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CARBON MONOXIDE POISONING IN THE HOME*

Cyril John Polson

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Carbon monoxide poisoning in the home has for long been a commonplace. It is clear, however, that so long as accidental poisoning continues to occur there is room for recurrent reminders of the dangers of carbon monoxide.

The present account is based on a detailed examination of the records of over 700 fatalities which have occurred during the past twenty five years in the City of Leeds.

THE DANGERS PECULIAR TO CARBON MONOXIDE

It requires no reflection to appreciate that any poison which is gaseous, and at the same time colourless, non-irritant and, may be, odourless, has grave potential dangers. Although coal gas, the usual source of carbon monoxide, has a distinctive smell there are a number of persons who are unable to detect its presence even in high concentration. It may be they suffer from a cold in the head or have an impaired sense of smell because of age or some inherent defect.

It must be recalled that the blood pigment, haemoglobin, the prime function of which is to abstract oxygen from the air for the nourishment of the body tissues, also has an affinity for carbon monoxide. This affinity, originally recognised by Claude Bernard, was shown by Haldane and Douglas, by personal test, to be almost exactly 300 times greater than the affinity between haemoglobin and oxygen (Haldane, 1931); subsequent estimations (Taylor, 1948) assess it as between 200 and 250 times. Therefore the blood, when presented with a mixture of carbon monoxide and air will take up carbon monoxide in preference to oxygen; moreover, this will continue so long as the atmosphere contains carbon monoxide, or until the blood is saturated with it. Of its several dangers this cumulative effect is perhaps the most important. The practical consequences are that not only high but also low concentrations of carbon monoxide are dangerous. Even a concentration of only one per cent or 1,000 parts per 100,000 will kill those

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exposed to it for a brief period. When Haldane (1895) inhaled such a mixture the concentration of carbon monoxide in his blood reached half saturation, a dangerous level, in 15 minutes and death would have occurred in under half an hour. Exposure to a concentration of only 150-200 parts per hundred thousand, for one to four hours, will produce dangerous symptoms. H.M.Factory Department (1945) recommend that where men are to be exposed for several hours the concentration of carbon monoxide in the atmosphere can be up to and below 10 parts per 100,000 (0.01%).

The cumulative effect of the poison also indicates removal of the victim from the poisoned atmosphere as the first and immediate step in rescue attempts. Delay even by minutes may make all the difference between the survival and death of the victim.

The effects of oxygen want, which is the essential result of this poisoning, are exaggerated by effort. Ataxia or unsteadiness is likely even at rest when the blood is half saturated, and an attempt to escape would then result in immediate collapse.

It is common experience that persons fail to remember these dangers although their occupation compels a special knowledge and experience of carbon monoxide.

One instance will suffice. An acquaintance, who is a heating engineer and a former member of a mines rescue team, nearly lost his life because he did not remember the danger created by exhaust fumes of a motor car in a closed garage.

One evening during the last war he had to effect some repairs to his motor car; the garage doors were closed to prevent any light showing outside. After a time he switched on the engine to test it. Presumably he was intent upon the results of his work and then, feeling unwell, he realised he was poisoned by carbon monoxide. He managed to stagger to the garage doors before he collapsed, and, fortunately, they were insecure and burst open under his weight. The escape of light from the garage attracted attention, and he was found lying unconscious in the drive.

The speed with which a dangerous situation can arise in such circumstances has been ascertained by experiment. The engine of a 20 H.P. motor car will produce a cubic foot of CO per minute and therefore it requires half an hour or less for the atmosphere to become lethal, when such an engine is run in a closed garage of average size (Henderson & Haggard, 1927). This was confirmed by tests with a five-seating motor car, the engine of which, when run for twenty five minutes in a closed garage of 2,950 cu.ft. capacity, raised the concentration of CO in the atmosphere to 1.31%; at the end of an hour the concentration was raised to 2.1% (Yant, Jacobs, and Berger, 1924).

THE INCIDENCE OF CARBON MONOXIDE POISONING

In recent times fatalities due to carbon monoxide poisoning in England and Wales have totalled about 2,000 each year. Except in respect of industrial accidents, accurate figures are not available concerning non-fatal poisonings. During the past 25 years there were 711 domestic fatalities in Leeds. The annual incidence ranged from 15 in 1930 to 52 in 1951 and averaged 28 per year, representing a rate of approximately 5.5 per 100,000 of the population.

In industry, despite the wide use of carbon monoxide, often in odourless mixtures, the annual accident rate is one of only about 220 cases each year and of these less than 10% prove fatal (H.M. Factory Department, 1945).

Suicidal fatalities in Leeds accounted for 625 or 87.9% of the series; accidental poisonings totalled 60, or 8.4%, and there were 5 homicides, representing 0.7%. The remaining 21 deaths, or 3%, occurred in circumstances which led to an "open" verdict. It is probable that the Leeds experience is representative of that in other cities and urban areas; it is in close agreement with a London series of 838 fatalities (Camps, 1950).

Amongst suicides, as is well recognized, carbon monoxide is the common mode; it is responsible for a third to nearly a half of all suicides, depending upon whether it is an urban or rural area, whereas the next choice, namely drowning, accounts for only a sixth. Suicide by poisons other than carbon monoxide, despite the increase in their use, accounted for only one tenth of the suicides and takes fourth place. There have been 1,372 suicides in Leeds during the past 25 years and of these 615 or 44.7% were by carbon monoxide poisoning, 242 or 17.6% by drowning, 173 or 12.6% by hanging, and only 144 or 10.5% by poisoning other than by carbon monoxide.

The Pattern of Suicide. The essential features of suicidal poisoning, as might be expected, either overtly or indirectly, show intent. They are sufficiently well known to require only a brief recapitulation.

At least a third of the deceased leave letters, notes, or notices in which their intention to commit suicide is plain. Some are lengthy documents which, on occasion, may be written during the act and in which the subject records his sensations until he can no longer write. Others content themselves with the display of a simple warning notice of the presence of gas. Theoretically these documents could be forged by a person who sought to mask a murder by staging a suicide. It is, however, the general practice of Coroners to ask a relative or friend,

familiar with the handwriting of the deceased, to identify it. Although such persons are rarely experts in this difficult field, it is unlikely that they would be deceived by the clumsy forgery which is alone likely in such circumstances. The expert forger, an aristocrat of crime, rarely descends to murder.

There is usually ample evidence of preparation, which is indirect evidence of intent. Few of these suicides omit some provision for their bodily comfort, although it be no more than a pillow or cushion for the head. It is rare that they inhale the gas in circumstances of positive discomfort. Indeed, when this is apparent the probability of suicide is at once remote. Camps (1950) instanced the case of a woman who was found in circumstances which but for one simple detail were those of suicide. Her head rested in a dirty frying pan on the top of the gas stove. It should occasion no surprise if further examination, as then, shows that the death was due to throttling and the murderer has attempted to conceal his crime by staging the death as a suicide.

The degree of preparation ranges within fairly wide limits. Difficulty in interpretation may arise as between suicide and accident if the gas is inhaled whilst the victim is seated and no steps have been taken to hasten the effects of the poison.

Another important, if indirect, indication of intent is found in the steps which may be taken to ensure certainty and speed of the effect of the gas. The majority of suicides construct a gas tent which concentrates the flow of gas around or within the mouth and nose. The tent varies in kind from the gas oven to relatively elaborate contraptions. A common but simple gas tent is made by throwing a coat, blanket, or rug over the head and leading the gas tube under it and into the mouth. The tube may be tied to the neck. Misuse of such articles as an army kit-bag is sometimes seen but, perhaps because they are uncomfortable to wear, few suicides used the gas respirator supplied by the Government although it has certain distinct advantages unintended by its designer.

Attempts to concentrate the gas in the room and to prevent its escape are occasionally made. The lack of the necessary materials to block crevices in doors, windows, and fireplace, or if they are available, the time required to apply them may be reasons why only a few suicides take this step. When taken it is presumptive of suicide because a murderer, pressed for time, is unlikely thus to falsify the scene. Moreover he would have to leave his exit unobstructed.

It is not unusual for the suicide to arrange matters which ensure

privacy. The window may be obscured, and the door of the room is locked on the inner side.

The place of poisoning is usually determined, irrespective of the circumstances, by the situation of a convenient gas point. When, therefore, the poisoning occurs in a room in which there is no gas point and steps have been taken to lead gas into it there is at once a presumption of suicide. It is scarcely probable that it is other than suicide when the gas has been led from the kitchen to a front room by means of rubber tubing which is 37 feet in length or when a series of short lengths are joined together so as to cover a like distance. On another occasion poisoning was effected by ripping up floor boards to find the service pipe situated at some distance from the room. The pipe was cut with a saw and rubber tubing was attached to lead the gas into a bedroom.

It is popularly supposed that the suicide commonly uses the gas oven but the records show that as many others or more, simply detach the flex of a gas ring or gas poker to provide a gas tube. It is important on such occasions, since the death may have been by accident, to note whether the rubber connection is slack and, therefore, could have been detached by an accidental blow. Suicide by inhaling gas from a gas fire or geyser is unusual and is an unlikely choice since these fittings do not readily permit inhalation of gas in a manner which is both certain and speedy. The flex of a gas fire, on the other hand, is not infrequently detached and used by suicides.

The Pattern of Accidental Poisoning. Although accidental poisoning by carbon monoxide can occur in widely differing circumstances their pattern is in effect the converse of those of suicide, namely, there is no evidence of intent.

ACCIDENTS DUE TO DEFECTIVE EQUIPMENT

On a few occasions an escape of gas has resulted from unsatisfactory closure or sealing of disused gas points or piping.

For example when a woman was found dead in bed in a gas filled room, the escape was from a disused gas point behind one of the bedroom curtains. A small piece of wood which fitted the orifice of the tap was found on the floor nearby, and it was known to have been inserted into the tap to close it. It appears that, following her usual custom, the woman had arisen, opened her curtains and returned to bed. On this occasion the curtain had dislodged the wooden plug and, having fallen asleep, the woman was unaware of the escape.

Cracked flex or piping is another potent source of danger, but it may require close inspection to discover the fault.

Three elderly inmates of a lodging house lost their lives because of an escape of gas from a cracked flex. The fault was known, but the only remedy had been the wrapping of a cloth round the flex. In another case the flex lay between two gas taps, one of which was between the flex and the service pipe and the other between the flex and the gas ring. When operated by the service pipe tap there was little danger and since this had been the practice, the fault was not apparent. One evening, however, the upper tap was left open and the tap near the gas ring was closed. In consequence gas escaped in quantity from the crack and two persons in the house lost their lives.

Gas radiators, when kept in good order, are a safe means of space heating. If, however, the burners are allowed to become fouled by dust, the fuel broken and the flue is inadequate, these appliances are at once a potent source of danger. This applies in particular to portable gas fires which should not be used in bedrooms. Teare (1950) drew attention to the circumstances of bed-sitting rooms in one part of London in which faulty gas stoves were a veritable death trap.

Gas geysers have also been responsible for a number of deaths. If fitted with an adequate flue and the burners are kept clean, they are safe, but old and untended appliances should be condemned.

ACCIDENTAL POISONING PRIMARILY DUE TO OLD AGE

The majority of accidental poisonings involve the elderly and by this is meant persons who are at least sixty-five years of age. This limit is sufficiently well-defined to make it necessary to scrutinise the circumstances with particular care whenever the victim is under that age. It does not follow, of course, that all above sixty-five who are poisoned by carbon monoxide have not committed suicide, because suicide by coal gas occurs at all ages, certainly between the age of fifteen and ninety years. But when the victim is elderly there is a strong presumption of accident.

The victims, by reason of age, no longer have an acute sense of smell, of hearing, or of sight. Therefore they can neither smell nor hear an escape of gas, nor can they readily notice open taps or defective flex or equipment. Often, also, they live alone and must depend upon themselves to detect such faults.

Age, moreover, may bring with it forgetfulness which may lead to accidental poisoning. They may open a gas tap and forget to light the burner. Degenerative changes in the circulatory system of the aged bring, in consequence, a liability to heart attacks, due either to coronary artery disease or increased blood pressure. On occasion it is possible, though proof is lacking, that a victim may have been seized by a heart attack at the time he opened a gas tap and was thus prevented from

closing it or lighting the burner; he was overcome by the gas before he recovered from the attack.

ACCIDENTS ASSOCIATED WITH PREPAYMENT METERS

Prepayment for a supply of gas has its advantages, and so long as one precaution peculiar to this arrangement is observed it presents no special danger when the supply of gas ceases. It is imperative that before more money is inserted in the meter, thought is given to the possibility that a gas point or points in the house are still open but unlit. Failure to observe this precaution can result in one of two kinds of accident which are well illustrated by recent examples. Both kinds of accident are by no means rare, and the first, due to an open, unlit, gas fire may occur in circumstances which arouse strong suspicions of homicide.

A woman retired to bed and lit her gas fire. She then fell asleep, and meantime, the gas supply was exhausted and the fire went out, but the tap remained open. On the following morning, unaware of this, her son went to prepare his breakfast. Finding the gas supply exhausted, he put money into the meter. When he went to call his mother he found her bedroom full of gas. Fortunately, on this occasion, the victim recovered, but these accidents are not rarely fatal.

The other kind of accident is typified by that which befell a woman who was preparing breakfast. Without warning there was a violent explosion, and she was suddenly thrown across her kitchen. The gas oven disintegrated into many pieces which flew in all directions, but although there were children nearby neither they nor the woman were seriously injured. Personal injury was limited to shock, sustained by the woman (Yorkshire Post, August 25th, 1952).

The latter accidents arise through failure to remember, when obtaining a fresh supply of gas, that there are open but unlighted burners in the gas oven. The housewife places a dish in the oven where it is to cook for a lengthy period. Meantime the gas supply becomes exhausted. Forgetful of the oven when she wishes to use the gas ring, and finding there is no supply of gas, she puts money in the meter and lights the gas ring. Soon the oven fills with gas which ascends, in an explosive mixture with air, to the region of the lighted burner. There is a sudden striking back into the oven, and the resulting explosion destroys it.

Although these accidents are not rare none has as yet proved fatal; no fatality has occurred in Leeds nor was an instance known to the local branch of the Gas Board.

ACCIDENTS DUE TO THE FRACTURE OF GAS MAINS

Gas mains are usually made of cast iron and lie at about two feet

below the surface of the pavement or road. They are vulnerable to sudden and appreciable change in temperature, especially when they have been long in use. In winter and in summer, therefore, fracture of gas mains is not uncommon, and in winter but not, it would seem, in summer, these accidents are often fatal. This is to be expected since the extremes of temperature in summer occur at a time when people are up and about and able to detect an escape of gas.

The usual story of these fatalities is that the household retired to bed unaware of the danger to come. Whilst they are asleep the main fractures and gas percolates into the house; those present, irrespective of age, may be found dead next morning. On other occasions, if the fracture occurs during the day time, as happened outside a drug store in Leeds in February 1949, the escape is usually detected before serious symptoms of poisoning develop.

If the main which is fractured lies at a distance from property and there is a fatality, it may for a time be inexplicable, especially if the possibility of carbon monoxide poisoning is not in mind. The victim is found dead without any marks of violence upon him, and there is no smell of gas in the house. This situation arises because the gas has been deodourised during its passage through the soil.

Although the principal cause of fracture of gas mains is abrupt and appreciable change of temperature, the age of the main is a contributory factor. There are still many miles of old piping, but even were the materials and labour available, the cost of general replacement is prohibitive. Occasionally, the passage of traffic over or near the mains causes them to fracture.

In November 1950, for example, at a time when there was no frost, a gas main which was in good condition fractured. The pipe was eighteen inches below flags which were in perfect order, and there had been no submergence of the soil beneath it; a three inch break was present in the pipe. Investigation showed that it was the practice of a local firm to drive vans containing heavy goods onto this part of the pavement; although not proved to be the cause, it was the only probable factor.

ACCIDENTAL POISONING DUE TO INCOMPLETE COMBUSTION

Coke Stoves. A rapid accumulation of carbon monoxide can occur in a room when the ventilation of a coke stove is inadequate. This can result from the not uncommon practice of stoking the stove to the limit in order to keep it burning through the night. Or the flue may be obstructed by refuse.

Accidents in Caravans and Cabins. Caravans, and the cabins of small craft, have been the occasional scene of fatal poisoning by carbon

monoxide. Although the total number of these accidents is small, they are important because they are preventable. They result from failure to maintain adequate ventilation when artificial heating is in use.

The internal capacity of these caravans is only about 300 to 400 cubic feet, and when the door, windows, and ventilators are closed the caravan is almost airtight. The expiration of carbon dioxide by the inhabitants, moreover, exaggerates the ill-effects of negligible ventilation. When, therefore, gas is burnt in such circumstances incomplete combustion will occur, and a dangerous concentration of carbon monoxide is soon produced.

The danger is well illustrated by an accident which occurred in a holiday camp in North Wales in September 1950. It involved a family of three adults and two children. They had hired a caravan of which the gross internal capacity was 400 cu. ft. Because the weather was very cold at night, the gas stove was lit for about half an hour to warm the caravan. Next morning the father got up at 7 a.m., and lit the small gas ring to boil the water for tea; he also lit the larger ring to warm the caravan. By the time he had made the tea, and was passing a cup to his wife, their small baby "went into violent pains. He appeared to have fainted". He was at once taken to hospital; the older child, who also felt ill, remained in the caravan.

When the father returned at 10 a.m., with the baby, who had recovered after simple treatment, he found the caravan door and the blinds still closed. His wife and her mother had collapsed and died on the bed, and the small boy, now obviously ill, was seated on the floor beside it. The deaths were proved to be due to carbon monoxide poisoning.

There was no doubt that the principal cause of the accident was inadequate ventilation which had made an appliance, otherwise safe, emit carbon monoxide. The gas, a mixture of butane and propane, requires thirty volumes of air for each volume of gas to effect complete combustion. Tests showed that without allowance for effects of vitiation of the air by respiration the stove produced carbon monoxide to the amount of 0.193% in the air, by the end of an hour. It is probable, therefore, that at the time of the accident this dangerous concentration was attained in only a few minutes (H. Llewellyn Jones, 1950).

More recently a similar accident occurred in the cabin of a 30 foot motor cruiser, where four adults died of carbon monoxide poisoning (Yorkshire Evening News, Oct. 18th, 1951).

Pressure Lamps. If lamps which require their fuel to be fed under pressure are not operated in accordance with the maker's instructions, incomplete combustion of the fuel results in the production of carbon monoxide and dioxide. When this happens in a restricted space the air becomes dangerous.

In 1951 a man was found in a caravan lying dead on the bed and his dog, as if asleep, was also dead nearby. The interior of the caravan measured just over 300 cu. ft., and the door, windows, and ventilator were

closed. There was no evidence of any disturbance nor any marks of violence on the bodies. Both the man and the dog had died of carbon monoxide poisoning. A Tilley radiator lamp, which was empty, stood on the top of the cooking stove.

By test it was shown that when the lamp was burned until the reservoir was empty, without pumping up the pressure, which is ordinarily necessary, "a considerable proportion of carbon monoxide was present in the burning gases". In a small caravan, which is almost air-tight, faulty operation of the lamp could and did build up a lethal concentration of carbon monoxide in the air. The tests also showed that the lamp produced an air concentration of up to about 4% of carbon dioxide under these conditions (Nicholls, 1951).

ACCIDENTS IN THE GARAGE

Fatal accidents in these circumstances occur almost exclusively in privately-owned garages and usually in those of relatively small size. There was only one exception in a series of sixty-three deaths described by McNally (1928). Of these, five-sixths were deemed to be accidental although only eleven of the victims appeared to have been gassed whilst making repairs to a motor car.

Present experience, however, whilst confirming that the deaths occur in small private garages, does not confirm that most are accidental. Some are unequivocal suicides, and others occur in circumstances which permit no clear interpretation. A close scrutiny of all available details is essential, and even then accurate interpretation may be impossible.

When steps are taken to lead the exhaust fumes into the interior of the motor car, little difficulty in interpretation arises because intent is clear. Interpretation is difficult when the deceased is found on the ground at the back of the car, and there is nothing to suggest that he had been engaged upon repairs or a test of the engine. Suicide by lying on the floor near the open end of the exhaust is well recognized. It is also important to bear in mind the possibility of alcoholic intoxication. Logan (1930) instanced two deaths, each of which occurred as the result of a fall, whilst drunk, which permitted the victim to inhale the exhaust fumes of a motor car. They had been unable to escape from danger, and death was due to carbon monoxide poisoning.

Some idea of the difficulty of accurate interpretation is given by a death which occurred in 1951. The victim was found in a crouching or kneeling posture at the back of his car. His head rested on the floor, within a yard of the open end of the exhaust; his right hand and forearm rested on the back bumper of the car, and his left hand was beside his head. The empty reservoir of a radiator lamp, used to protect the engine from frost, was beside his head and the fingers of his left hand were still in contact with the lamp. His hat was lying upside down near the body and had apparently fallen off his head. A corked bottle of paraffin, fuel for the lamp, stood on a drum a yard to the left, and behind, the body.

The engine ignition was "on", but the car engine was at rest; the petrol tank was empty. The car was housed in a small garage, 18 ft. 6 in. x 8 ft. 6 in., which was without windows or ventilators. The door was closed but unlocked; its open padlock was suspended outside the door.

Death was due to carbon monoxide poisoning; the blood was 80% saturated by carbon monoxide. It was known that he was accustomed to run the engine in the garage to charge the battery of the car. There was no motive for suicide.

It was believed that he had run the engine to charge the battery, and this had created a dangerous atmosphere of which he was either forgetful or unaware. He had gone behind the car to fill the radiator lamp, but on his way to the paraffin he had been overcome by the fumes. (Post-mortem 2355).

On another occasion, tools were left on and near the engine, as if some minor repairs had been in progress. Other aspects of the case, notably evidence of mental illness and a note left by the deceased, led to the return of an open verdict (Post-mortem 1299).

ACCIDENTS ARISING OUT OF PSYCHOLOGICAL ABNORMALITY

This group of accidents is probably small. No instance is traced in Leeds, but Camps (1950) has given examples. On none of these occasions did the deceased intend to lose his life. The victims are exclusively males and usually adolescents or young adults. Some of the deaths are manifestations of exhibitionism, when the deceased, anxious to be the centre of attention, staged a suicide by coal gas poisoning but intended that he should be rescued; unfortunately he was not discovered until it was too late.

Other accidents are associated with sexual deviation, when the abnormal practice is accompanied by the induction of partial asphyxia. The victims achieve this either by partial hanging or by the inhalation of coal gas. These are dangerous practices because it is by no means easy to ensure that the limit of safety is not exceeded. Occasionally, there is a fatal miscalculation. In this area, as yet, all the deaths were by hanging and none by carbon monoxide poisoning. Cases reported elsewhere (Camps, 1950) show, as might be expected, that either at the scene, or elsewhere in the house, there will be evidence of sexual deviation by which the true nature of the circumstances will be made known.

FICTITIOUS CIRCUMSTANCES OF POISONING

Occasionally a murderer may endeavour to conceal his crime by staging the scene as one of suicide. Since the true cause of death is usually by violence, for example, strangulation or head injuries, the marks of injury will be present and probably obvious. It is unlikely, whatever opportunity and skill the murderer might have, unless the

murder be by carbon monoxide, that he could for long mislead those who are skilled in the investigation of deaths from unnatural causes.

Interference with the scene of a suicide to simulate accident or death from natural cause is another possibility. In general these attempts are unsuccessful especially if the intention is to make the death appear to have been due to natural causes. The high concentration of carbon monoxide in the blood, leading to an abnormal colour of the body, ought not to escape the notice of a medical man, and it would be exceptional for a pathologist to fail to recognize it.

Now and again, and it is likely when the death has occurred in a garage, intelligent persons, anxious to obscure a suicide, can take steps which result in an open verdict if not one of accidental death.

MURDER BY CARBON MONOXIDE

The wide distribution and ease of access to coal gas and the simplicity of its administration would appear to make this an ideal agent for murder. There are, however, several factors which, fortunately, nullify these advantages sufficiently to make it likely that few attempts to murder healthy adults will succeed. It is otherwise when the victims are children or adults incapacitated by illness.

There are now some twenty to thirty murders by coal gas each year, but most, if not all, occur in circumstances which are other than those commonly regarded as murder.

The majority of these murders are committed by a parent, usually the mother, who intends to take her own life as well as the life of her child. Or, she takes the life of the child in the mistaken belief that it is in its best interests. Such children may be mentally defective or affected by physical disease. Distressing though these cases are, the law regards them as murder, and if the mother survives, and is fit to plead, she must stand her trial on a charge of murder.

A few murders are the result of suicide pacts; in English law a survivor must face a charge of murder.

The deliberate killing of a healthy adult by another, who himself had no intention to suffer any ill effects of gassing, appears to be rare. A few reports of attempted murder in these circumstances are available and reported examples, mentioned later, indicate some of the difficulties which will prevent success.

It might be suggested that there are murders by gassing which pass as suicides or accidents or occur in circumstances which result in the return of an open verdict. It may well be that some of these deaths are certified as due to natural causes. An examination of the records,

however, does not suggest that this is a common event, because, in the majority of poisonings, there appears little doubt about the accuracy of interpretation of accident or suicide. Occasionally, for example, an open verdict has been returned when there was insufficient evidence to warrant one of suicide or one of suicide when circumstances could have been those of murder.

The murderer is faced, in the first instance, with the difficulty of getting his victim into a situation which permits the attempt. There must be some unwitting co-operation, or the victim must be young or incapacitated by illness. If a healthy adult, it is further necessary to make the attempt whilst they are asleep or under the influence of drink or drugs. If asleep, there is then the risk that they will awaken and, realizing their danger, raise an alarm. Even if this does not result in criminal proceedings, the intended victim's suspicions would be sufficiently strong to make any second attempt impracticable. The poisoning, moreover, is not rapid, and, unlike arsenic, the dose cannot readily be repeated without the victim's knowledge. If the attempt succeeded, the cause of death is easily established and subsequent investigation is calculated to show that the death was not by accident or by suicide.

The circumstances commonly present in known murders are of the following kind. In 1951, a woman who was mentally ill, became suicidal; at first she intended only to take her own life, but later she changed her mind. She was found dead with her three children in a gas filled room at her home. In 1938 the mother of a mentally defective child, also the victim of Little's disease, gassed the child because it was to be taken from her and placed under care in a mental hospital.

Murder by coal gas, arising out of a suicide pact, has not occurred in Leeds during the past twenty-five years, nor is there any instance of murder of a healthy adult by gassing. One of the suicidal deaths could have been murder. A man returned home drunk and next morning was found dead in the scullery; a gas poker, from which gas was escaping, was near the body. It is conceivable that he had been found comatose from drink and his gassing was arranged to appear as a suicide. This, however, is mere supposition.

The reports of attempted murders by gassing include the cases of Sidney Fox (Tennyson Jesse, 1934) and G. H. Varenhorst (Browne & Tullett, 1951). There was insufficient evidence to warrant a prosecution of Fox, who was later convicted and hanged for the murder of his mother by strangulation, but Varenhorst was convicted and sentenced to penal servitude.

The possibility of murder of a chronic invalid or elderly person by gassing is always to be had in mind whenever the circumstances are not unequivocally those of death from natural causes. A relatively short exposure may be sufficient to kill, and the scene may be tidied and ventilated before the death is reported. Moreover, if a chronic invalid, it is likely that the victim has received medical attention within fourteen days of the death. If the illness was of a kind likely to result in death, a practitioner might with good reason issue a certificate of death from natural causes, and he is under no obligation to examine the body. The small amount of carbon monoxide in the blood, moreover, might be insufficient to be noted at an autopsy especially in the presence of natural disease sufficient to account for death. Except when the circumstances are devoid of suspicion it is a wise precaution to include an examination of the blood for carbon monoxide as a routine step at an autopsy on any of these bodies.

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