

ence and the absence of proof that such training has been beneficial to scuba divers who follow advised rules for safe diving)?

- 6 Course time is limited. Is time better spent in thorough indoctrination in safe diving practice or in practicing emergency ascents, i.e. accepting that no/low air situations are inevitable?¹⁸
- 7 Are pupils warned of the potential dangers in practicing such ascents when unsupervised by a trained instructor and of the likely decay of their skills if they are not practiced?
- 8 Are pupils to be advised that their buddy is likely to have a reduced air supply when theirs is no/low status and that a tank supplied buoyancy vest fails to operate when the tank is near empty?
- 9 Is there any evidence that there is justification for the differences in the scuba training courses defined by each major Instructor organisation?

This paper does not provide a definitive answer to such questions because there is inadequate data available (i.e. incident reports) to form a firm basis for a definitive analysis. There is a need for instructor organisations to recognise the value of the Divedata Databank concept of confidential management of reporting of all types and severities of diving-related misadventures and to take a more active stance in supporting efforts to obtain such reports.

Acknowledgements

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SCUBA DIVING AND PREGNANCY

Catherine M Leslie

Introduction

Diving during pregnancy is a relatively new concept and consideration in obstetrics. Over recent years with the influx of improved equipment and the accessibility to the equipment necessary for diving, the number of divers has greatly increased. The percentage of women divers has also dramatically increased. As few women consistently dived in the 1960s not much thought was given to the effects upon them and their unborn child whilst diving. As the number of women divers increased during the late 1970s and on into the 1980s, this is increasingly becoming an area of concern for many women. 20% of the diving population are women and they are mostly of the child bearing age.

What is worrying is that women do not know that they are pregnant until they miss a period when they are probably at least two weeks pregnant. The questions that are continually asked are “Should I dive when I am pregnant?” and “If it is alright to dive, to what depths and time limits?”. In the following paper I will look at the information available and attempt to answer these questions according to the current recommendations.

Potential Problems of the Pregnant Diver¹

MATERNAL FACTORS

- Morning sickness and motion sickness
- Reduced respiratory function
- Circulatory competition with placenta
- Altered sympathetic response
- Reduced fitness and endurance: unusual fatigue
- Size: fit of wetsuit, harness, etc.; clumsiness with the possibility of injury
- Effects of lifting
- Increased fat and fluid leading to increased susceptibility to DCS
- Mucous membrane swelling causing difficulty clearing ears

FETAL FACTORS

General

- Hypoxia from various mishaps
- Hyperoxia which might cause blindness, closure of ductus arteriosus, haemoglobin breakdown or consumptive coagulopathy
- Exercise hyperglycemia possibly followed by post-exercise hypoglycemia
- Exercise hyperthermia
- Physical injury
- Leaking membranes allowing infection
- Maternal envenomation causing direct or indirect damage
- Decompression producing bubbles and perhaps altered placental flow

Early Pregnancy

- Malformations related to maternal decompression sickness (DCS)
- Possible teratogenic effects of pressure, oxygen, nitrogen, dive-related medications, bubble formation and other problems
- Recompression treatment leads to exceptional exposure to O₂ and N₂
- Decompression causes bubbles and may cause birth defects

Late Pregnancy

- Prematurity (Ama diving)²
- Decompression bubbles may cause stillbirth

Maternal Problems

In the first trimester, especially between the sixth and twelfth weeks, there is a very definite increased incidence of nausea, vomiting and sea sickness potential. This is so even without the more obvious “morning sickness”. In view of the harmful effects on the fetus of the various anti-motion sickness medications, there is no justification for taking these drugs just to go diving.

During pregnancy, probably due to the effect of progesterone, there is a progressive interference of respiratory function with difficulty with oxygenation of the blood flow through the lungs, and also an increase in the resistance in the airways to air flow. The results of this may be to reduce the woman’s ability to cope with strenuous activity and perhaps also to increase the likelihood of pulmonary barotrauma.

From the fourth month onwards there tends to be fluid retention and mucosal swelling, thereby making the middle ear equalisation process more difficult, and predisposing to sinus and middle ear barotrauma.

The change in shape of a pregnant woman has unfortunate side effects. Wetsuits no longer fit. Weight belts cause backache and heavy and awkward equipment is uncomfortable. The weight gain and the change in posture results in the woman being less nimble physically and more likely to lose her balance, therefore at a higher risk of getting injured. There is also increased fatigue and the practical aspects of entries and exits.

During the last trimester some women experience a “leak” through the membranes without being aware of it. If sea water should enter the uterus because of this leak, there is a high risk of infection and/or premature labour.

The possibility of decompression sickness during pregnancy may be increased by the increased blood flow, the increased fluid retention, and the increase in blood clotting mechanisms. Many women also store increased amounts of body fat. As nitrogen is more soluble in fat than lean tissue, this increased amount of body fat might lead to the intake of more nitrogen.

Dr A Bove³ noted that in pregnancy, supine hypotension, including syncope, may occur if the gravid uterus falls back against the inferior vena cava, reducing venous return. He suggested that assuming an equivalent position in the water could result in syncope after the first trimester. This raises the question whether a tight-fitting wet suit could produce the same pressure.

In general the Underwater Medical Society Workshop 1978⁴ concluded that while mild exercise associated with diving would be beneficial to cardiovascular condi-

tioning, it is not clear how strongly the uterine artery blood flow responds to emotional stresses, hypoxia, hyperoxia, hypercapnia, or to many drugs. The well-being of the healthy pregnant woman (without consideration of the fetus) would not seem to be compromised by non-strenuous diving to depths less than 4 ATA (40 metres).

Post partum diving should not be undertaken until after the six week check up. There is a possibility of uterine infections if the os is not closed. Exercise fitness may take longer in returning so one should start with relaxed dives.

Fetal Problems

HYPOXIA

Unfortunately, when diving there are many causes for a reduction in oxygen levels of the blood and one of the major possible problems faced by the fetus is hypoxia. This is thought to increase the possibility of both miscarriage and birth abnormalities. There are several ways in which a diver can suffer hypoxia or asphyxia. The most common is drowning and near-drowning, with or without aspiration of water. Hypoxia may also develop as a result of carbon monoxide contamination of the breathing gas. The chance of a pregnant diver becoming hypoxic because of exercising oxygen debt is unlikely.

Although it is true that the fetus is equipped to survive a level of hypoxia that might kill the mother, serious intra-uterine hypoxia or asphyxia may have catastrophic consequences. Sundell⁵ believes that nearly all infants who present with hyaline membrane disease have previously suffered intra-uterine asphyxia. He noted the many instances in which full term babies exposed to massive asphyxia develop cerebral oedema and multiple organ damage. He stated that his studies with sheep have confirmed these observations. Sundell reported that when the uterine artery blood flow was significantly lowered, it produced hypoxia and acidaemia in the fetus. Further, at the end of gestation, nearly 50% of the lambs so insulted in utero developed hyaline membrane disease, although none of the controls presented with this disorder.

OTHER GASES

Other gas concentrations may be altered in divers, e.g. an increase in the carbon dioxide levels due to the resistance of breathing with scuba, and also a rise in the nitrogen level, which happens with all compressed air diving. The harmful effects on the fetus which is experienced with theatre staff who inhale small quantities of anaesthetic gases in operating theatres may well be similar to the effect of breathing nitrogen under higher pressure than normal.

DECOMPRESSION SICKNESS

It has been concluded by some that the fetus is more susceptible than the mother to decompression sickness if

circulating bubbles in the fetus are compared to clinical symptoms in the mother. This comparison is reasonable since the adult lung normally acts as a bubble filter, preventing gas bubbles from reaching the arterial side. On the other hand, any bubble found in the fetus' venous system has a clear pathway to the arterial side via the patent foramen ovale. Thus, circulating gas bubbles in the fetus must be considered *prima facie* evidence of arterial gas emboli. If this argument is valid, this suggests that, the fetus is more vulnerable to decompression sickness than the mother.

OXYGEN TOXICITY

What effect does an increased maternal PIO_2 have on fetal arterial PO_2 and therefore on possible fetal oxygen poisoning? This question was studied by Assali and his associates in pregnant sheep.⁶ They found there was a significant rise in the amount of oxygen supplied to the fetus under the test conditions. On the other hand, Rankin⁷ reported that the fetus will not be exposed to a high PO_2 if the mother does not breathe oxygen to a partial pressure above about 700 mm Hg, equivalent to an air dive of about 100 fsw. These findings indicate that the fetus may not become hyperoxic during a normal air dive. However, a problem may arise if the mother is exposed to pure oxygen at 3 ATA, as is common during hyperbaric oxygen therapy. In one study in sheep, the average umbilical vein PO_2 was raised from an air breathing level of 31 mm Hg to 458 mm Hg during oxygen breathing at 3 ATA⁶. This remarkable elevation of fetal arterial PO_2 raises the possibility of oxygen toxicity. Fujikura⁸ has shown in rabbits that maternal exposure at these levels resulted in retrolental fibroplasia in the newborn fetuses.

There is a lack of experimental data upon which to assess the potential damage to the unborn fetus from oxygen toxicity. The rabbit and rat studies did not expose the experimental subjects to oxygen levels and times similar to those used in human treatments. Fetal rabbits are known to be especially susceptible to retrolental fibroplasia.

TERATOGENS

The fetus can be damaged by extraneous stimuli. It is this influence on the fetus, disrupting its development, that has persuaded so many women to avoid other toxic agents, such as smoking, alcohol, stimulants, etc, during their pregnancy. Other drugs which can aggravate this are decongestants and anti-seasickness tablets. These are often used during diving activities.

Little information is available on the effects of marine animal envenomation on the unborn. Even though there is no reason to believe that the Portugese Man of War stings or other envenomations, per se, are dangerous to the fetus, the injuries can cause generalized reaction in the mother which might be dangerous to the fetus.

Animal Experiments

The first known work on the effects of diving during pregnancy was published by Boycott, Damant and Haldane in 1908⁹ and consisted of a series of observations noting that pregnant ewes presented intravascular bubbles at autopsy after dives to 168 fsw (6.1 ATA) for periods ranging from 15 to 240 minutes. The authors concluded that a young fetus four inches or less in length had too active a circulation and too small a bulk to develop bubbles. Further, there were no bubbles even in an advanced fetus if the exposure lasted for 15 minutes or less. This part of the study was overlooked until 1979 when attention was drawn to it by Bolton¹⁰.

In 1968, McIver¹¹ exposed 28 anaesthetised pregnant dogs to a simulated depth of 165 fsw. Thirteen were exposed for a bottom time of 60 minutes, and fifteen for 120 minutes. All of the 28 adult animals presented marked disseminating intravascular bubbles at autopsy. Two of the 94 fetuses of the first group and two of the 99 fetuses of the second group had bubbles in their coronary arteries, but no bubbles were seen in any other vessels. The amniotic fluid surrounding all 193 fetuses contained numerous bubbles, but all fetuses survived the dives. Also 23 newborn pups were exposed to air at a simulated depth of 165 fsw for 60 minutes, and eight showed marked bubbling throughout the vascular system.¹¹

Chen¹² observed another instance of fetal resistance to decompression sickness in 1974. While using rats to study another problem, he noted that the fetuses of anaesthetised pregnant rats did not show intravascular bubbles even though the mother developed fatal decompression sickness. Both of these studies suggested that the fetus was more resistant to decompression sickness than the mother, which caused many workers to conclude that as long as a pregnant diver did not herself develop decompression sickness, her fetus was safe.

In 1978 Fife et al.¹³ called attention to the fact that the placentas of both the dog and the rat have a countercurrent arrangement between the maternal and fetal microcirculations, while the human placenta has a concurrent arrangement of the two microcirculatory systems. Since the concurrent arrangement is less efficient for the exchange of substances between mother and fetus than a countercurrent system, data derived from dogs and rats should probably not be considered applicable for humans. This concern led to a search for an animal whose fetal/maternal microcirculatory dynamics more closely resembled that of humans. The sheep was suggested as a model.

In 1978, Fife and his co-workers¹³ instrumented seven pregnant sheep by implanting Doppler ultrasonic transducers around one maternal jugular vein and one of the fetal umbilical arteries. Seventeen simulated air dives were made. It was found that a dive considered safe for humans (100 fsw for 25 minutes) produced circulating air bubbles in the maternal jugular vein. In fact, although circulating bubbles

were detected in the fetus after dives to depths as shallow as 60 fsw, no bubbles were detected in the maternal jugular vein of any of the animals. Further, no clinical symptoms of decompression sickness were noted in any of the mothers after any of these dives, although it should be noted that in most cases as soon as bubbles were confirmed in the fetal circulation, the mother was recompressed immediately. It is possible that on some dives she might later have developed symptoms. These observations suggested that the fetus of an animal having placental microcirculatory dynamics similar to those of humans might be at greater risk of decompression than its mother.

It is believed that bubbles are generally created when a diver surfaces even after a no-decompression dive to less than 60 fsw. Initially these bubbles may remain in or near the peripheral capillaries, particularly in muscle tissue. They can easily be forced into circulation by muscle action, including shivering. Normally, however, in the adult these venous bubbles are filtered out by the lungs and thus prevented from becoming arterial gas emboli. Contrary to earlier views, the mother may actually develop circulating bubbles before her fetus does.¹⁴ However, on some dives the fetus may develop circulating bubbles before the mother presents clinical symptoms of decompression sickness. Because the fetus has a patent foramen ovale, its lungs are not able to serve as a bubble trap, and umbilical artery bubbles quickly become arterial gas emboli with potentially serious consequences. Thus umbilical artery bubbles should be regarded as a grave threat to the fetus, in contrast to the usually benign consequences of a modest number of venous bubbles in the adult.

It appears that the age of the fetus may affect its susceptibility to decompression sickness. The Boycott, Damant, and Haldane 1908⁹ study in sheep showed that fetuses 100 mm (4 inches) or less in length did not present with bubbles, while those over 100 mm (4 inches) often did. Studies by Fife et al.¹³ also suggest that fetuses in the first trimester may be more resistant to decompression sickness than those in the third trimester. However, in early embryonic development destruction of even a single cell may result in serious or lethal abnormalities when growth and differentiation have taken place. For this reason, the consequences of decompression sickness in the embryo or early fetus may be worse than in the fetus near term.

Human Data

The Ama are the free diving women of Korea. These breath-holding Ama divers, who dive up until a few days before childbirth, have a 44.6% incidence of prematurity with an infant of less than 2.5 kg; compared to 15.8% in the non-diving females of the same district².

SUSAN BANGASSER¹⁵

In a survey where 72 women who dived whilst preg-

nant were questioned, one third stopped in the first trimester when they found out they were pregnant. More than a third stopped during the second trimester mainly due to increased size, and the rest continued on. 39.4% claimed they maintained the same level of diving activity during pregnancy.

Most were seasoned and competent divers. The deepest dive was to 54 m (180 ft) and the average depth was 18 m (60 ft). The average age was 30 years. Nausea in the first trimester sometimes kept a diver out of the water. There was no decompression sickness in any of the mothers. 5 decompression dives were made.

The babies delivered by pregnant divers were all normal according to their mothers. One babe was underweight at birth. The complications that occurred during pregnancy include; one premature birth, one septic abortion (caused by an accident, not diving related), two miscarriages (one woman had four miscarriages in all, 2 prior to learning to dive and 2 after). All but one woman dived after pregnancy. Fifteen women dived during more than one pregnancy.

MARGARET BOLTON¹⁰

Information from 208 women of whom 109 dived during pregnancy and 69 did not. This showed a raised incidence of abortion, stillbirth, low birthweight, neonatal death and congenital abnormalities. Twenty women dived to 30 metres or more, during the first trimester, 3 had babies with congenital abnormalities. The incidence is normally 1:50 of pregnancies. This figure is 6 times higher. Four others diving to lesser depths had babies with other congenital malformations (2 with congenital heart disease and 2 with minor abnormalities). There are no recorded malformations in the babies of mothers who did not dive during pregnancy. More than 6% of the babies in the diving group were small for gestational age compared with only 1.4% in the control group.

CASE HISTORY BY G TURNER AND I UNSWORTH¹⁶

A report on a baby born with arthrogryposis and some dysgenic features whose mother went scuba diving in early pregnancy. She was a 22 year old primi gravida. Both parents went on holiday from the 40th-55th day after last normal menstrual period. The mother dived at least once daily to a total of 20 dives in the 15 days. Most dives were to a depth of 18 m or less but 3 were to 30 m and 1 to 33 m. The ascent rate used by the mother and her husband was 18 m per minute, though this was usually estimated rather than actually timed. When decompression was required, a modified version of the USN tables was used. All the dives except one were without complications, the exception involved an "equipment failure" of the husband whom she was buddying, at the end of a strenuous 15 minute bottom time dive at 18 m. The rate of ascent of both was described as "very rapid". She felt well but tired after this dive.

No medications were used apart from oral Sudafed 60 mg on 2 or 3 occasions to aid ear clearing, early in the holiday.

The rest of the pregnancy was uneventful. The abnormalities noted in the baby were unilateral ptosis, small tongue, micrognathia and short neck. The penis was adherent to the scrotum. The upper limb joint movements were all normal except for the hands. The fingers were in fixed flexion with some webbing between 3rd, 4th, and 5th fingers, the thumb was digitalised but had two phalanges. The hip joints were dysplastic with reduced range of movement and one hip was dislocated. There was fixed flexion deformity of the knees and bilateral equino-varus deformity of the feet. The head circumference was normal and motor development was appropriate for the baby's age at 3 months. Karyotype, electromyogram (EMG) and muscle biopsy were normal.

The embryopathic timetable of thalidomide affected the upper limbs around the 40th day and the lower limbs between the 41st and 45th day. Thalidomide specifically affects the migration of cells destined to form the posterior root ganglia. Arthrogryposis is presumed to result from either muscle disease or abnormalities of the cells forming the anterior root ganglion so the same timetable may be applicable.

Recommendations

UNDERSEA MEDICAL SOCIETY WORKSHOP⁴

- 1 There is no contraindication to diving for the normal, healthy non-pregnant female. The same general health criteria should apply to both male and female divers.
- 2 The fetus may be at greater risk than the diving mother. The potential risk primarily consists of decompression sickness, but hyperoxia, hypoxia, hypercapnia and asphyxia may also be involved.
- 3 There is insufficient experimental evidence at this time to establish diving depth and time profiles that are definitely not hazardous to the human fetus. Although a large number of women have dived while pregnant, results of epidemiological studies on the fetal effects of these dives on the fetuses have not yet been thoroughly analysed.
- 4 The number of unanswered questions about the effects of diving on the human fetus should encourage physicians to inform their patients of the potential risks and to advise them to act in the most conservative manner.
- 5 Pregnant women who choose to dive against medical advice should be informed that the potential risk to the fetus apparently increases as the no-decompression limits are approached, as the oxygen tension of the inspired gas

increases, and perhaps also a function of other factors that remain to be identified.

6 Until further studies are made, we recommend that women who are or maybe pregnant not dive.

DR JOHN BETTS¹⁷

Advises pregnant divers not to dive deeper than 20 metres and to cut their dives short by taking five minutes off the no-decompression time for their dive. Also in addition any woman trying to start a family should do likewise. He feels that those who follow the rules would seem to have little cause for worry.

SUSAN BANGASSER¹⁵

She recommends that for the pregnant diver considering diving that this is not the time to learn to dive. For the experienced diver, it is recommended that she takes things a little easier, making one dive a day, avoiding difficult surf, and using common sense. That the pregnant diver stay in less than 10 msw (33 ft). She feels that scuba diving is a great physical and mental conditioner, but common sense must always prevail. If a woman does not feel well, for example nauseated, cramps or whatever, she should not go diving.

There is a problem for the woman, who dives the first six weeks of pregnancy, because she may dive deeper than desirable, not realising that she is pregnant. The only guide here, is if a woman has discontinued birth control and plans to have a family, to begin diving shallower. This may mean a lot of shallow diving for some, but a few deeper dives can be fitted into the schedule. Once she has had her period, and it is over (usually this means she is not pregnant but not always) would be the time for any deep dives she may wish to make. She should dive shallow once ovulation or conception could be possible.

ANONYMOUS AUTHOR IN SKINDIVER MAGAZINE¹⁸

Dive to 9 m (30 ft) and snorkel only on the surface. For the less conservative, dive to 18 m (60 ft) to half the time in the US Navy tables. Avoid exertion and stay warm.

TURNER AND UNSWORTH¹⁶

It would be wise for women to refrain from diving below 9 m if conception is a possibility or if they are pregnant. A course of perfection would be to abandon diving for the duration of the pregnancy.

DR KEN KIZER¹⁹

Until further studies establish the safety of scuba diving during pregnancy, it is recommended that all diving activity be stopped as soon as a woman thinks that she might be pregnant and that no diving is done during the duration of the pregnancy.

Similarly, women who are trying to become pregnant should stop scuba diving before attempting to become

pregnant. However if an unplanned pregnancy does occur, there is no reason, at this time, to recommend having an abortion just because diving was done after the beginning of pregnancy.

For the inveterate divers who cannot keep out of the water no matter what the risks, he recommended that these women limit their dives to less than 9 m (30 feet), avoid repetitive dives or getting chilled or unduly fatigued, do not dive when size becomes a problem (usually after the sixth month) and otherwise dive very cautiously and conservatively.

DR CARL EDMONDS²⁰

The question as to whether a pregnant woman should dive has answers that are very complex. However the final decision must be left to the diver.

There may be an issue between personal liberty and a conservative safe attitude. It is likely that those people who insist on the former, will continue to dive no matter what is said to them. It is also likely that the latter will not dive because it could never be proved 100 per cent safe.

E H LANPHIER¹

“A birth defect, with the possibility that it was caused by diving, would be a very high price for any benefit that diving in pregnancy could possibly confer.”

Conclusions

From the evidence displayed by the animal experiments especially those carried out on sheep (whose placental microcirculatory dynamics are similar to humans) the fetus is more likely to develop DCS than its mother. The workers involved with these experiments have concluded that at this stage it is not advisable for pregnant women to dive.

In the studies done on humans we see some evidence in Bolton's study¹⁰ that there are more defects in the babies born to mothers who dived while pregnant. Bangasser's study¹⁵ appeared to show little detrimental effect on the babies. However the case history presented by Turner and Unsworth¹⁶ was quite frightening. I feel that more studies on the actual effects of diving during pregnancy on humans need to be done, but how can this be done? How many women will continue to dive for the benefit of a study if they are aware of the risks involved to their unborn child. Also the women who have experienced some form of problem during their pregnancy or given birth to a child who has some form of birth defect is more likely to have responded to the questionnaires used by Bolton¹⁰ and Bangasser¹⁵. So it may be possible that the percentage of birth defects is not a true reflection of the number of babies with birth defects from mothers who dived during pregnancy.

There is now the legal aspect of advising a woman to dive or not to dive during pregnancy. In the 1985 workshop on Women in Diving, Innes²¹ remarked “.....for those of you who are here who are instructors or practicing obstetrics or gynecology, you would be well advised from your attorneys to advise your clients not to dive. All you have to do is put one of these studies before a jury and you are sunk if your client had birth defects,nothing is foolproof when you have got a baby with a missing hand in front of the jury”. This seems to well cover the legal aspect.

For some women, as there is no absolute proof that diving is any more dangerous when they are pregnant, they will continue to dive. As with smoking and alcohol many women will not give these up although it has been shown to be detrimental to the baby's growth and health. It really is a matter for personal choice, as long as women have been informed about the pros and cons of diving in pregnancy.

The time, place and amount of diving done by these pregnant women may also depend on where she lives and her local dive areas and where she may holiday. I think that most women probably give up diving either when they know that they are pregnant or because of morning sickness or sea sickness. In Melbourne a wetsuit is needed for all diving even during summer. As with increasing size the wetsuit gets too small and the discomfort of wearing a weight belt will make most women still diving give up at this stage. However for women living in warmer, tropical areas or visiting these places whilst on holidays, the lure of diving may be greater as it is not necessary to wear a wetsuit. The rationale that may be used by some women, especially while on holiday, is that this is a new and exciting dive location and that they will not do many dives and will limit their bottom time, after all this is a holiday and a few dives cannot hurt. Again this is a personal choice, providing that it has been made as an informed decision.

Following the research that I have done regarding scuba diving and pregnancy, at this time I personally will not dive during pregnancy. In agreement with Lanphier¹, I think that the risk of having a child with a birth defect outweighs any pleasures gained from diving. Women generally believe that they will have a “normal” baby with no problems and most will avoid doing things that may place their baby in jeopardy.

I also think that a non-diving approach would be advisable while trying to get pregnant. The theory used by Bangasser¹⁵ for the time for deep diving could be used for the time of any diving following menstruation and the anticipated time for ovulation thus the possibility for conception. I would be happy to settle for surface snorkeling if holidaying in the tropics or the like whilst pregnant.

A conservative approach is needed when no-one is really sure what the effects of diving are on pregnancy. This attitude naturally can be changed if new information or evi-

dence is found showing that there is little effect on the mother or the fetus. However, at present the old adage still holds. It is better to be safe than sorry !

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PAPERS FROM THE JOINT SPUMS AND ROYAL HOBART HOSPITAL MEETING NOVEMBER 1988

CARBON MONOXIDE POISONING

Alan Wood

Here is an outline of the problem of carbon monoxide (CO) poisoning in Tasmania. These figures do not cover accidental deaths.^{1,2} It should be noted that a lethal concentration of CO can be reached in a closed garage in ten minutes.³

	1981	1984
Total Suicides	63	52
Gassing and other Vapours	14	N/A
Male to Female	5 to 1	3 to 1

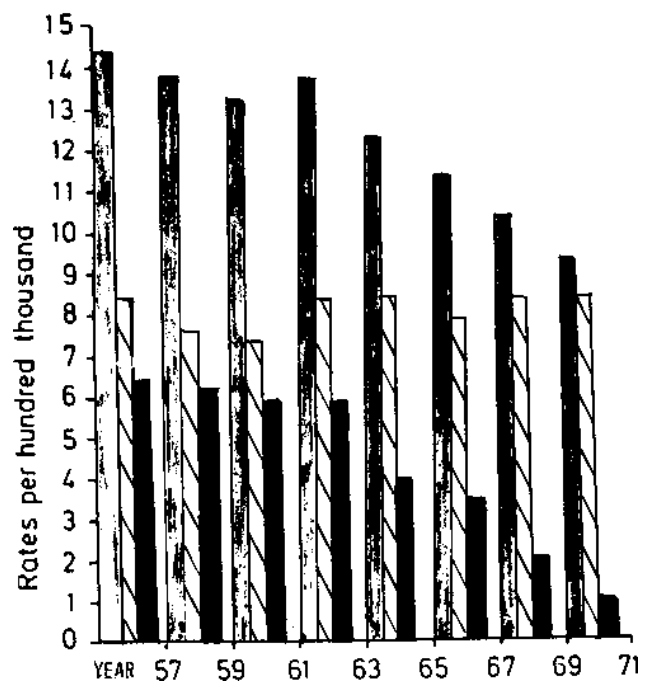
Figure 1 shows the reduction of the number of people using gassing as a means of suicide in Britain since the introduction of North Sea gas⁴. It makes the point that the availability and lethality of methods of suicide are important determinants of the numbers dying by these means.

More surprising is that when one looks through the older literature to determine outcome of survivors of poisoning with carbon monoxide it is very difficult to find good articles. This poses a problem as there is not a good yardstick by which the outcome of populations treated by hyperbaric oxygen can be measured. A commonly quoted article⁵ states that of 63 survivors (no hyperbaric treatment) followed up at three years, 43 % had memory impairment, 33 % had deteriorated personality, 11 % had what was described as "Gross damage".

Reviewing more recent articles several themes emerged as I went through the data. The first issue that arises is the usefulness of carboxyhaemoglobin levels. It seems clear from the literature that there is a lack of correlation between carboxyhaemoglobin levels and clinical status⁶. Hence these levels should not override a full clinical assessment, and it may be quite dangerous to allow this one parameter to dictate treatment. Tissue levels of carbon

FIGURE 1

**UK SUICIDE RATES BY MODE OF DEATH
1957-1971**



Solid columns are carbon monoxide deaths, hatched columns are non-carbon monoxide deaths and stippled columns are total deaths from suicide. The graph has been constructed from data in reference 4.

monoxide are what needs to be measured and this cannot be performed in a clinical laboratory. Higher cognitive functions (such as memory, attention, concentration, calculation, etc.) may be more easily assessed and reflect impairment of the high metabolic rate tissue of the central nervous system (CNS).