

MICHAEL K. JEANES, CLERK
BY S. Keimov
FILED
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1 John-Chester: Stuart
2 c/o: 21001 N. Tatum Blvd.,
3 Suite 1360472
4 Phoenix, Arizona state
5 Pro Per

6 All Civil and Human Rights violations
7 MUST BE INVESTIGATED per U.S. Code

8 SUPERIOR COURT OF THE STATE OF ARIZONA

9 IN AND FOR THE COUNTY OF MARICOPA

10 STATE OF ARIZONA,
11 Plaintiff,
12 vs.
13 JOHN C. STUART,
14 Defendant.

Case No.: CR-2008-006332-001DT

Notice by Affidavit
of the jail's unlawful
use of torture

15 John Stuart, Real Party in
16 Interest/Third Party Intervener
17 having all rights

18 Third Party Intervener appears and petitions, in the nature of a
19 motion, specifically and not generally, to Notice by
20 Affidavit of the jail's, 4th Ave jail under control
21 of Sheriff Joe Arpaio, unlawful use of Torture
22 in violation of the VIII Amendment of the federal
23 constitution, the corresponding Article of the
24 Arizona constitution and THE INTERNATIONAL
25 CONVENTION ON CIVIL AND POLITICAL RIGHTS
Articles 18, 20, 21, et al. Arizona is required
to follow the requirements of each estoppel,
contract and/or treaty according to the
"full faith and credit" clause of the federal
constitution agreed to by Arizona's representatives,
on or about February 14, 1912.

Page 1
of 14

1 This notice MUST be responded to forthwith,
2 within at least five (5) days, with a hearing
3 and ALL witnesses to such torture must
4 be immediately removed from the custody
5 of the accused torturers. It shall be
6 noted by the court that if any harm comes
7 to the witness, specifically John Stewart,
8 Judge Freinley, Pros. Charbel, A.G. Thomas,
9 and Sheriff Joe Arpaio shall be held accountable
10 jointly and severally, personally, without the
11 immunity of their office, due to the violation
12 of their oath, for the injury and/or death
13 of Stewart. Such injury and/or death shall
14 be considered done with malice aforethought
15 and with aggravating circumstances.

16 It is important for the court to note that
17 the following list of torture is used on
18 people that are not convicted, some of
19 which are completely innocent and are only
20 victims of prosecutorial misconduct.

21 Regardless torture, even for people convicted
22 of heinous crimes is unconstitutional and abhorrent
23 to a civilized society. Specifically the VIII Amendment
24 to its federal constitution prohibits "cruel and unusual
25 punishment" and does not restrict such prohibition to
physical torture, but as required by S.C.O.T.U.S., such lack of
restriction, "not being excluded is therefore included" also
must include, without limitations, Psychological and emotional torture.

Types of Torture used by the 4th Ave Jail on a daily basis on "unconvicted" people being "detained" often unlawfully, for trial:

i) Slow strangulation; prisoners are held in 10' x 20' cells with up to 91 other prisoners as witnessed repeatedly by Stuart, especially on or about 7:00 AM April 30, 2008. Such conditions cause a slow and painful depletion of oxygen and buildup of carbon dioxide causing extremely painful headaches and deleting the ^{suddenness} _{page 3} cognitive ability of said prisoners thus invalidating any and all agreement signed by any and all prisoners after such detention. This type of detention occurs during the transport of prisoners between "lockup", the cells, and court. The normal response of the Detention Officers, hereafter D.O., is to laugh once the prisoners start appearing to be close to passing out then open the door and let a moment of air come in, then close the door laughing. Such torture is standard operating procedure, S.O.P., for the D.O.s and occurs several times a day to hundreds of "unconvicted" prisoners. This torture is extremely painful, confussing and terrorizing as experienced by John Stuart on numerous occasions. Said torture may last several hours

1 and causes prisoners possible permanent
2 brain damage and physical and emotional
3 trauma. Prisoners often sleep for extended
4 periods after such torture, a known symptom
5 of PTSD personality and physical and emotional injury and
6 ii) slow starvation; prisoners are only fed
7 once every 12 hours, a direct violation
8 of the INTERNATIONAL COVENANT ON CIVIL
9 AND POLITICAL RIGHTS that requires, as
10 agreed by the U.S. and all of the States,
11 that All prisoners be fed every 5 hours
12 during waking hours. Starvation is not only
13 used as a means of torture on prisoners it
14 is also used by Arpaio to increase his wealth,
15 as prisoners are "allowed" to buy food from
16 Arpaio's store or in the alternative, slowly
17 starve to death. Such torture is specifically
18 hard on the "indigents" almost all of which
19 are minorities and/or illegal immigrants who,
20 in attempts to obtain enough food from other
21 prisoners, work for food by cleaning cells.
22 The food served by the jail is rarely edible
23 and consist mostly of "outdated" food
24 consider inappropriate for human consumption.
25 Stuart has witnessed as stated and even seen
date stamps on food well over a month old.
Specifically bread pastries on April 28, 2008
dated "use by March 16, 2008"; and

iii) sideways dragging; this is an incredibly painful experience but of great delight to the D.O.(s). Prisoners are chained at the ankles with a chain and padlock only. When walking the chain pulls and twist around the ankle and achilles tendon causing a constant pain with every step. If a prisoner attempts to fold down his socks and/or tuck his pants under the chain to ease the pain they face severe retaliation from the D.O.(s). Prisoners are then "hand cuffed" to each other. Such "cuffing" causes the prisoners to have to walk in an unnatural and very painful sideways position for great distances. This pain may last several days and is mainly in the hips and lower back. Such pain does not subside quickly and causes loss of sleep for days. The D.O.(s) attempt to receive additional enjoyment by ordering the prisoners in different directions at the same time causing the prisoners in the middle to be pulled in separate directions, reminiscent of medieval "drawing" on the "rack" torture. Screams of pain and complaint can lead to extreme beatings by D.O.(s) as witnessed on April 25, 2008 by Stuart. Stuart does not know if said prisoner survived the beatings. This court may check with the Phoenix fire

1 department as they did remove the prisoner while
2 performing P.P.R. and

3 iv) religious requirement denials: Christians are
4 denied their religious requirements concerning
5 food. Certain Judeo Christian beliefs require
6 a specific diet, similar to the more commonly
7 known "Kosher" diet of the Jewish religion, such
8 diet is purposely denied by the jail, as
9 evidenced by Swartz's repeated attempts to
10 be given said diet. D.O. (s) and the jail only
11 recognize "MUSLIM" diets and as such
12 many prisoners convert to "MUSLIM" to
13 eat better meals. This is an obvious violation
14 of religious protection and appears to be
15 the jail's attempt to torture prisoners into
16 becoming "MUSLIM". It should be noted that
17 an abundance of prisoners claim to be "Muslim"
18 are not truly "Muslim" and claim so only for
19 more and better food. Such desire to increase
20 the "Muslim" statistical count of prisoners
21 may be a government propaganda attempt
22 to perpetuate the wars against Muslim
23 countries, such statement is obviously only
24 speculation and intended only as a theoretical
25 explanation and not intended as an "anti-government"
statement or to be misconstrued as factual, it
is only an un-educated guess.

1 Other Violations of law by 4th Ave Jail
2 and Arpaio;

3 i) denial of access to law library; prisoners
4 have no opportunity and or access to a law
5 library and/or legal research. inmate legal
6 services repeatedly denies requested information
7 as evidenced by Stuart's Form (4) denied
8 request. This is a blatant attempt for the
9 jail to assist the court, an unlawful conspiracy,
10 in violation of the RICO Act, to fraudulently
11 obtain pleas and or convictions against
12 prisoners, especially pro per prisoners, for
13 lack of appropriate information; and

14 ii) lack of proper medical attention; as probably
15 expected by the general public, the jail's
16 medical facilities and personnel are atrocious.
17 There is no facilities, personnel or equipment for
18 dental issues. Any and all issues concerning
19 teeth are dealt with by "pulling" the tooth.
20 As any dentist knows such unnecessary
21 removal of a repairable tooth is not acceptable
22 and will lead to additional dental issues.

23 This may be also listed as a form of torture; and
24 The foot wear supplied by the jail is
25 cheaply made and lacking any arch support.
Such improper foot wear leads to spinal
vertebrae deterioration which is a painful
and irreversible disorder and the common

1 yet very painful "ingrown" toe nails. Such may
2 lead to bad infection and permanent damage
3 to the toes and feet. The jail's manner of
4 handling such issue is by no means in
5 accordance with or approved by any
6 private practicing podiatrist; and
7 iii) mail; the jail's unlawful handling of
8 prisoners mail is in violation of several
9 U.S. Postal Regulations and the court is
10 hereby directed to report these violations
11 to the Post Master General to file the
12 appropriate charges. Such violations include
13 without limitations:

14 a) purposeful destruction of mail; prisoners
15 that the D.O.(s) want to upset often
16 receive their "postcards" the only mail
17 prisoners are allowed to receive by
18 4 ave jail rules, are often wrinkled,
19 tore, etc and unreadable; and

20 b) mail is not delivered to prisoners timely
21 and often is received in bulk with post
22 dates being up to weeks apart; and

23 c) prisoners outgoing mail is often held
24 by the D.O.(s) for days and even weeks
25 before the D.O.(s) actually mail them.

iv) lockdown; prisoners are "locked down" in
a '6' x 12' cell, 2 per cell, for sixteen (16)
hours a day and are only out in a

1 "day" room for 8 hours. There is no logical
2 reason for such lockdown as the day room
3 is large enough for both shifts, a cell block
4 contains two levels, & have access to the day
5 room during the day time. The day room
6 was designed for such as evidenced by
7 64 seats at the tables, and 6 phones
8 equalling 70 spaces with a cell maximum
9 capacity of 72, counting handicap. The
10 lockdown in cell is a drastic form of
11 psychological torture and was outlawed by
12 the Geneva Convention and other WORLD
13 HUMAN RIGHTS entities, pre and post
14 Nuremberg trials, which brings to point
15 Arpaio's apparent guide to prisoner treatment.
16 Such could be none other than Adolf Hitler as
17 Arpaio's concepts of torture under the
18 guise of efficiency are similar to Hitler's.
19 By behavior comparison, Sheriff Joe Arpaio
20 is Arizona's 'Führer' Adolf Hitler. One
21 may be tempted to say Arpaio is not as
22 evil in number as Hitler, but a cursory
23 inspection of the total numbers of deaths
24 at Arpaio's concentration camps may
25 cause a reasonable man to question such
a concept. The similarities between Arpaio's
system and Hitler's are at the least
overwhelming;

1 a) slow strangulation in over crowded cells in
2 similar by design and in nature to the "boxcar
3 showers" used in Auschwitz and other camps.
4 The basic idea of using gas to murder a room
5 full of people is the same. But as always,
6 Arpaio found a cheaper more torturous way
7 than Hitler could have thought of; and
8 b) starvation, as most can remember at
9 some time seeing pictures of the almost
10 "skeltonized Jews"; But again, Arpaio
11 found a means to torture into profit by
12 allowing prisoners to buy food from him so
13 they would not starve to death; and
14 c) dragging, even the German Armies practice
15 of marching troops for great distance did not
16 include chaining people's ankles with
17 actual chains and not cuffs; and
18 d) religious, I hesitate to discuss this in
19 respect for the 6 million to 10 million innocent
20 Jewish souls that lost their lives to the
21 mad man called Fuhrer and the dozens of
22 Americans that lost their lives to the mad
23 man called Sheriff, but it must be said
24 Hitler used starvation to murder Jews and
25 Arpaio uses starvation to murder people
to Muslim. One may make their own assumption;
and

1 V) grievance procedure, There is a requirement
2 for such Internationally, Federal and per the
3 State. Yet such requirement is hollow. Stuart
4 has witnessed on four (4) occasions how
5 D.O.(s) handle such grievance. Three times
6 it involved four (4) D.O.(s) entering the cell
7 of the complaining prisoner and the prisoner
8 eventually withdrawing the complaint. On the
9 fourth and most recent event the prisoner
10 did not withdraw the complaint. Less than
11 an hour later six (6) D.O.(s) known as
12 S.R.T. entered the cell block and all prisoners
13 were locked in their cells. The prisoner
14 at issue was "tazed" "gassed" and beaten
15 by the six (6) guards. Stuart has not seen
16 said prisoner since. Thus although a
17 "grievance process" is in place it could
18 only be described as wings glued to a
19 pig, it just won't fly.

20
21 The similarities between Arpaio's question
22 of human rights violations and Hitler's are
23 too numerous to list. Although Hitler did
24 murder more people than Arpaio it is such
25 not because of morals but because
Arpaio is more interested in profit than
murder, and he leaves the torture to the
D.O.(s)

Summary

Sheriff Arpaio has unlawfully converted the Maricopa County Jail to a Marquis de Sade Torture chamber employing a group of "sadomasochistic nerds" who get to spend their days torturing possibly innocent people in exchange for keeping the Arpaio profit center profitable.

The torture is also used to convince the accused to accept plea agreements that should be considered void ab initio as the torture used to obtain the plea is a blatant act of unlawful coercion. Most prisoners consider the conditions at 4 Ave so horrendous they will SIGN DEALS FOR TWICE AS MUCH TIME IN PRISON AS AT 4th AVE. Any plea signed after transfer from 4 Ave to court is unlawful and void due to the temporary and compulsive status of the prisoner caused by the oxygen deprivation and carbon dioxide poisoning purposely inflicted by the guards.

Arpaio has purposely converted 4 Ave jail to a torture chamber to assist the county attorney and prosecutors in obtaining convictions. Such conduct is not only heinous it is a violation of RICO Act and

1 make Arpaio, Maricopa County and its court,
2 the county attorney, all the prosecutors, D.O.,
3 deputies, court officers, agent, and etc like,
4 etc. et al. liable personally, jointly and severally,
5 criminally and civilly, especially civilly
6 under 42 U.S.C § 1983. All such are
7 also liable by various International Treaties
8 with the WORLD COURT and CONVENTIONS
9 ON HUMAN RIGHTS. The heads of each
10 individual may also be attached pursuant to
11 the safety agreements and contracts with
12 ARIZONA RISK MANAGEMENT.

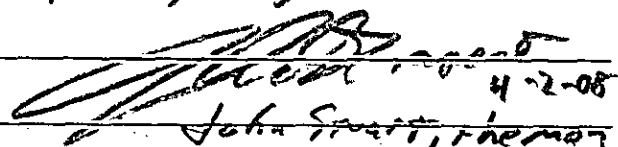
13
14 For clarification sake I, John Smart, state
15 I have witnessed and been a victim of
16 numerous and unrelenting acts of torture
17 for over three (3) weeks. Such acts were
18 committed by D.O. (s) and/or Deputies) against
19 myself and/or other people that are innocent
20 or at the least have not been convicted yet.
21 I am in fear for my life, not from prisoners,
22 but from the D.O. (s) and/or Deputies) and
23 hereby accuse Judge Sterale, Pros. Charbel, Det. Dalton
24 Sheriff Arpaio, A.G. Thomas, et al of my murder,
25 with their malice aforethought. If I should
somehow die while in this jail. As usual,
if I am murdered I am sure Sheriff Arpaio
will make it look like a suicide and/or accident.

1 The fact I am unlawfully imprisoned by a
2 fraudulently obtain indictment due to perjury
3 and illicit activities committed by Pros. Charbel
4 is prime facie evidence that my life is
5 in danger and the court is a co-conspirator
6 by not releasing me even though it is well
7 aware that I am unlawfully imprisoned as
8 evidenced by Judge Steink's signed order
9 and Steink's subsequent self-recusal.

10
11 If and when my death or great injury
12 does occur I hereby acknowledge and
13 authorize this document to be used in court
14 against the aforementioned parties and to
15 be considered "my dying declaration" as
16 it has become apparent to me by the court's
17 refusal to release me that it is quite
18 possible said parties have already decided
19 to murder me.

20
21 In the interest of justice and the safety of
22 an obviously innocent man who has not violated
23 any laws, the court is hereby moved to release
24 Stuart, the man, before he is murdered by a
25 D.O.(s).

To the best of my knowledge, everything written in
this document is true.


John Stuart, the man
4-2-08

Addendum to Notice by Affidavit

Additional Types of purposeful and planned torture designed to humiliate and psychologically damage unconvicted and possibly unlawfully imprisoned prisoners:

i) denial of physical visual visitations:

all visitations for prisoners are on camera only which is emotional and psychologically damaging as the absence of physical appearance has known permanent effects as listed as the cause of several "personality disorders" per the D.S.M. 4, which is considered legally valid for determination of mental illness in all courts in America; and

ii) inappropriate shaving materials; prisoners are only issued what must be described not as "razors" but as "pullers." The cheap Chinese manufactured "razors" are extremely dull and undescritably painful to attempt to shave with. No shaving cream or the like is supplied. Such "razors" are by no means acceptable and although may be a financial savings for the jail, it is really just another tool for the D.O.(s) to use to torture prisoners; and

iii) moving of cell mates; D.O.(s) have a habit of moving cell mates if there is no trouble in the cell block for an extended

1 period of time. Such movement causes undue
2 strike in the cell block which leads to aggravation
3 and such aggravation is capitalized by the
4 D.O.(s) to use aggression and violence against
5 the prisoners. Said prisoner movements are
6 without any other reason and done without
7 warning. This activity would be similar to a
8 fireman starting a fire, so he could put it
9 out and arrest someone else for arson.

10 It is a weekly occurrence and is used as a
11 form of psychological torture by the D.O.(s); and
12 iv) sexual insults, D.O.(s) purposely move male
13 prisoners past female prisoners and make
14 insulting comments about how the male
15 prisoners will never get to such a woman
16 again and will have to picture a man
17 looking like a woman. Such remarks are
18 prime facie evidence of the D.O.(s) domineering
19 and sadistic personalities. There is obviously
20 no reason for such comments and the only
21 purpose is psychological torture; and
22 v) allowing females to handle unclothed male
23 prisoners. Such is not allowed Scripturally
24 and abhorrent to several religions. It is unlikely
25 that male D.O.(s) are allowed to handle unclothed
female prisoners so such is also a civil rights
violations and blatant discrimination.

{from page 33

scientific data concerning CO₂ poisoning.

10'x10'x10 rooms: lethal for a resting man in 24 hours
lethal for moderate exercise in 12 hours
lethal for extreme exercise in 4 hours

thus: lethal for 8 people in 3 hours, if people
are moving and talking, less than 2 hours.

thus: a 10x20x12 room with well over
50 chained men sharing one toilet, usually
without toilet paper and always without
soap, could be considered possibly lethal
in less than 30 minutes.

Specifically: the 10x20x12 room holding John
Stuart and 91 other prisoners on
April 30, 2008 became lethal in
approximately 10 minutes and Stuart
and others were detained in said
room for well over 1 1/2 hours with
the door only opened 5 times, each
time less than 1 minute. Stuart
and others were extremely disoriented
and in pain. Such torture easily
rises to the level of "cruel and
unusual punishment" and unlawful
coercion.

1 In response to the scientific data:

2
3 It may take several hours and possibly
4 days to recover from CO₂ poisoning even
5 when oxygen is administered immediately.
6 Such poisoning if not fatal does cause
7 loss of, and at times, extreme loss of cognitive
8 ability making said victims non compis
9 mentis and any decisions made by said
10 individual is null and void ab initio, therefore
11 any contract and/or plea signed by said
12 victim is invalid.

13
14 Therefore any and all plea agreements
15 signed by any and all prisoners held
16 by the Maricopa County Jail are
17 accordingly null and void, ab initio, and
18 must be reconsidered forthwith.

19 Also, all such unlawful abhorrent storing
20 of prisoners should cease and desist
21 immediately or the perpetrators, including
22 without limits, Armas, Thomas, all D.O.(s),
23 and all court officers are thus committing
24 said acts with knowledge of forethought.

25 The court must also note that use
of nuclear, biological, chemical agents
against citizens has been outlawed

1 by various Treaties dating as far back
2 as shortly after the end of WWI, 1917,
3 and reportedly concurred as a violation
4 of human rights, with exception to nuclear
5 for pre-WWII inventions.

6 The use of Carbon Dioxide as a weapon
7 against prisoners is therefore a violation
8 of said Treaties, as such is considered a
9 chemical weapon. The fact said CO₂ was
10 produced by the prisoners themselves is
11 inconsequential and nothing in any law or
12 treaty allows an exemption for such. Case
13 in point Saddam Hussein's use of gas against
14 his countries civilians who produced the
15 same gas. Such action led to a conviction
16 and hanging of Hussein by the World Court
17 under the law of nations.

18 An issue is the fact that gassing of
19 prisoners is not solely a state issue, such
20 actions rise to the level of federal and
21 International Human Rights violation and
22 MUST be reported to the appropriate federal
23 and International agencies pursuant to the
24 UNITED NATIONS ACCORD and several
25 treaties. The courts purposeful violation
of reporting this activity, once informed, is
by definition treason and is in itself an
additional crime.

1 List of people associated with purposeful
2 use of outlawed weapons, chemical, against
3 civilian population, unconvicted and untried
4 prisoners are by law civilians.

5
6 Maricopa County Attorney: Andrew Thomas

7 Maricopa County Sheriff: Joe Arpaio

8 Prosecutor: Susie Charbel

9 Homicide Detective/Phoenix: Paul Dalton

10 Superior Court Judge: Roland Steink

11 Superior Court Judge: "John Doe" Ryan

12 County Commissioner: Lisa Vanderburg

13 Detention Officers: John Doe, Jane Doe (s)

14 Deputies: John Doe (s), Jane Doe (s)

15 All Government Officials: John Doe (s), Jane Doe (s)

16
17 Agencies that must by law be informed
18 of the aforementioned violations:

19 Office of Safety Health Administration "OSHA"

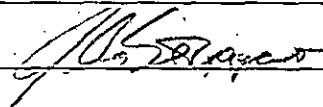
20 United Nations office of Human Rights

21 HAGUE CONVENTION

22 FEDERAL BUREAU OF INVESTIGATION

23 NORTH ATLANTIC TREATY ORGANIZATION

24 WORLD COURT

25 

John Stewart, the man

4-2-08

1 John-Chester: Stuart
c/o: 21001 N. Tatum Blvd.,
2 Suite 1360472
Phoenix, Arizona state
3 Pro Per

4
5
6 SUPERIOR COURT OF THE STATE OF ARIZONA
7 IN AND FOR THE COUNTY OF MARICOPA

8 STATE OF ARIZONA,
9 Plaintiff,
10 vs.
11 JOHN C. STUART,
12 Defendant.

) Case No.: CR-2008-006332-001DT

) ORDER TO RELEASE
) IN THE INTEREST OF
) SAFETY AND JUSTICE

13 John Stuart, Real Party in
14 Interest/Third Party Intervener
having all rights

15 ~~Third Party Intervener, appears and petitions, in the nature of a~~
16 motion. The court having read and considered

17 RPII/TPI is Notice by Affidavit and being fully
18 advised in the premises and good cause appearing
19 therefore;

20 IT IS HEREBY ORDERED that RPII/TPI,
21 John Stuart, the man, be released forthwith
22 from custody without being returned to jail.

23 DONE IN OPEN COURT this _____ 2008

24
25
Judge

Suffocation, CO₂ poisoning.

One of the things I had to bother to research was the consequence of being shut up in a hermetically sealed space. (No air or other gases can get in or out). Particularly, how long can you survive in a portable hole, a sealed room, or an underground chamber sealed off by a cave-in? As it turns out, after considerations of the partial pressures of oxygen and CO₂, it isn't a lack of oxygen that will kill you but an over abundance of CO₂ that will poison you to death. As such, when you hear people talk about how much air or oxygen they have in such a space you should know the real concern is the CO₂ levels being given off by respiration, combustion, or other sources of CO₂.

As it turns out, a 10 X 10 X 10 foot space, or 1,000 cubic feet, will be filled with a lethal concentration of CO₂ by one resting human sized individual in just 24 hours. (The CO₂ level reaches about 1% in that time). Moderate activity will cut this time to 12 hours, and strenuous activity to 6 hours. Thus, 8 hard working individuals in such a space will die in about 6/8th of an hour or 45 minutes. Naturally, this would make travel in an extra dimensional space possible since many people could survive the time taken to plane shift or teleport to a new location. It is, therefore, possible to move relatively large groups of people using this technique, provided the individuals who are outside of the space, plane shifting or teleporting, don't run into any problems preventing them from releasing their passengers in a timely fashion. Remember that plane shifting on the border ethereal plane just increases your movement rate by a factor of 100, but the deep ethereal by about 10,000 - or to more safely travel, about a factor of 1,000 on some middle ground. The higher speeds may be necessary in order to get the group out of the portable hole before they die.

Say 8 people, resting, will use the air in a 10 x10 x 10 space in 3 hours. So you can only get about 720 miles in the near ethereal, but 7,200 miles to 72,000 miles while in the deep ether. Naturally, since Orlantia's circumference is only 1700 miles or so, one can get anywhere on Orlantia in that time if they go via the deep ether.

In case you are wondering, it is assumed a movement rate of 12" will result in 24 miles in 10 hours of travel. This is 2.4 miles/hour. For 3 hours, this will result in 7.2 miles on the PMP, 10 times that or 720 miles traveling via the border ethereal plane, 10 times that or 7,200 miles traveling the deep ether, but doing it carefully so as to subtract up to one encounter roll, or 10 times that or 72,000 miles without the caution, perhaps risking 3 encounter rolls for an unknown path. But if you are more interested in the mechanics of planar travel, you should follow the link below.

[The Planes Of Existence, A Better Look](#)

© May of 1999
by
James L.R. Beach
Waterville, MN 56096

[BACK](#)

How long can we survive in a sealed enclosure?

B. Geerts

12/97

The average concentration of oxygen in the atmosphere is 21.0% by volume, but in polluted environments it may be lower. The US Occupational Safety and Health Administration has adopted a lower acceptable limit of oxygen in the workplace of 19.5%. At 12% a loss of consciousness is likely, although people with medical conditions may lose consciousness at 15% or even more.

Question: How long can 10 healthy adult people survive in a sealed room of dimensions 3m x 4m x 2.5m before they run out of oxygen (i.e. the oxygen concentration drops to 12%)? An adult of average weight consumes about $3.33 \cdot 10^{-6} \text{ m}^3 \text{ s}^{-1}$ of oxygen while at rest. The typical volume of an adult is 0.1 m^3 .

Answer: The equation for rate of change of oxygen concentration in an enclosure without oxygen replacement (neglecting the buildup of carbon dioxide) is:

$$(\text{total oxygen consumption rate}) = (\text{volume of oxygen consumed}) / (\text{total time lapsed})$$

or

$$nC = \{V_r - nV_p\} \{L_i - L_f\} / t$$

Where:

t = time lapsed from initial time to time of loss of consciousness (s)

V_r = volume of enclosure (m^3)

V_p = volume of a person (about 0.1 m^3)

L_i = initial oxygen concentration (21% or 0.21)

L_f = final oxygen concentration (12% or 0.12)

n = number of people in enclosure

C = per capita rate of oxygen consumption ($3.33 \cdot 10^{-6} \text{ m}^3 \text{ s}^{-1}$)

Therefore:

$$t = \{V_r - nV_p\} \{L_i - L_f\} / nC$$

Now plug in the numbers:

$$t = (30-1)(0.21-0.12)/(3.33 \cdot 10^{-5}) \text{ s} = 7.8 \cdot 10^4 \text{ s}$$

So the people are likely to have suffocated after $7.8 \cdot 10^4$ s or 21 hours and 47 min. In reality this period may be shorter, because people exert more energy and (demand more oxygen) when the CO_2 content of the air increases, because they need to breathe more heavily. Also if there is any panic.

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- Gas Analyzer

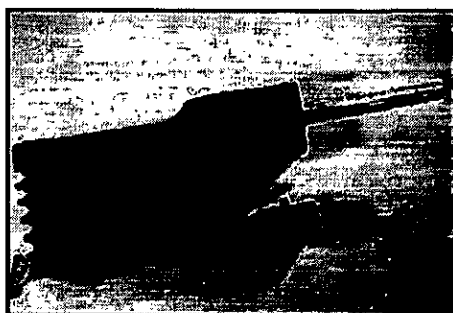
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Toxicity of Carbon Dioxide Gas Exposure, CO₂ Poisoning Symptoms, Carbon Dioxide Exposure Limits, and Links to Toxic Gas Testing Procedures

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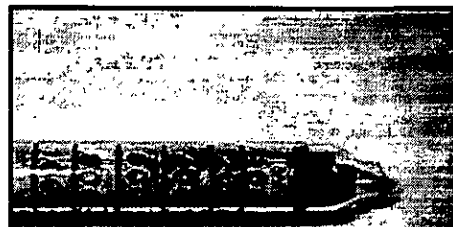
Benzene Exposure Guide
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This document discusses the toxicity and exposure limits for exposure to carbon dioxide gas (CO₂). We give references and explanation regarding Toxicity of Carbon Dioxide, based on literature search and search on Compuserve's Safety Forum by Dan Friedman. This is background information, obtained from expert sources. This text may assist readers in understanding these topics. However it should by no means be considered complete nor authoritative. Seek prompt advice from your doctor or health/safety experts if you have any reason to be concerned about exposure to toxic gases.

Links on this page also direct the reader to carbon monoxide gas information in a separate document. **IF YOU SUSPECT ANY BUILDING GAS-RELATED POISONING GO INTO FRESH AIR IMMEDIATELY and get others out of the building, then call your fire department or emergency services for help.** © Copyright 2008 Daniel Friedman, All Rights Reserved. Information Accuracy & Bias Pledge is at below-left. Use the links at page left to navigate this document or to go to Other Website Topics. Green links at left show where you are in our document & website.



CO₂ POISONING SYMPTOMS - Carbon Dioxide poisoning symptoms

The photo shows a Drager colorimetric gas detection tube used to test the CO₂ levels in air. In an indoor air test (in our laboratory) the detector found that the CO₂ level was about 600ppm which is typical of indoor air and is an acceptable and safe level.

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- At 1% concentration of carbon dioxide CO₂ (10,000 parts per million or ppm) and under continuous exposure at that level, such as in an auditorium filled with occupants and poor fresh air ventilation, some occupants are likely to feel drowsy.
- The concentration of carbon dioxide must be over about 2% (20,000 ppm) before most people are aware of its presence unless the odor of an associated material (auto exhaust or fermenting yeast, for instance) is present at lower concentrations.
- Above 2%, carbon dioxide may cause a feeling of heaviness in the chest and/or more frequent and deeper respirations.
- If exposure continues at that level for several hours, minimal "acidosis" (an acid condition of the blood) may occur but more frequently is absent.
- **Breathing rate** doubles at 3% CO₂ and is four times the normal rate at 5% CO₂.
- **Toxic levels of carbon dioxide:** at levels above 5%, concentration CO₂ is directly toxic. [At lower levels we may be seeing effects of a reduction in the relative amount of oxygen rather than direct toxicity of CO₂.]

Symptoms of high or prolonged exposure to carbon dioxide include headache, increased heart rate, dizziness, fatigue, rapid breathing, visual and hearing dysfunctions. Exposure to higher levels may cause unconsciousness or death within minutes of exposure.

Distinguishing between high carbon dioxide levels CO₂ and low oxygen levels O₂ in air

What may be unclear in some cases is whether the sub-acute (sub-toxic) effects at modestly-elevated levels of CO₂ in air stem from more from exposure to higher levels of carbon dioxide or whether they are due to reduced levels of oxygen. In an enclosed space such as a tight home or an enclosed basement or work space, increasing the level of CO₂ is likely to simultaneously reduce the proportion of Oxygen (O₂) in that same breathing air.

Some experts opine that a complaints that seem to be associated with high CO₂ problem in *many if not most* circumstances are likely to be actually due to the corresponding *reduction in available oxygen* in air rather than *high toxicity levels of CO₂* in the air. As carbon dioxide levels climb above a few percent the relative proportions of gases making up that air change: the concentration of oxygen in the air inhaled is reduced as the amount of CO₂ is increased.

More carbon dioxide may mean less oxygen: Let's say, sake of simplicity, that we're converting oxygen to carbon dioxide in an enclosed space. Then *when the CO₂ level has increased* from its normal amount in air (about 0.03%) up to a higher concentration in air of 1.4% CO₂ *the concentration of oxygen in air will have decreased* from 20.9 to 19.5%. Reducing the *oxygen* concentration from 20.9% down to 19.5% is equal to a 6.7% reduction in the oxygen level. -- Thanks to thanks to Dr. Roy Jensen for assistance with these details.

What are the effects on humans (and other animals) of reduction of the oxygen levels in air? At sea level, breathing air in which the O₂ level has fallen to 16% percent is equivalent to being at the top of a 9,200-foot mountain - close to the level at which many people will experience shortness of breath while walking. 12% Oxygen in air at sea level corresponds to breathing normal air at an elevation of about 17,400 feet.

CO₂ HEALTH EFFECTS - Potential Health Hazards of Toxic Gas Exposure

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Hazard evaluation consists of comparing measurements of exposure (or dose) with exposures (doses) known to be safe or known to be hazardous. For the most part, because of biological variation, "no effect" levels are much easier to estimate than are "first effect" or other levels indicative of injury.

Toxic levels of carbon dioxide: According to occupational exposure and controlled atmosphere research into CO₂ toxicology, CO₂ is hazardous via direct toxicity at levels above 5%, concentrations not encountered in nature [except perhaps at or near an active volcano or at water-logged soils]. At these high levels there is risk of death from carbon dioxide poisoning. At lower levels there may health effects and there certainly are complaints of exposure at lower levels.

In the preceding section of this article, at CO₂ POISONING SYMPTOMS we discussed symptoms of carbon dioxide exposure. On specific individuals, the effects of exposure to elevated levels of carbon dioxide (CO₂) vary by individual and with exposure level, and exposure duration, ranging from drowsiness (perhaps at levels over 1000

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ppm continuous exposure) to the toxic effects listed just above.

How might CO₂ accumulate at a dangerous level in a residential property?

Carbon dioxide, CO₂, from a small leak is unlikely to be dangerous, as it can be expected to be diluted with fresh air mixing in a building. But there can be exceptions in which carbon dioxide may accumulate and reach higher, even dangerous concentrations indoors.

- **Flue gas spillage:** in an enclosed gas-fired boiler room with a deficient chimney draft can produce high levels of CO₂. In a case in which there is sufficient combustion air, say from a direct air duct to the gas burner, the system may not be producing more dangerous carbon monoxide (CO), but the heating system may nonetheless spill flue gases with a high level of CO₂ into the room from a defective chimney. Since CO₂ being more dense than air it may accumulate in an enclosed basement, crawl space, or boiler room. Alternatively, because the CO₂ in this case is a heating system exhaust, it may be warmer than surrounding air and it may rise upwards in the building into the living space. For this reason when we measure for the presence of flue gases, even if the gas is one which is "supposed to be" heavier than air, we may measure both high and low in the test area.
- **Soil sources of high carbon dioxide in buildings:** NIOSH reports on an investigation of complaints by homeowners of blurred vision, breathlessness, and "episodic mild confusion" caused by exposure to from elevated carbon dioxide levels in a finished basement and an adjacent crawlspace. West Virginia Department of Environmental Protection detected carbon dioxide levels up to 9.5 percent in the basement and CO₂ levels up to 11 percent in the crawlspace grave, with 12 percent in the basement floor drain (suggesting a soil source of CO₂ in a home in West Virginia home, according to a NIOSH report. CO₂ levels in the soil surrounding the home were measured at levels up to 8 percent. The probable source of the high CO₂ levels in the soils under and around this home were probably due to [coal] mining activities.

Are the effects of breathing CO₂ permanent?

Any detrimental effects of low-level CO₂ exposure are reversible, including the long-term metabolic compensation required by chronic exposure to 3% CO₂. -- "A Review of Human Health and Ecological Risks due to CO₂ Exposure," American Geophysical Union, Spring Meeting 2001, abstract #H31C-13, Hepple, R. P.; Benson, S. M., 05/2001.

More Reading:

"Gases: Toxic gases, indoor exposure levels, testing, identification" additional information on gas exposure detection, toxicity, and remedy for a wide range of toxic and other gases.

CO₂ EXPOSURE LIMITS - Carbon dioxide exposure limits PEL and TLV set by OSHA and NIOSH

Carbon dioxide is regulated for diverse purposes but not as a toxic substance.

- **The U.S. EPA CO₂ exposure limits:** The U.S. EPA recommends a maximum concentration of Carbon dioxide CO₂ of 1000 ppm (0.1%) for continuous exposure.
- **ASHRAE standard 62-1989** recommends an indoor air ventilation standard of 20 cfm per person of outdoor air or a CO₂ level which is below 1000ppm.
- **NIOSH CO₂ exposure limits:** NIOSH recommends a maximum concentration of carbon dioxide of 10,000 ppm or 1% (for the workplace, for a 10-hr work shift with a ceiling of 3.0% or 30,000 ppm for any 10-minute period). These are the highest threshold limit value (TLV) and permissible exposure limit (PEL) assigned to any material.
- **OSHA CO₂ exposure limits:** OSHA recommends a lowest oxygen concentration of 19.5% in the work place for a full work-shift exposure. As we calculated above, for the indoor workplace oxygen level to reach 19.5% (down from its normal 20.9% oxygen level in outdoor air) by displacement of oxygen by CO₂, that is, to reduce the oxygen level by about 6%, the CO₂ or carbon dioxide level would have to increase to about 1.4% 14,000 ppm.

In summary, OSHA, NIOSH, and ACGIH occupational exposure standards are 0.5% CO₂ (5,000 ppm) averaged over a 40 hour week, 3% (3,000 ppm) average for a short-term (15 minute) exposure [we discuss and define "short term exposure limits" STEL below], and 4% (40,000 ppm) as the maximum instantaneous limit considered immediately dangerous to life and health. All three of these exposure limit conditions must be satisfied, always and together.

What laws regulate carbon dioxide exposure levels?

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Of the several industrial hygiene standards-setting groups in this country, the most important and/or most quoted are the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) but these are recommended standards, not laws.

Standards promulgated by OSHA (called Permissible Exposure Limits or PELs) have the force of law. The other standards are advisory. However OSHA claims the power to force compliance with NIOSH "Recommended Standards" if it chooses to do so. (The main advantage of ACGIH Threshold Limit Values (TLVs) is that they are reviewed and updated annually; neither NIOSH nor OSHA updates its standards with any regular frequency.)

NIOSH limits on Carbon Dioxide Exposure: NIOSH's recommended CO₂ exposure limit for 15 minutes is 3 percent. A CO₂ level of 4 percent is designated by NIOSH as immediately dangerous to life or health.

OSHA limits on Carbon Dioxide Exposure: The U.S. Department of Labor Occupational Safety & Health Administration, OSHA, has set Permissible Exposure Limits for Carbon Dioxide in workplace atmospheres at 10,000 ppm of CO₂ measured as a Time Weighted Average (TWA) level of exposure and OSHA has set 30,000 ppm of CO₂ as a Short-Term Exposure Limit (STEL). OSHA has also set a Transitional Limit of 5,000 ppm CO₂ exposure TWA. [OSHA's former limit for carbon dioxide was 5000 ppm as an 8-hour TWA.]

Definitions of Short Term Exposure Limits or STEL

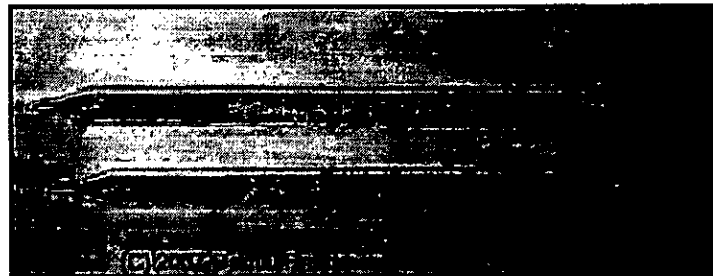
What is the definition of "short term exposure" or "Short-Term Exposure Limit (STEL)"? The ACGIH has defined STEL as the concentration (in this case of a gas in air) to which workers can be exposed continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

What is a "short period"? and what is "short term exposure"?: The definition of "short period" is provided indirectly by ACGIH:

1. If during an 8-hour work shift (and before it has ended) a worker is exposed to a substance in excess of the threshold limit value, time weighted average exposure permitted exposure level for the entire shift, then that exposure has exceeded the short term exposure limit or STEL.
2. If a worker is exposed to more than four STEL periods during the course of an 8-hour work shift, with less than 60 minutes between those exposure periods, then also that exposure has exceeded the STEL.

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TYPICAL CO₂ LEVELS Indoors and Outside

How to use gas detection tubes for measuring the level of various gases

The colorimetric gas detection tubes, here showing a tube made by

Drager, are a relatively inexpensive way to test for the level of specific gases. The tubes are quite accurate and can be selected and used down to very low concentrations of various gases, provided that a properly chosen and calibrated gas testing pump is used. In some cases for very precise measurements a correction factor needs to be applied for temperature at the time of measurement. We use Drager tubes as well as another system of tubes and pump made for and sold through GasTec for testing indoor levels of specific gases.

What are the component gases that make up normal air and in what proportions or percentages do they occur?

At sea level on earth, what is the composition of the air we breathe? That is, what gases make up normal outdoor air? How much CO₂ is in air? How much oxygen is in air? and how much nitrogen is in the earth's atmosphere?

Here is the mix of gases in normal outdoor air. The earth's atmosphere (measured close to ground level) is made up of 78.1% nitrogen, 20.9% oxygen, 0.9% argon, 0.03% carbon dioxide, and 0.04% other gases. Let's look at some typical CO₂ levels in both percentage and expressed in parts per million, which is how most instruments measure gas concentrations. [The mix of gases in air near some manufacturing facilities or in some cities may be a bit different.]

What are typical Carbon Dioxide levels in air?

- Carbon dioxide CO₂ levels outdoors near ground level are typically 300 ppm to 350 ppm or 0.03% to 0.035% in concentration.

- Carbon dioxide CO₂ levels indoors in occupied buildings are typically around 600 ppm to 800 ppm or 0.06% to 0.08% in concentration. You'll find this data in many indoor air quality articles and books and it's consistent with what we find typically in our own field measurements.
- Carbon dioxide CO₂ levels indoors in an inadequately vented space with heavy occupation is often measured around 1000 ppm or 0.10% in concentration. I have measured levels around 1200 ppm in occupied basement offices in a hospital where the staff worked in an area which had no decent fresh air intake into their ventilation system. In 1989 I also measured 1200 ppm at chest height in the center of the sanctuary in a Jewish synagogue during the high holy days in a small New York city. I also observed people nodding off. We were never sure if it was a droning sermon, exhausted worshipers at the end of a long week, or the CO₂ level. But there was no doubt that we were not meeting recommended ventilation standards for that space.
- Carbon dioxide levels above 1500 to 2000 ppm are likely to be reached only in unusual circumstances (being enclosed in an airtight closet for a long time) or in industrial workplace settings such as we cited above.

Oxygen gas level measurements & poisoning symptoms: If you reached this paragraph by scrolling down, read about

Carbon Monoxide Gas Level Measurements & Poisoning Symptoms: If you reached this paragraph by scrolling down, read about CARBON MONOXIDE - CO hazards, detection, exposure limits, and health effects by using the links at the left on these pages.

Technical Reviewers

Particular thanks are due to experts and also consumers who read these articles and suggest corrections, changes, and additions to the material. Content suggestions, technical corrections and content critique are invited for any of the content at our website.

- Daniel Friedman - principal author
- Dr. Roy Jensen, Department of Chemistry, Grant MacEwan College, Edmonton, AB for technical review and critique 8/23/07. Dr. Jensen notes that if we increase the CO₂ level in air in an enclosed space from its normal level of about 0.03% (we counted it as starting at 0) to a level of 1.4%, we obtain a corresponding decrease in the oxygen level from its normal level (at sea level) of about 20.9% down to 19.5%, for a 6.7% reduction in the amount of oxygen available. The amount of oxygen lost is 6.7 % ($1.4/20.9 * 100$ %). Our earlier version of this document was incorrect in this calculation.
- **Technical reviewers are invited** to comment or ask questions - contact us

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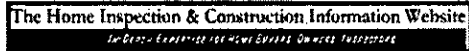
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More Information on Toxic Gas Detection, Exposure, Test Procedures, Toxicity, and Remedy, & Building Diagnostic Inspections and Repairs

Toxic Gas Exposure Hazards and Test Protocols including links to our toxic gas exposure screening and gas testing protocols.

Gases: Toxic gases, indoor exposure levels, testing, identification

- **A Toxic Gas Testing Plan:** A Gas Sampling Plan for Residential and Commercial Buildings lists some of the toxic indoor gases for which we test, depending on the building complaint and building conditions
- **Gas Exposure Hazard Levels:** for Toxic Gas Exposure to Ammonia, Arsine, Arsenic, Bromine, Carbon Dioxide, Carbon Monoxide, Hydride, Ozone - allowable exposure levels and hazard levels
- **Carbon Dioxide Gas Toxicity** hazard level, poisoning symptoms, & testing
- **Carbon Monoxide Gas Toxicity** hazard levels, poisoning symptoms, & testing
- **Formaldehyde:** US EPA. UFFI (Urea Formaldehyde Foam Insulation) was previously considered a hazard (formaldehyde outgassing). Subsequent research virtually closed concern regarding this material; however formaldehyde appears to remain a health concern for sensitive individuals.
- **Ozone Warnings - [PDF]** Use of Ozone as a "mold" remedy is ineffective and may be dangerous.
- **Sampling for gases in air** such as VOC's, MVOC's, toxic chemicals, and combustion products. Unfortunately no single test or tool can detect all possible building contaminants. We use methods and equipment which can test for common contaminants. If the identity of a specific contaminant is known in advance we can also test for a very large number of specific contaminant gases in buildings. We use gas sampling equipment provided by the two most reliable companies in the world, Draeger-Safety's detector-tubes and Dräger accuro□ bellows pump, the Gastec □ cylinder pump and detector-tube system produced by Gastec or Sensidyne, and we also use Sensidyne's Gilian air pump. For broad screening for combustibles and a number of other toxic gases and for leak tracing we also use Amprobe's Tif8850. All of these instruments, their applications, and sensitivities (minimum detectable limits) for specific gases are described in our Gas Sampling Plan online document.
- **Radon Gas** U.S. EPA Radon level maps



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The Mold Information Center: What to Do About Mold in Buildings, When and How to Inspect for Mold, Clean Up Mold, or Avoid Mold Problems



Home Inspection Construction Consulting Services & advice for home buyers



Use this simple, economical mold test kit by following our instructions on how to collect and mail mold samples to our lab



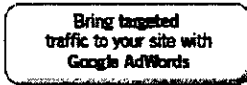
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Q: suffocation, lung capacity, human oxygen useage (Answered ★★★★★, 1 Comment)

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Question

Subject: **suffocation, lung capacity, human oxygen useage**
 Category: Science
 Asked by: **jrudland-ga**
 List Price: \$2.00

Posted: 19 Sep 2003 04:50 PDT
 Expires: 19 Oct 2003 04:50 PDT
 Question ID: 258239

how long does it take to suffocate in an air tight room? i.e if I had a 10 x 10 x 2 Meter room, how long would it take an average male to suffocate?

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Answer

Subject: **Re: suffocation, lung capacity, human oxygen useage**
 Answered By: **knowledge_seeker-ga** on 19 Sep 2003 06:32 PDT
 Rated: ★★★★★

Hi jrudland-ga,

The issue of suffocating in an enclosed space is not one of running out of oxygen; it's one of being poisoned by carbon dioxide -- CO2. CO2 becomes toxic at a concentration of 1%. (Normal atmospheric concentration is 0.036 percent (360 ppmv).) A concentration of 10% can cause respiratory paralysis and death within a few minutes.

How fast the CO2 level builds depends on how fast you produce it. This would be related to how fast you are breathing. At rest you would exhale much less than if you were exercising.

Given that a moderately active or stressed person produces about 1.7 cubic feet of CO2 per hour and assuming a concentration of 3% CO2 is the highest safe limit, here is an equation you can use to calculate how long a given number of people can stay in a given space before toxic levels of CO2 build up ---

T = Number of hours of air in a sealed room

$$T = \frac{(\text{Volume of air inside the room in cubic feet}) \times (3\% \text{ or } 0.03)}{(\text{Number of people}) \times (\text{one person's hourly production of CO2})}$$

Cerebral hypoxia

From Wikipedia, the free encyclopedia

This article or section is in need of attention from an expert on the subject.



WikiProject Medicine or the Medicine Portal may be able to help recruit one.

If a more appropriate WikiProject or portal exists, please adjust this template accordingly.

For other uses of the term "hypoxia", see hypoxia.

Cerebral hypoxia refers to deprivation of oxygen supply to brain tissue. Mild or moderate cerebral hypoxia is sometimes known as **diffuse cerebral hypoxia**. It can cause confusion and fainting, but its effects are reversible. Total deprivation of oxygen to the brain is called **cerebral anoxia**. Extended periods of cerebral hypoxia can lead to brain death or permanent brain damage.

Most cases of cerebral hypoxia are caused by a sudden change in brain oxygen levels. The body can normally respond to mild gradual changes in blood oxygen with little or no noticeable effect on brain function. The acclimatization process used by high altitude climbers is an example of such adjustment.

The presence of cerebral hypoxia symptoms indicates that the brain has been overwhelmed by a change in its oxygen supply. Consequently, even mild symptoms of cerebral hypoxia require immediate medical attention.

Contents

- 1 Classification
- 2 Causes
- 3 Signs and symptoms
- 4 Treatment
- 5 Prognosis
- 6 See also
- 7 References

Classification

Cerebral hypoxia is typically grouped into four categories depending on the severity and

location of the brain's oxygen deprivation:^[1]

- **Diffuse cerebral hypoxia**. A mild to moderate impairment of brain function due to low oxygen levels in the blood.
- **Focal cerebral ischemia**. A small localized reduction in the flow of oxygen from the blood to the brain. Damage to neurons is usually irreversible. Mild strokes.
- **Cerebral infarction**. A complete stoppage of the flow of oxygen from the blood to a region of the brain. Significant irreversible brain damage occurs in the region around the blockage. Major strokes are an example of cerebral infarction.
- **Global cerebral ischemia**. A complete stoppage of blood flow to the brain.

Cerebral hypoxia can also be classified by the cause of the reduced brain oxygen:^[2]

- **Hypoxic hypoxia**. Limited oxygen in the environment causes reduced brain function. Divers, aviators,^[3] mountain climbers and fire fighters are all at risk for this kind of cerebral hypoxia. The term also includes oxygen deprivation due to obstructions in the lungs. Choking, strangulation, the crushing of the windpipe all cause this sort of hypoxia. Severe asthmatics may also experience symptoms of hypoxic hypoxia.
- **Hypemic hypoxia**. Reduced brain function is caused by inadequate oxygen in the blood despite adequate environmental oxygen. Anemia and carbon monoxide poisoning are common causes of hypemic hypoxia.
- **Ischemic hypoxia** (a.k.a. stagnant hypoxia). Reduced brain oxygen is caused by inadequate blood flow to the brain. Stroke, shock, and heart attacks are common causes of stagnant hypoxia. Ischemic hypoxia can also be created by pressure on the brain. Cerebral edema, brain hemorrhages and hydrocephalus exert pressure on brain tissue and impede their absorption of oxygen.
- **Histotoxic hypoxia**. Oxygen is present in brain tissue but cannot be metabolized. Cyanide poisoning is a well known example.

Causes

Cerebral hypoxia can be caused by any event that severely interferes with the brain's ability to receive or process oxygen. This event may be internal or external to the body.

Mild and moderate forms of cerebral hypoxia may be caused by various diseases that interfere with breathing and blood oxygenation. Severe asthma and various sorts of anemia can cause some degree of diffuse cerebral hypoxia. Other causes include work in nitrogen rich environments, ascent from a deep water dive, flying at high altitudes in an un-pressurized cabin, and intense exercise at high altitudes prior to acclimatization.

Severe cerebral hypoxia and anoxia is usually caused by traumatic events. Examples

include choking, drowning, strangulation, smoke inhalation, drug overdoses, crushing of the trachea, status asthmaticus, and shock.^[4]

It is also recreationally self-induced in the choking game and in autoerotic asphyxiation.

Signs and symptoms

The brain requires approximately 3.3 ml of oxygen per 100 g of brain tissue per minute. Initially the body responds to lowered blood oxygen by redirecting blood to the brain and increasing cerebral blood flow. Blood flow may increase up to twice the normal flow but no more. If the increased blood flow is sufficient to supply the brain's oxygen needs then no symptoms will result. ^[5]

However, if blood flow cannot be increased or if doubled blood flow does not correct the problem, symptoms of cerebral hypoxia will begin to appear. Mild symptoms include difficulties with complex learning tasks and reductions in short-term memory. If oxygen deprivation continues, cognitive disturbances and decreased motor control will result. ^[5] The skin may also appear bluish (cyanosis) and heart rate increases. Continued oxygen deprivation results in fainting, long term loss of consciousness, coma, seizures, cessation of brain stem reflexes, and brain death. ^[6]

Objective measurements of the severity of cerebral hypoxia depend on the cause. Blood oxygen saturation may be used for hypoxic hypoxia, but is generally meaningless in other forms of hypoxia. In hypoxic hypoxia 95-100% saturation is considered normal. 91-94% is considered mild. 86-90% is considered moderate. Anything below 86% is considered severe. ^[7]

It should be noted that cerebral hypoxia refers to oxygen levels in brain tissue, not blood. Blood oxygenation will usually appear normal in cases of hypemic, ischemic and histoxic cerebral hypoxia. Even in hypoxic hypoxia blood measures are only an approximate guide – the oxygen level in the brain tissue will depend on how the body deals with the reduced oxygen content of the blood.

Treatment

The first goal of treatment is to restore oxygen to the brain. The method of restoration depends on the cause of the hypoxia. For mild to moderate cases of hypoxia, removal of the cause of hypoxia may be sufficient. Inhaled oxygen may also be provided. In severe cases treatment may also involve life support and damage control measures.

A deep coma will interfere with body's breathing reflexes even after the initial cause of

hypoxia has been dealt with. Mechanical ventilation may be required. Additionally severe cerebral hypoxia causes an elevated heart rate. In extreme cases the heart may tire and stop pumping. CPR, defibrillation, epinephrine, and atropine may all be tried in an effort to get the heart to resume pumping.^[7] Severe cerebral hypoxia can also cause seizures. Seizures put the patient at risk of self injury. If convulsions are sufficiently severe medical professionals may not be able to provide medical treatment. Various anti-convulsant drugs may need to be administered before treatment can continue.

Brain damage can occur both during and after oxygen deprivation. During oxygen deprivation, cells die due to an increasing acidity in the brain tissue (acidosis). Additionally, during the period of oxygen deprivation, materials that can easily create free radicals build up. When oxygen enters the tissue these materials interact with oxygen to create high levels of oxidants. Oxidants interfere with the normal brain chemistry and cause further damage. This is called reperfusion injury.

Techniques for preventing damage to brain cells are an area of on-going research. Controlled hypothermia, anti-oxidant drugs, control of blood glucose levels, and hemodilution (thinning of the blood) coupled with drug-induced hypertension are some treatment techniques currently under investigation.^[8]

In severe cases it is extremely important to act quickly. Brain cells are very sensitive to reduced oxygen levels. Once deprived of oxygen they will begin to die off within five minutes.^[8]

Prognosis

Mild and moderate cerebral hypoxia generally has no impact beyond the episode of hypoxia. Severe cerebral hypoxia is another matter. Outcome will depend on the success of damage control measures, the amount of brain tissue deprived of oxygen, and the speed with which oxygen was restored to the brain.

If cerebral hypoxia was localized to a specific part of the brain, brain damage will be localized to that region. The long term effects will depend on the purpose of that portion of the brain. Damage to the Broca and Wernicke's areas of the brain (left side) typically causes problems with speech and language. Damage to the right side of the brain may interfere with the ability to express emotions or interpret what one sees. Damage on either side can cause paralysis of the opposite side of the body.

The effects of certain kinds of severe generalized hypoxias may take time to develop. For example, the long term effects of serious carbon monoxide poisoning usually may take several weeks to appear. Recent research suggests this may be due to an autoimmune response caused by CO induced changes in the myelin sheath surrounding neurons.^[9]

If hypoxia results in coma, the length of unconsciousness is often used as an indication of long term damage. In some cases coma can give the brain an opportunity to heal and regenerate,^[10] but, in general, the longer a coma continues the greater the likelihood that the person will remain in a vegetative state until death.^[4] Even if the patient wakes up, brain damage is likely to be significant enough to prevent a return to normal functioning.

The effects of long term comas are not limited to the comatose person. Long term coma can have significant impact on their families.^[11] Families of coma victims often have idealized images of the outcome based on Hollywood movie depictions of coma.^[12] Adjusting to the realities of ventilators, feeding tubes, bedsores and muscle wasting may be difficult.^[13] Treatment decision often involve complex ethical choices and can strain family dynamics.^[14]

See also

- Altitude sickness
- Deep water blackout
- Physical trauma
- Hypoxia (medical)
- Choking game
- Space exposure

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CARBON DIOXIDE, CAVES and YOU

Read pg 6-8

By Garry K. Smith © 1997

Member of the Newcastle & Hunter Valley Speleological Society -
NSW Australia. and the Australian Speleological Federation.

Condensed from a comprehensive paper by Garry, presented at the 21st biennial Australian Speleological Federation conference 1997 (published in the proceedings) and an article published in the 1993 Australian Caver No. 133, Pages 20-23. For more detailed information refer to these papers.

Carbon Dioxide (CO₂) is the body's regulator of the breathing function. It is normally present in the air at a concentration of 0.03% by volume. Any increase above this level will cause accelerated breathing and heart rate. A concentration of 10% can cause respiratory paralysis and death within a few minutes. In industry the maximum safe working level recommended for an 8 hour working day is 0.5% .

Caves often contain elevated levels of Carbon Dioxide (CO₂), consequently cavers may be putting themselves at risk without really knowing the full potential danger.

A cave atmospheres containing greater than 1% Carbon Dioxide (CO₂) is called **Foul Air**. This is the most likely hazard to be encountered in deep limestone caves with relatively still atmospheres. Having said that, one must be aware that there are many caving areas around Australia, where Foul Air is not a significant problem.

To the novice caver the first encounter with foul air is often a

frightening experience. Typically there is no smell or visual sign associated with foul air and the first signs are increased pulse and breathing rates. Higher concentrations of CO₂ lead to clumsiness, severe headaches, dizziness and even death. Experienced foul air cavers can notice a dry acidic taste in their mouth, however the average caver may not notice this effect.

Because an elevated CO₂ concentration in caves, corresponds to a depletion in O₂, cavers have for many years used the naked flame test to determine whether the cave atmosphere contained an elevated level of CO₂. The naked flame test involves lighting a match or cigarette lighter in the cave air, or carrying a burning candle into a suspected foul air area of the cave and the flame would extinguish when a particular concentration was reached. This test has in the past been widely accepted by the caving fraternity as a fairly accurate indications of percentage concentrations. During January 1997, I undertook extensive testing in controlled atmospheres which revealed that **the Naked Flame Test is not a reliable test of CO₂**

concentrations, other than to indicate that the cave atmosphere is most likely dangerous to human life. In fact the naked flame is only measuring the O₂ concentration and the CO₂ has such a small influence over combustion that it can be ignored within the concentration range found in caves. For example a 1% increase in CO₂ concentration will raise the O₂ concentration required to support combustion of a given fuel by less than 0.05% O₂ .

Without sophisticated measuring instruments a caver cannot determine the CO₂ concentration as the flame test only measures a lack of oxygen. To make things really complicated, it is not the lack of Oxygen which is the real danger in the majority of cave atmospheres, but the elevated CO₂ concentration.

Elements required for Combustion

Most people are aware that before combustion can occur, three conditions must be satisfied.

1. There must be a fuel or substance which can be burnt.
2. The fuel must be heated to its *ignition temperature*. That is the lowest temperature at which combustion can begin and continue.
3. There must be enough oxygen to sustain combustion, either in the surrounding air or present in the fuel.

Without going into the subject too deeply, one can see that the naked flame test is actually measuring the concentration of O₂ required to sustain combustion of various fuels, such as the match, butane cigarette lighter fluid or paraffin candle wax. The results are shown in the table below.

Table 1. Condition of flame in relation to percentage of oxygen in the controlled atmosphere.

Match	Candle	Butane Cigarette lighter
21% - 18% easily burns all of match .	>19% normal flame.	
17.5% Burns head and flame transfers down paraffin to wooden splint on most occasions	17% - 16.5% burns with elongated flame.	
17% - 16.5% ignited head and on nearly every occasion, burns down onto paraffin coating then extinguishes.	16.5% - 16% flame begins to shrink, but candle remains alight.	
16% - 15.5% ignited head just ignites paraffin coating on splint (some matches only)	16% burns slowly with small flame	
15% - head burns briefly	< 15.0%, A burning	> 15% O ₂ , A Butane

with whispery flame & goes out.	paraffin candle is extinguished.	Cigarette Lighter can easily be lit and will stay alight.
		14.5% - weak blue flame with orange top, just stays alight
		<14.25% - Flame will extinguish
14% match head burns very briefly & goes out. (burns due to the O ₂ in potassium chlorate contained in the head.)		14% - 13% Large flashes of flame but will not stay alight.
<13% head flares & extinguishes immediately (less than 0.5 seconds)		12.5% sparks with partial ignition, small fireballs
		<10% - no ignition, only hot sparks from flint.

Footnote on Safety Matches

Wooden "Safety" matches are generally made of poplar wood, which is dried to reduce moisture content to below 7%, then the "splint" is treated with an anti-afterglow solution (retardant) which prevents embers from forming after a flame is blown out. The second stage in production is dipping approximately 10 mm of the tip end into paraffin. This provides a base to carry the flame from the head to the wood. Then the tip (sometimes called a bulb) is added. Some match manufacturers add a final chemical coating that protects the match from moisture in the air.

Interesting phenomena with cigarette lighter in O₂ deficient air.

A cigarette lighter when lit in an atmosphere which will support combustion of butane will burn with the flame extending directly from the jet. When this lit cigarette lighter is slowly lowered into an atmosphere that will not support combustion (lower O₂, higher CO₂ concentration), an interesting phenomena occurs. The flame will magically stay burning where the atmosphere will support combustion, just above the interface between the high and low CO₂ concentration, while the lighter is several centimetres below the interface.

In the CO₂ Pit of Gaden Cave (WE-2) NSW Australia, a demonstration by Mike Lake showed that the flame extended to about 100 mm above the lighter as it was gradually lowered into the higher concentration in the Pit. At one stage a 25mm high flame flickered some 75 mm away from the lighter. Because of the low concentration of O₂ (proportional to high concentration of CO₂) there was no flame for the first 75mm out from the lighter jet.

This phenomena can not occur with the other solid fuels, such as matches and candles, as the heat from the flame is required to vaporise the volatiles which then burn.

HOW CO₂ GETS INTO CAVES.

It is a proven fact that CO₂ enters caves by several methods. Each method has a bearing on the gas ratio composition of the cave atmosphere and its variation to that of the above-ground atmosphere.

The two main methods in which CO₂ gets into caves are:-

1. CO₂ is absorbed by the ground water as it passes through surface soil containing high concentrations of the gas, due to the decay of vegetation. This water percolates through the rock strata and enters the cave system, usually taking part in the calcite deposition cycle. In this instance the addition of extra CO₂ to the cave atmosphere displaces O₂ and nitrogen (N₂).
2. Secondly, CO₂ may be a by-product of organic and micro-organism metabolism or respiration by fauna such as bats or humans. Simply the oxygen concentration is reduced in proportion to the increase in CO₂. The N₂ concentration stays constant.
3. The other factor which one has to consider is that in deep caves where air movement is minimal, CO₂ will build up in the lower part of

the cave. So, even though the CO₂ may have entered the cave by one of the two above mentioned methods, a very still cave atmosphere may allow CO₂ to sink to the deepest part of the cave and displace O₂ and N₂. Thus building up the concentration of CO₂ to a higher concentration, at the lowest point in the cave.

Even though CO₂ is 1.57 times heavier than nitrogen and 1.38 times heavier than O₂, it will have a tendency to disperse in an isolated volume of air, due to molecular diffusion. In other words a mixture of gasses will not separate into layers of various density gases if they are left for a long time in a still chamber. A possible explanation of the high concentration of CO₂ in deep caves (with a relatively still atmosphere), is that CO₂ is being produced metabolically or entering the cave via ground water at a greater rate than the gas can diffuse into the cave atmosphere, thus settling at the bottom of the cave because it is a dense gas.

EFFECTS OF CO₂ ON HUMANS

As each persons body has a slightly different reaction and tolerance to stressful situations the following symptoms are general, however nobody is immune to the dangers of CO₂.

Table 2. Generally accepted physiological effects of CO₂ at various concentrations by volume.

Concentration	Comments
0.03%	Nothing happens as this is the normal carbon dioxide concentration in air.
0.5%	Lung ventilation increases by 5 percent. This is the maximum safe working level recommended for an 8 hour working day in industry (Australian Standard).
1.0%	Symptoms may begin to occur, such as feeling hot and clammy, lack of attention to details, fatigue, anxiety, clumsiness and loss of energy, which is commonly first noticed as a weakness in the

	knees (jelly legs).
2.0%	Lung ventilation increases by 50 percent, headache after several hours exposure. Accumulation of carbon dioxide in the body after prolonged breathing of air containing around 2% or greater will disturb body function by causing the tissue fluids to become too acidic. This will result in loss of energy and feeling run-down even after leaving the cave. It may take the person up to several days in a good environment for the body metabolism to return to normal.
3.0%	Lung ventilation increases by 100 percent, panting after exertion, Symptoms may include:- headaches, dizziness and possible vision disturbance such as speckled stars.
5 - 10%	Violent panting and fatigue to the point of exhaustion merely from respiration & severe headache. Prolonged exposure at 5% could result in irreversible effects to health. Prolonged exposure at > 6% could result in unconsciousness and death.
10 - 15%	Intolerable panting, severe headaches and rapid exhaustion. Exposure for a few minutes will result in unconsciousness and suffocation without warning.
25% to 30%	Extremely high concentrations will cause coma and convulsions within one minute of exposure. Certain Death.

Effects of O₂ deficiency on Humans

If we consider an atmosphere consisting of just N₂ and O₂, where the O₂ is at a lower concentration than the normal atmosphere, the human body would be affected in the following manner.

Table 3. Generally accepted physiological effects of reduced O₂ concentrations.

O ₂ % by volume.	Symptoms
reduced from 21 to 14%	First perceptible signs with increased rate and volume of breathing, accelerated pulse rate and diminished ability to maintain attention.
between 14 to 10%	Consciousness continues, but judgment becomes faulty. Rapid fatigue following exertion. Emotions effected, in particularly ill temper is easily aroused.

10 to 6%	Can cause nausea and vomiting. Loss of ability to perform any vigorous movement or even move at all. Often the victim may not be aware that anything is wrong until collapsing and being unable to walk or crawl. Even if resuscitation is possible, there may be permanent brain damage.
below 6%	Gasping breath. Convulsive movements may occur. Breathing stops, but heart may continue beating for a few minutes - ultimately death.

HOW THE HUMAN BODY GETS RID OF CO₂.

The human body under average conditions inhaling air which contains approximately 21% oxygen and 0.03% carbon dioxide. The air breathed out of the lungs contains approximately 15% oxygen and 5.6% CO₂. A person at rest inhales and exhales approximately 6 litres of air per. minute but in times of stress, this may increase to more than 100 litres per minute.

The CO₂ level in the blood is an important stimulus to respiration. Nerve receptors in the aorta near the heart and in the carotid artery that goes to the brain, monitor changes in the CO₂ in the body. If the amount of CO₂ in the blood increases, both the rate and depth of breathing increases. Changes in oxygen levels are also monitored, but the receptors are not as sensitive to changes in oxygen as to CO₂.

The exchange of the two gases (CO₂ and oxygen) takes place in the lungs by diffusion across the walls of the air sacs (alveoli). Oxygen from inspired air diffuses across the lining of the air sacs and enters the circulation, while carbon dioxide moves in the opposite direction. Then the gases are transported between cells and the lung by the blood circulation.

The principle by which diffusion occurs dictates that a gas in high concentration will move to an area of relatively low concentration, until an equilibrium is reached. This enables CO₂ in the body at a higher concentration to diffuse to the inhaled air.

Humans expire air during normal breathing, composed of approximately 5.6% CO₂ and 14 to 15% oxygen. This is sufficient to revive a person with Expired Air Resuscitation. (EAR).

WHAT TO DO WHEN ENCOUNTERING CO₂.

A test should be made as soon as foul air is suspected and if a naked flame test fails, then all members of the party should immediately exit the cave in an orderly manner without panicking. Inexperienced cavers in the group should be especially watched and guided to the entrance.

When undertaking vertical pitches in caves suspected of foul air the first person down should make thorough checks for CO₂. Besides carrying ascenders, a safety belay is a wise option in the event that the first person down may be overcome when suddenly descending into an area of high concentration.

A safety belay should be mandatory with all pitches where a ladder is more than just a hand-hold.

Cavers should only enter areas of foul air during special circumstances, such as search and rescue operations, exploration and scientific work. Under these circumstances special precautions should be taken to ensure the safety of the group. For more information regarding safety precautions refer to ASF Cave Guidelines.

CONCLUSION

If sophisticated measuring equipment is not available, the best advice is to carry out a "Naked Flame Test" when you or a member of your group experiences the first signs of labored breathing, headaches, clumsiness, loss of energy or any of the other signs associated with elevated concentrations of CO₂. Ideally cavers should use a cigarette

lighter flame. This will reduce the amount of unpleasant fumes emitted from matches burnt by people experimenting in the confines of a cave. The best advice is, "If in doubt, get out", in an orderly manner.

Laboratory tests have proven that combustion of a match, candle or butane cigarette lighter will cease at about 14.5% to 15% concentration of oxygen. Twenty one percent (21%) being the oxygen concentration in normal atmosphere. Bearing in mind that humans on average breath out air containing 15% oxygen and this is enough to revive a person using mouth to mouth resuscitation. In fact humans can survive in an atmosphere containing 10% oxygen, so when the flame test just fails it is still measuring an atmosphere containing enough oxygen to survive.

The real danger is the carbon dioxide concentration which is the main trigger for the human body to increase the breathing rate. Prolonged exposure to a concentration of just 5 or 6% may be enough to cause suffocation. In the majority of cases, if a person has any of the symptoms of elevated carbon dioxide levels, a simple naked flame test will fail to ignite. This is a sure sign of foul air and it is time to get out.

Carbon dioxide when treated with respect is no worse than the other dangers in caves. Despite the possible dangers, caving is still safer than driving a motor vehicle, which most of us take for granted.

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