of the blood pressure occurred. They found that slow injections of dilute solutions minimized the undesirable effects on respiration and circulation of piperidine derivatives resembling pethidine when administered to patients under nitrous oxide and oxygen anaesthesia.

Summary

The employment of pethidine hydrochloride as an adjunct to nitrous oxide and oxygen anaesthesia has been discussed, with special reference to its anticholinergic and antihistaminic properties.

A method of maintenance by a continuous intravenous pethidine drip is outlined.

The importance of slow injections of dilute solutions is emphasized.

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POST-MORTEM EXAMINATIONS ON AIR-CRASH VICTIMS

BY

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On October 31, 1950, a Viking aircraft of British European Airways, flying from Paris to London, crashed in thick fog at London Airport. The wreckage burst into flames and 28 out of the 30 occupants of the plane were killed. Post-mortem examinations on all the victims were ordered by the coroner of the district, for the purposes of identification and to determine the cause of death. Since the religious tenets of many of the victims required a rapid burial the examination of the remains became something of an urgent problem.

Organization

The facilities of the local mortuary were not ideal for examination of such a large number of bodies. It had a refrigeration chamber for six, one fixed post-mortem table, and room for three trolleys. A marquee was set up close to the mortuary, in which the bodies were first placed and numbered. They were there stripped of such clothing as remained, and this was put into bags and similarly numbered. To assist in the identification, there were present a coroner's officer and a senior member of an undertaking firm, who had had experience in similar types of disaster. They had a complete passenger list of the occupants of the plane when it left Paris. There were two mortuary assistants and several bearers. The post-mortem reports were typed out directly in the mortuary by my secretary. The general principle employed was to examine those readily identifiable first, and so narrow down the number which might prove difficult of identification towards the end.

As it was thought necessary to estimate the carbon monoxide haemoglobin of each victim, 4 ml. screw-cap bottles were numbered in advance and 28 post-mortem reports were similarly numbered.

The specimens of blood were taken into these screw-capped bottles, filled to the brim to obviate any loss of carbon monoxide from the blood—a loss which may vitiate the value of a carboxyhaemoglobin estimation, particularly if the bottle is shaken in transport. Urea estimations were performed on the specimens of blood at varying intervals, up to seven days, in the hope of finding some variation which might assist in the estimation of the time of death in cases in which such time was unknown. They proved valueless.

Identification

Though most of the bodies were very severely burnt, particularly about the face and head, the problem of identification did not prove as difficult as was at first thought. Facial recognition was, except in a few cases, quite impossible, but in most cases the clothing of the chest and abdomen was relatively spared and passports were recovered from the inside coat pockets of the majority of the men. The women, keeping their passports in handbags, proved the more difficult to identify. The question of sex never presented any difficulty, but stature was difficult to estimate owing to the destruction and contortion of the limbs as the result of heat. The age could be roughly estimated by the state of the costal cartilages, skull sutures, and other skeletal changes.

As soon as a body was definitely identified, either by papers or by clothing, the name was added to the number on the body, on the clothing, and on the post-mortem report and specimen of blood. These steps led to the rapid identification of 25 of the victims. There remained two women and one man, and these three were all identified positively by means of their teeth. It must be remembered that, while a person's name may appear on the passenger list of a crashed aircraft, the relatives are not unnaturally loath to accept this as the only evidence of the death of one close to them. The man was an American, and his dental chart was transmitted from New York for identification.

The Cause of Death

The post-mortem examinations revealed several important points. All the victims had received injuries which would lead to immediate loss of consciousness or death. Twenty-three of the victims had no measurable concentration of carbon monoxide in their blood; three had less than 15%; and two between 15% and 20%. None of the latter showed any burning of the internal air passages such as is seen in the victims of a bursting boiler or the "flash and flame" discharge of a high-voltage electric current. It was reasonable to suppose, therefore, that most of the victims were dead before the outbreak of fire, and that the remainder, whose injuries were very severe, were unconscious and lived only for a matter of seconds in the fire. Furthermore, it would appear that had no fire occurred the fate of the occupants would have been the same. The actual causes of death may be summarized as follows:

Fractured skull	..	..	..	..	..	10
Fractured cervical spine	..	..	..	..	..	1
Traumatic subarachnoid haemorrhage	..	..	..	..	..	1
Ruptured aorta	..	..	..	..	..	8
Ruptured lungs	..	..	..	..	..	3
Ruptured heart	..	..	..	..	..	3
Ruptured liver and spleen	..	..	..	..	..	2

It will be seen that 16 of the 28 died of injuries to the chest and upper abdomen, and that, of these, eight had died of a most unusual injury—rupture of the aorta in its descending thoracic part. I have seen only three other cases of death from traumatic rupture of the aorta in 25,000 necropsies, and, of these three, one was the radio-operator of the Dakota which crashed at Mill Hill a fortnight earlier; the other two resulted from crushing injuries to the chest in traffic accidents. The radio-operator of the Viking was among those dying of rupture of the aorta.

The ruptures of the aorta were associated with fractures of the ribs, disruption of the intercostal muscles, fractures of the spine, or laceration and bruising of the anterior surface of the liver. These injuries were, in my opinion, caused by acute flexion of the body over the safety-belt. A similar mechanism could well have accounted for the findings in the eight who died from laceration of the heart, lungs, or liver and spleen. It would also appear that had these travellers been seated with their backs "to the engine" and supported by cushioned upholstery these particular types of injury might have been avoided.

It is clearly of little consolation to escape a sudden death only to die in a conflagration, but not all crashed aircraft catch fire, and presumably with advances in foam-protected petrol tanks the danger of fire will diminish.

Witnesses were not available to tell how the passengers in the aircraft were seated, but a study of the injuries revealed a remarkable similarity between the injuries of seven pairs of victims who might reasonably be expected to be sitting together. Thus two married couples all had ruptures of the aorta, another couple both had ruptures of the liver and spleen, while two men who had good reason to be seated together were the least severely injured—both sustained head injuries only, of a severity which suggested that had the speed of impact been a little less they might well have escaped. This is pure hypothesis, but suggests that certain parts of an aircraft are more dangerous than others in the event of a crash—a fact which is possibly obvious, and well supported by the escape of the steward of the Dakota at Mill Hill and the stewardess of the Viking, who were both in their correct positions in the tail of the aircraft.

Conclusions

Such a disaster as the crash of a passenger-carrying aircraft presents special problems to a pathologist called on to perform necropsies.

(1) The post-mortem examination of air-crash victims requires a small but efficient organization to facilitate identification and burial.

(2) Blood-urea estimations are of no value in estimating the time of death.

(3) The problem of identification should be approached by dealing with those easily identifiable first, and so narrowing the field of the more difficult cases.

(4) Identification by means of dental records is the most certain method in this class of accident.

(5) The immediate cause of death in more than half of the victims was acute flexion of the body over the safety-belt.

(6) This hazard might be lessened by air passengers travelling "back to the engine."

THE PROZONE PHENOMENON IN HAEMAGGLUTINATION REACTIONS

WITH SPECIAL REFERENCE TO
THE QUANTITATIVE ANTIGLOBULIN TEST*

BY

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Quantitative studies of precipitin and flocculation reactions have shown that both require optimal proportions of antigen and antibody. It is well known, for instance, that a series of test-tubes in which decreasing amounts of diphtheria antitoxin are mixed with a constant amount of toxin often shows a "prozone" of antibody excess where the antigen-antibody complex remains soluble (Ramon, 1922). Similarly, a flocculating system of decreasing amounts of horse serum and a constant amount of rabbit antiserum shows a prozone where the antigen-antibody complex is soluble in an excess of antigen (Dean and Webb, 1926). Many other examples have been published since these original reports.

It is well known, of course, that the optimal ratio differs for each antigen-antibody complex if either the constant antigen or the constant antibody technique is alternately used. But this has no bearing on the fact that prozones are in both cases due to an excess of antigen or antibody where the complex is "protected" against the precipitating effect of environmental factors, especially of salts.

Prozones have also been met with in the agglutination reactions. In this particular case of the antigen-antibody reaction, however, it is noteworthy that each bacterial or red cell has a fixed "load" of antigen. As the agglutination can be easily read only in a very narrow range of strength in the cell suspension, it is very difficult to vary the antigen concentration in the system. The prozones observed in agglutination reactions are then always situated in the antibody-excess range and could be interpreted as a purely quantitative phenomenon.

Other explanations have arisen from the study of these prozones. Shibley (1929), for instance, observed prozones with moderately heated agglutinating antisera, and postulated that heat had modified the agglutinin into an agglutinoid which combined with the antigen without bringing an agglutination. He showed, indeed, that the cells within the prozone were subsequently unagglutinated by an agglutinating dose of fresh antiserum. The work by Bawden and Kleczkowski (1942) suggests that heat would combine some serum albumin with the antibody molecules and induce the blocking property.

On the other hand, with the discovery of the blocking effect in anti-Rh sera, Wiener (1944) suggested that blocking antibodies could be held responsible for the prozone phenomena met with in titrations of anti-Rh sera. This interpretation was supported by a blocking effect within the prozone.

While studying prozone-giving anti-Rh sera Levine and Waller (1946) observed that suitable absorption

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