IRREVERSIBLE COMA

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Mollaret and Goulon in 1939 reported several cases who could only be maintained on reanimation as a heart-lung preparation and called this state "Coma dépasse" or irreversible Coma (4).

Before the era of reanimation, the severest type of coma was known as "Coma Carus" (15). A patient in this state had complete unconsciousness, areflexia and a loss of motor and sensory nerves besides a severe disturbance of neuro-vegetative system which governs respiration and circulation. When this disturbance reaches a certain stage, the patient dies of either circulatory or respiratory failure. The reanimation methouds applied during the last 15 - 20 years maintain satisfactory circulation and respiration even in patients with neuro-vegetative disfunction in deep coma. Some of these patients recover completelyl arter being maintained on artifitial respiration, circulation and nutrition for a satisfactory period of time, if the central nervous system disturbance is reversible. If the central nervous system disturbance is irreversible, reanimation enables the patient to maintain a half-dead state as a heart-lung preparation for a few more days until the heart stops.

A new problem came up when some of these patients were considered as organ for organ transplantations. A decision should be reached before the organs suffer irreversible damage. The answers irreversible damage. The answers to the following two questions will be helpful for this decision.

1 — What are the signs that indicate the patient is unable to recover?

2 — When can this patient be considered dead?

This subject is still open to discussion from the point of law, morality and medicine. We will consider the problem from the medical point of view and discuss the answers to the above questions.

I — The Diagnosis of Irreversible Coma :

According to Mollaret and Goulan (15) who first used the term "Coma dépasse" in 1959 describing 23 cases that they have studied in a year period the chief signs of irreversible coma are as follows:

— Hypotonia

— Complete loss of all reflexes (plantar reflexes are not elicited, idiomuscular reflex can be elicited as mio-edema)

— Bilateral mydriasis and motionless eyeballs

— Complete lack of response to all stimuli (loss of medullar automatism)

— Complete loss of spontaneous respiration

— Cardio-vascular collapse (when nor-adrenalin perfusion is stopped)

— Disturbance of thermic regulation (hypo- or hyper-thermia related to environmental temperature)

— Linear EEG pattern and lack of response to stimuli (often EEG is observed in EEG as a disturbance)

In cases with signs of spontaneous respiration, this EEG pattern is not enough to make a diagnosis of irrecersible coma.

The following etiological factors are discovered in Mollaret and Goulon's 23 cases:

Trauma to the head (4 cases), ventricular haemorrxhage (3 cases), untreated purulant menengitis (2 cases), phlebitis in the brain (2 cases) intracranial hematoma formed during status epilepticus (2 cases), syncope and hypotension during sutgery (2 cases), posterior fossa operation (4 cases), thrombos is of arteria Silvius (1 cases), delivery in a myastenic treated with quinine (1 case) and viral encephalitis (2 cases).

The four cases summaries showed a duration of 3-5 days.

Agaén in 1959 Fischgold and Mathis (6) described irreversible coma and called it "Coma Stade IV", "As a result of severe heart and respiratory failure, life can be maintained only with artificial respiration, cardiac reanimation and hypertensive drugs. Brain stem and bulbus are unable to maintain vegetative functions spontanebusly and brain does not live. In more advanced stages medula spiralis also fails."

They also described the same clinical and electroencephalographic picture of irrecersible coma and stressed the impossibility of diagnosing these cases with electroencephalography alone.

In later years similar conclusions were drawn by Schwab et al. (22), Rosof and Schwab (20), Schharfetter and Schmoigl (21) and Fischgold (5).

In 1968 the French EEG and Clinical Neurophysiology Society formed a special commitee to investigate "the EEG criteria of irreversible damage to cerebral function". In the report published by the commitee in 5.3.1969, a very important point is emphasized 1): the above criteria of irreversible coma are not satisfactory in casesof acute intoxication, accidental and indced hypothermia and in children yonger than 8 years.

The following is a summary of this report wich deals with all the details of this problem.

A — Chief causes of irreversible coma:

1 — Local causes (head traumas, brain-menincs hamorhages, brain tumors increased intracranial pressure, diffuse encephalitis, purulant menengitis).

2 — Sistemic causes (circulatory failure of long duration, respiratory failure of long duration, hypoglycemias).

1 — Signs before the establishment of irreversible coma (coma, clonic convulsions, posterior tonic convulsions, disturbance in vegetative functions, transitory respiratory failure, hyperthermia, tachicardia, bradicardia, hypertension).

2 — Essential signs (spontaneous arrest of respiration when artificial respiration is stopped for 1 - 3 minutes complete lack of motion, hypotonia, no response to all stimuli, total aareflexia, bilateral mydriasis).

3 — During the first two hours after respiration stops, Babinski may remain positive, signs of medullar automatism and tonic contractions may be seen.

4 — Vegetative signs:

a) Hypotension

— may be the cause of irreversible coma

— may be one of the first signs of irreversible coma appearing in the first few minutes.

— may form slowly and may respond to treatment with analeptics and may be kept at a level for 48 hours or so.

b) Cardiac beat is regular. Heart is insensitive to central-acting drugs such as atropin and to anoxia. When artificial respirator is stopped heart beat may continue for 10?20 minutes.

c) Hypothermia may appear after 6-24 hours.

d) Diuresis is dependent upon hemodinamic condition, Polyuria insipidus may appear and responds to pitressin not infrequently.

5 — Lividity appears in 2-3 days. Although there is no apparent signs of circulation in the large arterics, lividity continues. The heart stops in 4-5 days in spite of all efforts of reanimation

II - The EEG Pattern of irreversible coma and points requiring special attention during the taking of EEG :

In 1955 Fois and Gibbs (7) reported that EEG became a straight line in cases with somplete loss of cerebral activity, indicative of a grave prognosis for the patient. They also pointed out that this EEG pattern may appear during anesthesia, not related to and organic lesion.

Fischgold and Mathis (6) claimed that the electrical cilence in EEG did not necessarily mean cerebral death and emphasized two observations which demonstrated that the decisionf of death cannot be reached by EEG alone.

1 — The first is a case of Guiot and Arfel, who had a cardiac standstill for 5 minutes at the beginning of an operation under Trilen-Ether anesthesia. EEG's taken 15 minutes and 2 hours after cardiac standstill showed the linear pattern, there was no corneal reflex, the pupils were mydriatic but the patient reacted to pinching. This patient recorvered slowly and the EEG became normal. The patient died suddenly 11 days after surgery.

2 — Another case went into a coma during surgery because of gas emboli. EEG taken 24 hours later showed a linear pattern. The patient continued to have spontaneous respiration although no reflexes could be elicited. This patient recovered completely.

These two cases illustrate the view that central nervous system death cannot be diagnozed solely on the basis of EEG findings. In the first case when the EEG was a straight line, the patient reacted to pinching. In the second case spontaneous respiration was present during EEG silence. These findings indicate that the patients were not in irreversible coma from the clinical point of view. Of all the clinical findings of irreversible coma are not present, 1. c. is out of question even in the presence of linear EEG. This dictum has not lost its value since 1959.

In later years there were more reports on the bad prognostic sign of isoelectric EEG pattern.

Hockaday et al. (9) investigated the correlation between EEG pattern and prognosis in cases of cerebral anoxia due to respiratory and circulatory failure. 14 patients with linear EEG patterns were all dead. Prior and Valvka (18 reported that all cases of cardiac standstill with isoelectric EEG patterns, even those with minimal delta activity, died.

On the other hand, Mellerio (14) reported recovery of a case of intoxication with a linear EEG for 24 hours. Kruz (11) reported 3 patients with linear EEG's for 3 hours recovered subsequently. There are several other papers claiming that the electrical silence, although a bad pragnostic sign, is not enough for the diagnosis of irreversible coma (10, 13, 16, 21).

In addition to isoelectric EEG all the clinical signs of irreversible coma. In order for a definite diagnosis of death Nedey and Gouvet (17, 10) required two EEG's taken 12 hours apart, Riehl (19) 24 hours apart, and Rosof et al. (20) 24-72 hours apart to show linear patterns.

The following technical points should also be taken into consideration during EEG taking:

1 — At least 10 electrodes should be used.

2 — The distance between two electrodes should be 5-6 cm.

3 — The resistance on surface electrodes sholud not be less than 1o,000 ohms.

4 — If needle electrodes are employed, the resistance should be measured by a special instrument. (Electrolysis formed around the electrode increases the resistance).

5 — The time constant should be 0.3 or 0.7.
6 — Filters should not be used.
7 — Amplification should be increased to 12.5 mic V/cm.
8 — Electrodes should be tied bipolarly.
9 — Simultaneous EEG should be taken in order to differentiate artefacts.

EEG taken under these conditions must show a linear patterm and no activity is recorded after severs stimulation. More than 50 % of cases show EKG disturcance in the EEG. Arfel (2, 3) proved that the response to photic stimulation in some cases is actually electroretinogram, reflecting retinal activity ax instead of activity.

III — Brain Angiography in Irreversible Coma :

A patient going into irreversible coma develops brain edema and increased intracranial pressure. If the ratio of arterial pressure/ intracranial pressure falls lower than 13/3.5 blood flow decreases. Gros (8) proved this point in experimental animals and showed that the arrest in the blood circulation in the brain results in death in a few days. Aangfitt et al. (12) reached to similar conclusions and showed that the arrest in blood circulation in the brain results in the disappearance of electrical activity in the EEG. Lorenz (13) claims that if the blood circulation in the brain is slower than 15 seconds, it is incompatible with lire. Radio-opaque material does not reach higher than the base of the brain in a patient in irreversible coma in the carotis angiogram, and in rare cases the circulation stops at the arterial phases (8). Even in the latter cases heart beat can be maintained for a few more days by reanimation methods.

The arrest in cerebral circulation is an important sign of irreversible coma but technical difficulty of angiography nad the possibility of harming the patient prevent its application in every patient. If it can be done, it is a valuable sign.

IV — Conclusions of several committees formed for the investigation of Irreversible Coma :

1 — An investigation conducted among the members of the German EEG society in 1967 reached the following conclusions (23).

Irreversible coma

A patient can be declared dead if there is no spontaneous respiration, but there is araflexian and bilateral mydriasis, if am EEG taken with a 4-canal instrument, with high amplification but no filters shows na activity and all these signs last at leatst 6 hours.

2 — In 1968 a special committee formed by Harward Medical School described irreversible coma as follows (4) :

a) No signs of sensitivity or reaction to stimulf.

b) No motion (When the respirator is stopped, no respiration activity in) minutes while PCO_2 is normal).

c) Complete areflexia. The pupils remain mydriatic.

d) Linear EEG does not change with stimulation (EEG should be taken at least lo minutes).

A second examination performed in 24 hours must show the same findings.

They also emphasized that it is imperative that the patient should not be in hypothermia (lower than 32.2° C) or under the effect of central nervous system depressors such as barbiturates.

3 — The summary of the findings of the special committee formed by the French EEG and Clinical Neuro-pyhsiology Society was given in a previous cestion. They differ from the Harward committee in two points:

a) The French committee recommends 2 EEG's taken 12-24 hours apart lasting at least 1 horu each instead of the 2 EEG'e taken 24 hours apart lasting 10 minutes each.

b) As emphasized above, the French committee claimed that all these criteria are not enough to make a diagnosis of irreversible coma in children under 8 years.

4 — The Medical Ethics committee formed by the Turkish Medical Association published a declaration in June, 8. 1968 and described "Physiological death" as follows:

a) Bilateral constant mydriasis

c) Arrest of spontaneous respiration and circulation and inability to regain these functions after adequate reanimation.

d) The functional status of the brain should be checked preferably by EEG which shows no activity and reanimation methods are without effect in producing electrical activity.

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