1939

The Differential diagnosis of coma

Neil M. Burr
University of Nebraska Medical Center

THE DIFFERENTIAL DIAGNOSIS OF COMA

Neil M. Burr

Senior Thesis Presented

to the

University of Nebraska College of Medicine

Omaha, Nebraska

April, 1939

CONTENTS

INTRODUCTION

The subject of this paper as a senior thesis was inspired by a situation in which a fellow student found himself while taking a practical examination for an internship. The patient that he was supposed to examine had been admitted to the hospital with very little history and had not been diagnosed at the time he saw him in a comatose condition.

The above situation brought to my mind that in less than a year as an intern, I might be confronted with many such problems, and that although during the four years spent in medical school, one learns several facts concerning the subject, there has never been a complete correlation of these facts in my own mind, and I believe this situation is similar to that of fellow students. Text book articles have a tendency to discuss the subject in a very general and abstract way, without special regard to the practical clinical aspects of the problem at hand.

An effort will be made to deal with the subject as a condition that presents itself as a presenting sign, rather than to consider in detail every possible cause of comatose conditions, insomuch as it

impossible to think of any disease entity that might end fatally, where coma would not preceed death.

Treatment will not be dealt with except in those cases where diagnostic proceedures tend to be likewise therapeutic.

The aim of the paper in general is to define and classify the condition, to present the approximate incidence of the various types, to discuss in a general the diagnostic approach to such conditions, and to briefly discuss the differentiating features of the more common types of comatose conditions. Finally, the summaries of three articles will be combined to suggest a diagnostic routine for Coma, as a presenting sign.

After reviewing the literature on the subject, it was found that most of the work in this country has been done by Philip Solomon, M.D., C.D. Aring, M.D., H. H. Merritt, M.D., W. W. Bissell, M.D., E. R. LeCount, M.D., F. Fremonst Smith, M.D., who with other authors the writer of this paper is greatly indebted for material used.

DEFINITION, SCOPE AND IMPORTANCE OF SUBJECT

If we consult one of the more commonly used medical dictionaries in search of a definition of the term, "Coma", we will find the following, " Coma -- A state of complete loss of consciousness from which the patient cannot be aroused even by the most powerful stimulation". Dorland (1936)

As was stated in the introduction an attempt will be made to discuss coma as a condition which presents itself for diagnosis and treatment by the interne or the physician. It should be said that a very small percentage of deaths will occur without the patient going through a period of coma before death. However it was found upon surveying the literature that a surprising number of hospital admissions during a year were patients in comatose states, the origin of which was not definitely known at the time of entrance to the hospital. In the year 1933, 1,167 such patients or 3% of the total admissions in the Boston City Hospital,were in such a condition. Of these patients 68% entered the hospital without an immediately available history.
Solomon & Aring, (Boston, 1934)

The importance of immediate diagnosis is of course evident since the condition without treatment

will always offer a grave prognosis for life. Naturally, proper treatment cannot be administered until the proper diagnosis has been made. One can easily see where the incorrect treatment because of a mistaken or careless diagnosis of the condition might give fatal results. An example of such an error would be administering insulin to a known diabetic, who rather than suffering from diabetic coma was in a state of hypoglycemia due to an overdose of insulin.

The importance of immediate and correct diagnosis will be further emphasized in the the portion of this paper dealing with the incidence of coma. Various authors have tabulated the number of comatose patients entering hospitals, the number of cases ending fatally, and the number of deaths that could have been prevented by a correct diagnosis. The figures are self explanatory in that chapter and will not be further discussed here.

One might further state that it is the responsibility of the medical profession of the present day more so than in former years, to properly diagnose such conditions since there is so much more to be done for the patient than a few

decades ago. According to George S. Young, (1934) the discovery of insulin and other endocrine products, which may be used to relieve comatose states, as well as rapid strides in the development of brain surgery have introduced new hope in caring for all such cases.

From a historical point of view it is interesting to note the following quotations from The Lumleian Lectures (1850). "Among the most formidable indications of disturbance of the great central organ of the nervous system, the brain, are those states which are known as coma or delerium. It is during these times that the physician is forced to appeal to all of his former experience to guide him in his prognosis and to direct his practice, then too he is compelled to examine the grounds of his principles to assure himself as to their soundness and as to the safety of following the cause which they indicate". Certainly, after nearly one hundred years this is still very true.

In order to make a logical diagnostic approach to the various comatose conditions it will first be well to arrive at a systematic classification of the causes of coma. Various authors have made different classifications, which have as their basis for the most part, the etiology.

The first attempt at classification in the series of articles reviewed is that of J. T. Eskeridge, (1898) who offers the following classification.

I Transient (Syncope or fainting)

II Coma from lethal doses of medicine.

Chloral	Lead
Alcohol	Belladona
Opium	Hyoscyamus

III Coma from other poisons

Asphyxia	Uremia
Ptomaines	Diabetes

IV Convulsive States
- Preemptive stage of Exanthemata
- Reflex convulsions
- Epilepsy
- Hysteria
- Epileptoid and appoplectoid attacks due to paralytic dementia.

V Voluntary Coma or malingering

VI Coma from profound disturbances of cerebral circulation but without organic lesions.

Shock	Congestion
Concussion	Anemia

VII Coma from organic disease.

Coma from organic disease cont'd

Simple apoplexy	Brain abscess
Traumatic apoplexy	Brain tumor
Syphilis	Cerebral hemorrhage
Cerebral meningitis	Cerebral embolism
Cerebral thrombosis	

A later classification is that of Forsyth, (1912) a summary of which follows.

He says that in the foreground of our minds would should always keep;

1. Vascular derangements of the brain.
2. Injuries to the head.
3. Epilepsy.
4. Diabetes
5. Poisons
6. Stokes Adams disease

He further classifies them into three large groups as follows.

I Derangements of Cerebral circulation
- Hemorrhage
- Thrombosis
- Embolism

Mechanical injury
- Fractures
- Compression
- Epilepsy
- Uremia
- Diabetes
- Poisons
- Stokes Adams Disease

II
- Meningitis
- Encephalitis
- Cerebral abscess
- Cerebral tumor
- Fevers
- Eclampsia
- Cholaemia
- Epidemic Enteritis
- General Paralysis
- Disseminated sclerosis

III Pernicious malaria
Muscular exhaustion
Heat stroke

Friedman, (1933) offers the following classification.

I General Causes

Alcoholism	Opium
Uremia	Gas
Diabetes	Hypoglycemia

II Epilepsy

III Intracranial lesions with or without focal signs

Apoplexy	Tumor of brain
Meningitis	Encephalitis
Brain abscess	Spontaneous sub-arachnoid hemorrhage.

IV Trauma

Concussion of the brain
Gross hemorrhage with or without fracture.

Probably the most complete classification of coma that has been offered up to the present time is that in French, (1936).

Group A includes:

1. Certain severe fevers in which coma may occur as a terminal phenomenon.

Typhus fever	Rheumatic fever	Influenza
Typhoid fever	Yellow fever	Spirochaetosis
Cholera	Blackwater fever	Lobar Pneumonia
Dysentery	Malignant malaria	Small pox
Measles	Infective Endocarditis	
Scarlet fever	Diptheria	

2. Acute inflammatory lesions of the brain or the Cerebral meninges:

Acute encephalitis	Epidemic meningitis
Suppurative meningitis	Encephalitis Lethargica
Tuberculous meningitis	Sleeping sickness
Basal meningitis	

3. Certain less acute lesions of the central nervous system:

Cerebral tumor	Post epileptic state
Cerebral abscess	Paresis
Disseminated sclerosis	Syphilis of the brain

4. Diseases in which the general metabolism is at fault:

Uremia	Addison's disease
Diabetes mellitus	Raynaud's disease
Cholaemia	Myxoedema

5. Late stages of certain other maladies that exhibit prominent symptoms other than coma before coma supervenes:

Acute yellow atrophy of the liver
T.N.T. poisoning
Phosphorous poisoning
Pernicious anemia
Leukemia
Cirrhosis of the liver
Kala-azar
Aeroplane-dope poisoning
Botulism

Group B includes: Cases in which coma comes on early and may be the most prominent feature of the case

1. The results of head injury:

Compression by meningeal hemorrhage
Concussion
Fracture of the base of the skull

2. Vascular lesions of the brain:

Embolism	Subarachnoid hemorrhage
Intracerebral hemorrhage	Traumatic hemorrhage
Thrombotic occlusion of venous sinus of the head.	

3. The acute effect of drugs, particularly:

Alcohol	Bromides
Opium	Chloroform
Morphine	Myrtol
Omnopon	Eucalyptus oil
Heroin	Camphor
Carbolic Acid	Luminal
Oxalic acid	Barbitone
Carbon monoxide	Medinal
Coal gas	Dial
Absinthe	Quadronox
Chloral Hydrate	Hyperinsulinism
Veronal	
Sulphonal	
Chlorodyne	
Chloralamide	
Phenazone	
Phenacetin	
Pyramidon	
Petrol fumes	
Fire damps	
Sewer gas	
Carbon dioxide	
Trianol	
Tetranol	

4. The chronic effects of chemical, especially plumbism, (saturnine encephalopathy).

5. The effects of extremes of temperature: Heat stroke and excessive cold.

6. The effects of rapid and great alteration in the surrounding atmospheric pressure:

Divers brought too rapidly to the surface
Caisson workers decompressed too fast
Balloonists and aviators rising rapidly to great hights.

7. Excessive loss of blood from:

Ruptured tubal gestation	Duodenal bleeding
Postpartum hemorrhage	Intestinal bleeding
Hemoptysis	Ruptured aneurysm
Haematemesis	Severed artery

8. Stokes Adam's disease

9. Sudden nervous shock

10. Hysterical trance

French says that all coma's may be classified according to the treatment they should receive when they enter the hospital as follows:

1. Cases in which immediate trephinings are required for example for traumatic meningeal hemorrhage.

2. Cases in which active treatment by lavage of the stomach or by administration of antidotes is required, as in opium or other cases of poisoning.

3. Cases in which active medicinal or physical treatment is required: for instance diabetic coma requiring the administration of alkalis and insulin, or uremia requiring venesection, or coal gas poisoning requiring the administration of concentrated oxygen.

4. Cases in which absolute rest is indicated, especially in cerebral hemorrhage, or in fracture of the base of the skull.

Another and more recent writer, W.H. Lewis Jr., (1938) has formulated another, yet not as complete classification of coma as to whether the cause is external or internal.

External Causes:

Trauma

Injury with hemorrhage & shock

Cont'd on next page

Electric shock or other physical injury.
Intoxication with alcohol, carbon monoxide, barbital, morphine, etc.

Internal Causes

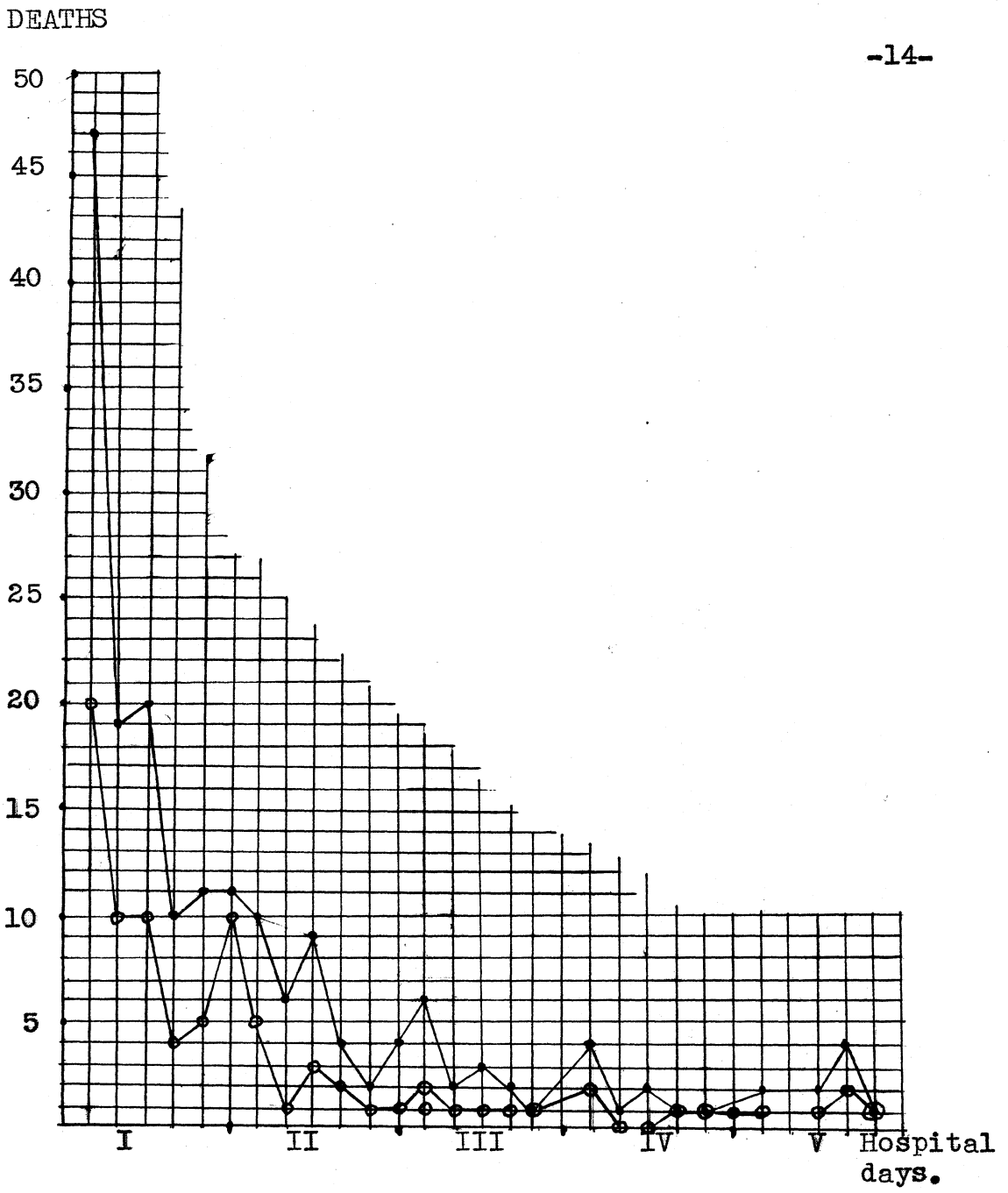
Cerebro-vascular conditions
Epilepsy
Cardio-vascular diseases
Pneumonia
Meningitis
Diabetes mellitus
Uremia

Delerium tremens
Brain abscess
Brain tumor
Eclampsia
Cirrhosis of the liver
Encephalitis
Lead encephalopathy

Bissell and Lecount in (1915) and in (1917) compiled statistics from the records of the Cook county hospital in Chicago from all those cases admitted in coma and tabulated their results in an attempt to show the relative incidence of the various causes and also to show the accuracy of diagnosis of the various types. They reviewed 200 cases which were admitted to the Cook County Hospital in a state of coma, that later died and have arrainged them in the order of their frequency and also charted the total number of deaths in relation to the time they were in the hospital and the percentage of cases correctly diagnosed in relation to the time they were in the hospital.

CAUSES OF 200 COMAS PRODUCING DEATH

Skull fracture	85
Cerebral Hemorrhage	59
Uremia	12
Lobar Pneumonia	10
Meningitis	8
Diabetes	6
Atrophic Cirrhosis of Liver	5
Delerium Tremens	4
Acute Endocarditis	2
Cerebral Embolism	2
Cerebral Thrombosis	2
Suppurative Mastoiditis	2
Acute Miliary Tuberculosis	2
Puerperal Sepsis	2
Lung Abscess	1
Acute Syphilitic aortitis	1
Carcinoma of the Prostate	1
Tuberculous peritonitis	1
Senility (Bronchopneumonia)	1
Addison's Disease	1



In the above chart, the black line represents the number of deaths and the day on which they occurred and the blue line represents the number of the cases that were correctly diagnosed before death. The diagnoses in all cases were confirmed by post mortem examination.

Of the 200 deaths which occured over a period of two and one half years 47 occured within four hours after admission to the hospital and 42.5% of these were correctly diagnosed. Eighteen deaths occuring from four to eight hours contained 10 or 55.5% correct diagnoses. Of 116 deaths within 24 hours after admission there were 59 or 50.7% that were correctly diagnosed. On the second day there were 35 deaths, 37% of which were correctly diagnosed, and on the fourth day 9 deaths of which 44.4% were correctly diagnosed. Of the remaining 26 deaths occuring from the fifth to the seventeenth day, inclusive, eighteen or 70% were correctly diagnosed. The conclusions that may be drawn from these figures might be stated as follows:

1. Over half of the patients admitted in coma died within 24 hours.
2. Few live longer than five days.
3. Of those who died within four days the accuracy of diagnosis was little affected by the time element But of the deaths occuring from the fifth to the seventeenth day, inclusive, the accuracy of diagnosis seems to increase with the increase of time in which the condition may be studied.

Two years later the same two men added to their

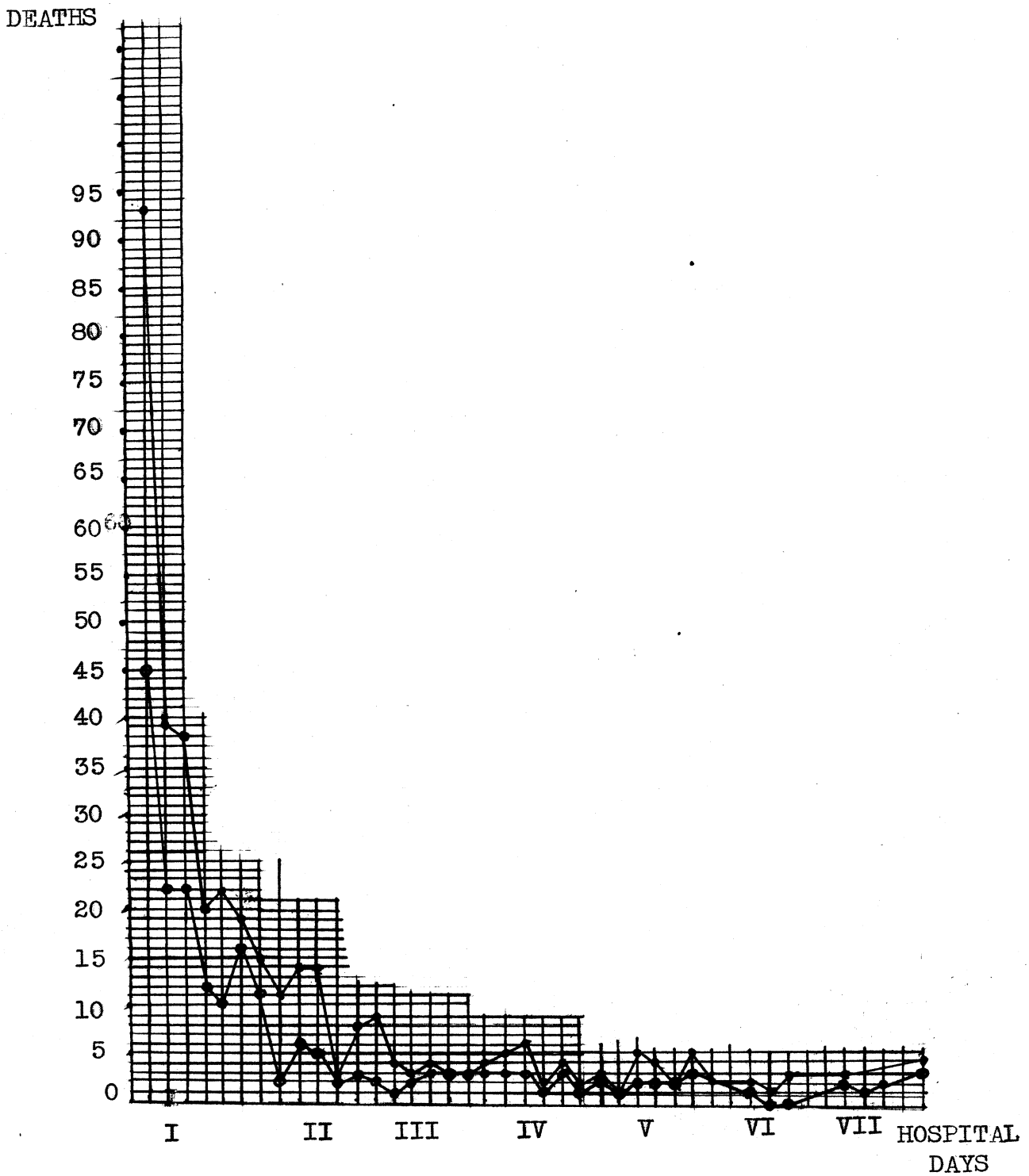
above study an additional 200 cases and have tabulated their results in a similar manner.

CAUSES OF 400 COMAS PRODUCING DEATH

CAUSE	Number of cases	Percentage
Skull Fracture	144	36
Cerebral Hemorrhage	95	23.75
Miscellaneous	26	6.5
Meningitis	21	5.25
Lobar Pneumonia	19	4.75
Uremia	14	3.5
Cardiovascular disease	14	3.5
Cerebral Circulatory conditions	12	3.
Delerium Tremens	11	2.75
Atrophic Cirrhosis	7	1.75
Diabetes mellitus	6	1.5
Brain Abscess	4	1.
Traumatic Hemorrhage	4	1.
Fracture ribs	3	.75
Fractured vertebrae	3	.75
Senility (Bronchopneumonia)	2	.5
Suppurative mastoiditis	2	.5
Acute Miliary Tuberculosis	1	.25
Puerperal Sepsis	1	.25
Lung Abscess	1	.25
Tuberculous peritonitis	1	.25
Carcinoma of Prostate	1	.25
Addison's disease	1	.25
Bronchiectasis	1	.25
Eclampsia	1	.25
Erysipelas	1	.25
Epilepsy	1	.25
Poisoning	1	.25
Pulmonary Tuberculosis		
Fractured Mandible with phlegmanous condition of face	1	.25
Total	400 cases	

In the chart that follows on the next page, the black line represents the number of deaths for each four hour period and the lower blue line represents

the number of each of these groups receiving correct clinical diagnoses.



Thus it can be seen that 93 died within the first

four hours after entrance and of these 47.3% were correctly diagnosed clinically. Similarly 230 died within 24 hours after admission and of these 127 or 55.2% were correctly diagnosed. The abrupt descent of both curves from the first four hours to the end of the third day is a most graphic expression of the high and rapid mortality of persons entering the Cook County hospital in coma. From the fourth to the 31st day 84 died and of these 49 or 58.33% were diagnosed correctly.

In the above chart 21 deaths in coma are not plotted: They occured as follows; 6 on the 8th day, 3 on the 9th, 4 on the 10th, 1 on the 11th, 1 on the 21st, 1 on the 13th, 1 on the 14th, one on 22nd, 1 on the 28th, 1 on the 31st. The clinical diagnoses were correct in 11 of these cases.

It is also noted by Bissell & LeCount, (1917) that in comparing the two sets of figures as to skull fracture that of the 200 cases in 1915, 61 or 72% of 85 deaths from skull fracture were diagnosed correctly and in the second series, 46 or 78% were diagnosed correctly. Of those deaths occuring from Cerebral hemorrhage 27 or 51% of 53 deaths were diagnosed correctly in the first series while 31 or 74% of 42 deaths in the second series were diagnosed correctly.

Four years later we find a similar study by Blair Holcomb, (1921) in which he studies the results of 346 comatose conditions as they entered the hospital in a manner similar to that of LeCount & Bissell.

The cases chosen for this study are those of patients entering the hospital in coma of obscure origin who died without regaining consciousness. They cover the period between the years 1916-1920, inclusive. Death in coma from such causes as illuminating gas and heat stroke have been omitted, as well as acute fulminating influenza during the two epidemics of this disease. The details as to the other patients in coma are not included because the clinical observation extended for some time and the disease was well understood, for some recovery occured and for others no post mortem examination was made.

CAUSES OF COMA

	NUMBER
Skull Fracture	92
Cerebral Hemorrhage	88
Uremia	37
Meningitis	23
Cerebral Thrombosis	20
Pneumonia	18
Alcoholism	16
Cerebral Embolism	12
Diabetic coma	8
Tuberculous Meningitis	6
Syphilis	4
Ruptured Aneurysm	4

Cont'd

Pulmonary Tuberculosis	3
Bran abscess	2
Contusions of Brain	2
Lethargic Encephalitis	2
Pancreatitis	2
Perforated Duodenal Ulcer	2
Acute Endocarditis	1
Carcinoma of Stomach	1
Empyema	1
Endocarditis (Chronic)	1
Typhoid Fever	1
Otitis Media	1
TOTAL	346 cases.

Holcomb has dealt with 346 deaths, 27 of which occured between the 6th and 51st days inclusive. The following is a tabulation of the number of deaths occuring on the first 6 days and the percentage of correct clinical diagnoses that were made.

HOSPITAL DAY	DEATHS	CORRECT DIAGNOSES	PERCENTAGE
I	186	111	59%
II	40	28	70
III	33	17	51
IV	24	8	33
V & VI	56	18	50

He has compared his results with those of Bissell & LeCount (1915 & 1917) in an effort to determine if over a period of 6 years there has been any improvement in making correct diagnoses on such cases. His findings were that on the first hospital

day that there were approximately 8% less correct diagnoses in his series of cases than those of Bissell and LeCount, that on the second and third days there was an improvement of 33% and 8.2% respectively, and that on the fourth day the two earlier series showed 11.4% more correct diagnoses and for the remainder of the time the two earlier reports showed 2% more correct diagnoses than the summary by Holcomb. He concludes finally that the accuracy of clinical diagnosis does not depend upon the length of time for observation. It would also seem that the total number of correct clinical diagnoses in the two different studies do not vary enough to be of significance.

The next attempt to arrive at the frequency of the different causes of coma was made by Solomon and Aring, (1934). Their series of cases is taken from the entries of the Boston City Hospital, and includes cases entering the hospital in a state of coma, the etiology of which has not been determined. The total number of cases was 1,167, or 3% of the total hospital entries for the time studied and it is noted that 68% of the total number entered the hospital without any history.

DISEASE	NUMBER	FATALITIES	PERCENTAGE
Alcoholism	690	14	2
Trauma	152	48	31.5
Cerebro-vascular lesions	118	91	77.1
Poisoning	33	3	9
Epilepsy	28	0	0
Diabetes	20	11	55
Meningitis	20	20	100
Pneumonia	20	18	90
Cardiac Decompensation	17	12	70.6
Exsanguination	10	10	100
Central Nervous system syphilis	7	0	0
Uremia	7	7	100
Eclampsia	7	3	42
Miscellaneous	38	26	68.4

It will be noted immediately that the same causes do not occupy the same relative positions in this table and those of Bissell and LeCount and of Holcomb, however their studies were based on deaths from coma while the above set of figures is based on the number of entries in comatose states.

vIt was also noted that when the total number of patients who entered the hospital in coma was considered from the standpoint of correct diagnoses that 94% of the total number were correctly diagnosed. Solomon and Aring, (1936)

In addition to the afore-mentioned studies, W. H. Lewis Jr., (1938) in the same series of cases has recorded the percentage of fatalities of some of the more common causes as follows: Hemorrhage and shock, 100%; Meningitis, 100%; Eclampsia, 43%; Cerebrovascular lesions, 70%; Fracture of skull, 32%; Alcoholism, 2%; and Epilepsy, 0.

Before attempting to give the differentiating points of any individual types of coma it seems wise to discuss in a general way the approach to comatose conditions, some of the various methods that may be employed and their relative merit.

First of all it might be said that the differential diagnosis of a patient in coma is no different than any diagnostic proceedure in that it is necessary to base one's conclusions or diagnosis on the history, physical examination, laboratory findings, and radiological findings. However, as one author has stated, (Solomon & Aring, 1936) "Remember that this is essentially vetinary medicine, and that your patient cannot help you by telling you a thing".

In the majority of cases it will be possible to obtain some sort of a history either from an associate of the patient or in case of accidents, from someone who saw the accident or from the ambulance driver who brings the patient to the hospital. In obtaining a history the examiner should keep in mind of course the more major causes of coma which will include, Alcoholism, Traumatic or acquired brain lesions of all kinds, Poisoning, Uremia, Diabetes mellitus, Cardiac conditions, and in view of the recent far reaching advances in endocrinology

one should certainly remember to think of the various crises occuring with a pronounced increase or decrease in function of any one or group of endocrine glands.

Friedman, (1933) has said of coma cases "first examine, diagnosticate, then treat", and gives some good suggestions to be followed in taking a history.

1. Always inquire as to the presence of any previous diseases, such as ascites, sinus infections, diabetes, nephritis, hypertension, syphilis, hyperthyroidism, or hypothyroidism etc.

2. Always ask as to the occurence of any previous injury.

3. Mode of onset: Was it sudden, gradual; were there convulsions, etc.?

4. Associated symptoms such as convulsions, headache, diziness, vomiting, etc.

The history of a patient's habits will have some bearing on the diagnosis, especially in cases of alcoholism. It has been said by Strause and Binswanger, (1936) that the history of patient being a chronic alcoholic or a total abstainer adds much to the finding of an alcoholic breath and makes it mean more than merely its presence may im-

ply, since alcoholic breath is present in so many instances where it is not actually responsible for the coma.

Solomon and Aring in their article in (1935) have compiled what they deem the important features of a history and what they tend to suggest.

HELPFUL HINTS IN A HISTORY

Injury	Suggestive of Trauma or Hemorrhage
Previous shock or strokes	Cerebro-vascular lesions
Suicide attempt	Drug ingestion.
Convulsions	Epileptic coma, meningitis Cerebral hemorrhage, Eclampsia, Central nervous system syphilis.
High Blood Pressure	Cerebral vascular lesions, Cardiac decompensation, Uremia, Eclampsia.

They have compiled another table in the same manner in relation to physical findings.

PHYSICAL CHANGES OF ASSISTANCE

Odor of Breath	
Alcohol	Alcoholism
Acetone	Diabetes or Uremia
Illuminating gas	Carbon Monoxide Poisoning
Color of Skin and Mucous Membrane	
Hyperemic	Alcoholism
Cherry Red	Carbon Monoxide poisoning
Cyanosis	Cardiac Decompensation or Pneumonia
Pallor	Hemorrhage or Pernicious Anemia
Jaundice	Cholemia

Local Signs of Injury Trauma Burn Hemorrhage Epilepsy Erysipelas	
Temperature	
Increased	Pneumonia, Meningitis, Encephalitis
Decreased	Carbon Monixide poisoning Diabetes.
Pulse	
Rapid	Diabetes, Pneumonia Meningitis, Eclampsia
Irregular	Cardiac Decompensation
Slow	Stokes-Adams Disease
Respiration	
Kusmall	Diabetes
Increased	Pneumonia
Hemiplegia	Cerebro-vascular lesions
Observation of Convulsions	Epilepsy, Cerebro-vascular lesions, Central Nervous system syphilis, and Alcoholism
Vomiting	Cerebral hemorrhage and Poisoning
Stiff Neck	Meningitis, Cerebro-vascular lesions
Kernig's leg sign	Meningitis and Cerebro-vascular lesions.
Chest signs	
Consolidation	Pneumonia
Fluid	Ruptured aortic aneurysm, and Empyema
Pulmonary Congestion	Ascites, enlarged liver, distended neck veins, Cardiac decompensation.
Distention and spasticity of abdomen	Ruptured Esophageal varices, Carcinomatous erosion of G.I. Tract.

	Ruptured ectopic gestation, Miliary Tuberculosis.
Muscular twitching	Uremia
Abdominal Tumor	Eclampsia
Bulging Fontaneles	Meningitis
Soft Eyeballs	Diabetes Mellitus
Wounds or Scars on Tongue	Epilepsy
Vaginal Abnormality	Pelvic malignancy or ruptured ectopic.
Blood Pressure Increased	Cardiovascular lesion, Eclampsia, Uremia, Trauma

No physical examination of a comatose patient would be complete without a thorough neurological examination. A summary of an article found in "Practice of Medicine" by Tice on this phase of examination is therefore presented.

Naturally a different technic must be employed for patients in coma, stupor, aphasia or of those who are uncooperative because of their mental state.

Careful inspection for scalp bruises and lacerations or skull injury should be first conducted. Occassionally depressions due to fractures may be found. A facial palsy may be detected by drooling from one corner of the mouth or blowing out more of one cheek during expiration. All the pupillary signs should be looked for as it is important to determine

if a forced conjugate deviation of the eyes is present.

The usual methods are used to determine muscle tone. A clue to the presence of a paralysis can be obtained by raising the limbs and permitting them to fall by their own weight to the bedclothes. If the two limbs on the same side fall in that manner and those of the opposite side do not, a hemiplegia is suspected. Normally, if the stupor is not too deep, they do not fall limply. Postures which resemble the decerebrate should be looked for. Painful stimuli may cause movements of the limbs. Supra-orbital pressure may cause movement of the face.

Reflexes may be elicited in the usual manner, emphasizing particularly the plantar reflex, sphincter control and tonic neck reflexes. The reaction to pain sensation may be indicated by the withdrawal of a limb. If pain is felt on a paralyzed side, the opposite limb will reflexly attempt to brush the pain source aside. Bringing the finger into the lateral visual field very close to the eye should cause a defense closure of the lids, otherwise a hemianopsia may be suspected. Opthalmoscopic examination is very important, especially before a spinal puncture is attempted.

Since in the case of many poisons, the overdosage of which will produce a comatose condition, produce definite pupillary reactions it is important that we note the pupils in examining a comatose patient. W. C. Menninger (1927) has conducted a study of the pupillary conditions found in some various forms of coma, a brief report of which follows.

His study is based on Coma resulting from Alcoholism, Diabetes, Uremia, Cerebral hemorrhage, Pontine hemorrhage, Carbon monoxide poisoning, and Fracture of the skull.

In 58 cases of alcoholic coma, the finding that was most persistent was contraction in 43.1% of the cases. This is contradictory, according to Menninger from most writings in that most of them maintain that the pupils are dilated. Many authors report that anisocoria, or inequality of the pupils is a common finding in alcoholism but Menninger found it in only 13.8% of cases. It is commonly accepted that chronic alcoholism tends to give a fixed pupil where in Menninger's series it was found in less than half or in 36.2% of the cases.

In his study of 10 cases of Diabetic coma, the most common findings were mid-dilation and a prompt reaction to light.

In his study of 8 cases of Uremic poisoning, the

only finding that stood out by any constancy at all was a sluggish reaction to light.

In a study of 10 cases of Cerebral hemorrhage an inequality of the pupils was found in 60% of the cases and fixed pupils were found in 90% of the cases, and 50% of the pupils were dilated, rather than being mid-dilated or contracted.

In a study of 25 proven cases of fracture of the skull, 10 showed mid-dilation, 9 contraction, 10 were fixed, 8 sluggish in their reaction to light while 7 were prompt, and 8 showed inequality. In 30 probably cases of skull fracture 13 showed inequality of the pupils, 7 dilation, 4 mid-dilation, 5 contraction, while 14 were not noted. In their reaction to light, 10 were prompt, 5 sluggish, 13 fixed and 2 were not noted.

In a review of 2 cases of Pontine hemorrhage, they both showed contraction of the pupil but both cases were at variance on the other features. Of three cases of suspected pontine hemorrhage that were not posted 3 showed contraction, 2 fixation, and 2 inequality.

There were 43 cases of Carbon monoxide poisoning and the only findings that were present with any regularity were mid-dilation in 50.6% of cases and a prompt reaction to light in 48.3% of cases.

He concludes as follows: "Pupils may aid in diagnosis of trauma to the brain but they are of

little or no help in Alcoholism, Diabetes mellitus, Uremia or Carbon monoxide poisoning".

Following a careful history and a thorough physical examination the proper laboratory proceedures or those indicated should be carried out. In Solomon and Aring's article (1935) they outline the helpful diagnostic laboratory proceedures and the things that different findings point to.

LABORATORY OBSERVATIONS

Lumbar Puncture	
Pressure	
Increased	Cerebro-vascular lesions Trauma, Syphilis of the Central Nervous system.
Decreased	Diabetes
Bloody Fluid	Cerebro-vascular lesions Trauma
Purulent Fluid	Meningitis
Organisms by Smear or Culture	Meningitis
Sugar	
High	Diabetes
Low	Meningitis
Protein	
High	Meningitis or Central Nervous System Syphilis
Spinal Fluid Positive	Central Nervous System Syphilis

Cont'd

Blood Examination	
Sugar High	Diabetes
Low	Insulin Shock
N.P.N. High	Uremia
Wasserman positive	Syphilis
Low Red count with abnormal smear	Pernicious anemia or Leukemia
Culture positive	Pneumonia, Meningitis, Septicemia.
Urinalysis	
Sugar	Diabetes
Gross Albuminaria	Eclampsia Uremia Cardiac Decompensation
Gastric Lavage	Examine contents for poisons.
Roentgenograms	
Skull	Fracture across middle meningeal artery in extra-dural hematoma
Lungs	Pneumonia, Empyema and Miliary Tuberculosis
Heart	Cardiac Decompensation
Electrocardiograph	Heart block, Cardiac Decompensation.

It is felt that examination of the cerebrospinal fluid plays a part of great importance in the diagnosis of coma, expecially in differentiating between the various conditions associated with the Central Nervous system. The following indications and contraindications for spinal puncture are taken from Merrit and Smith's recent book on the subject. (1938)

INDICATIONS: Lumbar puncture should be performed in any patient with symptoms or signs of meningeal irritation, and in all patients in whom the cerebrospinal fluid findings would be of aid in the diagnosis and treatment. It is especially valuable in:

1. The diagnosis and treatment of acute or chronic inflammation.
2. The diagnosis and treatment of injuries to the head or spine.
3. The diagnosis of diseases of the central nervous system in which the clinical signs and symptoms are not diagnostic.
4. The intelligent treatment of syphilis.

CONTRAINDICATIONS: Lumbar puncture should not be performed if it is necessary to puncture through infected skin or subcutaneous tissues. A puncture is often necessary to establish the diagnosis of spinal epidural abscess, and it can be safely performed if the proper precautions are followed.

Puncture of the subarachnoid space is contraindicated whenever the diagnosis is established and no additional information in regard to treatment would be obtained. This is especially true in patients having high grade choked discs. Often, however, a patient has signs and symptoms suggestive of an expanding intracranial lesion, but lumbar punctures have obviated many needless craniotomies. Further

references will be made to spinal fluid findings in the chapter that deals with the different types of coma.

A very important proceedure, both as to diagnosis and treatment of comatose conditions where accidental or purposeful poisoning is suspected is lavage of the stomach. In fact, according to Strause and Binswanger, (1936) it is the first thing to do in all such cases.

According to H. L. Mamott, (1933) it should not be forgotten that lavage in comatose patients is not to be accomplished without a certain amount of danger. Often the cough reflex is absent, and this may prove very dangerous to the patient. It is highly advisable according to Mamott to do the proceedure in the operating room if possible, where he should be put in the Trendellenberg position. Additional advantage of being in the operating room are access to electrical suction, apparatus for oxygen and carbon dioxide administration and good light.

In an effort to include as many as possible types, in as systematic a manner as possible the different types of coma will be discussed in the order in which they appear in French's classification. From time to time the outline will be deserted to make use of discussions or differential points found in the literature. Likewise, some of French's causes will be omitted since they do not fall within the phase of the subject being dealt with in this paper.

In the first group of causes or that group of infectious fevers in which coma may occur as a terminal phenomenon, there are few of these causes that will bring the patient into the hospital in coma without the diagnosis being made before coma intervenes. However, Solomon and Aring (1935) warn the physician that pneumonia is a commoner cause of such a condition than is commonly suspected and should never be overlooked in a differential diagnosis. In very young or old patients it should always be suspected, and signs in the chest are always present, at least in the group of cases which they studied. In Solomon's article (1938) he says that in cases of pneumonia, the fever, rapid respirations, cyanosis and chest signs are practically diagnostic.

Next in French's classification are those acute inflammatory lesions of the brain or meninges, the first of which is acute encephalitis, or as named by Cecil (1937) "Postinfection Encephalitis" The disease is characterized by producing either a myelitic or encephalitic syndrome, and is rarely insidious in onset, and is ushered in by pyrexia, headache, vomiting, and drowsiness. A preceeding infection will be very helpful in making a diagnosis. According to Houston and Smith (1938) the Cerebrospinal fluid picture includes a normal or increased pressure, a moderate pleocytosis, an increased protein content and a normal or midzone gold curve. According to Cecil, (1937) the main entities that will be confused with it in a differential way are the other encephalitides, but however the previous presence will usually help rule these out. The actual diagnosis according to Rivers, (Cecil 1937) cannot be made until autopsy.

The diagnosis of a case of Encephalitis Lethargica will usually be made easier by the presence of an epidemic, and should always be suspected in puzzling cases of fever and delerium in the presence of an epidemic. According to Cecil, it may display many and numerous symptoms, at the onset, the most common

of which are somnolence, meningeal irritation, external or internal opthalmoplegia, neuralgias or paralyses in the cerebral nerve domains. According to Merrit and Smith, (1938) the cerebrospinal fluid in epidemic encephalitis shows no changes or only slight deviations from normal. There may be a slight pleocytosis and a mild change in the colloidal gold curve are the only significant changes that occur. The presence of any pronounced abnormal finding should cast a good deal of doubt on the diagnosis.

The Meningitides

The meninges of the brain may become inflammed by practically any organism that will attack human tissues. The infection may be the terminal stage of an epidemic form, otherwise called Epidemic Cerebrospinal meningitis or a lymphatic or blood born extension from some other source of infection. According to Neal et al, (1934) the most common causative agents of meningitis are the meningococcus, pneumococcus, streptococcus, staphylococcus, and the influenzae bacillus. However, it may be caused by any organism, two of the commoner ones being the Tubercle bacillus and the spirochaete of syphilis.

In considering the physical signs, helpful in diagnosing a case of purulent meningitis of the acute

variety, one might say that the most common findings are retraction of the head, stiffness of the neck, positive Kernig's and Brudzinski's signs, a relatively slow pulse and often other vagus irregularities, (Cecil, 1937).

Important in making a diagnosis will be the results of lumbar puncture. Merritt and Smith, (1938) say that the changes in the spinal fluid in a case of acute purulent meningitis, will be practically the same regardless of the organism, excluding syphilis and tuberculosis. The changes consist chiefly of an increase in pressure, a pleocytosis, an increase in protein, and a decrease in sugar and chloride contents. The fluid in the early stages of the disease are only slightly turbid and later become cloudy or frankly purulent. In the majority of cases the cell count is between 1000 and 10,000 cells.

In diagnosing a case of tuberculous meningitis, history of contac, or radiological evidence of an acid fast infection, less severe signs of meningeal irritation than in the usual case of meningitis are factors that point toward an acid fast meningitis. The physical signs present are very similar to those found in the more acute types of meningitis except for the fact that they are usually not so marked. The spinal

fluid findings of diagnostic significance are an increase in pressure, a pleocytosis, an increase in protein and a decrease in the sugar and chloride contents. The type and grade of the pleocytosis, the amount of sugar and chloride together with the bacteriological findings, distinguish tuberculous from the other forms of meningitis.

The pressure on the whole is less than in the acute type of meningitis, varying in most cases from 150 mm. to 200 mm. in contrast to the more acute variety where it is usually between 200 and 500 mm. (Merrit & Smith, 1935). The fluids in most instances are clear, especially so when compared to the purulent fluids of the acute types. There is commonly a faint yellow color and a tendency for the fluid to form pellicles when allowed to drop. The cell count varies but in a great majority of cases is between 50 and 500 cells. The protein is between 100 and 500 mg.% in more than half of the cases, and the sugar averages 28 mg. per 100 cc. The chlorides are moderately reduced averaging about 608 mg. per 100 cc. in 60 cases, of Merritt and Smith, (1935)

The value of Cerebrospinal fluid examination in cases of tuberculous meningitis is further emphasized

by L. L. Krafchik, and Slobody, (1938) when they reported a case of coma in a child that strongly resembled and was diagnosed and treated as Diabetes mellitus and after failure of the patient to respond to insulin therapy, repeated spinal taps proved the case to be due to an acid fast infection of the meninges.

Another similar case to the above is reported by A. E. Rouselle, (1926) in which he reports a cases of pneumococcic meningitis that was treated as a diabetic coma until proper laboratory studies misproved the diagnosis.

Since as medical students, we are often told that Syphilis is the great imitator, no attempt will be made to completely cover all of its different manifestations in the central nervous system but a brief discussion of Syphilitic meningitis as an entity follows.

According to Cecil, (1937) the meninges are involved in a great percentage of cases but the number of cases that show definite clinical evidence and especially comatose conditions are in the minority of cases. These cases occur early in the course of the disease, commonly with the skin symptoms. The disease at this stage seems to have a predilection for

the basal portion of the brain and often involves the crainial nerves. Cecil, (1937) warns that onset of epileptic convulsions in anyone thirty or more should strongly suggest syphilis of the meninges.

The Cerebrospinal fluid in acute syphilitic meningitis, according to Merrit and Smith, (1938) shows an increased pressure, a pleocytosis of a varying degree, an increased protein content, an abnormal colloidal gold reaction and a positive Wasserman reaction. Strong,(Cecil, 1937) warns that the Wasserman reaction may be negative. The pressure is usually above 200 mm., the fluid usually colorless, or slightly yellowish. The cell count averaged 450 cells per cubic millimeter, the protein averaged 110 mg. % the sugar 49 mg.%, the chlorides 696 mg. per 100 cc. The colloidal gold curve was abnormal in 95 % of cases and the Wasserman reaction positive in 85% of cases.

Although Cerebral Trypanosomiasis is practically limited to tropical countries, it should be mentioned as a cause of coma. The stage of coma has usually been preceeded by a prodromal stage in which the patient has a fever, polyadenitis, and asthenia, followed by sleep and coma. Diagnosis, although suggested by certain clinical symptoms cannot be made

except by demonstration of the parasite which is accomplished by demonstration in the blood, but more often and easier from infected glands. (Cecil, 1937)

Less Acute Lesions of the Central Nervous System

While, these conditions are not as frequent in the etiology of comatose states in patients entering the hospital without a diagnosis, they are still worthy of consideration as conditions that must be ruled out in many cases. From Solomon and Aring's report (1934) it will be noted that Central Nervous System Syphilis and Epilepsy are the only ones of this group that appeared in 1167 cases, however this does not rule them out as possible causes of the phase of the subject with which this paper deals.

It is not common for brain tumors to cause coma without first causing symptoms severe enough to bring the patient to his physician. These symptoms according to Dr. Keegan, (Junior notes in Surgery, 1937), may be classified as general and local signs. The general signs will be those of increased intracranial pressure, vomiting, headache, and papilloedema. The local signs will be abnormal neurological findings depending upon the location of the tumor.

According to Merritt and Smith, (1938) Brain

tumors must be differentiated from Brain abscess, Subdural hematoma, Cerebral hemorrhage, Cerebral thrombosis, Syphilis of the nervous system, Uremia, Encephalitis lethargica and multiple sclerosis.

Brain Abscesses always show a pleocytosis with a large percentage of polymorphonuclear leukocytes, and a history of a septic focus can usually be obtained. Subdural hematoma cannot usually be differentiated from brain tumor except by a history of trauma.

Cerebro-vascular lesions can usually be differentiated by the presence of a frankly bloody fluid in cases of the cerebro-vascular conditions.

Uremia can be excluded by the normal nonprotein nitrogen in case of brain tumor and Encephalitis lethargica and multiple sclerosis are excluded by an increased cerebrospinal fluid pressure. Syphilis of the nervous system may offer more trouble, but Wasserman test is the best method and should always be repeated to exclude the possibility of a false positive.

The presence of a brain abscess is usually preceeded, as mentioned above by a focus of infection, such as a mastoiditis, sinusitis, furunculosis etc. According to Cecil, (1937) Brain abscesses do not

cause complications such as are being dealt with in this paper until they erode into the ventricles or the subarachnoid space. The symptoms caused by such an occurence are; chills, hyperexia, delerium, convulsions, coma and eventually death. The spinal fluid findings according to Merritt and Smith, (1938) are an increased pressure, a mild or moderate pleocytosis, an increased protein content and a normal sugar content.

Post epileptic coma in Solomon and Aring's investigations, (1935) was usually diagnosed by history of previous attacks and abrupt onset.

According to Lennox and Merritt, (1936) the Cerebrospinal fluid findings in epilepsy are practically always normal, except for a few cases of increased pressure, and they say in conclusion that in the event of abnormal findings in the cerebrospinal fluid that a diagnosis of essential epilepsy should certainly be questioned.

Disseminated or Multiple sclerosis as a cause of coma without the previous history of symptoms of the disease is so rare that it is practically never encountered. The history of remissions of symptoms, the previous presence of Charcot's triad, Nystagmus, intention tremor, and scanning speech are diagnostic. The spinal fluid findings are usually negative.

Syphilitic involvement of the central nervous system has been previously mentioned, but the type mentioned with this group of conditions is more commonly known as Paresis or Syphilis of the brain. It is usually preceeded by signs of mental deterioration. The diagnosis, if the patient is seen for the first time in coma will depend upon history of previous infection, positive spinal fluid Wasserman, and a paretic type of gold curve.

Metabolic Disorders:

The diagnosis of these conditions in prompt order is much more important now than it was ten years ago since the rapid advances in endocrinology have made it possible to better treat them.

Uremia is a very common cause of coma and is usually diagnosed by history of kidney disease, muscular twitchings, acetone breath, abnormal eye-grounds, enlargement of the heart, grossly abnormal urine and an increase in the blood non protein nitrogen. Solomon and Aring, (1935) .

According to Lecount and Guy, (1925) Uremia may easily be confused with Spontaneous intracranial hemorrhage and should be seriously considered in the differential diagnosis. They reviewed 30 autopsied cases in which intracranial hemorrhage was the cause

of death. Nine of these had been clinically diagnosed as uremia, and in only three cases had the other been mentioned as a possibility. The main differential points according to the above men are, blood in the cerebrospinal fluid in the case of hemorrhage and elevated non protein nitrogen in the case of uremia.

The acidosis resulting from the derrangements of metabolism in Diabetes mellitus is a common etiological factor in patients being brought to the hospital in coma. The coma is usually preceeded by an increase in the cardinal symptoms of Diabetes, polyphagia, polydypsia, and polyuria, along with nervous irritability, later nausea, vomiting and the patient may even show the picture of an acute abdomen. When coma finally intervenes, the patient exhibits a deep regular sighing type of breathing, described by Kusmall. The main findings are dry skin, soft eyeballs, dry beefy red tongue, Kussmal breathing, acetone odor to breath, rapid heart, low blood pressure and occasionally anuria. Laboratory proceedures will reveal acetone and diacetic acid and sugar in the urine and carbon dioxide combining power of the blood will be decreased. The above and the following table are taken from an article by J. T. Beardwood, Jr., (1938)

Symptom	Diabetic Acidosis	Hypoglycemia (insulin Shock) Regular	Protamine
Onset	Gradual 12-48 hrs.	Rapid	Gradual
Premonitory Symptoms	Nausea, Anorexia Headache	Hunger Irritability	Headache Memory loss
Convulsions	Rare	Late	Occasionally
Muscular Twitching	Absent	Frequent	Frequent
Respirations	Kussmall	Normal	Normal
Breath	Acetone odor	Normal	Normal
Skin	Dry	Moist	Normal or Moist
Eyes	Soft eyeballs	Normal	Normal
Pupils	Dilated	Normal or Contracted	Normal or Contracted
Vomiting	Frequent	Absent	Infrequent
Abdominal pain	Common	Absent	Rare
Blood Pressure	Subnormal	Normal or elevated	Elevated
Temperature	Subnormal Rapid rise	Subnormal	Subnormal
Urine	Sugar, Acetone & Diacetic.	Sugar free	No sugar No Ketones
Blood	High sugar Low Co2	Low Sugar Normal Co2	Same
W.B.C.	Increased	Normal	Normal
Response to Glucose	None	Prompt response	Prompt response May Relapse

In addition to the above information, E. J. Kepler, (1938) adds that the oral secretions are tenacious and viscid, the tendon reflexes absent, and that there is no babinski reflex.

Hypoglycemia is a condition that will produce coma. It may result from inward abnormalities of metabolism or from over dosage of insulin. According to Kepler, the symptoms depend upon rapidity of change in the level of the blood sugar. The condition is preceeded by parasthesias of the limbs, general convulsions, maniacal behavior, weakness, tremor, sweating, hunger, ataxia, and distorted speech. There is usually a rapid heart, dilated pupils and a positive babinski. Quantitive blood sugar studies differentiate it from confusing conditions.

The crisis of Addison's disease, although a rare condition, (Kepler, 1938) should be mentioned. It may be identified by the prodromal signs of buccal pigmentation, hypotension, asthenia, fatigue, apathy, constantly decreasing blood pressure, blood volume and subnormal metabolic rate, and temperature. The signs of help after the patient is comatose are; hiccups, nausea, mania, muscular twitchings, meningeal irritation, increased blood urea, polyuria, and a poor tolerance for potassium.

The crisis associated with Exopthalmic goiter is more common according to Kepler than one would expect and is encountered in the early fulminating group, old cases discontinuing iodine and following thyroidectomy among patients who have had exopthalmic goiter and who have not been given sufficient iodine preoperatively. The findings in addition to the cardinal symptoms of hyperthyroidism are anorexia, diarrhea, crying spells, and fibrillation. Dorland and Kepler, (1938) say that the diagnosis is never difficult unless the hyperthyroid manifestations are minimal.

A. R. Barnes, (1927) describes a case that was preceeded by influenza in which the only symptom of hyperthyroidism at the time of admission was auricular fibrillation coupled with a moderately enlarged gland. The case promptly responded to iodine treatment.

Spandler and Bilbon, (1937) report two cases of thyroid crisis in which they were confused with diabetic coma, and summarize their article by saying, "When stupor is accompanied by high fever, restlessness or delerium and rapid ectopic cardiac rythm, then the clinical picture is strongly suggestive of thyroid storm and it is important to recognize it since treatment can be very effective".

Acute Parathyroid insufficiency most commonly occurs following thyroidectomy, when they are removed in error. The symptoms are the results of hypocalcemia. It is diagnosed by blood calcium determinations following the occurence of convulsions, which tend to show bilateral tendencies. (Cecil,1937)

Myxoedema may be easily diagnosed by history since stages far enough advanced to produce coma have a definite history back of them. According to Merrit and Smith, (1938) Myxoedema is commonly confused with brain tumor in that they both have a similar spinal fluid picture. They both show an increased pressure and an increase in protein. In such cases a basal metabolic rate would provide a diagnosis.

Conditions in Which Jaundice is Present

This will involve conditions in which liver damage or damage to the red cells occurs and will involve various poisons which will produce acute yello atrophy of the liver, cirrhosis of the liver etc. The poisons are T.N.T., and Phosphorous in the main and may be differentiated in the general manner for differential diagnosis in these cases. (See Poisons and General Approach)

According to R. Bauer, (1934) these conditions are usually very vague and difficult to diagnose, but according to recent work it has been found that liver extract is very helpful in treating such conditions.

It is theorized that the severe symptoms of coma are due to a secondary breakdown of protein and that the liver extract helps the liver to prevent this from happening. It is also found to be good in post-eclamptic coma.

Conditions Complicating Pregnancy

Besides rupture of an ectopic pregnancy which is discussed under another heading, these conditions are Eclampsia, Puerperal Sepsis, and a type of milk fever described by Kinnimoth, (1931).

Eclampsia, according to Solomon and Aring, (1935) in 7 out of 1167 cases, furnished the following diagnostic features: Pregnancy, convulsions, vomiting, abdominal tumor, rapid pulse, peripheral edema and an increased blood pressure.

Puerperal sepsis, offers very few diagnostic problems from the standpoint of coma. A history of delivery followed by chills, and an abnormal temperature and still later, coma would be diagnostic.

Kinnimoth, (1931) describes a case that occured in England a few years ago, the summary of which follows.

After a normal labor, and fourty eight hours of normal post partum progress, the patient became

acutely ill, with severe nausea and vomiting and ran a rather low grade temperature, not at all compatible with post partum sepsis. On the third day coma intervened, without the patient showing any signs of a typical puerperal sepsis. She was jaundiced. Acting on a "hunch", the physician in charge inflated her breasts with air and within two hours she had come out of the coma, and in slightly more than 24 hours, she was completely normal, neurologically speaking. It was diagnosed as milk fever, a condition analagous to one found in cattle but infrequently occuring in people.

Under the next classification, or late states of certain other maladies that exhibit prominent symptoms other than coma before coma supervenes, these topics will be discussed under other headings, since most of them may be more conveniently discussed with other groups.

The Results of Trauma to the Head

The diagnosis of these cases is usually not difficult since the history of trauma is usually present. In Solomon and Aring's (1933) cases they constituted 13% of the total number of cases and they found a mortality of 31.5%.

They summarized their results later, (1935) and noted that a history was usually available, alcoholic odor was often present on the breath, vomiting was a common finding and usually meant increased intracranial pressure.

In the physical examination evidence of injury was always present, and that a compound fracture with bleeding and drainage along with signs of surgical shock were serious prognostic signs. Conditions which may be confused with it are Epilepsy, Diabetes, Uremia, Alcoholism, etc., but the history, checked by x-ray findings will usually determine the traumatic origin if it be such.

Merrit and Smith, (1938) say of the spinal fluid findings that it is usually bloody and under an increased pressure. According to Munro, (1934) the use of repeated lumbar punctures in conjunction with the intravenous injections of hypertonic solutions is invaluable in the control of the increased pressure in such cases.

Vascular Lesions of the Brain

One of the earliest references to such conditions is quoted from Hipocrates; (Adams, 1884). "When the common origin of nerves is affected and

from it all other parts of the body have lost their motion and sensibility, the affection is called Apoplexy, by which the healing energies are impaired. But if obstruction is in either side, it is called Hemiplegia and paralysis".

In considering this group as a whole, Solomon and Aring (1935) say that of their 118 cases over 90% were over 40 years of age. In many the onset was abrupt, many showed convulsions, as well as previous history of high blood pressure or heart disease.

Common signs present on entry were complete or partial hemiplegia, stiffness of neck, convulsions, high fever, elevated blood pressure and unilateral abnormality of the pupils. Unless contraindicated a lumbar puncture should always be done. (See contraindications for lumbar puncture).

According to R. H. McDonald, (1938) the most common accident accompanying cerebro arteriosclerosis is cerebral hemorrhage. It is common in the aged male, has a sudden onset, and opthalmoscopic reveals arteriosclerosis and perhaps edema. Neurological findings, as well as albuminaria are usually present. It is to be differentiated from the following entities.

Cerebral Thrombosis	Cerebral Embolism	Subarachnoid Hemorrhage
More gradual in onset Coma less pronounced Late in middle life and old age.	Very sudden Follows surgery or trauma	May occur in younger people. Blood in spinal fluid & Meningeal irritation.

Arring and Merrit (Archives of Internal Medicine 9-35) have studied cerebral hemorrhage in relation to Cerebral thrombosis and draw the following conclusions.

1. The average age of a patient with Cerebral hemorrhage is lower than in cerebral thrombosis.
2. Blood pressure is higher in cerebral hemorrhage.
3. Arteriosclerosis is more common with cerebral thrombosis.
4. Eye findings are most often found with hemorrhage.
5. Stiffness of the neck indicates cerebral hemorrhage.
6. Leukocyte count will be more likely to be up in hemorrhage.
7. Spinal fluid pressure is usually higher in hemorrhage.

Houston H. Merrit, (1938) says that the salient features of primary subarachnoid hemorrhage are cloudy mental state, stiff neck, positive Kernig and that laboratory findings show 10,000 to 20,000 white cells. There will be blood in the spinal fluid and a spinal

fluid pressure of from 300 to 500 mm. of water. The differential between this and hemorrhage is difficult but, convulsions preceeding coma favor hemorrhage.

He says of Cerebral embolus that it may occur at any age that the onset is sudden and that focal signs are usually present. Other signs favoring embolus are a septic temperature, abnormal heart findings, normal or only slightly elevated spinal fluid pressure, negative serological reactions for Wasserman reaction and a positive blood culture.

Another condition which occurs, similar to the above, is a thrombotic occlusion of any of the venous sinuses of the head. This may usually be diagnosed by the presence of previous infection in the region drained by the sinuses involved. It is rarely primary, except in Marasmus and extreme cardiac weakness. (Cecil, 1937). The prominent symptoms of sinus thrombosis are usually those of meningeal irritation, coupled with venous stasis, which gives rise to edema and cyanosis of the eyelids, and surrounding tissues. The spinal fluid is not greatly altered unless meningitis has developed. Prognosis is poor but has been improved in recent years by successful surgical attacks.

While it is not a condition associated with the brain, since embolic phenomena have been discussed under the above heading, a word should be mentioned as to Pulmonary Embolism. The symptoms of this condition are usually so classical that differential diagnosis is seldom difficult. They usually occur in a hospital since they usually follow surgical proceedures or a previous illness. The onset is sudden with pain in the chest or a sense of tightness in the chest, the patient becomes an ashen color, anxious, cyanotic and dyspneic. Recover is rare, death occuring in from a few minutes to several hours.

Coma From Overingestion of Poisons and Drugs

Naturally the more common ones will be discussed since the overingestion of any drug or chemical will cause death if enough is taken.

By far the most common of the group in relation to coma is Alcohol. Solomon and Aring, (1935) report that a history of alcoholism can usually be obtained. Other features are hyperemia of the face, injection of the throat and conjunctivae, diminished or absent reflexes, alsoholic odor to the breath, vomiting, enlarged heart, pulmonary rales,

It may be confused with trauma, since so many traumatic cases will exhibit alcoholic breath. The cerebrospinal fluid findings are normal except for a slight increase in pressure in about one fourth of the cases.

Poisoning from all the different derivatives and alkaloids of the opiates will be considered under one heading. The prodromal symptoms, after ingestion of the drug, are euphoria, pleasant bodily sensations, giddiness, lassitude, dreams, incoordination and finally coma. History of ingestion followed by gradual onset of coma, along with pin point contracted pupils will help to differentiate it from other conditions. Naturally lavage is helpful in both a diagnostic and therapeutic way.

Purves, et al, (1934) in a discussion of barbital poisoning describe the condition as showing a depressant effect on heart, lungs, and kidneys. When coma supervenes the pupils are moderately contracted but continue to react to light. The limbs are flaccid, the tendon reflexes are lacking. The heart is rapid and the patient cyanotic, the blood pressure falls and basal pneumonia may be a complication. They suggest gastric lavage both as a diagnostic and therapeutic proceedure. They also suggest withdrawal of

spinal fluid in an effort to diminish the toxic effect of the drug on the brain.

Carbon Monoxide poisong is described by Aring and Solomon, (1935) as being a condition where the coma is usually slight, the odor of gas is on the breath, the skin and mucous membrane are of a cherry red color, the temperature is subnormal, and the pulse high with an increased leukocyte count. Lumbar puncture is usually normal, the patient responds to inhalation of carbon dioxide and oxygen and fatal results occur rarely.

Bromide poisoning is another common cause mentioned by Solomon and Aring, and they conclude their discussions on poisons with the statement that except for the cherry red color that is pathognomonic of carbon monoxide poisoning, that the history and presence of the poison in the gastric contents or the spinal fluid are the diagnostic features of such conditions.

Lead encephalopathy is the result of a more chro nic form of intoxication of which coma is often the terminal phase. It should be diagnosed before coma supervenes but a few of the findings in the comatose condition will be mentioned. Weller and Christensen,

(1926) in a summary of the literature on the subject say that besides the usual findings of lead poisoning and history of the disease, that the spinal fluid pressure, which may be elevated to 750-1000 mm., is due to an extreme degree of cerebral edema. The fluid may be tinged with yellow but not necessarily. If pleocytosis is present it is present in a mild degree. Lead may be found in the fluid.

The Effects of Physical Extremes

In this group is included comatose states or shock resulting from extremes in cold, heat or contact with high voltage electrical currents. As far as the diagnostic problem is concerned, the history, when available will usually make a diagnosis. Earl C. Elkins, (1938) differentiates between heat exhaustion and heat storke by saying that the first is due to exhaustion, the skin is pale and clammy, the pulse rapid, and the temperature is subnormal. Heat stroke exhibits similar symptoms except that it is usually more sudden in onset and exhibits a definite rise in temperature. The treatment in the first case is that of shock, while that in the second is an attempt to get the body temperature to normal.

Diagnosis of the other two will be made by history and treatment will be that of shock.

Effects of Rapid and Great Alteration in the Surrounding Atmospheric Pressure.

This group of conditions, Caison's disease, coma resulting from bringing divers too rapidly to the surface, and conditions arising when baloonists and aviators rise too rapidly to great heights will necessarily depend on history and it is inconceivable for them to present themselves as causes of coma where a history would not be available. The cardinal symptom of Caisons disease is pain or "The bends" in one or more extremities, followed later by dyspnea, choking and finally coma. According to Cecil (1937) once collapse has occured, recovery is very remote.

Excessive Loss of Blood

According to George Johnson, (1869) the cause of any type of coma is deoxidation of the brain tissues, and that this is brought about lack of sufficient blood, lack of thorough aeration, lack of proper circulation, or violent contraction of the arteries which he believed was responsible for epilepsy.

Of the conditions falling under this heading in French's classification the diagnosis is usually obvious except perhaps in the case of a rupture of a tubal pregnancy.

According to DeLee, (1934) when a woman in the reproductive period misses a menstrual period, then later complains of cramp like pains in the lower abdomen, one should always think of an ectopic gestation. When rupture occurs, and bleeding occurs to such an extent that coma intervenes, there will usually be no or little bleeding externally, the symptoms will far exceed the apparent blood loss, a mass may be found alongside of the uterus.

Stokes Adam's Disease and other Heart Conditions

Edgar A. Hines, (July 1938), says, "The Stokes Adam's syndrome, or convulsive syncope is one of the most dramatic phenomena of heart disease, the treatment very discouraging, and palliative at best".

According to Best and Taylor, (1937) the cardinal features of the Stokes Adam's syndrome are as follows: Extrasystoles, delay in A-V conduction, complete heart block.

Of Solomon and Aring's cases (1935) 1.4% were cases of cardiac decompensation. The diagnostic points were: history of heart disease, and high blood pressure, abnormal heart findings, cyanosis, pulmonary congestion, peripheral edema, dyspnea, and quite commonly an enlarged liver. These findings of course should be confirmed by E.K.G.

Sudden Nervous Shock Hysterical Trance
Narcolepsy

These conditions are rare as causes of coma but should be mentioned. Malingering should be mentioned with them. It may be diagnosed by absence of any positive findings as to history or physical or laboratory proceedures.

Sudden nervous shock when an etiological agent will be diagnosed by history and the surrounding circumstances, and usualy produces no more than a transient or temporary coma.

Hysterical Trance and malingering will be difficult to differentiate between and will both be suggested by lack of positive findings. However, every effort should be made to find something organically wrong before making such a diagnosis.

Luman E. Daniels, (1934) in a survey of the literature concerning Narcolepsy, says that the diagnostic points are: history of previous attacks, desire to sleep which is irresistible, presence of cataplexy, and disturbance of nocturnal sleep. R. L. Gordu, (1938) says that the narcoleptic will have in history the idea that he falls asleep at times whether he wants to or not yet will feel himself to be in perfect health.

Routine Handling of Comatose Conditions

Several authors in the last several years have written on the advisability and the need for a definite routine to be used in hospitals for the handling of comatose patients when they enter the hospital due to the fact that the the resident staff is constantly changing. It is their opinion that if this is carried out that the incoming internes will receive the benefit of diagnostic helps picked up by preceeding members of the resident staff. A summary of these articles of Bishop and Appelbaum, (1929), Solomon and Aring, (1936), and P. Solomon, (1938) follows.

The medical student ordinarily receives little instruction from school and text book in the practical matter of handling coma. The hospital interne soon acquires skill in this by experience but it seems advisable that he have a definite routine to follow.

I The history is of paramount importance and if no friends are along, talk to the ambulance man who brought the patient to the hospital. Send out a policeman or social worker to get a history if it is unobtainable by other means. Inquire as to the type of onset, whether or not there was injury. Inquire about

the use of alcohol, ingestion of poisons, previous infections. Were their convulsions? Did the patient have a previous illness, headache, diabetes, kidney disease, heart disease or high blood pressure?

II In the matter of physical examination be rapid and thorough. Remember that this is essentially vetinary medicine. The patient cannot help you. Use your eyes, note color, posture, movements, look for wounds, especially in scalp injuries. Examine the pupils, eyegrounds, eardrums, and throat. Use your nose to determine odor of breath. Is it alcoholic, acetone, illuminating gas or what? Use your hands and feel for stiff neck, fractures, muscle and vaso-motor tone, for enlarged glands. Palpate the abdomen and test reflexes. Listen to the heart and lungs and take the temperature, pulse, respiration and the blood pressure.

III Roentgenograms should be taken on the way to the ward, unless the patient is in shock. Skull plates should be taken routinely in the accidents and in any other case where it is indicated.

IV Gastric Lavage should be done in all cases of suspected poisoning and the contents should be saved for

examination. A catheterized urine specimen should be taken, examined for presence of reducing substances and acetone, albumin, and blood. Routine blood and blood cultures should be done when at all indicated. Take blood routinely for Wasserman and non protein nitrogen determinations on all non-traumatic cases. Other things that may be of assistance are: Spectroscopy, Icteric index, Vandenbergh, E. K.G., Blood Carbon dioxide, etc.

V Lumbar puncture: Routine in all injuries except if patient is in shock. It is especially important in suspected cases of cerebro-vascular accidents, meningitis, and any other brain or cord conditions. Note the pressure, color of fluid, Queckenstedt, cell count, protein, Wasserman reaction, gold reaction and any other routine that is indicated.

BIBLIOGRAPHY

Adams, F.L.: The Seven Books of Paulus Aegineta, Translated from Greek, London; Printed for Sydenham Society, 1884. V. I.

Aring, C.D., & Merritt, H.H. 1935. Differential Diagnosis between Cerebral Hemorrhage and Cerebral Thrombosis. Arch. Int. Med. V. 56, p. 435.

Barnes, A.R. 1927. Goiter Crisis with Coma. Proc. Staff Meet. Mayo Clin. v. 2 p. 162.

Bauer, E.R. 1934. New Treatment of Various Kinds of Coma with Liver Extract. Ann. Int. Med. v. 8, p. 595

Best & Taylor: Physiological Basis of Medical Practice, Baltimore, Maryland, William Wood & Co. 1937.

Bissell, W.W. & LeCount, E.R. 1915. Relative Frequency of the Various Forms of Coma with special reference to Uremia. J.A.M.A. v. 64, p.1041.

Bissell, W.W. & LeCount, E.R. 1917. Relative Frequency of Various Causes of Coma. J.A.M.A. v. 68, p. 500.

Bishop, L.F. Jr., & Appelbaum, E. 1929. A Coma Routine. New York State J. Med. v. 29, p. 1382.

Beardwood, J.T., jr., 1938. Coma and Acidosis in Diabetes Mellitus. Internat. Clin. v. 3, p. 30.

Cecil, R.L. A Text Book of Medicine. Philadelphia & London, W.B. Saunders Co., 1937.

Daniels, Luman E. 1934. Narcolepsy. Medicine. V. 13, p. 1.

DeLee, Joseph B. Principles and Practice of Obstetrics, Philadelphia and London, W. B. Saunders Co. 1934.

Dorland, W.A. Newman. A Medical Dictionary, Philadelphia and London, W.B. Saunders & Co. 1936.

Dorland, E.W., & Kepler, E.J. 1938. Exopthalmic Crisis. Proc. Staff Meet. Mayo Clin. v. 13, p. 817.

Dorland R.H. 1938. Differential Diagnosis between Cerebral Hemorrhage, Cerebral Thrombosis, Cerebral Embolism & Subarachnoid Hemorrhage. M. Clin. North America. v. 22, p. 479.

Elkins, Earl C. 1938. Discussion of Emergencies due to contact with physical agents. M. Clin. North America. v. 22, p. 1009.

Eskeridge, J.T. 1898. Difficulties in Determining the Causes of Coma. New York State J. Med. v. 67, p. 137.

Forsythe, D. 1912. Coma and its Differential Diagnosis. Brit. M.J. v. 1, p. 1063.

French, Herbert. An Index of Differential Diagnosis of Main Symptoms. Baltimore: William Wood & Co. 1936.

Friedman, E.D. 1933. Case of Coma from Unknown Cause. New York State J. Med. v. 33, p. 132.

Gordu, R.C. 1938. A Report of 62 Cases of Narcolepsy. Clin. Med. & Surg. v. 45, p. 318.

Hines, Edgar A. 1938. Discussion of Cardiac Emergencies. M. Clin. North America. v. 22, p. 101.

Holcomb, B. 1921. Causes & Diagnosis of Various Forms of Coma--further considerations. J.A.M.A. v. 77, p. 2112.

Johnson, George. 1869. Lectures on the Physiology of Coma and Anaesthesia. Med. Times & Gazette, v. 1, p. 351.

Keegan, J.J. 1937. Lectures in Junior Surgery course.

Kepler, E.J. 1938. Diagnosis & Treatment of Medical Emergencies. M. Clin. North America. v. 22, p. 1008.

Kinimoth, J.G. 1933. Puerperal Coma -- Rapid Recovery Following Inflation of Breasts. Brit. M.J. v. 1., p. 395.

Krafchik, L.L. & Slobody, L.B. 1938. Tbc. Meningitis resembling Diabetic Coma. Arch. Pediat. v. 55, p. 292.

LeCount, E.R. & Guy, C.C. 1925. Spontaneous Intercerebral Hemorrhage & Uremia. J.A.M.A. v. 85, p. 2005.

Lewis, W.H. Jr., 1938. Medical Aspects of Coma with Particular Reference to Respiratory Disturbances. J. M. Soc. New Jersey. v. 35, p. 23.

Lumleian Lectures, 1850. The Pathology & Treatment Of Delerium & Coma. London Med. Gazette. v. 45, p. 703.

Mamott, H.L. 1933. On Washing out the Stomach in Comatose States of Poisoning. Lancet, v. 1, p. 963.

Menninger, W.C. 1927. Pupils as an Aid in the Diagnosis of Coma. J. Nerv. & Ment. Dis. v. 65, p. 553.

Merritt, H.H. & Lennox, W.G. 1936. The Cerebrospinal Fluid in "Essential Epilepsy. J. Neurol. & Psychopath. v. 17, p. 97. Cited by Merritt & Smith(1938)

Merritt, H.H. & Smith, 1935. Cerebro Spinal Fluid in Tuberculous Meningitis. Arch. Neur & Psychiat. v. 33, p. 516.

Merritt, H.H. 1938. Diagnosis & Treatment of Vascular Lesions of Brain. M. Clin. North America. v. 22, p. 577.

Merritt, H.H. & Smith, F.F. The Cerebro Spinal Fluid. Philadelphia & London, W.B. Saunders & Co. 1938.

Munro, D. 1934. The Diagnosis, Treatment, and Immediate Prognosis of Cerebral Trauma. Introductory study of 1494 cases. New England J. Med. v. 210, p. 287. Cited by Merritt, & Smith, (1938).

Neal, J.B., Jackson, H.W. & Appelbaum, E. Meningitis due to Influenza bacillus of Pfeiffer. A study of 111 cases with four recoveries. J.A.M.A. v. 102, p. 513. Cited by Merritt & Smith, (1938).

Ohler, W.R. & Hurwitz. 1932. Spontaneous Subarachnoid Hemorrhage. J.A.M.A. v. 98, p. 1856.

Purves, J., Slavore, & Wilcox. 1934. Cisternal Drainage in Coma from Barbitone poisoning together with Observations on Toxic Effects of Continuous Barbital Medication. Lancet, v. 1, p. 500.

Rouselle, A.E., 1926. Pneumococcic Meningitis Simulating Diabetic Coma. Atlantic M. Journal. v. 30, p. 159.

Solomon, Philip, 1938. Causes, Diagnosis & Proper Handling of Coma. M. Clin. North America. v. 22, p. 617.

Solomon, P. & Arring, C.D. 1934. Causes of Coma in Patients Entering General Hospital. Am. J. M. Sc. v. 191, p. 357.

Spandler, B.P. & Bilbon, C.S. 1937. Association of Diabetes Mellitus with Thyroid Storm. New York State J. Med. v. 37, p. 2023.

Strause, S. & Binswanger, H.F. 1936. Treatment of Coma. M. Clin. North America. v. 19, p. 1265.

Tice, Frederick. Practice of Medicine. Hagerstown, Maryland; W.F. Prior Company. v. IX, p. 263.

Weller, C.V., & Christensen, A.D. 1925. The Cerebro spinal Fluid in Lead Poisoning. Arch. Neurol. & Psychiat. v. 14, p. 327.

Young, G.S. 1934. Differential Diagnosis of Coma. Canada Med. Ass. Journal. v. 31, p. 381.