

Chemical plants-cancer link studied

Two federal occupational health agencies have opened investigations of two Houston area chemical plants following reports of 15 deaths from rare brain cancers among workers at both facilities.

One investigation, being conducted jointly by the Occupational Health and Safety Administration (OSHA) and the National Institute on Occupational Safety and Health (NIOSH), involves petrochemical workers at a plant operated by Union Carbide Corp. The second investigation, by OSHA, involves a Monsanto chemical company plant. Both are located at Texas City.

The major investigation centers on the Union Carbide plant, where 11 cases of brain cancers have been discovered and all but one of the affected workers are dead. At the Monsanto plant, five employees have died of brain cancers.

Nine of the 11 cancers among Union Carbide employees and two of the five Monsanto cases were reported on death certificates from 1962 to 1978 to be glioblastoma multiforme, a type of brain cancer that has been linked in previous human studies to the chemical vinyl chloride, OSHA officials said.

BOTH VINYL CHLORIDE and acrylonitrile, a chemical that has been shown to cause brain tumors in animals, have been used at both plants at various times.

"Both (chemicals) are suspect solid leads," said Victor Alexander, MD, OSHA's chief medical officer. "But it's one thing to say the stuff is there and quite another to tie it all down completely, which we may never do," he warned. No firm correlation has yet been established with the Texas City cases, he emphasized.

At the Union Carbide plant, about 30 miles south of Houston, federal and company officials are preparing to computer code some 7,000 to 10,000 records of employees since the plant's opening in 1941 in attempts to identify all possible cases of brain tumors and to develop statistics for comparison with figures for Texas and nearby states, said Sanford

30 to 65. The plant currently has about 2,300 employees.

NIOSH investigators entered the case in early February after OSHA requested technical assistance.

The Monsanto plant became the subject of an OSHA compliance investigation in mid-February as an outgrowth of "information we were developing" in the Union Carbide study, said OSHA's Dr. Alexander.

"In developing that information, we got a list of people having primary brain tumors at a second plant, five names." Those cases are not confirmed, he said.

At this point, said Dr. Alexander, "We are concentrating our efforts on the first plant. We have 11 tumors there. There's more to go on. We're involved in a major investigation, a serious effort. The

information at the second plant is at a much more preliminary stage."

Dr. Alexander said if the nine glioblastomas among the 11 Union Carbide cases are confirmed, it would be an "unusual and striking cell type distribution — an unlikely distribution."

He said that in the areas surrounding the Texas City plants, it has been estimated that there would be only about 45 deaths from all types of brain cancer per 100,000 persons per year, with deaths from glioblastoma "only a fraction of that."

A key part of the investigation, he added, will be to set up a pathology referral center that would collect and study tissue slides, pathology reports, medical records and other worker health data in attempts to "determine the accuracy" of the death

certificates.

The compliance investigations at both plants are not yet complete and Dr. Alexander refused to comment on them.

Although Texas City has six or seven petroleum refining and chemical plants, federal investigators have not received reports of similar brain tumor clusters at other plants, he added.

According to preliminary information, said Dr. Leffingwell, investigators have not confirmed whether the Union Carbide workers may have been exposed to a carcinogen in any one area of the plant.

"There were a few who worked directly with vinyl chloride, but others who were not obviously exposed to it."

"The plant uses other chemicals which may be carcinogens — such as ethylene oxide and fair amounts of acrylonitrile — and we think it's important not to focus too narrowly on vinyl chloride in this investigation."

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emphasized

At the Union Carbide plant, about 30 miles south of Houston, federal and company officials are preparing to computer code some 7,000 to 10,000 records of employees since the plant's opening in 1941 in attempts to identify all possible cases of brain tumors and to develop statistics for comparison with figures for Texas and nearby states, said Sanford Leffingwell, MD, NIOSH medical officer and project officer. A "longer range plan," he said, is to check the records to develop statistics on all causes of death.

Meanwhile, Union Carbide officials also have announced plans to expand their own study to include records of past and current workers at two other plants near Charleston, W. Va., a group that may include up to 50,000 persons since the 1930s. At one of those plants in 1974, a significant number of cases of the rare liver tumor angiosarcoma were linked to vinyl chloride exposure.

"BECAUSE THE recent Toxic Substances Act and other legislation and studies have implicated or may potentially implicate dozens of molecules as human hazards, if we don't undertake a rather systematic, scientifically sound search of our data by research standards of contemporary epidemiology, then we can visualize ourselves doing this kind of Texas City study over and over again for a number of molecules," said Damon Engle, manager of the Texas City Union Carbide plant.

The 11 brain cancers among Union Carbide's Texas City workers came to light after an employee filed a complaint with the local OSHA office last Nov. 27, alleging a high incidence of such tumors among employees in the chemical shipping area of the plant, Engle said.

The employee made the complaint after he left work on a permanent and total disability, Engle added, although he refused to disclose whether the employee was one of the cancer victims.

After OSHA began a standards compliance investigation, Union Carbide officials began sifting through some 450 death certificates from employees who had died since 1941 and discovered nine of the 11 brain cancers, which they reported to OSHA. The workers ranged in age from



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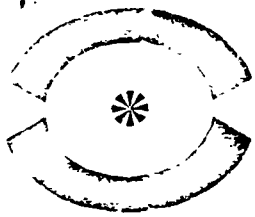
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- AN INVESTIGATION RELATIVE TO MEAT WRAPPERS SYNDROME -

Clear polyvinyl chloride (PVC) plastic film has been and is still utilized for the wrapping of meat in supermarkets. The PVC film is stored on a roll at the rear of the wrapping unit. A portion of the film is unrolled and a cut of meat placed on the film and wrapped by the operator. When completely wrapped the excess film is cut by a hot wire after which the package is sealed by placing it on a hot pad.

The major source of contaminate exposure results from the thermal decomposition products produced by passing the PVC film over the hot wire. The wire temperature allegedly ranges from 130°C to 230°C. Vandervort (1) reported that the decomposition products of the PVC film at 200 to 230°C were:

- Chloro-butane
- Benzene
- Toluene
- 1 Chloro-2 ethyl hexane
- 2 ethyl-1 hexanol
- Benzyl chloride
- Hydrogen chloride

In this study the PVC film exhibited a 1 to 5 percent weight loss due to volatile liberation in 10 minutes at 200°C. The above compounds except for hydrogen chloride were present in very low concentrations. Hydrogen chloride was the predominant breakdown product. However the decomposition took place only after prolonged heating.

Bovee, et al (2) observed the cutting efficiency of the hot wire over a wide range of temperatures. At 150°C the wire would melt through the film but only with some difficulty. With increasing temperature the cut was made more quickly and easily, smoke was observed above 175°C and hydrogen chloride detected above 230°C. In this study low levels of Ionol, a potential sensitizing agent was

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found in the decomposition products of several brands of film; isooctanol was detected in all six brands of film. The one major component comprising approximately 99% of the thermal decomposition was the plasticiser di-ethyl hexyl adipate (DOA).

In response to six requests for health hazard evaluations from retail meat wrapping employees in and around Seattle, Washington regarding exposure to thermal decomposition products of PVC of meat wrap, a limited study was undertaken. (3) Sixteen of eighteen meat wrappers interviewed in this survey were known to have suffered ill effects from the air contaminants. Eight admitted experiencing varying degrees of sneezing, rhinorrhea and eye irritation. Most individuals stated that the ill effects commenced from one to three hours after starting to wrap meat and as the work day progressed the symptoms increased in intensity. The symptoms would moderate in the evening hours and be non-existent during week-ends and vacations.

Five women experienced more severe clinical symptoms necessitating physician intervention and on occasion hospitalization. They suffered at times from severe shortness of breath, productive cough and nasal congestion. Onset of symptoms began from one-half to two and one-half hours after start of work. These ill effects led to increased absenteeism. All were on medication. This group also stated that a period of several days away from the meat wrapping environment was required for them to recover completely. Four of the women had experienced fifteen or more pack-years of cigarette smoking. Three meat wrappers had pre-existing susceptibility to upper respiratory symptomatology caused by severe disease process (rheumatic fever, chronic obstructive pulmonary disease and lung abscess).

Seventeen meat wrappers and a control population were also studied in Louisville, Kentucky (3). None of the controls reported any adverse clinical symptoms associated with their particular form of employment. The majority of controls worked as clerks in retail grocery stores.

The seventeen meat wrappers averaged nine years and three months of experience. Forty-five percent complained of irritation which resulted in itching eyes. Thirty per cent complained of burning or dryness of throat. Three of the seventeen (18%) experienced "painful breathing" and shortness of breath while working with PVC meat wrap. These same three had a history of allergies, were on medication, and were under a physicians care.

Pulmonary function tests on this small randomly selected group of meat wrappers revealed no gross pulmonary effects in comparison to a control population after one workshift of meat wrapping.

Sokol, et al (4) reported on three patients with meat wrappers asthma who developed respiratory symptoms when exposed to the fumes of PVC film cut with a hot wire. The patients were middle-aged women who smoked cigarettes and demonstrated reversible airway obstruction on pulmonary function testing.

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Johnson and Anderson (5) describe an outbreak which occurred in March and later in May of 1972 in Seattle, Washington. During March of 1972 an investigation was conducted in a meat packing plant where 15 women employees developed a mysterious recurring respiratory illness at first thought to be viral in nature. A second investigation in May of 1972 revealed a possible illness resulting from fumes emitted from the thermocutting and sealing meat wrap operation utilizing PVC film.

The onset of illness occurred between 2 and 3 hours after reporting to work and usually disappeared within a few hours after leaving work. Symptoms included cough, chest pains, breathlessness, headache, dizziness, drowsiness, fatigue, fever and myalgia.

When smokers were compared with nonsmokers, it was found that four of nine women who smoked complained of cough whereas none of the six nonsmokers experienced cough. Five smokers developed chest pains and five complained of unusual drowsiness and dizziness while only three of the nonsmokers admitted such symptoms. Six of the smokers had difficulty in breathing and only two of the nonsmokers found it difficult to breathe. Smokers experienced more severe respiratory symptoms than nonsmokers, while systemic symptoms were about equal in both groups.

Due to a great many complaints, an officer of the local meat cutters union requested the assistance of the Department of Environmental Health, School of Public Health and Community Medicine to investigate the possibility that the complaints could result from exposure to meat wrap fumes. The following summarizes symptoms relating to 25 of the above mentioned complaints:

<u>Symptoms</u>	<u>Cough</u>	<u>Throat</u>	<u>Irritation</u> <u>Nose</u>	<u>Eyes</u>	<u>Chest</u> <u>Pains</u>	<u>Difficulty</u> <u>Breathing</u>	<u>Under Doctors</u> <u>Care</u>
Number	13	11	7	5	3	8	19

Of the 25 meat wrappers, 13 experience cough, 11 irritation of the throat, 7 of the nose and 5 irritation of the eyes while 8 reported difficulty in breathing. Nineteen were under a doctor's care and two (nonsmokers) could no longer work. Fourteen of the women were nonsmokers.

In the meantime samples of meat wrap were again analyzed with results substantiating the previously reported work by Bovee et al. This time, however, after subjecting a sample of meat wrap to the thermogravimetric analyzer at 230°C, the condensate adhering to the cool portions of the hangdown tube of the balance was collected for analysis.

The condensibles were successfully extracted with ether and acetone. Both extracts were examined by infrared spectroscopy and found to contain absorbances indicative of high molecular weight oxidized hydrocarbon compounds similar to fatty acid esters. A large portion of the condensed material was probably DQA. However, higher molecular weight oxygenated hydrocarbon were also indicated (for a further discussion of the possible effects see Appendix B).

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With the assistance of the Respiratory Physiology Clinic, University of Washington Hospital a questionnaire (Appendix A) was developed and distributed by the Union. Two hundred and seventy-two members returned completed questionnaires.

RESULTS

The age distribution revealed that 35 (13%) of the women were between 18 and 30 years of age; 64 (25%) between 31 and 40 years; 99 (35%) between 41 and 50; 64 (24%) between 51 and 60; and 10 (4%) were over 60 years old.

Work experience involved 27% with less than 5 years experience, 17% with 5 to 10 years experience; 25% from 11 to 15 years experience; 23% with 16 to 20 years; and 3% with over 20 years employment.

According to smoking history there were 101 women (37%) who presently smoked cigarettes, 56 (21%) who smoked in the past but had stopped and 115 (42%) who never smoked.

A review in the prevalence of cough (Table 1) indicated that meat wrappers who smoked at present experienced more problems with cough than the nonsmokers. For example 47% of the present smokers were troubled with cough first thing in the morning while 29% of the past smokers and 22% of those who never smoked experienced similar problems. Cough during the night, cough for as much as 3 months of the year, and duration of cough followed the same general pattern.

Breathing difficulties (Table 2), including breath sounding wheezy or whistling; attacks of shortness of breath or wheezing; and shortness of breath when hurrying or walking up a slight hill, were much greater in smokers both present and past than in the nonsmokers. Shortness of breath when walking with people of own age on level ground was not much different when present and past smokers were compared with those who never smoked.

The severity of respiratory illness (Table 3) during the past 3 years was greater in the "moderate" and "great deal" category for both groups of smokers. Smokers were also unable to perform their usual activities because of illness a greater number of times than those who had never smoked.

An evaluation of the effects of exposure to plastic breakdown products (Table 4) on the other hand indicated that smokers as well as nonsmokers were affected at the same relatively high percentage rate. Sixty-seven percent of the present smokers were upset by the fumes, as were 70% of the past smokers and 69% of those who never smoked. There was also little difference between the three groups in relationship to irritation of the eyes. Coughing and wheezing were slightly higher in smokers while stomach upset was higher in women who never smoked.

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TABLE 1 RESULTS OF RESPIRATORY QUESTIONNAIRE (COUGH)

<u>SYMPTOMS</u>	<u>SMOKING HABITS</u>		
	<u>SMOKE PRESENT</u>	<u>SMOKE PAST</u>	<u>NEVER SMOKED</u>
(Totals)	(101)	(56)	(115)
Cough first thing in morninn	47%	29%	22%
Cough other times during night	38%	25%	16%
Cough most days for as much as three months of the year	49%	32%	25%
How many years have you had cough			
< 2 years	24	9	10
2 - 5 years	17	16	10
> 5 years	23	16	9

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TABLE 2 RESULTS OF RESPIRATORY QUESTIONNAIRE
(SHORTNESS OF BREATH AND WHEEZING)

<u>SYMPTOMS</u>	<u>SMOKING HABITS</u>		
	<u>SMOKE PRESENT</u>	<u>SMOKE PAST</u>	<u>NEVER SMOKED</u>
(Totals)	(101)	(56)	(115)
Breath sound wheezy on whistling	53%	51%	21%
Have you ever had attacks of shortness of breath	52%	52%	26%
Shortness of breath when hurrying on level ground or walking up slight hill	58%	54%	41%
Shortness of breath when walking with people of own age on level ground	26%	21%	16%

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TABLE 3 RESULTS OF RESPIRATORY QUESTIONNAIRE
(RESPIRATORY ILLNESS)

<u>SYMPTOMS</u>	<u>SMOKING HABITS</u>		
	<u>SMOKE PRESENT</u>	<u>SMOKE PAST</u>	<u>NEVER SMOKED</u>
(Totals)	(101)	(56)	(115)
During past 3 years how much trouble with respiratory illness			
None	29	23	41
Slight	25	21	33
Moderate	31	29	18
Great deal	15	27	8
During past 3 years how often have you been unable to perform usual activities because of above illness			
Once	16	18	13
2-5	28	32	13
> 5	11	11	4
Do you think you have ever had asthma, emphysema or some kind of bronchial trouble			
	32	52	16
Has doctor ever told you that you have respiratory trouble			
	29	52	16
Are you presently under doctors care for respiratory illness			
	12	29	4
Do you suffer from allergies			
	33	32	22

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TABLE 4 RESULTS OF RESPIRATORY QUESTIONNAIRE
(EXPOSURE TO MEAT WRAP BREAKDOWN PRODUCTS)

<u>SYMPTOMS</u>	<u>SMOKING HABITS</u>		
	<u>SMOKE PRESENT</u>	<u>SMOKE PAST</u>	<u>NEVER SMOKED</u>
(Totals)	(101)	(56)	(115)
When you cut plastic wrap does fumes upset you?	67%	70%	69%
Does plastic upset you when you are not cutting it?	10%	11%	10%
If fumes upset you, do they:			
Upset stomach	29%	27%	42%
Irritate eyes	50%	54%	43%
Make you cough	52%	41%	33%
Make you wheeze	17%	22%	11%

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CONCLUSION:

From the results of this limited investigation it was evident that exposure to meat wrap thermal breakdown products was responsible for a number of adverse effects including upset stomach, irritation of the eyes, and coughing and wheezing in a large number of the exposed population. The severity of respiratory symptoms were greater among smokers both past and present than among the nonsmokers. In addition, the 25 initial complaints indicated the presence of even more severe symptomatology such as difficulty in breathing and chest pains. Furthermore two of these women, both nonsmokers, were no longer able to continue work as a meat wrapper.

A discussion of this problem with a number of allergists, some of whom had patients who were meat wrappers, indicated the possibility that one or more of the thermal breakdown products could well be respiratory sensitizers. If an employee did develop a sensitivity to the meat wrap fumes, then removal from further exposure would be desirable.

In view of the difficulty and expense likely to be involved in attempting to determine the exact cause of the "meat wrap syndrome" it would appear desirable that a program of control be instituted immediately. The most effective method for control would be to substitute a mechanical cutter to replace the hot wire. If this does not prove feasible then a local exhaust ventilation system should be considered. A slotted hood placed in close proximity to the cutting wire with accompanying exhaust fan and carbon filter could be designed and installed at minimum cost.

Finally the possibility of vinyl chloride as one of the breakdown products has been investigated. No vinyl chloride has yet been isolated at the temperatures reported for the hot wires utilized for cutting PVC meat wrap. Since all of the different meat wrap formulations have not been examined, further investigation into this problem is being continued.

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APPENDIX A
QUESTIONNAIRE

1. Name _____ Female _____ Male _____
2. Birth date _____
3. What job do you do most of the time? _____
4. How long have you worked at that job? _____
5. Do you usually cough first thing in the morning? Yes _____ No _____
6. Do you usually cough at other times during the night? Yes _____ No _____
7. Do you cough on most days for as much as three months of the year? Yes _____ No _____
8. For how many years have you had this cough?
_____ Less than 2 years
_____ 2 - 5 years
_____ 5 or more years
9. Does your breathing ever sound wheezy or whistling? Yes _____ No _____
10. Have you ever had attacks of shortness of breath or wheezing? Yes _____ No _____
11. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? Yes _____ No _____
12. Do you get shortness of breath walking with other people of your own age on level ground? Yes _____ No _____
13. During the past 3 years, how much trouble have you had with respiratory illnesses, such as chest colds, asthma, bronchitis, pneumonia, or emphysema?
_____ None
_____ Slight
_____ Moderate
_____ Great deal

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14. During the past 3 years, how often were you unable to perform your usual activities because of the above mentioned illnesses? ☐ One time
☐ 2-5 times
☐ More than 5
15. Do you think that you have ever had any of these chest disorders: asthma, emphysema, or any kind of bronchial trouble? Yes ☐ No ☐
Don't know ☐
16. Has a doctor ever told you that you had asthma, emphysema or some kind of bronchial trouble? Yes ☐ No ☐
17. Are you presently under a doctor's care for asthma, any kind of bronchial trouble or emphysema? Yes ☐ No ☐
18. Do you suffer from any allergies? Yes ☐ No ☐
19. Is your doctor a general practitioner ☐
allergist ☐
other ☐
20. Have you ever smoked? Yes ☐ No ☐
21. How many years ago did you start?
22. Have you stopped smoking? Yes ☐ No ☐
23. How many years ago did you stop?
24. Were you influenced to stop because you had a cough, wheezing, or shortness of breath? Yes ☐ No ☐
25. What form of tobacco did or do you now use? ☐ Cigarettes
☐ Cigars
☐ Pipe

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26. How many cigarette did you or do you now smoke per day, on the average? _____
27. When you cut the plastic wraps, do the fumes upset you? Yes _____ No _____
28. Does the plastic upset you when you are not cutting it? Yes _____ No _____
29. If the fumes from the plastic upset you, do they:
- | | | |
|----------------------------------|-----------|----------|
| (1) Smell or upset your stomach? | Yes _____ | No _____ |
| (2) Irritate your eyes? | Yes _____ | No _____ |
| (3) Make you cough? | Yes _____ | No _____ |
| (4) Make you wheeze? | Yes _____ | No _____ |
30. If they make you cough or wheeze, is this better or worse after you have had a cigarette? Better _____ Worse _____

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APPENDIX B

While there might be other substances in the meat wrapping area that could be responsible for the problem discussed in this investigation, the available circumstantial evidence strongly implicates the thermal breakdown products associated with cutting polyvinyl chloride film as the likely causative agent.

In the review of the breakdown products the relatively long-chain condensable oxygenated hydrocarbons present an interesting possibility.

Recently the department investigated, at managements request, a problem relating to respiratory symptoms, similar to those experienced by the meat wrappers, among employees working adjacent to a machine which cut and sealed various sizes of polyethylene bags.

Prior to admospheric surveillance samples of the plastic bags were examined in a thermogravimetric device which heats a known weight of sample through a predetermined temperature range and at the same time records the weight loss. The breakdown products were then analyzed by mass spectroscopy. Results indicated that at the operating temperatures of the machines (720°F to 810°F) the volatilized breakdown products ranged from light molecular weight to very heavy molecular weight, long chain hydrocarbons with the largest percentage being in the latter category.

The next task was then to decide how to collect both the light and long-chained heavy hydrocarbons for analysis. An initial series of samples were collected utilizing charcoal tubes and micropore filters. Unfortunately very little material was isolated from these samples for analysis.

A second series of samples were again collected this time utilizing charcoal tubes, micropore filters and electrostatic precipitation. Once again the charcoal tubes proved negative. The four filter samples indicated particulate concentrations ranging from 0.7 mg/m³ to 1.3 mg/m³. The residue collected by the electrostatic precipitator was analyzed by infrared spectroscopy and appeared to consist of highly oxidized hydrocarbons related to carboxylic acid. These acids consist of long-chain fatty acids such as stearic acid, palmitic acid, etc. The actual breakdown products however were longer chain fatty acids than the above mentioned acids.

A sample of residue collected from the ventilation system was also analyzed by infrared and appeared to be of the same general composition as the electrostatic precipitation sample.

It was concluded that the breakdown products from heating polyethylene at 700 to 800°F appeared to consist of a series of long-chain highly oxidized hydrocarbons resembling long-chain fatty acids.

A review of the literature failed to turn up any appreciable toxicity data. The only significant finding was noted in a publication "Definition and Classification of Noninfectious Reaction of the Lung", National Tuberculosis Association, under the section entitled "Lipid Pneumonia".

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PATHOLOGIC FINDINGS:

The introduction of lipids into the lung evokes an acute inflammatory reaction or a reaction which may merely consist of phagocytosis of oily droplets by mononuclear cells. The character of the reaction is in large part determined by the nature of the lipids. Highly saturated fats and free fatty acids are intensely irritating.

As the result of the above information, it appears possible that a similar type of problem might well be associated with the heating of the PVC film.

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