 

**MIDDLE SCHOOL**

**Green Chemistry**

**Solvent Snapshot**

**Background:** Solvents play an important role in chemistry. Because many solvents are toxicants, we do not recommend working with them in the classroom. For more information on the solvents used in this lesson, please see the references listed on the last 2 pages of this lesson.

**Goal:** To introduce the concept of solvents and allow students to process information about the toxicity of solvent choices

**Objectives:** Students will …

* Define solvent
* Understand how solvents apply to making shampoo
* Read information on solvents
* Analyze toxicity levels of different solvents

**Materials:**

* Art supplies
* Construction paper or butcher paper
* 1 solvent card for each student
* Copies of student directions, rubrics, and brainstorming charts for each student

**Time Required:** 90 minutes

**Standards Met:**

* Science as inquiry: Abilities necessary to do scientific inquiry
* Science in personal and social perspectives: Personal health
* Physical science: Properties and changes of properties in matter

**Green Chemistry Principles Addressed:**

* **Safer Solvents & Auxiliaries.** Avoid using solvents, separation agents, or other auxiliary chemicals. If these chemicals are necessary, use innocuous chemicals.

**Procedure:**

* Review definition of a solvent
  + Solvent: substance that dissolves another to form a solution (www.dictionary.com)
  + For example, water is a solvent to dissolve sugar in lemonade.
* Ask students to turn to their elbow partner and jot down as many products that contain solvents as they possibly can.
* Have them share their answers.
* Explain that to make shampoo, they have to use a solvent to dissolve the sodium hydroxide (lye).
* They will have a variety of choices about which solvent to use.
* Show students the sample picture of a Snapshot & tell them that they will each be creating a snapshot for one of the solvents.
  + Please note: this snapshot is from a reading assignment!
* Give each student a student direction sheet and review the requirements. Also pass out the grading rubric and review the expectations.
* Give each student one solvent card & an industry solvent guide
  + Please note! The cards are differentiated. Water is the easiest reading level. Benzene is grade level. Dichloromethane is the most difficult.
  + Please note! The International Programme on Chemical Safety does not have an International Chemical Safety Card on water. The card included here was developed by Beyond Benign staff.
* Allow them time to read the cards.
* As they are reading, give students brainstorming charts and allow them to complete the charts for their solvent.
* Give students the final copy paper and art supplies and allow them to complete their Solvent Snapshots
* Once they are completed, jigsaw students to share the information about each solvent.
* Write the principle below on the board and review what it means
  + **Safer Solvents & Auxiliaries.** Avoid using solvents, separation agents, or other auxiliary chemicals. If these chemicals are necessary, use innocuous chemicals.
* Have students get into their shampoo groups to determine which solvent they would like to use.

**Sample Snapshot:**

**Solvent Snapshot – Student Directions**

Solvent: substance that dissolves another to form a solution (www.dictionary.com) For example, water is a solvent to dissolve sugar in lemonade.

To make shampoo, the sodium hydroxide must be dissolved in a solvent. Chemists frequently have choices about which solvent to use, and they have to weigh the risks and benefits of different solvents. In order to help you choose which solvent to use, each student will make a solvent snapshot and share the information with the class.

A solvent snapshot uses words to create a picture of a certain solvent. Your snapshot will create a picture of one of the solvents you might use to make your shampoo. You will need to:

1. Read the solvent card given to you by your teacher
2. For one of the solvents, brainstorm words related to:
   1. **overall toxicity:** words to describe the general toxicity level of your solvent, is it safe? Not very dangerous? Extremely harmful?
   2. **human impacts:** words to describe how humans may be affected by your solvent, both short and long term
   3. **lab safety:** words to describe how safe this solvent is to use in a lab setting, consider storage, safety precautions (need gloves, safety glasses, respirator...), explosiveness, transportation
   4. **environmental impacts:** words to describe how the environment may be affected by your solvent
3. You will need to include an explanation of significance of each of your words on the charts given to you.
4. You will use a color-coded key to distinguish between different aspects of the solvent.
   1. For example, all of your words relating to the human impacts would be in blue, or all of your words relating to the environmental impacts would be green.
   2. Your color choices should reflect how benign or toxic the solvent is.
   3. Be sure to **include the color key** on your final product.

**Solvent Snapshot: Brainstorming Charts**

Directions: Brainstorm words for each chart. You need to have as many words as there are spaces. You may not use any word (or form of that word) more than once!

**Overall toxicity**

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| word | why you included it |
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**Human Impacts**

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| word | why you included it |
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**Lab safety**

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| word | why you included it |
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**Environmental Impacts**

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| word | why you included it |
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**Solvent Snapshot: Grading Rubric**

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|  | **5** | **4** | **3** | **2** | **1** |
| **Content** | This clearly, creatively, & accurately gives information about the solvent. | This accurately gives information about the solvent. | Most of your project accurately gives information about the solvent; one or two items were confusing. | Some of your project accurately gives information about the solvent; more than 2 items were incorrect or confusing. | Your project misinforms a reader about the solvent. The information is incorrect & incomplete. |
| **Vocabulary** | All words are varied & mature. | All words are varied & right on track. | Most words are varied & right on tract. | Some words are varied & right on track. | Words repeat & are below grade level OR you are missing many. |
| **Neatness**  **&**  **Creativity** | Extremely easy to read.  Illustrations & word design is impressive. Michelangelo has nothing on you! | Easy to read  Illustrations & word design helps convey meaning. | Legible  Illustrations & word design is complete, but challenging to understand. | Barely legible  Illustrations & word design is complete, but lacking in thoughtfulness. | illegible  Illustrations & word design is incomplete & uninspiring. |
| **Color Choice** | Clearly reflects the toxicity level of the solvent. Key is included and very easy to understand. | Reflects the toxicity level of the solvent. Key is included and easy to understand. | Mostly reflects the toxicity level of the solvent. Key is included and mostly understandable. | Some of your colors do not reflect the toxicity level of the solvent. Key is included. | Most of your colors do not reflect the toxicity level of the solvent. Key is missing. |
| **Spelling** | 0  mistakes | 1-2  mistakes | 3-4  mistakes | 5-6  mistakes | More than 6 mistakes |

**Solvent Snapshot - Solvent Card: Dichloromethane**

Dichloromethane is not without its health risks as its high [volatility](http://en.wikipedia.org/wiki/Volatility_(chemistry)) makes it an acute inhalation hazard.[[4]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-3) Dichloromethane is also metabolised by the body to [carbon monoxide](http://en.wikipedia.org/wiki/Carbon_monoxide) potentially leading to [carbon monoxide poisoning](http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning).[[5]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-4) Acute exposure by inhalation has resulted in optic neuropathy[[6]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-5) and hepatitis.[[7]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-6) Prolonged skin contact can result in the dichloromethane dissolving some of the fatty tissues in skin, resulting in skin irritation or chemical burns.[[8]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-7)

It may be [carcinogenic](http://en.wikipedia.org/wiki/Carcinogen), as it has been linked to [cancer](http://en.wikipedia.org/wiki/Cancer) of the [lungs](http://en.wikipedia.org/wiki/Lungs), [liver](http://en.wikipedia.org/wiki/Liver), and [pancreas](http://en.wikipedia.org/wiki/Pancreas) in laboratory animals.[[9]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-USDHHS-8) Dichloromethane crosses may be harmful to babies in the womb. [Fetal](http://en.wikipedia.org/wiki/Fetal) toxicity in women who are exposed to it during [pregnancy](http://en.wikipedia.org/wiki/Pregnancy) however has not been proven.[[10]](http://en.wikipedia.org/wiki/Dichloromethane#cite_note-9) In animal experiments it was toxic for a fetus at doses that were maternally. In many countries products containing dichloromethane must carry labels warning of its health risks.

In the European Union, the European Parliament voted in 2009 to ban the use of dichloromethane in paint-strippers for consumers and many professionals.

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| |  |  | | --- | --- | | **DICHLOROMETHANE: International Chemical Safety Card** | **ICSC: 0058** | |  | | |

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| **TYPES OF HAZARD / EXPOSURE** | **ACUTE HAZARDS / SYMPTOMS** | **PREVENTION** | **FIRST AID / FIRE FIGHTING** |
| **EXPLOSION** | Risk of fire and explosion (see Chemical Dangers).  Gives off irritating or toxic fumes (or gases) in a fire. | Prevent build-up of electrostatic charges (e.g., by grounding). | In case of fire: keep drums, etc., cool by spraying with water. |

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| **EXPOSURE** |  | **PREVENT GENERATION OF MISTS! STRICT HYGIENE!** |  |
| **Inhalation** | Dizziness. Drowsiness. Headache. Nausea. Weakness. Unconsciousness. Death. | Use respirator, Ventilation, local exhaust, or breathing protection. | Fresh air, rest. Artificial respiration may be needed. Refer for medical attention. |
| **Skin** | Dry skin. Redness. Burning sensation. | Protective gloves. Protective clothing. | Remove contaminated clothes. Rinse and then wash skin with water and soap. |
| **Eyes** | Redness. Pain. Severe deep burns. | Safety goggles, face shield or eye protection in combination with breathing protection. | First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor. |
| **Ingestion** | Abdominal pain. (Further see Inhalation). | Do not eat, drink, or smoke during work. Wash hands before eating. | Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest. |

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| **EMERGENCY RESPONSE** | **STORAGE** |
| Transport Emergency Card: TEC (R)-61S1593  NFPA Code: H2; F1; R0; | Separated from metals (see Chemical Dangers), food and feedstuffs. Cool. Ventilation along the floor.  Do not ship with food |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | **IPCS**  International  Programme on  Chemical Safety | http://www.inchem.org/documents/icsc/icsc/UNEP.GIF | http://www.inchem.org/documents/icsc/icsc/ILO.GIF | http://www.inchem.org/documents/icsc/icsc/WHO.GIF | http://www.inchem.org/documents/icsc/icsc/EUROPE.GIF | Prepared in the context of cooperation between the International Programme on Chemical Safety and the Commission of the European Communities © IPCS, CEC 2005 | | |

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| **PHYSICAL STATE; APPEARANCE:**  COLOURLESS LIQUID, WITH CHARACTERISTIC ODOUR.  **PHYSICAL DANGERS:**  The vapour is heavier than air. As a result of flow, agitation, etc., electrostatic charges can be generated.  **CHEMICAL DANGERS:**  On contact with hot surfaces or flames this substance decomposes **forming toxic and corrosive fumes**. **Reacts violently** with metals such as aluminium powder and magnesium powder, strong bases and strong oxidants causing fire and explosion hazard. Attacks some forms of plastic rubber and coatings.  **OCCUPATIONAL EXPOSURE LIMITS:**  confirmed animal **carcinogen** with unknown relevance to humans | **ROUTES OF EXPOSURE:**  The substance can be absorbed into the body by inhalation and by ingestion.  **INHALATION RISK:**  A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C.  **EFFECTS OF SHORT-TERM EXPOSURE:**  The substance is irritating to the eyes, the skin and the respiratory tract. Exposure could cause lowering of consciousness. Exposure could cause the formation of methaemoglobin.  **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:**  Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the central nervous system and liver. This substance is possibly carcinogenic to humans. |
| **PHYSICAL PROPERTIES** | |
| Boiling point: 40°C Melting point: -95.1°C |  |
| **ENVIRONMENTAL DATA** | |
| This substance may be hazardous in the environment; special attention should be given to ground water contamination. | |
| **NOTES** | |
| Addition of small amounts of a flammable substance or an increase in the oxygen content of the air strongly enhances **combustibility**. Depending on the degree of exposure, periodic medical examination is suggested. The odour warning when the exposure limit value is exceeded is insufficient. | |

**Solvent Snapshot - Solvent Card: Benzene**

Benzene is a [colorless](http://en.wikipedia.org/wiki/Color) and highly [flammable](http://en.wikipedia.org/wiki/Flammable) liquid with a sweet smell and a relatively high melting point. it is an important industrial [solvent](http://en.wikipedia.org/wiki/Solvent) in the production of [drugs](http://en.wikipedia.org/wiki/Medication), [plastics](http://en.wikipedia.org/wiki/Plastic), synthetic [rubber](http://en.wikipedia.org/wiki/Rubber), and [dyes](http://en.wikipedia.org/wiki/Dye). Benzene is a natural part of [crude oil](http://en.wikipedia.org/wiki/Petroleum), and may be made from petroleum. In the 19th and early-20th centuries, benzene was used as an after-shave lotion because of its pleasant smell. Prior to the 1920s, benzene was frequently used as an industrial solvent, especially for degreasing metal. As its toxicity became obvious, benzene was replaced by other solvents, which are not as carcinogenic. For humans, it is a known [carcinogen](http://en.wikipedia.org/wiki/Carcinogen) (cancer causing agent). Many students were exposed to benzene in school and university courses while performing laboratory experiments with little or no ventilation. This very dangerous practice has been almost totally eliminated. The short term breathing of high levels of benzene can result in [death](http://en.wikipedia.org/wiki/Death). Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the [stomach](http://en.wikipedia.org/wiki/Stomach), dizziness, sleepiness, convulsions, and death.

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| **TYPES OF HAZARD / EXPOSURE** | | **ACUTE HAZARDS / SYMPTOMS** | | **PREVENTION** | | | | **FIRST AID / FIRE FIGHTING** | |
| **FIRE** | | Highly flammable. | | NO open flames, NO sparks, and NO smoking. | | | | Powder, AFFF, foam, carbon dioxide. | |
| **EXPLOSION** | | Vapour/air mixtures are explosive. Risk of fire and explosion: see Chemical Dangers. | | ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools. Prevent build-up of electrostatic charges (e.g., by grounding). | | | | In case of fire: keep drums, etc., cool by spraying with water. | |
| **EXPOSURE** | |  | | **AVOID ALL CONTACT!** | | | |  | |
| **Inhalation** | | Dizziness. Drowsiness. Headache. Nausea. Shortness of breath. Convulsions. Unconsciousness. | | Ventilation or breathing protection. | | | | Fresh air, rest. Refer for medical attention. | |
| **Skin** | | MAY BE ABSORBED! Dry skin. Redness. Pain. | | Protective gloves. Protective clothing. | | | | Rinse skin with plenty of water. Refer for medical attention. | |
| **Eyes** | | Redness. Pain. | | Face shield & breathing protection. | | | | First rinse with plenty of water for several minutes, then take to a doctor. | |
| **Ingestion** | Abdominal pain. Sore throat. Vomiting. | | Do not eat, drink, or smoke during work. | | | | Rinse mouth. Do NOT induce vomiting. Refer for medical attention. | |
| **SPILLAGE DISPOSAL** | | | | | | | | |
| Remove all ignition sources. Collect leaking and spilled liquid in sealable containers. Absorb remaining liquid in sand and remove to safe place. Do NOT wash away into sewer. Do NOT let this chemical enter the environment. Extra personal protection: complete protective clothing including self-contained breathing apparatus. | | | | | | | | |
| **SAFE STORAGE** | | | | | | | | |
| Fireproof. Separated from food and feedstuffs oxidants and halogens. | | | | | | | | |
| **IMPORTANT DATA** | | | | | | | | |
| **Physical State; Appearance** COLOURLESS LIQUID, WITH CHARACTERISTIC ODOUR.  **Physical dangers** The vapour is heavier than air and may travel along the ground; distant ignition possible.  **Chemical dangers** Reacts violently with oxidants, nitric acid, sulfuric acid and halogens causing fire and explosion hazard. Attacks plastic and rubber. | | | | | **Routes of exposure** The substance can be absorbed into the body by inhalation, through the skin and by ingestion(swallowing).  **Effects of short-term exposure** The substance is irritating to the eyes, the skin and the respiratory tract. Swallowing the liquid may allow it to get into the lungs with the risk of chemical pneumonitis. Exposure far above the occupational exposure limit value may result in unconsciousness and death.  **Effects of long-term or repeated exposure** The liquid irritates the skin in an extreme manner. The substance may have effects on the immune system, resulting in a decrease of blood cells. This substance is carcinogenic to humans. | | | |
| **PHYSICAL PROPERTIES** | | | | | | **ENVIRONMENTAL DATA** | | |
| Boiling point: 80°C Melting point: 6°C | | | | | | The substance is very toxic to aquatic organisms. | | |
| **NOTES** | | | | | | | | |
| Depending on the degree of exposure, medical examination is needed. | | | | | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **IPCS** International Programme on Chemical Safety | WHO | ILO | UNEP | EC | Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission  **© IPCS 2004** |  |  |  | | --- | --- | | **LEGAL NOTICE** | Neither the EC nor the IPCS nor any person acting on behalf of the EC or the IPCS is responsible for the use which might be made of this information. | | | | | | | | | | | |
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**Solvent Snapshot - Solvent Card: Water**

Water is widely used in chemical reactions as a solvent. It works very well, is relatively safe, and is not harmful to the environment. For humans, water has many distinct properties that are critical for [life](http://en.wikipedia.org/wiki/Life). All known forms of life depend on water. Water is vital within the body. Humans are encouraged to drink at least 64 oz of water each day. It positively impacts human bodies. Humans are also encouraged to bathe in water daily to help remove other potential contaminants.

In the environment, water is very important. Just like humans, all life forms in the environment need water to survive. It is not harmful, and it is a positive element on all life. Water is fundamental to photosynthesis and respiration; the exchange that plants need to survive. It helps plants grow.

Water has not been banned by any government and is sought out by many.

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| |  |  | | --- | --- | | **WATER: International Chemical Safety Card** | **BBBC: 0001** | |  | | |

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| **TYPES OF HAZARD / EXPOSURE** | **ACUTE HAZARDS / SYMPTOMS** | **PREVENTION** | **FIRST AID / FIRE FIGHTING** |
| **EXPLOSION** | No risk of fire and explosion |  |  |

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| **EXPOSURE** | In a gaseous state, minor burns could occur | Keep distance when heating to extreme temperatures |  |
| **Inhalation** | In liquid form, coughing | Don’t stick your head under water | CPR in extreme cases |
| **Skin** | wetness |  | Dry with towel |
| **Eyes** | Wetness and tearing | Safety goggles |  |
| **Ingestion** | Recommended at least 64 oz per day | Never drink anything in a lab |  |

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| **EMERGENCY RESPONSE** | **STORAGE** |
| Transport Emergency Card: TEC (R)-61S1593  NFPA Code: H2; F1; R0; | Keep in waterproof container |

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| **PHYSICAL STATE; APPEARANCE:**  COLOURLESS LIQUID, WITH NO ODOUR.  **PHYSICAL DANGERS:**  none  **CHEMICAL DANGERS:**  On contact with hot surfaces or flames this substance turns to steam, which can burn skin.  **OCCUPATIONAL EXPOSURE LIMITS:**  none, more is better | **ROUTES OF EXPOSURE:**  The substance can be absorbed into the body by ingestion; this is recommended.  **INHALATION RISK:**  none  **EFFECTS OF SHORT-TERM EXPOSURE:**  Increased strength, brain power, and cell function  **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:**  Repeated or prolonged contact positively impacts body function for humans, plants, and animals |
| **PHYSICAL PROPERTIES** | |
| Boiling point: 100°C Melting point: 0°C |  |
| **ENVIRONMENTAL DATA** | |
| This substance is important in the environment; special attention should be given to keeping water clean. | |
| **NOTES** | |
| Water is possibly the least toxic substance on earth. It is good for humans and the environment. Whenever possible, this substance should be used. | |

**Solvent Snapshot – Industry Solvent Guide**

**References**

1. ^ [***a***](http://en.wikipedia.org/wiki/Dichloromethane#cite_ref-Ullmann_0-0) [***b***](http://en.wikipedia.org/wiki/Dichloromethane#cite_ref-Ullmann_0-1) [***c***](http://en.wikipedia.org/wiki/Dichloromethane#cite_ref-Ullmann_0-2) M. Rossberg et al. “Chlorinated Hydrocarbons” in Ullmann’s Encyclopedia of Industrial Chemistry 2006, Wiley-VCH, Weinheim. [doi](http://en.wikipedia.org/wiki/Digital_object_identifier):[10.1002/14356007.a06\_233.pub2](http://dx.doi.org/10.1002%2F14356007.a06_233.pub2)
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3. [**^**](http://en.wikipedia.org/wiki/Dichloromethane#cite_ref-2) [Shell Bitumen](http://en.wikipedia.org/wiki/Royal_Dutch_Shell). ["The Shell Bitumen Handbook"](http://books.google.co.uk/books?id=bA1tIkRJL8kC&pg=PA277&lpg=PA277&dq=aliquot+bitumen+solvent+methylene+chloride&source=bl&ots=paPjPrz_YQ&sig=OxFZ3GvgkLfRVnabn6qR8_dqHNo&hl=en&ei=F0nKSdz4EOHKjAeAzOTNAw&sa=X&oi=book_result&resnum=1&ct=result). <http://books.google.co.uk/books?id=bA1tIkRJL8kC&pg=PA277&lpg=PA277&dq=aliquot+bitumen+solvent+methylene+chloride&source=bl&ots=paPjPrz_YQ&sig=OxFZ3GvgkLfRVnabn6qR8_dqHNo&hl=en&ei=F0nKSdz4EOHKjAeAzOTNAw&sa=X&oi=book_result&resnum=1&ct=result>.
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8. [**^**](http://en.wikipedia.org/wiki/Dichloromethane#cite_ref-7) Wells G, Waldron H (1984). ["Methylene chloride burns"](http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pmcentrez&artid=1009322). *Br J Ind Med* **41** (3): 420. [PMID](http://en.wikipedia.org/wiki/PubMed_Identifier) [6743591](http://www.ncbi.nlm.nih.gov/pubmed/6743591).
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