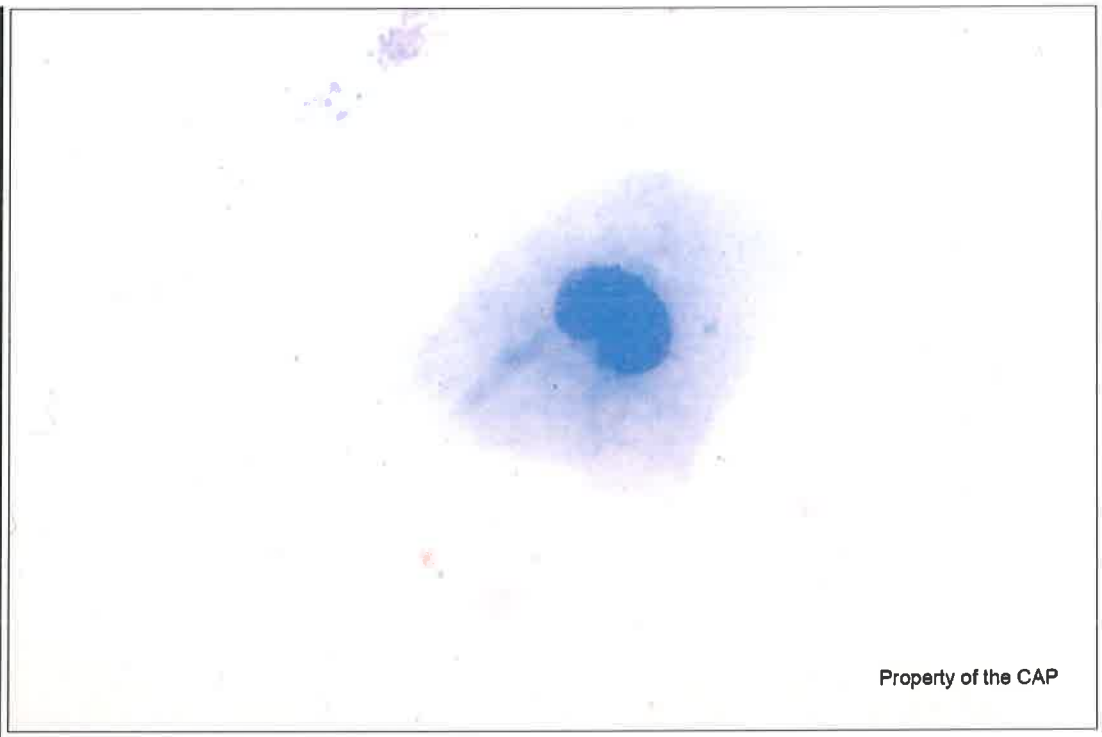
Hematology and Clinical Microscopy Resource Committee

References:

1. Thigpen MC, et al. Bacterial meningitis in the United States 1998-2007. *N Engl J Med.* 2011;364:2016-25.
2. Tunkel, A. Bacterial Meningitis. In: UpToDate, Calderwood, S (Ed), UpToDate, Waltham, MA. (Accessed 1-1-2016.)

CMMP – Clinical Microscopy Miscellaneous Photographs

CMMP-32



(NASAL, WRIGHT-GIEMSA) High power magnification

Identification	CMMP Participants No.	%	Performance Evaluation
Eosinophils are absent	2184	98.3	Good

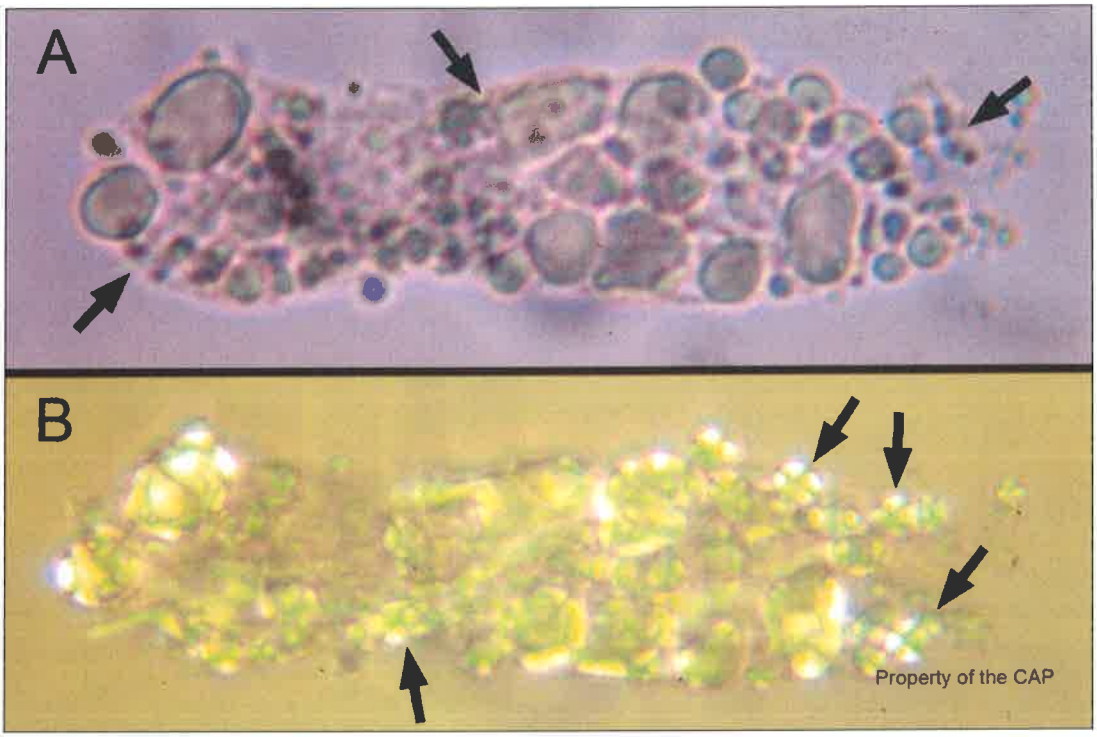
This nasal smear is negative for eosinophils. Nasal eosinophils are seen in patients with clinical allergic rhinitis. In nonallergic causes of nasal discharge, either acellular mucus or neutrophils will be present on the nasal smear. Nasal smears for eosinophils are prepared by having the patient blow his/her nose in a nonabsorbent material (wax paper, plastic wrap). A swab is then used to transfer the mucus to a glass slide. A thin smear is prepared and allowed to air dry. Staining may be performed usually using a Wright-Giemsa stain. The Hansel stain is less widely available. Eosinophils are recognized microscopically by their typically bilobed nuclei and characteristic eosinophilic granules.

CMMP – Urine Sediment Color Photographs

Case History USP-01 and USP-02

This patient is a 20-year-old man with minimal change disease. Laboratory data include: Specific gravity 1.025; pH 7.0; protein = positive (large); blood, ketone, leukocyte esterase, and nitrite = negative. Crystals show Maltese cross pattern under polarized light.

USP-01



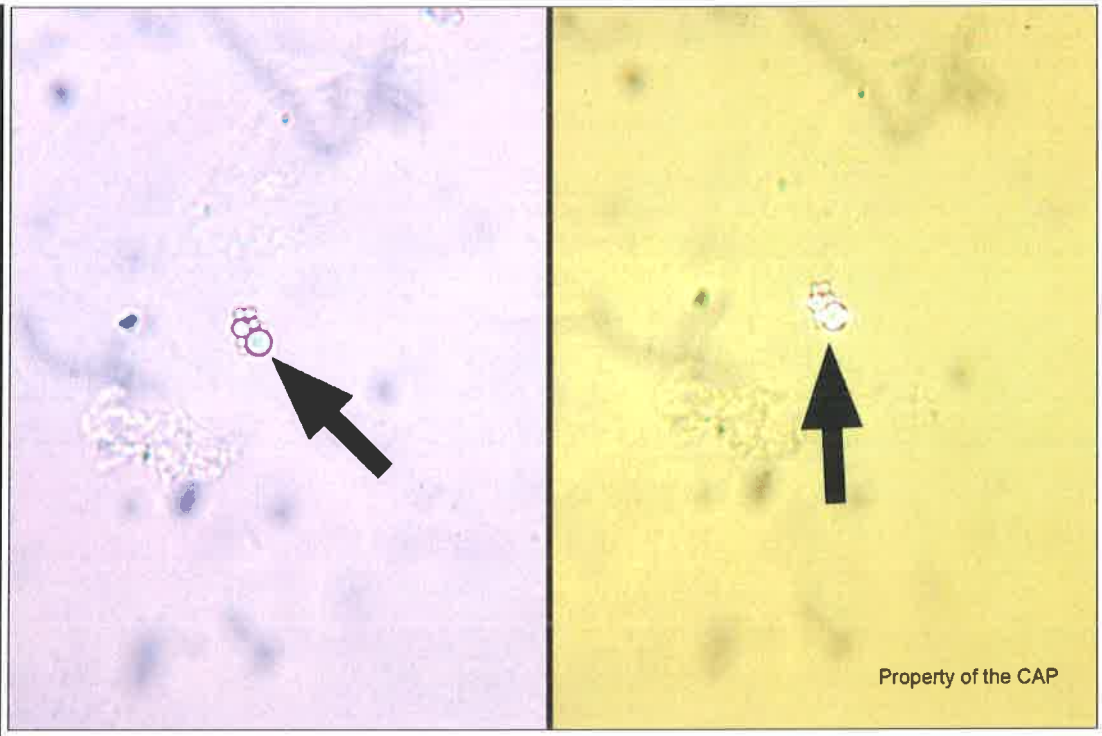
(URINE, UNSTAINED, HIGH POWER)

Identification	CMMP Participants No.	%	Performance Evaluation
Fatty cast	3418	94.9	Good

The arrowed objects are fatty casts, as correctly identified by 94.9% of participants. These casts are composed of multiple spherical lipid droplets of variable size. The droplets are highly refractile and demonstrate a Maltese-cross pattern under polarized light. A Sudan black stain can also be used to confirm the presence of lipid. These casts are associated with significant proteinuria and the nephrotic syndrome.

CMMP – Urine Sediment Color Photographs

USP-02



(URINE, UNSTAINED, HIGH POWER)

Identification	CMMP Participants No.	%	Performance Evaluation
Fat droplet	3422	95.0	Good

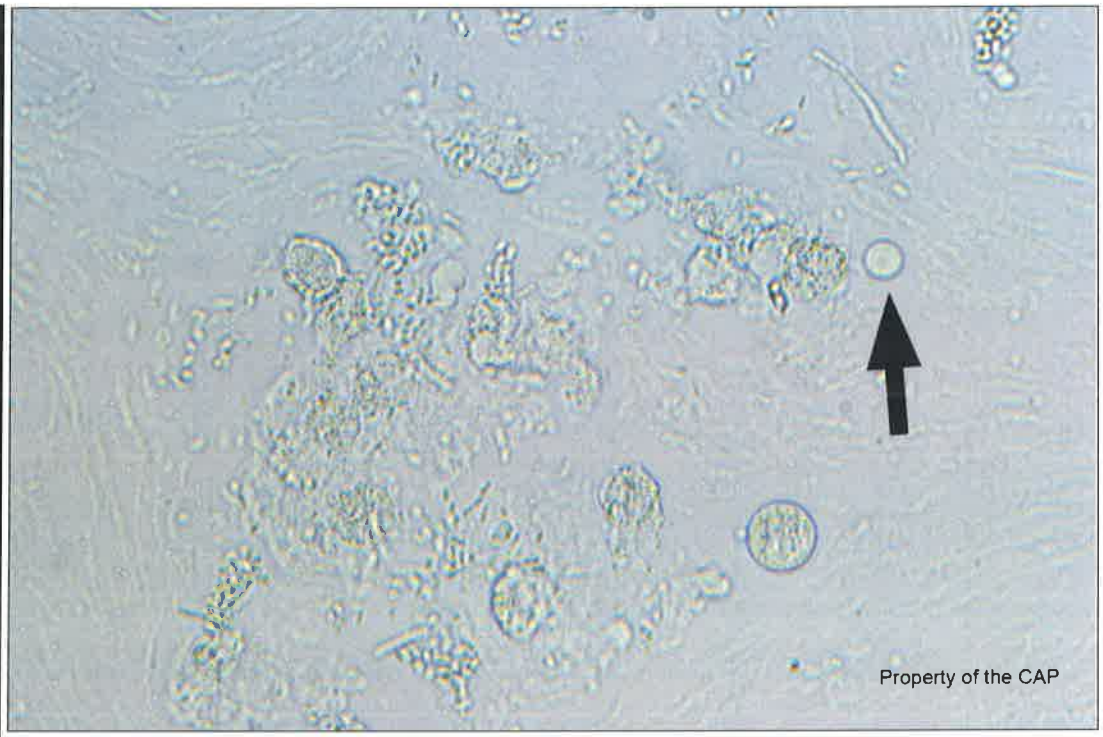
The arrowed objects are fat droplets, as correctly identified by 95.0% of participants. They can be identified by their round shape and variable size. The droplets may be dark under low power, but usually are clear at high power. The droplets are refractile, show a Maltese-cross pattern under polarized light, and will stain positively with fat stains such as Sudan black. Fat droplets are often seen with fatty casts, and like the casts are associated with the nephrotic syndrome. Fat droplets can also be seen with contamination from oils or topical creams.

CMMP – Urine Sediment Color Photographs

Case History USP-03

This patient is a 13-year-old girl with recent history of strep throat now presenting with bloody urine, malaise, and decreased urine output. Laboratory data include: Specific gravity = 1.020; pH = 7.2; protein, ketones, leukocyte esterase, and nitrite = negative; blood = positive (large).

USP-03



(URINE, UNSTAINED, HIGH POWER)

Identification	CMMP Participants No.	%	Performance Evaluation
Erythrocyte	3509	97.5	Good

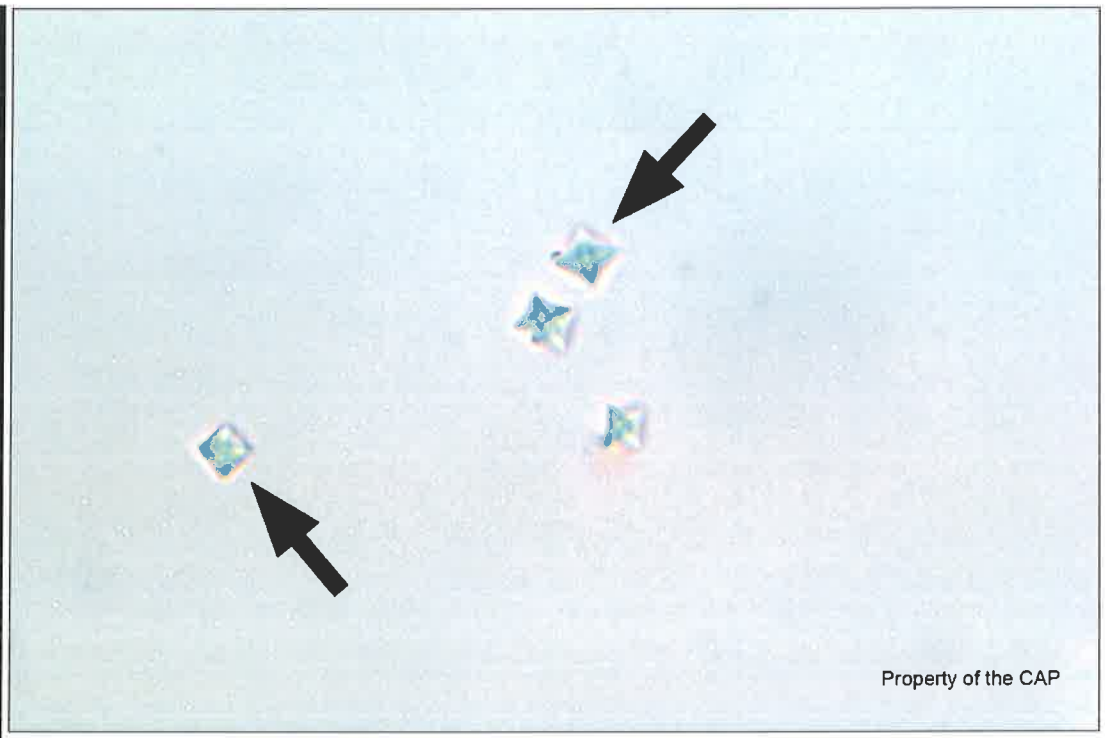
The arrowed object is an erythrocyte, as correctly identified by 97.5% of participants. Unstained erythrocytes are discs approximately 7 to 8 mm in diameter, which may have a pale yellow-orange coloring. They can also appear as faint, colorless "ghosts" in hypotonic urine, or have crenated edges in hypertonic urine. Erythrocytes can usually be distinguished from leukocytes by their size and lack of granularity. Potential mimics include oil/lipid droplets or yeasts. The former would show multiple droplets of various sizes and would be refractile. Yeast forms would occasionally be oval, are smaller than erythrocytes, and often show budding. Small numbers of erythrocytes can be observed in urine sediment of healthy patients. Larger numbers are indicative of injury anywhere along the upper or lower urinary tract, or can be seen in states of increased bleeding such as anticoagulant therapy or bleeding disorders. False positives for erythrocytes or blood are often seen due to contamination by menstrual blood.

CMMP – Urine Sediment Color Photographs

Case History USP-04

This patient is a 54-year-old woman who had a routine urinalysis with microscopic examination as part of an annual physical exam. Laboratory data include: Specific gravity = 1.015; pH = 5.3; blood, ketones, leukocyte esterase, protein, and nitrite = negative.

USP-04



(URINE, UNSTAINED, HIGH POWER)

Identification	CMMP Participants No.	%	Performance Evaluation
Calcium oxalate crystals	3586	99.6	Good

The arrowed objects are calcium oxalate crystals, as correctly identified by 99.6% of participants. Calcium oxalate crystals are seen in neutral or acid urine and are variably sized, sometimes much smaller than erythrocytes, and birefringent. Dihydrate forms (as seen here) are small clear octahedrons, bipyramidal in shape, which are also said to resemble envelopes or stars. Monohydrate forms are less common but can take on a variety of morphologies including oval, elliptical, or dumbbell shapes. Calcium oxalate crystals can be seen in healthy individuals, especially with consumption of oxalate-rich foods, but an also be seen in the presence of oxalate stones.

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