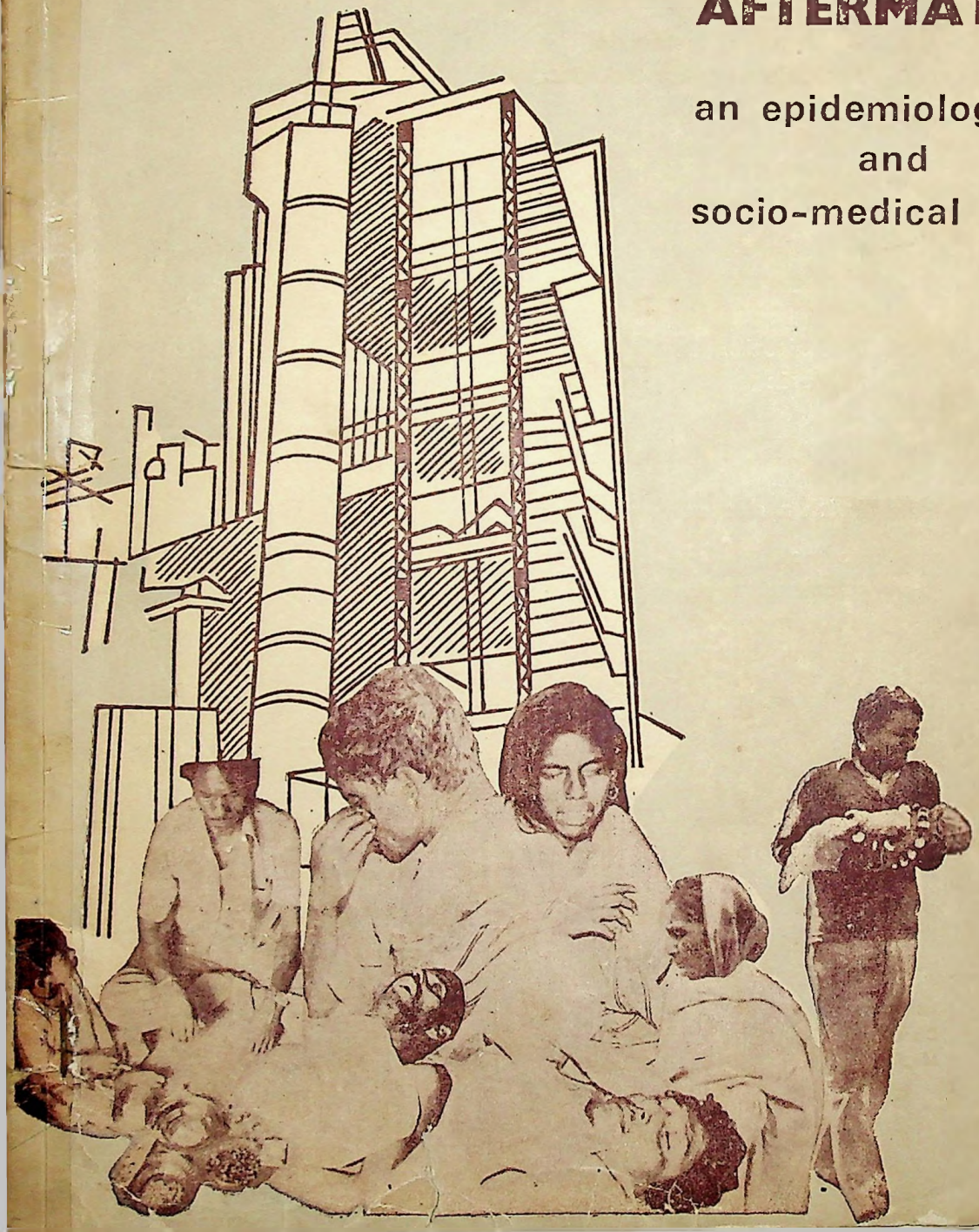
THE BHOPAL DISASTER AFTERMATH:

an epidemiological and socio-medical survey



medico friend circle

Dedicated to the thousands
who died or were disabled
by the Bhopal Gas Disaster

-- the worst industrial
accident in recorded history.

With a resolve

to prevent
medical research
from becoming an instrument of
exploitation of human
suffering.

With a determination

to make
medical research
an expression of
human concern.

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THE BHOPAL DISASTER AFTERMATH

an epidemiological and socio-medical study

15 – 25 March 1985

medico friend circle

ACKNOWLEDGEMENTS

To,

The people of Jaya Prakash Nagar and Anna Nagar for their warm and welcoming attitude which greatly helped our study.

Rukmini Bahen and friends of SEWA and Ramachandra Bhargava and colleagues of Gandhi Bhavan for their hospitality in Bhopal.

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A large circle of mfc friends and contacts for their support and encouragement, and for their critical comments on the draft manuscript of this report.

ERRATA

Page	Line	
1	3	'where' should read 'were'
6	34	'except' should read 'accept'
6	40	'polo' should read 'pool'
13	19	'weight (ii)' should read '(ii) weight'
43	24	'rigorouly' should read 'rigorously'
46	14	'Hindu' should read 'The Hindu'
52	16	'Gag' should read 'gas'
56	16	'muscie aches' should read 'muscle aches'
62	36	'paramteers' should read 'parameters'
63	31	'on' should read 'of'
65	7	'vlctims' should read 'victims'

TABLES

Page	Table No.	
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24	3A	Blurred vision/photophobia J P Nagar 77.02 (144) should read '77.02 (114)' A. Nagar 33.40 (53) should read 38.40 (53)
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PREFACE

The Bhopal disaster has been an unprecedented occupational and environmental accident. Equally unprecedented have been the imperatives for relief, rehabilitation and research in the aftermath of the disaster.

The local situation has been extremely complicated and dynamic. While health service providers and researchers have had to face many medical challenges, government and voluntary agencies involved in relief and rehabilitation have had to face many logistical and organizational challenges.

For the medico friend circle too, in its intervention in research and continuing education strategies in support primarily of voluntary agencies, it has been both a challenge and a thought provoking learning experience. The experience of planning, organising, analysing and communicating our research findings based on a modest study has brought us further in touch with the apathy, vested interests and status quo factors which obstruct action in favour of the disadvantaged in society.

Having seen the intensity of health problems of the disaster victims and the inadequacies in the strategies employed to ameliorate them we cannot but help raise critical comments on all components of the social medical system who are there to handle such problems.

Our objective, however, is more than critical analysis. Through this epidemiological study we have tried to make our own small contribution to a better understanding of the health problems that prevail in the aftermath of the disaster. We have also made suggestions for a more comprehensive relief and rehabilitation strategy.

A word of caution here—most of our observations are of the situation as it existed at the end of March 1985. Six months have passed in the process of analysis, consensus seeking and understanding our findings. During these six months, many further developments--both positive and negative--have taken place in Bhopal at the governmental and the non-governmental initiative.

We hope that this report will atleast help to highlight to our readers among other matters that--

(i) what people say and feel is as important evidence as what we can discover through our over-mystified medical technological approach;

(ii) in the absence of a community oriented epidemiological perspective, decision making about relief efforts, following a disaster can be adhoc and often irrelevant; and

(iii) for research to be relevant to the lives of the people, the findings and inferences drawn must be communicated to the health service providers and the patients themselves through an effective communication strategy.

Finally we hope that through this report, we shall stimulate debate, dialogue and a commitment to a deeper understanding of the problem, leading to more relevant and meaningful interventions.

Bangalore
2 Oct 1985

Ravi Narayan
Convenor

CONTENTS

CHAPTER 1

INTRODUCTION

Many months after the Bhopal gas tragedy, conflicting reports kept coming in from Bhopal. There were reports that the gas victims continued to present at the out patients departments with serious physical symptoms and they where getting very little relief by the standard package of treatment which included antibiotics, steroids, antacids, cough mixtures, eye drops and bronchodilators.

Doubts were being raised that the disaster victims were developing a sense of dependence and were exaggerating their symptoms in order to draw more and more benefits. It was also felt that the first wave of mortality and morbidity had receded and that there was no significant residual damage and morbidity. The feeling of *"all was well"* was becoming stronger.

In February 1985, another dimension of the human suffering in Bhopal came to light. The Indian Council of Medical Research (ICMR) came out with a finding that the gas affected population of Bhooal was probably suffering from a chronic cyanide like poisoning and that the use of an antidote - sodium thiosulfate— could improve their condition. The situation was, however, further compounded by a total clamp down of information by local state health authorities.

The medico friend circle (mfc) had decided at the annual meeting in Bangalore, end of January 1985, to respond to a series of appeals from various non-governmental groups and to undertake an epidemiological and medico social investigation with the primary purpose of supporting disaster victims, citizens' groups and voluntary agencies in their struggle for meaningful relief, rehabilitation, justice, and for information.

However, at that point the collective knowledge of mfc was too inadequate (cyanide poisoning was still in the future) for a meaningful formulation of the problem in Bhopal. Naturally the formulation of concrete objectives for the study was not possible either. This evolved as the study progressed in stages. It was however felt that the mfc should collect its own field data and get first hand information about the health status of the disaster victims.

A few mfc members had visited Bhopal in mid-February and had identified certain urgent areas for action (1).

The team for this epidemiological study was in Bhopal from 15 to 25 March 1985. It consisted of a voluntary group of clinicians, doctors working in community health projects and health activists from different parts of India. During the stay and subsequently as the collected data was being analysed, it was realised that two medical theories to explain the continuing symptoms were competing to gain supremacy :

i) *The 'pulmonary' theory* which believed that in view of the available information about the effects of MIC, only extensive lung damage (leading to diffused pulmonary fibrosis) and direct injury to corneas of eyes could be expected.

ii) *The 'enlarged cyanogen pool' theory* which believed that the effect of the released gases on the patients was to increase the cyanogenic pool inside their bodies leading to chronic cyanide-like poisoning.

Both these theories are explained further in the text. It is important to realise, however, that this was not a purely academic controversy but a very serious problem having a direct and immediate bearing on the lives of the people. The controversy had resulted in the adherents of the pulmonary fibrosis theory (who dominate the medical establishment in Bhopal) steadfastly refusing to treat the gas victims on a mass-scale with sodium thiosulfate which had been advanced as an antidote by the ICMR on the basis of its research findings. The net outcome of this unseemly controversy was that the suffering of the people was continuing without any relief in sight.

A study undertaken in a situation where two proponents of opposing theories are busy in a controversy cannot ignore these theories. We did not. In fact we consciously kept this controversy in mind and analysed our findings accordingly. Needless to add that the study does not and cannot aim to provide decisive arguments to resolve the controversy fully.

However the critical analysis does not remain narrowly confined to the merits and demerits of the contending theories only. It goes much beyond that. The inherent force of the logic of the criticism impinges upon the much wider issues of weaknesses in methodology, perspective, orientation and setting of objectives of medical research as it has been carried on in Bhopal. The serious gaps in the very fabric of research efforts have direct and vital connection not only with the urgent issue of relief from suffering, damages and compensation to the victims of the poison gas, but also with the issue of fixing the responsibilities on all those who have perpetuated the suffering of thousands of people of Bhopal.

We outline a series of conclusions and recommendations for urgent consideration by all concerned.

A summary of this report is also being released in English for wider circulation and a lay version in Hindi for the gas affected people in Bhopal.

If, through this modest effort we have moved towards the establishment of a 'people oriented science' and endorsed the people's 'right to know', we would have felt that our efforts were more than worthwhile.

- medico friend circle

Justice is but truth in action and we cannot hope to attain justice until we have the proper respect for truth.

—Anon

CHAPTER 2

OBJECTIVES OF THE STUDY

The Indian Council of Medical Research (ICMR) has initiated over 22 research projects to study the sub-acute, chronic and late effects of the Bhopal gas disaster. The objectives of the medico friend circle (mfc) intervention in Bhopal was not to duplicate the efforts of ICMR. We neither have the resources nor the access to technical supports that are required for such efforts; nor for that matter the mandate. We believe that the primary role of organising research linked to relief and rehabilitation efforts lies with the governmental and national institutions that have been established with the tax payers' money.

In January 1985 when we first decided to undertake this study, there was hardly any official information available on the health situation of the gas victims of Bhopal. The clamp down on information was unmistakable. From whatever little information we could obtain, it was clear that people in large numbers were reporting symptoms like shortness of breath, cough, excess lacrimation, fatigue headache, loss off appetite, etc. This was a list of symptoms. Only symptoms, apparently unconnected to one another by underlying patho-physiological mechanisms, dominated the scene.

Naturally at a meeting in Bombay we first set the following series of objectives.

(i) Assessing current health status and medico-social problems (ii) Prioritizing in terms of magnitude and implication for rehabilitation (iii) Identifying health problems that required health education efforts (iv) Studying existing plan of relief, research and rehabilitation services and (v) Studying people's perception of these services.

Later on, when the study was in progress in Bhopal, we came across more substantial information. The conflict of two medical theories came before us in sharp focus and the far reaching implications of this conflict for relief, rehabilitation, compensation etc. were tentatively grasped in those days. The objective was slowly evolving and finally came to be a thorough-going critique of the two medical theories and the implications flowing from them. Our initial fact finding, appraisal of information and situation analysis, led us to identify a series of issues of concern: (i) secrecy on any type of data/information on the disaster; (ii) secrecy of ICMR research study plans; (iii) absence of open scientific debate on research findings, (iv) the vertical, clinical and organ centred nature of research projects; (v) the absence of encouragement to non governmental initiatives; (vi) the adhoc and populist approach to relief and rehabilitation; (vii) the absence of authentic scientific and research based information for the medical teams providing services; (viii) the absence of demystified but authentic information to the disaster victims for their evolving movement/struggle for a more relevant relief and rehabilitation programme.

These concerns led to a reassessment of the Bombay objectives and a series of new objectives emerged to best meet the emerging situation. These were-

(i) To assess the current health status and related problems of the people on a sound epidemiological/ community basis;

(ii) To assess the findings in the light of the medical controversy between 'exclusive pulmonary pathology' vs. an 'enlarged cyanogenic pool' leading/ to a chronic cyanide like poisoning;

(iii) To evolve a critique of the ongoing research and medical relief programme;

(iv) To identify factors that have important implications for the relief, rehabilitation strategy (including claims for compensation);

(v) To assess the people's perception of the ongoing health care services;

(vi) To make suggestions for a more meaningful relief/research/rehabilitation policy.

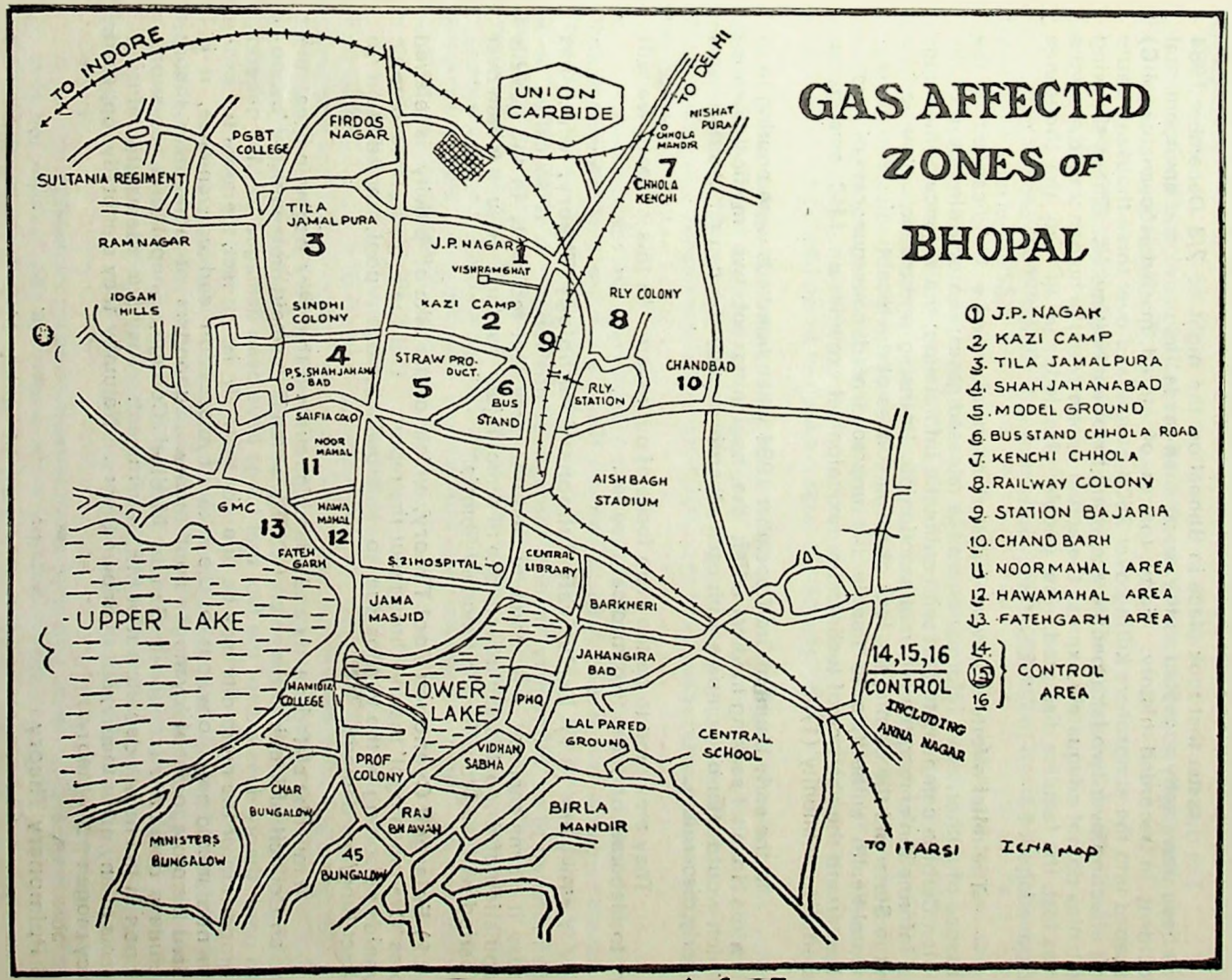
The health problem situation as it evolved in Bhopal which helped give a final shape to the objective, has another interesting aspect which bears on methodology of the study.

During and after the study many have commented that our reliance on symptoms is somewhat unsatisfactory, that they are subjective and therefore we are on shaky ground and that more objective data like bio-chemical measurements, X-rays etc. as were done by other groups (e.g. the Nagrik study) is missing in our study, rendering it less solid. This faith and attachment to laboratory tests, X-rays and other types of 'objective' tests is interesting but difficult to understand.

When predominance of a broad range of symptoms was the only important fact known and even after the fact of 'enlarged cyanogen pool' came to be known, what could be the biochemical-pathological tests that could be done in a sample population so as to make our study more objective and less shaky? The only biochemical tests of real value, suggested by the 'cyanogen pool' theory are augmented output of urinary thiocyanate following intravenous sodium thiosulfate and study of blood gases. Both these tests were of course, beyond our reach. However, that should not mean that studies at less sophisticated levels like ours, have no objectivity about them.

With regard to X-rays, it should be noted that the place of chest-radiography is extremely limited. Its only legitimate use is in the detailed follow-up of those whose pulmonary function studies have shown very significant lung diseases (19). Furthermore X-ray findings sometimes bear little relation to the patient's disability, loss of function or severity of other symptoms (10) The other test which is of real value is pulmonary function tests. The forced vital capacity (F V.C.) and the forced expiratory volume in the first second (F.E.V. 1) are the simplest, most repeatable, valid and among the more discriminating tests reflecting mechanics of breathing. They have had most extensive trials during the past 25 years and regression equations for predicted normal performance are better documented than for any other respiratory test (10,19). We have in our study undertaken these tests.

Biochemical parameters, which are routinely studied in clinical settings where the problem situation is much more settled and clear-cut, cannot be easily and automatically used with a view to improve objectivity, in a situation like the Bhopal gas disaster. This is completely new and unknown territory in so far as little is known about MIC's effect on the body. To use such parameters would be like shooting in the dark. These 'solid' 'objective' tests themselves do not necessarily lend objectivity to any study in such an inherently difficult and ill-defined problem situation. In doing so we are only reinforcing and perpetuating the popular, mythical notions about scientific objectivity. To study symptoms is not necessarily to be subjective—but about this later.



STUDY AREAS - 1 & 15.

CHAPTER 3

BACKGROUND : TWO MEDICAL THEORIES

The disaster that took place in Bhopal on the night of 2/3 December 1984 has been universally accepted as the worst man-made industrial and environmental accident in recorded history. Forty tonnes of stored methyl-isocyanate (MIC) escaped into the atmosphere killing over 2500 people and over three thousand cattle and affecting over two lakh people according to official estimates. These shocking statistics do not adequately express the actual enormity of the human tragedy—of the lives lost, the families disrupted, the people disabled and ill and the thousands impoverished.

The relief efforts that were initiated soon after were handicapped by the absence of authoritative information on the released gases; the unwillingness of the Union Carbide company to part with authentic information; the absence of meaningful information among the relevant sanctioning, licensing and inspecting authorities in the State and the Centre; the lack of preparedness of the local bodies and governmental health authorities to handle the unprecedented consequences of such a disaster and the absence of technical or toxicological expertise on MIC among our scientific community (1).

In the early hours of 3rd December 1984 when hundreds were pouring in to Hamidia Hospital seeking medical relief, the beginnings of two medical theories which would later on compete with each other to occupy the central position were clearly discernible.

They are going to be the main focus of our report. In this chapter we will try to elaborate on these two medical theories.

They are (3.1) **Exclusively Pulmonary Pathology Theory,** which has been referred to as 'Pulmonary theory' throughout this report. It is so called because it claims that all the mortality and the prevalent morbidity in the gas hit population of Bhopal is exclusively due to direct injury to lung tissues which over a period will lead to diffuse pulmonary fibrosis.

((3.2) **Enlarged Cyanogen Pool Theory,** which for the sake of brevity is referred to as 'Cyanogen pool' theory' throughout the report. This theory postulates chronic cyanide poisoning of the victims due to enlarged cyanogen pool, in addition to direct lung/eye damage.

It must be stated clearly and unambiguously at the very beginning that the Indian Council of Medical Research (ICMR) which is the main protagonist of 'cyanogen pool' theory does except the fact that lungs have been damaged by MIC gas and a proportion of the morbidity may be due to that. It is, in fact, therefore the proponent of mixed pathology, but for the sake of discussion and convenience, it is called the protagonist of 'cyanogen pool' theory. Supporters of pulmonary theory include a dominant faction in Gandhi Medical College, Bhopal and has strong support in the health department of MP Government. They are adamantly refusing to accept any other theory, but their own theory. Naturally they are totally opposed to cyanogen polo theory.

3.1 Pulmonary Theory

According to this theory, isocyanates, of which MIC is one member, are

toxic, irritant gases that directly damage the tissues they come in contact with-lungs and corneas of eyes. The acute and long lasting pathological effects therefore are to be seen only in lungs and eyes, and the effects of hypoxia secondary to lung damage.

A small proportion of (about 5-10%) persons exposed to these substances also develop sensitization (2,5).

The effects of isocyanates even in high doses on the gastrointestinal tract is minimal (4).

It can induce blindness or visual impairment depending on the degree and location of scarring (2,3).

Among the isocyanates toluene di-isocyanate (TDI) has been shown to produce Central Nervous System (CNS) damage, manifested as loss of memory, diminished mental capacity, persistent headache, personality changes, irritability, depression etc (6) But any such effect by MIC on CNS has been dismissed as anecdotal "because MIC is such a severe primary irritant it would be apt to produce such a severe degree of irritation that death would occur before sufficient absorption of the compound could occur to produce systemic effects" (6).

This brings us to the central point of the theory, which is to explain why MIC exposure must produce damage to only lungs and corneas excluding all other organ systems. Why for instance MIC, an isocyanate, cannot have long lasting CNS effects whereas another isocyanate, TDI, can have long lasting effect on brain function?

Among the three isocyanates used in industry MIC is much more reactive than the other two e.g. TDI and MDI (Methyl Di-isocyanate). It has been argued that *'MIC is so readily decomposed by water, the chances are "very very remote" that this iso-cyanate could enter the blood stream, be whisked to internal organs and produce damage there, by reacting with target proteins'*. It is further argued that *'for the same reason MIC lacks the hardiness to be a carcinogen. Molecules of the compound would have to penetrate the cell wall and reach the DNA to do their genetic dirty work. It is virtually unthinkable that molecules of MIC could survive such a cellular journey' (2,9)*.

This is the point : the high reactivity of MIC molecule renders it nonspecific and therefore it is bound to damage only those organs which come into direct contact with it—lungs, eyes and skin. The skin may however escape because MIC fumes may not penetrate the skin (3). The logical corollary of it is that long term problems in survivors can be due to extensive lung damage and corneal damage only.

Mr. W. Anderson, Chairman of Union Carbide Corporation, U. S. felt so confident that in a letter of 3rd January 1985 (exactly one month after the disaster) he wrote to an activist group which is monitoring the Bhopal Disaster to say that *'those injured by Methyl Isocyanate (MIC) are rapidly recovering and display little lasting effects . . . . . , for example, no case of blindness' (11)*.

The pulmonary theory therefore, must reject any other explanation for the presence of wide ranging symptoms in the community and also the treatment based on alternative explanations.

For the same reason **some U. S. Scientists have characterised such reports of Cyanide Poisoning of the exposed population 'highly questionable' and 'probably spurious'. They have further argued that there is no known metabolic pathway that converts isocyanate into cyanide (2).**

The clash of theories extends to the whole range of health problems in Bhopal.

Thus according to the *'pulmonary theory'* the large number of deaths in the early hours of the morning of 3rd December 1984 were due to carbon monoxide poisoning and to others the deaths were due to cyanide poisoning. We have no definite information regarding the nature and quantity of dangerous gases that were present in the atmosphere after the massive gas leak. However it is known that the thermal decomposition of methyl Isocyanate can lead to the production of a variety of toxic substances including Carbon monoxide (CO) and Hydrogen Cyanide (4). The temperature of toxic fumes gushing out of the tank was at least 120 degrees centigrade (12).

An investigation was undertaken by the ICMR at a very early stage to sort out this controversy. Particular attention was paid to find out clear evidence of carbon monoxide and/or cyanide. A large number of control blood samples and also samples of blood already preserved in the deep freeze in the Medico Legal Institute and fresh samples from cases who subsequently died were examined for evidence of carbon monoxide poisoning (carboxyhaemoglobin) or cyanide poisoning (cyanomethemoglobin) by spectrophotometric analysis (14). In none of the samples was there evidence of either.

In contrast to this, a study of 113 MIC affected people who themselves reported to K.E.M. Hospital, Bombay showed carboxyhaemoglobin (COHb) at a concentration of more than 2% in 93% of cases. (The normal levels of COHb in blood are 0.5 - 0.8 %. In smokers the levels could be as high as 15%, the average being being 5%) (13). This sample however is not a representative sample and the control is lacking. Moreover age/sex structure and smoking status are not given (8). Besides, the effects of COHb levels less then 5% are controversial. COHb levels of 20%, decrease tissue oxygenation and affect performance (10).

3.2 Enlarged Cyanogen Pool Theory

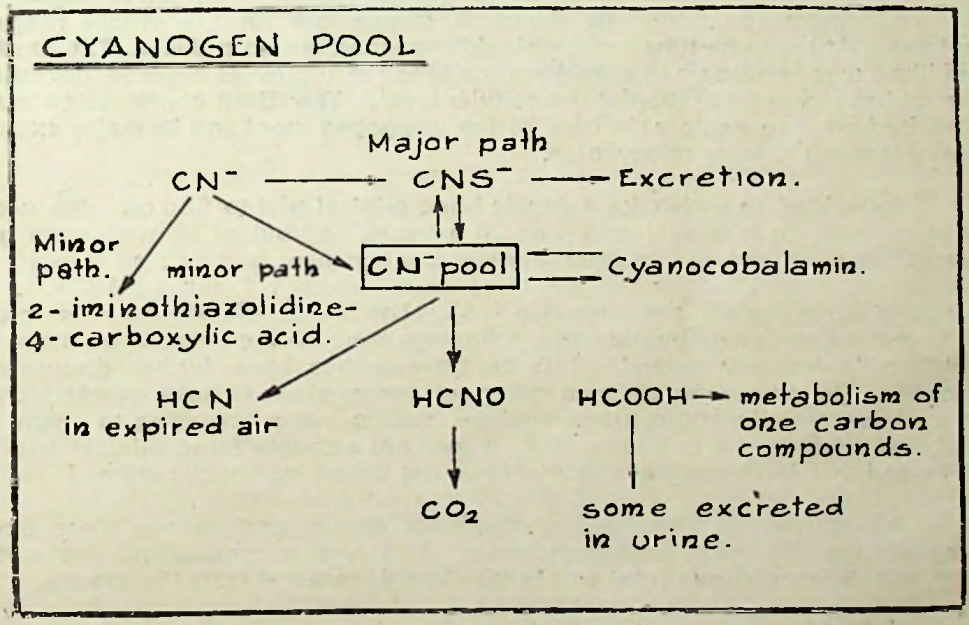
One of the most important developments of the complex findings among Bhopal disaster victims has been the evidence favouring what may be termed an 'Enlarged Cyanogen Pool' theory. Professor H. Chandra of Medico Legal Institute of Gandhi Medical College, Bhopal noticed in the early hours of 3rd December when the first autopsies were being performed that even the venous blood of dead bodies was cherry red in colour (so called arterialization of venous blood). All the internal organs, lungs, intestines, kidneys, brain, muscles, etc. were bright red in colour. This led him to suspect that victims could have succumbed to cyanide poisoning (14,15).

A visiting German clinical toxicologist Dr. Max Daunderer is reported to have detected cyanide in the affected patients (14,15,17) Unfortunately his findings could not be repeated because of technical and methodological problems (14,15). ICMR set out to 'identify the presence of either the original products'. The objective was to obtain a better understanding of the probable detoxification mechanisms which would help in the prompt use of an antidote to remove toxic substance still circulating in the body (14).

As has been pointed out in 3.1 above, attempts to establish the presence of either carboxyhaemoglobin or cyanomethemoglobin in the blood failed. However all the samples of all victims showed twin bands of oxyhaemoglobin(14) which is an indication of a change in the nature of the haemoglobin molecule.

Special note must be taken here that from as early as the first week of the disaster, the ICMR approach to the problem pointedly ignored the theoretical notion of the MIC molecule being too reactive to reach the blood stream and causing damage to the internal organs.

Following a rapid study of available literature by Dr. Sriramachari it was felt that the mechanisms of conjugation of isocyanate should be investigated vigorously. The equivocal results in the increase of blood urea in fresh autopsy tissue samples as well as qualitative reports of the presence of cyanide in tissue led to the hypothesis that either due to inhalation of hydrogen cyanide from the contaminant or cyanide radicals released by the breakdown of MIC within the body, there was every likelihood of either acute cyanide or chronic cyanide poison operating (14). This idea was reinforced by literature scan where in there is a reference **to the cyanide pool and its major excretory pathway through urinary thiocyanate (14)**



As shown in the diagram above, there is a cyanogen pool in the body which normally generates extremely small amounts of cyanide radicals in the course of normal metabolic processes of the body. These cyanide radicals are easily removed from the body by a process of detoxification which converts the cyanide radicals into relatively harmless thiocyanates which are excreted as urinary thiocyanates. This detoxification process is controlled by the enzyme called rhodanase in the liver.

The process of detoxification by the rhodanase system can be accelerated by sodium thiosulfate if given in large amounts. **This provides the rationale for injection of sodium thiosulfate for the treatment of cyanide poisoning. Also the amount of urinary thiocyanate excreted in the urine following injection sodium thiosulfate gives an indirect clue of the size of cyanogen pool in the body And this provides the rationale for sodium thiosulfate as an epidemiological tool of investigation of the hypothesis of 'enlarged cyanogen pool' in the MIC exposed population of Bhopal** to which we will return in the Chapter 6.

This pool of cyanogen is proposed to have been enlarged in the MIC exposed population of Bhopal. According to the theory small quantities of cyanide, but much larger than that which would be normally produced in the body, is continuously contributed to the cyanogen pool of the gas victims from MIC molecules which are attached to alfa chains of haemoglobin molecules - a process that is called carbamylation of haemoglobin. Cyanide blocks the activity of a large number of enzymes but the most important from the point of view of its effects is the enzyme called cytochrome oxidase in all the cells which controls the oxygen utilisation of the cells. This leads to under-utilisation or non-utilisation of oxygen at the cellular level producing chronic hypoxia which is responsible for the whole range of symptoms. At the same time carbon dioxide transport is also reduced. The study of gases like oxygen and carbon dioxide in the blood may provide clues to disturbance of gas utilisation and transport at the cellular level. The ICMR continued to pursue its inquiry further to explore the idea of the cyanogen pool and its major excretory pathway through urinary thiocyanate.

It decided to undertake a double blind clinical trial to find out the usefulness of sodium thiosulfate injections on 30 patients. 10 out of 19 who were given sodium thiosulfate showed marked clinical improvement and had an 8 to 10 fold increase in the excretion of urinary thiocyante, whereas 1 out of 15 who got injection glucose showed such increase (14). The full details of this most crucial trial have not been made public and the findings have been contested by those who uphold the 'pulmonary theory'. This controversy has been further discussed in Chapter 6. The opponents of 'cyanogen pool' theory claim to have conducted their own study with sodium thiosulfate and the results were according to them, discouraging. However it is known that it was not a double blind clinical trial like ICMR's and that full details of this trial have not been made public either !

Alongside this investigation, studies of arterial and venous blood oxygen and carbon dioxide levels were undertaken. This was to understand the state of oxygen utilisation at tissue level and carbondioxide removal from the tissues.

Following are the salient findings of the investigation.

a) Level of oxygen in arterial blood was lower than normal (14)

b) Similarly level of carbon dioxide in the arterial blood was also lower than normal (14)

c) Inspite of raised haemoglobin levels its oxygen carrying capacity was lowered. There is a probability of some compensatory mechanism, operating such as indicated by elevated levels of 2-3 Diphosphoglycerate (2-3 DPG) in the blood which is one of the mechanisms to improve the oxygen utilisation by the tissues (14)

d) Following the treatment with sodium thiosulfate the carbon dioxide level in venous blood increased, with improved clinical condition. This preliminary observation tends to indicate that following administration of sodium thiosulfate, patients appear to better utilise the oxygen. The higher levels of carbon dioxide in the venous blood probably means that venous carbon dioxide is being carried in solution. This could be due to some alteration in the haemoglobin molecule, possibly by mechanisms such as carbamylation of end-terminal amino groups (14) .

All these findings such as increased haemoglobin concentration, twin bands of oxyhaemoglobin, more than doubled normal values of 2-3 DPG in the blood and clinical improvement, augmented output of urinary thiocyanate and rise in carbon dioxide level in venous blood following sodium thiosulfate injections are unexpected but highly suggestive.

These findings strongly suggested that tissue utilisation of oxygen in gas victims is problematic. This is not a simple function of reduced diffusion—perfusion ratio leading to anoxia as one would expect in exclusive pulmonary damage.

The pathology is not only in the lungs, probably it is at a cellular level in all the vital organs. Logically speaking it is not imperative for the theory to chase only MIC molecule in the cellular processes. There may be other molecules derived from MIC or other toxic gases which contribute to the cyanogen pool. The cyanogen pool theory may stand or fall the critical tests but these findings if true are in need of explanation.

CHAPTER 4

MATERIALS AND METHODS

4.1 Sample Population

Two bastis (slum areas) were selected for the study: (i) JP Nagar, which was the worst affected, is situated right in front of the Union Carbide factory; (ii) Anna Nagar, which is about 10 km. south of the factory was selected as a control (see map) It is important to clarify here that no area in Bhopal which has similar bastis was unexposed to MIC at the time of the disaster and hence Anna Nagar was also exposed. However, it was one of the least affected areas. In the absence of any available information regarding the quantum of gas exposure of various communities differences in postexposure mortality can be taken as a criterion of difference in gas exposure. Our assumption, therefore, in selecting Anna Nagar as the least affected was based on the available mortality rates from the Department of Information and Publicity, Government of Madhya Pradesh - JP Nagar 2.34% and Anna Nagar 0.32% This assumption was further corroborated by our study-finding of a difference in mortality between JP Nagar (36.6/1000) and Anna Nagar (7.9/1000), in the three month period between MIC gas exposure and our study. Another significant finding which justified this selection of samples was the fact that 45 persons (30%) out of our sample in JP Nagar had been hospitalised after the gas exposure whereas the figure for Anna Nagar was one person (0.72%), a clear indication of the differential exposure.

Both these bastis were more or less comparable with respect to housing, sanitation and economic characteristics though there were some socio-cultural differences among the two areas, in that the inhabitants of Anna Nagar were predominantly migrant labour from the south who were, however, resident in Bhopal for many years.

We decided on a sample size of about 180 persons of both sexes of more than 10 years age for each basti (This was based on the assumption that significant morbidity would be atleast 15% in JP Nagar and 5% in Anna Nagar. We wished to have a 90% chance of finding this difference with significance level of 5% in a two tailed test i. e. $2\alpha = 5\%$ and $\beta = 90\%$). It needs to be emphasised here that the assumptions on which the sample size was computed, are quite stringent. For our purpose sample size is more than adequate. Since random selection of individual persons was not possible, we decided to select at random 60 families from each basti to yield the desired number of persons. Random selection of families in both bastis was fortunately possible because the ICMR had already provided a number plate for each household. This provided the much needed sampling frame from which random sampling of families was done with the help of random number tables.

Children below 10 years were excluded from our sample because of the fact that their reporting of symptoms and pulmonary function tests would be unreliable.

4.2 Methods

As will be noted by the readers, history-taking has been our most important method of study. Methodological issues arising in respect of this method have been discussed in Chapter 2—'Objectives of the study' 'and below in the section of 'Morbidity Analysis'. The following were undertaken during the study.

4.2.1 History-taking and physical examination of each individual

A detailed proforma was designed for the study which was to be administred to each eligible member of the selected families (Appendixl). It included the following sections.

Section I : This included the following information about each household: family composition; deaths or missing members since the gas leak; occupation; income; history of smoking or chronic respiratory diseases (TB, asthma and chronic bronchitis) of each member. Details of loans taken by the family and compensation received were also elicited.

Section II : This was to be filled for each individual in the household included in the sample. It included details of occupation and income; change in income due to illness/disability following gas leak; certain details about exposure and safety measures attempted; whether hospitalised after exposure and history of smoking and chronic respiratory illnesses (TB, asthma and chronic bronchitis).

Section III : Every individual included in the sample was subjected to a systematic enquiry of 26 symptoms. The patients own description of these symptoms were listened to avoiding much direct questioning.

A general physical examination was also done including (i) height and weight (ii) and (iii) pulse and respiratory rates for full one minute in resting position after lapse of considerable time to ensure relaxation (iv) eye examination including cornea, lens, pupillary reflexes, distant vision and near vision (v) general signs like oedema, jaundice, cyanosis (vi) examination of skin; (vii) respiratory system; (viii) cardiovascular system; (ix) central nervous system; (x) alimentary system.

The parameters for each system are shown in Appendix I.

Section IV : This was for each woman belonging to the reproductive age group included in the sample. It included menstrual history; history of gynaecological complaints before and after gas leak; pregnancy and its outcome; if a nursing mother then details of lactation before and after exposure.

4 2. 2 Pulmonary Function Tests (PFTs) which included Forced Expiratory Volume in 1st second (FEVI) and Forced Vital Capacity (FVC) for each individual. PFTs were recorded by Morgan's electronic spirometer set as BTPS. Three readings were recorded and the highest reading was taken for analysis.

For the interpretation of PFTs, height of each individual was measured by a straight aluminium rod on which a metal measuring tape was fixed. Weight was measured by standardised bathroom scales. The sample size of PFTs was further extended by additional observations on other families selected at random in both bastis. PFTs were performed by a doctor who had adequate experience of using the spirometer under field conditions.

4.2.3 Haemoglobin estimation using Sahli's haemoglobinometer was done on a random sample of the two bastis.

4.2.3 An enquiry into the **people's perceptions** of the existing services was done

by administering a questionnaire (section vi) to one member of each family included in the sample. These included questions recording availability and accessibility of services, quality of service, type of treatment given, attitude of examining doctor, cost of treatment, and nature of doctor-patient communication.

4.3 Building rapport with the people

The mfc team arrived in Bhopal to undertake the study in the third week of March 1985 (15th - 25th) . three and a half months after the tragedy. Numerous teams of investigators and relief workers both governmental and non-governmental had visited the selected bastis, made enquiries, offered or promised relief, raised expectations about compensation and assistance.

For the mfc team to ensure, therefore, that it would still be able to get reliable, authentic and relevant information it was necessary to counter this pre-conditioning of the basti dwellers and establish a meaningful rapport, free of suspicion, of false expectations and a sense of dependency. We therefore, employed the following strategy :

(a) Two days before the study, while selecting the samples the Coordinator and a team member visited the selected bastis and had informal discussions with some of the people explaining the objective of our study and the possible outcome;

(b) A hand-out prepared in Hindi was freely distributed among the basti dwellers. It clarified the role of the mfc, explained about the need for a sample and mentioned the possible follow up action. It specifically clarified that we were not providers of service but were facilitating a more relevant plan of serivces (Appendix II).

(c) During the actual survey, time was spent with each family answering their numerous enquiries and listening patiently to their stories. Occasionally when non-sample individuals/families approached the team members they were also listened to and occasionally given an examination;

(d) A summary of findings was made and handed over to each person in the sample; because we believed that it was a right of the people to get a record of the findings.

(e) In all our contacts with the people, it was very clearly stated that though the team was a medical one, it was not going to provide any treatment nor be involved with compensation claims. However, wherever it was necessary a prescription was given though this was rather occasional;

(f) A commitment was also made that the salient findings of the study and our recommendations would be made available to the people of the affected bastis to help them demand their rights to meaningful health services.

This methodology of informal, frank and participatory communication had its own rich dividends. The basti dwellers in both Anna Nagar and JP Nagar welcomed us into their homes warmly and took us into confidence. They appreciated our 'listening' attitude and this generated a lot of cooperation and support to our efforts. A major point of frustration for many of them was that though they had received treatment from government and other services, they had felt that the doctors were not taking them seriously and were summary in their approach. This affected the credibility of the existing services.

Our decision to concentrate very consciously on rapport building ensured that there was not one refusal among those who were present at the time of our visits. Moreover although several health surveys are supposed to have been done in these bastis, we found that in hardly any family, we had selected in our sample was there any health survey done. There was, therefore, no question of families being flooded with same types of questions and getting conditioned, consciously or unconsciously, to answer in a particular way or pattern.

4.4 Plan of Analysis

The plan of analysis of the data collected by us was as follows:

(i) All parameters in history, symptomatology and findings of clinical examination and lung function tests have been quantified and the percentage in each of the two bastis have been compared;

(ii) Relevant statistical tests have been applied to determine whether the differences, if any, are statistically significant;

(iii) Both the theories in the current medical controversy i.e. the pulmonary fibrosis theory and the 'cyanogen pool' theory have been kept in mind, consciously during the analysis to raise critical questions about both these theories from our findings;

(iv) Basically the important problem areas have been identified. There has been no attempt to group symptoms into specific diagnostic categories and both signs and symptoms have been taken into account in the analysis.

He is unwise who acts without investigation.

—**Charaka Samhita**

CHAPTER 5

OBSERVATIONS AND RESULTS

5.1 Non-responders: some observations

In JP Nagar in the 60 families selected there were 208 eligible persons whereas in Anna Nagar, the corresponding figure was 163.

In JP Nagar, 60 out of 208 individuals could not be interviewed and examined, giving a non-response rate of 29%. The corresponding figure for Anna Nagar is 15% (25 out of 163).

Several home visits were made by the survey teams in both the bastis to reduce non-response rates.

We feel that the given non-response rate in JP Nagar and Anna Nagar will not have a significant effect in the differences in rates of serious morbidities. Because, first, the age and sex structure of both responders and non-responders in both bastis is more or less similar. Secondly there was not one case where a person was at home but refused to cooperate. Had there been many such refusals amongst non-responders "the results would have been biased in unpredictable manner".

In JP Nagar majority of non-responders (about 60%) were out of town mainly for the reasons of treatment or fear of another gas leak. Twenty five per cent of them were out for work. At Anna Nagar about 50% were out of town for the purpose of social visits whereas 25% were out for work.

There have been large epidemiological studies where non-responders have been as large as 30%. This did not necessarily vitiate its results (22).

In the case of non-responders, if we are blind with respect to both exposure and outcome then the difficulty increases (22). In JP Nagar we have no information about the outcome in non-responders but we have recorded information that about 50% of them (28/60) were exposed to gas on 3rd December, in the remaining half many may have been exposed but we have failed to record definite information. No one among the non-responders in Anna Nagar was heavily exposed to MIC gas. Thus with regard to exposure status we are not completely blind.

If we make an assumption (though it is unlikely in view of available history of exposure in at least 50% of non-responders) that all the non-responders in JP Nager and Anna Nagar were normal, this will have an effect of narrowing down the differences in rates of morbidities between the two bastis. Even then the difference in rates of all serious symptoms between JP Nagar and Anna Nagar except for dry cough, lacrimation, breathlessness at rest and impotence remain statistically highly significant.

The reduction in sample size due to non-response rate has also not effected the outcome at all, because much greater differences in the rates of morbidity than had been expected (or assumed) between the two communities meant that our purpose of finding significant differences (if there was any) would have been served well even by much smaller size of the sample than the ones we studied.

5. 2 Comparison of samples of J P Nagar and Anna Nagar

Tables 1–A and 1·B show that both these sample populations are comparable with reference to age, sex structure, history of smoking habits and chronic diseases. Table 1-C shows that occupations and income levels are also comparable though the J P Nagar population was probably socio-economically better off than the Anna Nagar population. This income difference cannot however affect the observed differences in morbidities between the two samples. Table 2 shows that body surface areas (M^2) calculated from height and weight records are also comparable in the two samples. This is particularly relevant in the context of pulmonary function tests.

Comparisons of some of the important characteristics of J P Nagar and Anna Nagar populations (study/control populations)

Table 1 A

Age-Sex Structure

Age	Sex	J P Nagar % n = 148	Anna Nagar % n = 138
11-15 years	M	8.10	10.14
	F	9.46	4.35
16-45 years	M	35.81	34.78
	F	33.78	31.88
46 +	M	6.68	10.14
	F	6.75	8.70

Table 1 B

History of smoking and chronic diseases

		J P Nagar % (n = 148)	Anna Nagar % (n = 138)
Smoking (a)	+	22.75	25.0
	—	77.24	75.0
Chronic diseases (b)	+	9.58	10.37
	—	90.41	89.62

(a) a smoker is one who has smoked at least one cigarette per day for at least one year in a life time.

(b) chronic diseases specifically included asthma, chronic bronchitis, tuberculosis and others.

Table 1 C

Occupation and income levels

Occupation	J P Nagar % n = 148	Anna Nagar % n = 138
Unskilled	18.91	27.73
Skilled	7.43	8.73
Self-employed	13.51	15.32
Service	14.18	10.21
House work	29.72	24.08
Others	16.21	13.36
Per capita income per month before gas exposure		
Less than Rs. 50.00	4.68	4.58
Rs. 51-75	10.93	22.93
Rs. 76-100	16.40	21.10
Rs. 101-125	14.84	13.76
Rs. 126 and above	53.12	37.61

5.3 Socio-economic profile in the bastis

5.3.1 Occupational structure

The residents of both JP Nagar and Anna Nagar were long term residents of these bastis. Residents of JP Nagar were predominantly Muslims and Harijans with a wide range of occupations that included daily wage labour, construction workers, beedi rollers, cobblers, railway and factory employees, self employed artisans and others. Almost 1/5th (19%) of the working population in JP Nagar was unskilled.

Residents of Anna Nagar were predominantly Tamils and Maharashtrians and had a similar range of occupatian apart from a large number of potters. The percentage of unskilled workers was 28%.

The percentage of skilled persons in both samples was less than 10%. The category 'others' in the table is mainly represented by students.

5.3.2 Income levels and change in income since gas exposure

The income levels of both the samples are shown in Table 1-C. JP Nagar residents are generally of higher income levels as compared to Anna Nagar, e.g. before the disaster 68% of the families in JP Nagar had an income more than Rs. 100.00/ capita/month whereas the corresponding figure in Anna Nagar was 51%.

After the disaster, in JP Nagar 65% (42 out of 64) of the working persons experienced a drop in income ranging from 20% to 100% with a median of 50% drop in income (Fig. 1)

In contrast, in Anna Nagar only 9% (6 out of 64) reported a drop in income after the disaster. The extent of the drop in income was in the range of 20% to 55% (Fig.1).

Two individuals in JP Nagar showed an increased income after the gas disaster being exceptions rather than the rule.

(a) one person who was a loco-daily wage earner and got a job in the loco-loading department after the event with an increased scale of pay;

(b) one woman (housewife) who started brick loading after the disaster as her husband was not able to work after the disaster. Since our focus was on individual income rather than family income such an instance of increase is misleading. In actual fact with the husband being unable to work the family income had not been increased.

5.3.3 Compensation received and loans taken

During the acute phase of the crisis the only source of income if at all was the compensation received by families (only those who had deaths in the family) and loans taken from money lenders and others locally.

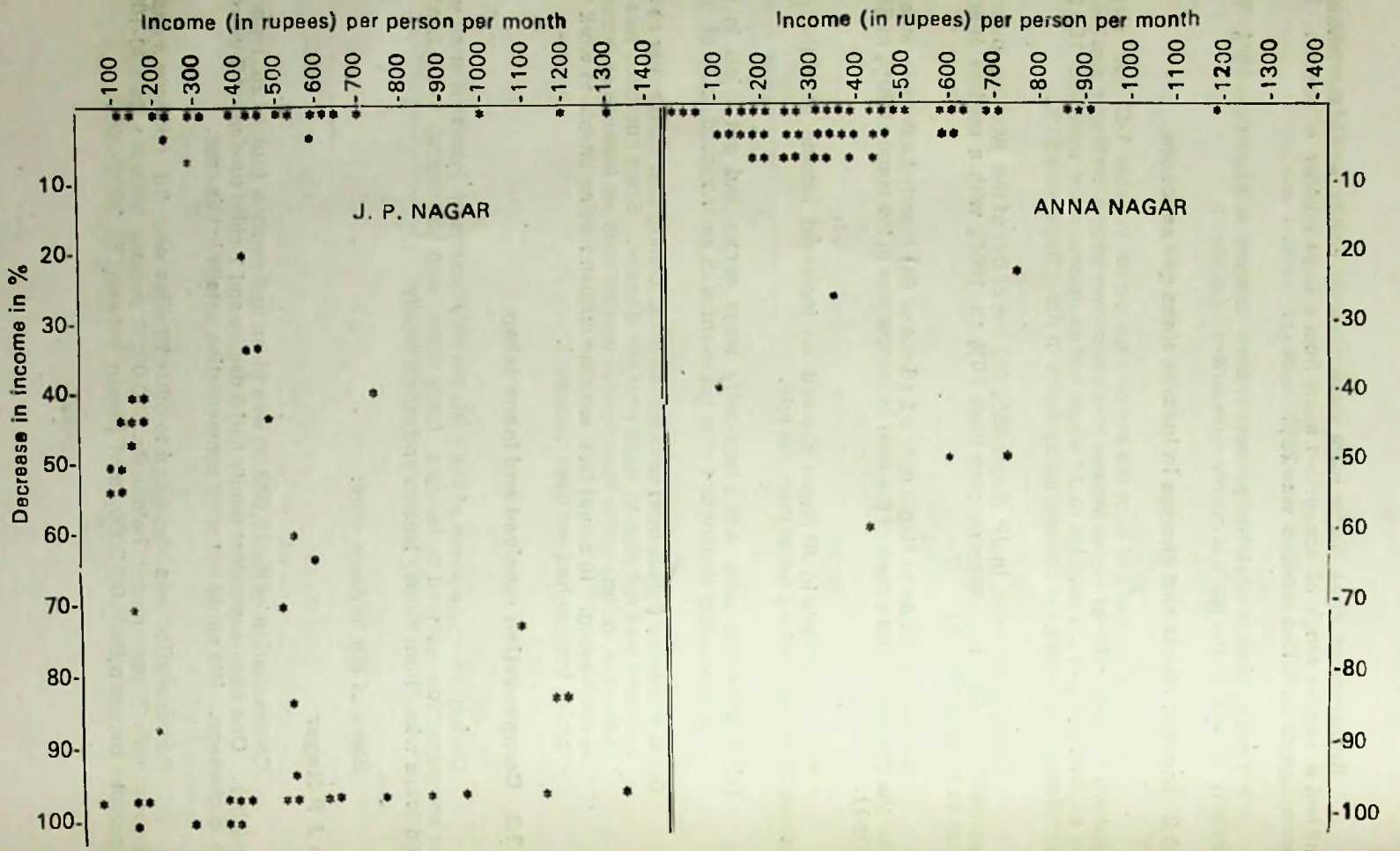
Some of our findings were:

In J P Nagar

Compensation of Rs.10,000.00 was given to 8 persons (out of 26 reported deaths). One non-respondent family had 5 deaths and 1 child survivor of 8 years in an orphanage. We could not elicit compensation details in this case.

Compensation was also given to other families who did not have a death. In our sample 2 persons got below Rs. 500.00; 3 persons between Rs. 500-1000, 4 persons between Rs.1000-2000 and 1 person between Rs. 2000-3000.

Figure 1. **Percentage change in income of individuals of both communities after gas exposure**



Twenty families in which there were no deaths and to whom no compensation was given had to take loans for medical treatment and for the migration during 'operation faith'. Many of them put their ornaments, vessels etc. on mortgage.

In Anna Nagar

Seventeen families who did not have a death in the family had to take loans. Most of them specifically mentioned that this was during *'operation faith'* when they went outside Bhopal for a while.

5.4 Morbidity Analysis

5.4.1 General comments

Before presenting the analysis of morbidity, two issues must be sorted out.

One, it must be stressed again that there is no population which matches JP Nagar socio-economically or in respect to housing and sanitation which was not exposed to the toxic gases on 3rd December, 1984. A control population selected like Anna Nagar is not strictly speaking a 'non-exposed' population as it should be but serves as a control population by virtue of being minimally exposed in comparison to JP Nagar. This also implies that even in our control population one would expect to observe some of the disabilities or debilitating morbidities in a higher proportion of the population than would be the case in an unexposed control area. Actually this is what we did observe and the Anna Nagar sample had definitely a larger number of serious symptoms in a sizeable proportion of persons studied (Tables 3-A to 3-C)

This is something which is quite unexpected and in fact narrows down the differences in rates of symptoms observed between the two populations. The health impact of the toxic gases on the exposed population is, therefore, much greater than what our study reveals.

Seen in this background alone can one appreciate the devastating impact on the health of highly exposed populations. Because in spite of the dampening effect on the differences in rates explained earlier, the rates of many serious symptoms (indicating widespread underlying damage to the physical and mental health of the victims of the gas disaster) in JP Nagar are higher than Anna Nagar with an extremely high level of significance (Table -3-A and 3-B).

Two, the dependence of the study on symptoms may be felt to be problematic by many, since it is 'subjective' and therefore less dependable. As discussed in Chapter 2 the problem situation as it was unfolding was such that one had few clues as to the pathophysiological disturbances taking place in the bodies of the gas victims. The only loud and clear clue was the people complaining of symptoms. What biochemical pathological parameters could be included in the study to enhance the objectivity of the study? None, except one as we have tried to argue above.

We acknowledge freely the problems of relying on symptoms reported by the individuals. *We would, however, like to draw attention to the fact that even in more understood problem situations like epidemiological studies of chronic bronchitis, emphysema, angina pectoris also, the most reliable tool of epidemiological study is recognised to be the questionnaire. Of course, these tools as developed by Medical Research Council (U.K.) and American Thoracic Society (U.S.A.) have been standardised to varying extents. Similarly, the epidemiological tool in the*

study of psychiatric disorders is also a questionnaire. It is not necessarily true that since symptoms are reported by the individuals, they are subjective and hence less reliable than biochemical measurements. The point is not whether we are using so called subjective or objective measurements, the point is whether we are employing appropriate methods and tools to answer clearly the critical questions we are raising in a given problem situation.

True, an important limitation of this study is non-standardization of the questionnaire i.e. ability of the questions to elicit the same answers on two or more occasions (reliability) and the ability of the questions to measure what was intended (validity). Due to limitations of time this was not possible.

However the varied symptomatology presented by the subjects of the study were not mentioned by them casually but given in graphic detail; words and examples used by the patients while describing their symptoms clearly showed the gravity of the symptom as well as its effect on the person's day to day work. The different manner in which the symptom was described also showed that the person was informing us of a problem based on his/her own experience and not just vague hearsay expressions. This is particularly important since in the absence of signs in the same proportion as symptoms, doctors attending on these people in busy government clinics were often passing off the symptoms reported, as compensation 'malingering' or 'not of clinical significance'. We have every reason to believe that these symptoms were real expressions of physical and mental ill health and many should be accorded the same significance as the use of patterns of cough with or without expectoration in the diagnosis of chronic bronchitis or the use of anginal history in the diagnosis of Ischaemic Heart Disease.

The commonest symptom reported was breathlessness on usual exertion and the specific descriptions recorded were : (1) while excessive talking; (2) on brisk. walking; (3) doing house-hold work in a hurry; (4) fetching water and firewood; (5) cannot go till the market; (6) little walking – say 100 yards; (7) while coughing; (8) while riding a bicycle etc.

5.4.2 Symptomatology and signs - a comparison

Tables 3-A - 3-C show the difference in rates of the 26 symptoms that had been enquired into in both the sample populations. It must be emphasised that *a symptom was recorded as positive only if it was present at the time of the study.* Five symptoms were not significantly different. These were blood in sputum, fever, jaundice, blood in vomit, stool or malena and vomiting.

Six symptoms were *significantly different.* These were dry cough, breathlessness at rest, lacrimation, skin problems, bleeding tendency and impotence.

Fifteen symptoms were *highly significantly different.* These were cough with expectoration, breathlessness on usual exertion, chest pain/tightness, blurred vision/photophobia, headache, weakness in extremities, muscleache, fatigue, loss of memory, tingling/numbness, nausea, abdominal pain, flatulence and anxiety/depression. Moreover critical symptoms like breathlessness on usual exertion, lacrimation, pain/tightness in chest, blurred vision, weakness in extremities, fatigue, loss of memory, tingling/numbness, anorexia, nausea, flatulence and anxiety/depression were not reported in a monosyllable 'yes' but described in such graphic detail that their presence could not be doubted.

5.4.3 Clustering

It was obvious from the study findings that most of the persons in JP Nagar had more than one symptom present. To further study the pattern of clustering of symptoms, we grouped the symptoms according to the system they naturally belong to. Some overlap in such grouping is inevitable but it does reveal the overall pattern e.g. an important symptom like breathlessness on usual exertion which is reported with highest frequency does not squarely belong to one system like cardiovascular or respiratory system alone. Both these systems can with equal legitimacy lay claim to this most frequent and crucial symptom and this is particularly important since we are examining critically two dominant medical theories in this study–'cyanogen pool' theory and 'pulmonary theory.'

All the symptoms were grouped together system wise as follows :

(a) Pulmonary system (P)

The grouping of symptoms suggesting diffuse pulmonary fibrosis is based on Harrison's Principles of Internal Medicine 10th edition, 1983 (Chapter 280, P.1567). They include breathlessness at rest and on accustomed exertion, dry cough and cough with expectoration, weakness in extremities and pain/tightness in the chest. To be included in this group the combination of symptoms had to have cough with or without expectoration and dyspnoea at rest or usual exertion.

(b) Gastro-intestinal system (GI)

They included anorexia, nausea, vomiting, abdominal pain and flatulence.

Table 2

Comparison between body surface area (M^2) in JP Nagar and Anna Nagar according to age-sex (figures in brackets show S .D)

Body surface area (mean) in Sq M^2		J P Nagar n= 136		Anna Nagar n = 137	
11-15 years	M	1.23	(0.14)	1.22	(0.19)
	F	1.22	(0.12)	1.15	(0.13)
15–45 years	M	1.49	(0.09)	1.51	(0.12)
	F	1.37	(0.11)	1.35	(0.12)
45-60 years	M	1.50	(0.14)	1.53	(0.09)
	F	1.37	(0.09)	1.41	(0.22)
61 + years	M	1.35	(0.04)	1.38	(0.15)
	F	1.32	(0.06)	1.28	(0.05)

Note: The differences in mean BSA's were tested by 't' test -- all the differences were statistically non-significant (NS)

Table : 3 A

Comparison of Symptoms reported by individuals in J.P. Nagar and Anna Nagar. (Expressed in percentage. Numbers of cases are shown in brackets.)

Sl No.	Symptoms	J.P. Nagar %	A. Nagar %	P. Value* (a)
1.	Dry Cough	27.70 (41)	14 49 (20)	P < 0.01
2.	Cough with Expectoration	47.29 (70)	23.91 (33)	< 0.001
3.	Breathlessness at rest	10.13 (15)	2.89 (04)	< 0.025
4.	Breathlessness on usual exertion	87.16 (129)	35 50 (49)	<< 0.001
5.	Chest pain/tightness	50.0 (74)	26.08 (36)	<< 0.001
6.	Weakness in Extremities	65.54 (97)	36·95 (51)	<< 0.001
7.	Fatigue	81.08 (120)	39.85 (55)	<< 0.001
8.	Anorexia	66.21 (98)	28 26 (39)	<< 0.001
9.	Nausea	58.10 (86)	16.66 (23)	<< 0.001
10.	Abdominal pain	53.37 (79)	25.39 (35)	<< 0.001
11.	Flatulence	68.91 (102)	25.36 (35)	<< 0.001
12.	Lacrimation	58.78 (87)	42.62 (58)	<< 0. 01
13.	Blurred vision/photophobia	77.02 (141)	33.40 (53)	<< 0.001
14.	Loss of memory for recent events	45.27 (67)	11.59 (16)	<< 0.001
15.	Tingling/numbness	54.72 (81)	20.28 (28)	<< 0.001

*(a) P Values were calculated by X^2 method.

Table : 3 B

Comparison of Symptoms reported by individuals in J.P.Nagar and Anna Nagar. (Expressed in percentage. Numbers of cases are shown in brackets.) **(Symptoms significantly different but not analysed further)**

Sl. No.	Symptoms	J. P. Nagar %	A. Nagar %	P. Value *(a)
1.	Skin problems	29.05 (43)	11.59 (16)	< 0.01
2.	Bleeding tendency	9.45 (14)	2.89 (04)	< 0.025
3.	Headache	66.89 (99)	42.02 (58)	<< 0.001
4.	Muscle ache	72.97 (108)	36.23 (50)	<< 0.001
5.	Impotence	8.10 (12)	0.72 (01)	< .05
6.	Anxiety/Depression	43.92 (65)	10.14 (14)	<< 0.001

Table : 3 C

Comparison of Symptoms reported by individuals in J.P Nagar and Anna Nagar (Expressed in percentage. Numbers of cases are shown in brackets.)
(Symptoms - Non-significant)

Sl. No.	Symptoms	J. P. Nagar %	A. Nagar %	P. value* (a)
1.	Blood in Sputum	10.13 (15)	7.24 (10)	N.S.
2.	Fever	27.70 (41)	28.98 (40)	N.S.
3.	Jaundice	0.67 (01)	00	N.S.
4.	Blood in vomit/stool/malena	12.16 (18)	10.14 (14)	N.S.
5.	Vomiting	11.48 (17)	5.79 (08)	N.S.

*(a) P Values were calculated by X^2 method.

(c) Eye Symptoms

They included blurring of vision and or lacrimation.

(d) Central Nervous System (CNS)

Disturbance or loss of memory and tingling and numbness.

The following symptoms were not included in this classification: impotence, anxiety/depression, headache, muscleache, bleeding tendency, skin problems,

Table 3-D shows the incidence of the combination of these symptom complexes. Some very interesting facts emerge.

As large as 63.5% (94/148) persons reported all the important symptoms. Only 2.7% (4/148) have symptoms which are exclusively pulmonary. Atleast 35.14% of persons do not have any pulmonary symptoms.

Table 3-E further explores the group of patients without pulmonary symptoms and we found the following significant facts:

About 21% persons have GI symptoms without pulmonary symptoms.

About 22% persons have eye symptoms without pulmonary symptoms.

About 15% persons have CNS symptoms without pulmonary symptoms.

In the last three categories symptoms of other systems may or may not have been present.

An important further point of comparison between JP Nagar and Anna Nagar with reference to this grouping of symptoms is that **every person in JP Nagar reported atleast one serious symptom but quite a few in Anna Nagar did not report any serious symptom.**

Table: 3 D

Symptoms

Symptom groups	No /Total	%
P + G. I. + Eye + CNS	92/148	62.16
P (Pulmonary only)	4/148	2.7
P - NIL (ie G.I./CNS/Eye)	52/148	35.14

(For symptoms included in grouping please refer 4.4.3)

Table : 3 E

Symptom Complexes excluding Pulmonary System

Symptom Groups	No./Total	%
G.I. (with or without eye/CNS)	31/148	20.94
Eye (with or without GI/CNS)	32/148	21.62
CNS (with or without GI/Eye)	23/148	15.54

Table : 4

Patterns of disturbance of vision in 10—45 yrs of population in J.P. Nagar and A. Nagar (Figures in brackets indicate actual number)

		J.P. Nagar %	Anna Nagar %
Blurring of vision	(1)	74.24 (98/132) (a)	28.57 (34/117)
Abnormal distant vision	(2)	42.0 (65/141) (a)	21.88 (21/96)
Abnormal near vision	(3)	17.55 (20/114) (b)	8.74 (9/103)
Corneal Opacity	(4)	4.7 (7/148) (b)	2.8 (4/138)

NOTE :—

1. Includes Photophobia.
2. Normal vision 6/9 — Distant Vision tested by means of Snellen's chart
3. By means of near vision chart
4. In J.P. Nagar and Anna Nagar each there are two central opacities.

(a) tested by X^2 d.f.I $P < 0.001$

(b) tested by X^2 d.f.I P - Non-significant

5.4.4 Disturbances of vision

Table 4 shows percentage disturbance of vision of the age group 10-45 years of population in both communities. Persons above 45 years of age have been excluded because of the higher rates of cataract in this population which would contribute to disturbance in vision.

Significantly higher percentage of individuals complained of blurring of vision in JP Nagar rather than in Anna Nagar. As large as 42% in JP Nagar had abnormal distant vision compared to 22% in Anna Nagar. The difference is highly significant statistically. As to the abnormalities in near vision the differences between the two populations are of some significance (but this difference misses 5% level of significance very narrowly : X^2 d.f.1 3.62).

The difference in the rate of corneal opacities between the two communities irrespective of their position on the cornea is not significant statistically (see Note 4 to table 4). However individual case histories had recorded that new corneal opacities had emerged after the gas leak in both JP Nagar and Anna Nagar.

Abnormalities of distan tvision, although large, cannot fully explain the extent of blurring of vision in JP Nagar. Moreover significantly larger proportion of abnormal distant vision in JP Nagar is itself in need of explanation. It is relevant at this stage to point out that examination of eyes by trained ophthalmologists undertaken by other teams have so far failed to identify abnormalities in the anterior and posterior chambers of the eyes to any significant extent (14).

The combination of these findings is unexpected but significant. The experts had predicted that there will be no problems of vision of such magnitude and whatever residual problems of vision there would be, that would be because of corneal opacities.

5.4.5 Pulse/Respiration Rate/Hemoglobin Concentration

Tables 5-A, 5-B and 5-C show the comparisons of resting mean pulse rates, resting mean respiratory rates and mean hemoglobin concentrations, respectively between the two samples and in both sexes.

Mean pulse rates and mean respiratory rates in both sexes in both JP Nagar and Anna Nagar are not different statistically. However, mean hemoglobin concentration in both males and females is significantly higher in JP Nagar than in Anna Nagar.

The higher concentration of hemoglobin is probably masking resting tachycardia and resting tachypnoea in JP Nagar but the degree of tachypnoea and tachycardia masked is not likely to be very high.

5.4.6 Other clinical findings

Clinical examination of all individuals in the sample showed the following:

(i) 9.4% (14/148) individuals in JP Nagar had *rales and rhonchi in the chest* as against 2.1% (3/148) in Anna Nagar. The difference is significant statistically ($P < 0.025$). Significantly higher rates of rales-rhonchi in JP Nagar may well be due to increased sensitization of the bronchial tree following

MIC exposure, but the rate is too small to account for the much higher rate of breathlessness on exertion;

(ii) We identified no case of *cyanosis*, a significant negative finding in view of the fact that 87% of the individuals in JP Nagar have breathlessness on exertion, have increased concentration of hemoglobin and that extensive pulmonary damage is expected to have occurred.

(iii) There was one case of oedema of leg, one case of hemiplegia (long term history) and one case of palpable hepatomegaly.

(iv) There was one case of jaundice and no splenomegaly;

(v) No significant findings in cardio-vascular system or central nervous system.

5.4.7 Effects on the Reproductive System Of Women

5.4.7.1 Gynaecological problems

The comparisons of symptomatology in this group of symptoms has been done in two stages :

(i) comparison between symptoms in women of JP Nagar before and after the gas leak (in the same women);

(ii) comparison between symptoms in women of JP Nagar and Anna Nagar after the gas leak (between samples).

Tables 6-A, 6-B, 6-C, 6-D and 6-E show the comparison of mean menstrual cycle lengths, percentage distribution of flow types, percentage distribution of colour and percentage distribution of dysmenorrhoea and leucorrhoea.

The salient findings are that women of reproductive age group in JP Nagar have significantly shortened length of menstrual cycles after the exposure to the gas compared to the lengths of cycles in the same group of women before the gas leak and lengths of cycles of women in Anna Nagar after the gas leak. Significantly more number of women in JP Nagar also had abnormalities of menstrual flow—scanty, or heavy and blackish discharge (Tables 6-A - 6-C), dysmenorrhoea (Table 6-D), and leucorrhoea (Table 6-E), after the gas exposure when compared to the internal/external control mentioned above.

It may be argued that increased rates of leucorrhoea in JP Nagar after the gas exposure may be because of break-down in sanitary conditions due to the disaster. The disaster obviously did not lead to physical destruction of the housings and whatever sanitation that there was, people did not flee to refugee camps where sanitory breakdown may be nearly total. Therefore this argument of sanitation is not really applicable to the study.

5.4.7.2 Pregnancies and their outcome

Four women in JP Nagar and five women in Anna Nagar were pregnant at the time of our study. There was one abortion in Anna Nagar and none in J P Nagar. There was no instance of still birth. The numbers in the sample are too small to

Table : 5 A

Mean pulse rate/minute (S.D.) in males & females of J.P. Nagar and Anna Nagar. *

	J.P. NAGAR	ANNA NAGAR
Male	77.13 (11.28) n = 67	77.94 (10.68) n = 73
Female	85.73 (13.21) n = 78	85.05 (11.20) n = 59
Total	81.70 (13.20) n = 145	80.4 (13.0) n = 132

* All the differences in mean pulse rates were tested stastically by 't' test and found to be non-significant.

Table : 5 B

Mean Respiration Rate/minute (S.D.) in males & females of J. P Nagar and Anna Nagar.*

	J.P.NAGAR	ANNA NAGAR
Male	21.73 (3.98) n= 69	21.21 (3.84) n=74
Female	21.84 (4.93) n=70	20.92 (3.70) n=56
Total	21.87 (4.51) n=139	21.09 (3.77) n=130

* All the differences in mean respiration rates were tested stastically by 't' test and found to be non-significant.

Table : 5 C

Mean blood Haemoglobin in gm.% in J.P. Nagar & Anna Nagar. (The figures in brackets are S.Ds of means. n = sample size.)

	J.P. NAGAR	ANNA NAGAR
Male	14.68 (1.79) n = 11 (a)	12.70 (1.35) n = 17
Female	12.7 (1.46) n = 20 (b)	10.79 (1.34) n = 18

(a) $t_{d.f26} = 3.18$ - $P < 0.01$
(b) $t_{d.f36} = 4.20$ - $P < 0.001$

Table : 6 A

Mean Menstrual cycle length in days in J.P. Nagar and Anna Nagar after and before gas exposure. (Figures in brackets indicate S.D. in days.)

J.P. NAGAR		ANNA NAGAR	
Before	After	Before	After
32.32	25.59	35.41	36.10
(13.51)	(12.04)	(20.09)	(19.89)
n = 31	n = 31	n = 29	n = 29
$t_j = 2.06$ d.f. 60 $P < 0.05$		$t_a = 0.131$ d.f. - 56 $P > 0.8$	

$t_{j.a.}$

j.a. :- differences in mean menstrual cycles length in days between J. P. Nagar and Anna Nagar after the gas exposure.

$t_{j.a}$ - 2.46
d.f. - 58
$P < 0.05$

Table : 6 B

Percentage distribution of Flow in J.P. Nagar & Anna Nagar before and after the gas exposure. (Figures in brackets are number of cases)

	J. P. NAGAR			ANNA NAGAR		
	Scanty	Excess	Total	Scanty	Excess	Total
Before	5.5 (2)	11 (4)	100 (36)	2.6 (1)	18.4 (7)	100 (38)
After	25.7 (9)	31.4 (11)	100 (35)	5.8 (2)	20.7 (7)	100 (34)

$X^2 = 11.96$
d f. = 2.
$P < 0.01$

$X^2 < 1$
d.f. = 2.
$P > 0.50$

After the gas exposure
J. P. Nagar & Anna Nagar

$X^2 = 7.82$
d. f. = 2.
$P < 0.025$

Table : 6 C

Percentage distribution of colour of menstrual flow in J. P. Nagar and Anna Nagar before and after the gas exposure. (Figures in brackets are No, of cases)

	J. P. NAGAR		ANNA NAGAR	
	Black	Total	Black	Total
Before	5.8 (2)	100 (34)	0 (0)	100 (37)
After	46 8 (15)	100 (32)	8 8 (3)	100 (34)

$X^2 = 14.46$
d.f = 1
$P < 0.001$

$X^2 = 3.41$
d.f. = 1
P - N.S.

After the gas exposure J.P. Nagar & Anna Nagar

$X^2 = 12.03$
d.f. = 1
$P < 0.001$

Table : 6 D

Percentage distribution of Dysmenorrhoea in J. P.Nagar and Anna Nagar before and after the gas exposure. (Figures in brackets are number of cases.)

	J. P. NAGAR		ANNA NAGAR	
	+ve	Total	+ve	Total
Before	28.5 (10)	100 (35)	48.7 (19)	100 (39)
After	65.6 (21)	100 (32)	39 (14)	100 (36)

$X^2 = 9.21$
d.f. = 1
$P < 0.01$

$X = 0.71$
d.f. = 1
P - N.S.

After the gas exposure
J. P. Nagar & Anna Nagar

$X^2 = 4.89$
d.f. = 1
$P < 0.05$

Table : 6 E

Percentage distribution of Leucorrhoea in J. P. Nagar and Anna Nagar— before and after the gas exposure. (Figures in brackets are number of cases.)

	J. P. NAGAR			ANNA NAGAR		
	Non-Specific Leu.	Specific Leu.	Total	Non-Specific Leu.	Specific Leu.	Total
Before	15.5 (7)	0 (0)	100 (45)	16.6 (7)	14.3 (6)	100 (42)
After	22.2 (10)	35.5 (16)	100 (45)	14.6 (6)	14.6 (6)	100 (41)

$X^2 = 22.5$
d.f. = 2.
$P < 0.001$

$X^2 = 1$
d.f. = 2
P—N.S.

After the gas exposure
J. P. Nagar & Anna Nagar

$X^2 = 7.455$
d.f. = 2.
$P < 0.025$.

reveal any significant changes. Moreover the foetuses which are likely to have been damaged about three months ago at the time of the gas leak are now in the second trimester and therefore, it will be a few more weeks before the adverse impact on pregnancies will be correctly estimatable.

5.4.7.3 Lactation

50% of nursing mothers in JP Nagar reported lactation failure or decrease in output as compared to 11% (1/9) of mothers in Anna Nagar.

5.4.8 Effects on Reproductive System : Of men

Impotence: Table 3-B shows that the percentage of men reporting symptoms of impotence was 8.1% (12/148) in JP Nagar and 0.72% (1/138) in Anna Nagar (significance of difference $P < 0.05$).

5.4.9 Pulmonary Function Tests

Table 7 shows the comparison between the sampled subjects of JP Nagar and Anna Nagar on two parameters of lung function measured in the study - Forced Expiratory Volume in the 1st second (FEV1) and Forced Expiratory Capacity (FVC).

The difference between JP Nagar and Anna Nagar are statistically significant in bothsexes in the age groups of 15-45 and 46-60 years. The difference in other age/sex categories are however, not statistically significant. This may be due to smaller number of observations in these categories. The mean values in all these categories and the FEV1/FVC ratio in all categories are diminished in JP Nagar in comparison to Anna Nagar.

The pattern in the age groups 15-44 and 45-60 shows a restrictive type of pulmonary function, while in the over 61's the pattern is mainly obstructive.

5.4.10 Anxiety/Depression

From our field level interviews in which we spent much time listening to the people's experiences we identified syndromes of anxiety and or depression in 43.92% of the subjects (65/148) in JP Nagar and 10.14% of subjects (14/138) in Anna Nagar. This difference is statistically significant.

From the sharing of experiences we gathered that there was much fear, apprehension, anxiety symptoms, gas-phobia, fear of the restarting of the factory operations and frank depression. In some cases there was some degree of mental confusion.

5.4.11 Impairment of Memory

Many people described a definite change in their memory for recent events. They narrated different examples of situations in which their memory seemed to fail causing them much worry: e. g. (i) forgetting where something has been kept; (ii) forgetting whether a meal has been taken or not; (iii) forgetting whether salt has been added to the 'dal' or not; (iv) forgetting the names of the children; (v) forgetting the day or time; (vi) after coming out of the house forgetting for what purpose one came out; (vii) students complained that they could not remember lessons or poems learnt before the episode.

Table : 7

Distribution of Mean values of Body Surface Area (M^2), FEV (Litre.), FVC (Litre) ., FEV/FVC% in different age-sex groups. in J. P. Nagar and Anna Nagar. (a) * (Figures in brackets are S.Ds) n = number of persons in each cell. P = P value.

Age-Sex	BSA (M^2)		FEV (Lit)		FVC (Lit.)		FEV,/FVC %	
in yrs.	J.P	A.N.	J.P	A.N.	J.P.	A.N.	J.P.	A.N
10-14								
M	1.23 (0.14) n=4	1.22 (0.19) n=4	1.59 (0.74) P=NS	1.93 (0.48)	1.72 (0.77) P=N.S.	2.20 (0.51)	87.05	87.8
F	1.22 (0.12) n=3	1.15 (0.13) n=6	1.76 (0.84) P=NS	1.77 (0.33)	2.07 (0 88) P=N.S.	2.10 (0.40)	84.3	84.2
15-44								
M	1.49 (0.09) n=45	1.51 (0.12) n=55	2.04 (0.47) P<).001	2.66 (0.51)	2.39 (0.47) P<0.001	2.99 (0.55)	79.1	88.9
F	1.37 (0.11) n=56	1.35 (0.12) n=52	1.64 (0.44) P<0.001	2.25 (2.42)	1.97 (0.38) P<0.001	2.54 (0.43)	76.3	88.6
45-60								
M	1.50 (0.14) n=12	1.53 (0.09) n=6	1.88 (0.53) P<0.05	2.26 (0.19)	2.20 (0.43) P<0.05	2.54 (0.24)	85.3	88.9
F	1.37 (0.09) n=11	1.41 (0.22) n=7	1.51 (0 48) P<0.01	2.13 (0.18)	1.86 0.58) (P<0.01	2.48 (0.21)	79.8	85.9
61 +								
M	1.35 (0.04) n=2	1 38 (0.15) n=4	0.94 (0.39) P<0:02)	1.91 (0.15)	1.83 (0.35) P=N.S.	2.17 (0.16)	61.8	88.0
F	1.32 (0.06) n=3	1.28 (0.05) n=3	1,39 (0.31) P<0.05	1.90 (0.07)	1.96 (0.31) P=N.S.	2.13 (0.15)	63.4	86.2

(a) * All the differences in Mean Values between J.P. Nagar & Anna Nagar in each age-sex category were tested by 't' test.

Table : 8

Exposure History and safety Measures

Where at the time of leak	J P Nagar				Anna Nagar			
	Wet towel	Blanket	Ran out	Nil	Wet towel	Blanket	Ran out	Nil
In the Basti	5	7	124	8	9	6	64	52
Out of home (in Bhopal)	1	-	1	2	-	-	2	5
Out of Bhopal	-	-	-	10	-	-	-	11
	Total No. 158				Total No. 148			

Note: Nil means remained in the house without safety measure.

Table : 9

Number of attacks (respiratory infections) in one month preceding the study

Age	JP Nagar			Anna Nagar		
	One attack	Often	Nil	One attack	Often	Nil
10-15 yrs	3	13	15	4	1	16
16-45	15	46	35	24	7	68
46 +	3	14	4	4	4	11
	21	73	54	32	12	95

In statistical terms 67/148 subjects in JP Nagar (45.27%) and 16/138 subjects in Anna Nagar (11.59%) complained of this symptom. The difference is highly significant.

Miscellaneous observations

5.4.12 School Performance of Children

A discussion with one of the school teachers in the affected area revealed that the school attendance had fallen because many families had moved away, many pupils had died or become too ill to continue. Of those who returned to school, the teachers felt that there appears to be no visible physical effect but they are not as 'active' as they used to be. They do not go out to play that often. They are not restless when they have to sit for long periods in class as they used to be. Some of them have developed a disinterest in school work. Even though all had not lost their immediate kith and kin, many had seen their friends and cousins die and were affected by this.

Many members of the team themselves observed this general listlessness or apathy of the children, and many were dyspnoeic as well. The visual impressions of these problems between JP Nagar and Anna Nagar was distinctly different, the impression in Anna Nagar being similar to what one expects in an average slum area - lots of children playing around, inquisitive, running about, active.

5.4.13 Effect on immunity/resistance

We enquired about the experience of respiratory infections in the study and control population in terms of number of attacks in the one month preceding the study. Table 9 shows this finding. 73/148 in JP Nagar had many attacks of respiratory infections while only 12/138 in Anna Nagar gave this history. In JP Nagar this was often described as a continuous respiratory problem. This is an important supportive finding but cannot be taken directly to mean a state of lowered resistance to infection resulting in frequent upper respiratory infections but is strongly indicative of it.

5.4.14 Enquiry into exposure and safety measures employed

Table 8 shows where the people in our sample were at the time of the incident and whether they employed any safety measures (wet towel, blanket, running out) to protect themselves against the gas leak.

The fact that many ran out and few used a wet towel is a good indication of the lack of awareness or safety education of the residents of the bastis. Most of them had no idea about the hazardous nature of the plant operation nor about measures to protect oneself in the event of a gas leak. Even those who used a wet towel used it by instinct rather than due to an awareness of precautionary messages.

Concern for man himself and his safety must always form the chief interest of all technical endeavours. Never forget this in the midst of your diagrams and equations.

Albert Einstein

CHAPTER 6

DISCUSSION

The present study is a community based, case/control study in randomly selected samples of families. It provides a much more authentic picture of the state of health of the gas affected communities than one can get from studies conducted on inpatient/outpatient populations of the hospital, which is the chief characteristic of the studies undertaken by the protagonists of the two medical theories. Self selection in hospital based studies necessarily occurs which distorts the community perspective. These efforts may give some understanding of the quality of the problem, but give little information on the actual pattern and quantum of morbidities prevalent in the community. There is no substitute for community based epidemiological studies. Our study has the merit of shifting the focus from the health problems of hospital based patients to the health problems in the community outside the hospital and dispensaries.

It is not too difficult to understand why the health establishment of Bhopal including the dominant faction in the medical college of Bhopal did not attempt such community based epidemiological studies.

However it is not easy to understand why the ICMR after having broken fresh ground and hit upon a potent and fertile hypothesis of 'enlarged cyanogen pool' theory did not go all out for community based epidemiological studies to exploit its full potentials.

But before we go into such intriguing and intricate problems let us first examine the role of chronic diseases and smoking in producing the morbidity and mortality in the Bhopal gas victims, and then critically assess the claims of 'pulmonary theory' in the light of our findings and available information.

6.1 Role of chronic diseases and smoking

Many have argued that a significant proportion of the mortality and residual morbidity is reflective of the base line ill health including a higher prevalence of chronic diseases like tuberculosis and higher smoking rates.

Our findings do not lend support to such speculation. Out of 26 persons who died in our sample study of JP Nager after the gas exposure, one was reported to have been a smoker and none to have had any chronic diseases.

The age/sex breakdown of the dead in JP Nagar are as follows

Age in years	0-1	2-5	6-15	16-45	45+
Male	1	4	2	5	—
Female	2	3	2	5	/

Among these only one 45 year old male was a smoker. Women in JP Nagar generally didn't smoke. Among the dead there were 13 women, 7 males under 15 and 4 males between 16-45 who did not smoke.

The findings of the morbidity survey are also significant. A quarter of the sample in both the communities — JP Nagar and Anna Nagar—were smokers and yet most of the serious symptoms are significantly higher in JP Nagar than in Anna Nagar. Moreover the given smoking rates in JP Nagar cannot fully explain the much higher symptom rates in JP Nagar. A similar argument would apply to the chronic diseases as well which in our survey specifically included history or tuberculosis, bronchitis and asthma. This was found to be around 10 percent in both communities and is much too small to explain the high rate of symptoms.

The question therefore we now come to is : How much do our study findings support or question either of the theories? or to put it differently, how much of our study findings can be explained by either of the theories.

6.2 Pulmonary theory : an assessment

Pulmonary theory's greatest strength is in its simplicity and plausibility.. The theory has a formidable backing of a range of western experts.

The adverse effects of isocyanates other than MIC, which are widely used in industry, have been extensively studied. These effects are mainly confined to lungs. Changes in the blood have never been implicated.

The probability of the MIC molecule's ability to enter the blood stream and reach other organs, thanks to its supposed high reactivity, has been rated extremely low indeed. Furthermore it has been argued that 'there is no known metabolic pathway that converts isocyanate into cyanide' (14).

Autopsy findings have consistently shown damage to the lung tissue, of course damage to the other organs has been shown too. Pulmonary function tests have consistently shown impairment of ventilatory functions. In so far as MIC causes direct damage to the corneas, impairment of vision is an expected finding.

The difference among the believers has been with regard to the type, extent and duration of damage.

Thus the American Public Health specialists maintain that eyes and lungs of a considerable proportion of the population will be greatly damaged. Sooner or later many victims will succumb to suffocating onslaughts of emphysema, asthma and pneumonia. Sizeable number of people could develop permanent blindness due to damage to the corneas. The damaged lung tissue of victims makes them much more vulnerable to common respiratory infections which could become fatal (9).

Then there are others who are much more optimistic about the extent and duration of damage. Thus as we have already quoted, Mr. W. Anderson, Chairman of Union Carbide, U. S. made a confident prediction as early as 3rd January 1985 that victims are rapidly recovering (11) .

These arguments favouring the 'pulmonary theory' are however general without specific reference to the actual situation in Bhopal where massive exposure to MIC gas has occured.

Let us now see how the 'pulmonary theory' stands up to critical examination in the light of facts brought out in Bhopal.

6.2.1 Deaths

The believers of the pulmonary theory have tenaciously held on to the idea that the very high death rate following the gas leak was due to Carbon Monoxide poisoning and not because of cyanide poisoning (besides pulmonary oedema).

As we have seen earlier, the ICMR studies have shown that blood samples of the dead stored in deep freeze and the blood samples of critically ill patients who subsequently died, showed no evidence of carboxy haemoglobin (carbon monoxide combined with haemoglobin) (14). The K.E.M. Hospital study on 113 self reporting MIC exposed persons cannot lend support to the theory of carbon monoxide poisoning either because of the reasons we have discussed in para 3.1, Chapter 3.

According to the theory one expects at least some of the post exposure deaths to be due to lung infections. In our study out of 26 deaths in JP Nagar 52 occured within 5 days of the gas leak because of the direct toxic effect of the gas.

6.2.2 Diseases - Disabilities

It is here however that the theory runs most into deep trouble. The pulmonary theory cannot explain the high rates of symptomatology even 3 months after exposure in a population which is not hospital bound. For instance it cannot explain fatigue(81%), blurring of vision (77%), muscle ache (73%), flatulence (68%), headache (67%), anorexia (66%), nausea (58%), excessive lacrimation (58%), tingling and numbness (54%), loss of memory (45%), and anxiety depression(43%). Even the most common and disturbing symptom like breathlessness on usual exertion (87%) cannot be fully explained by this. (Table 3A)

The simultaneous presence of all serious symptoms suggesting involvement of not only lungs but gastro-intestinal tract, brain and vision in as large as 62% of the sample population in JP Nagar cannot be explained by the pulmonary theory. (Table 3D). It is not the point whether all the above symptoms are part of the symptomatology of extensive pulmonary damage; the point is, are they all present simultaneously in such a large proportion of individuals who are not so ill as to be in the hospital? True, ventilatory capacities are diminished in JP Nagar significantly which supports the pulmonary theory, but even here the reduction is not large enough to explain such a high rate of breathlessness on exertion, weakness and fatigue. **It obviously cannot explain exclusively non pulmonary symptoms in as high as 15 to 21%** (Table 3E). Even if we grant that there is extensive lung damage in a large proportion of cases there should be commensurate clinical findings in those individuals. One naturally would expect high rates of respiration and pulse and cyanosis. None of these are found in our study (Table 5A and 5B).

This is an odd finding. One can of course argue that tachycardia and tachypnoea in JP Nagar is masked by rise in haemoglobin (Table 5-C) which is a result of hypoxia produced by extensive pulmonary fibrosis. But surely where extensive lung damage is supposed to have occured because of MIC exposure one expects 'suffocating onslaughts of emphysema, bronchitis, asthma', etc. (9) with attendent compromised gas exchange at alveolar level. This must lead to not only hypoxia (low oxygen level in the blood) but also to retention of carbon dioxide in the blood which in turn must lead to increased ventilatory efforts to wash out excess build up of carbon dioxide.

Besides, 'cyanogen pool' theory can explain haemoglobin rise without having to account for not much increase in pulse rate or respiratory rate.

Looking at visual disturbances also we see an interesting set of facts. The pulmonary theory explains and predicts visual impairments solely by virtue of direct injury to corneas which may result in opacities producing visual impairment (2,3). In JP Nagar only 7 out of 148 individuals have corneal opacities, of these only 2 are central opacities which matter. The rate in JP Nagar (4.7%) is not statistically significant when compared to the rate in Anna Nagar (2.8%). This extremely low rate of opacities can obviously not explain 74% of blurring of vision in JP Nagar which is statistically significantly higher than in Anna Nagar (Table 4). Carboxy haemoglobin levels of more than 5% in large numbers of individuals can explain this but there is no such evidence. The pulmonary theory cannot explain either the high abnormal rates of distant vision in JP Nagar (42%) which is highly significantly higher than that in Anna Nagar (22%) (Table 4). Finally the evidence from the effects seen on the reproductive system is significant. A significantly shortened menstrual cycle (Table 6-A), increased rate of dysmenorrhoea (Table 6-D), increased leucorrhoea after the disaster in the women (Table 6-E) and increased percentage of impotence in men of JP Nagar (Table 3 B) as compared to Anna Nagar cannot be explained by the pulmonary theory.

Very high rates of symptoms implicating all the important systems in the body call for a theory which can explain disturbances in all the systems by postulating a mechanism which must be operating in all the systems. 'Pulmonary theory' clearly lacks the theoretical mechanism with an integrative power to account for the wide range of symptoms in JP Nagar. 'Cyanogen pool theory' precisely achieves this at least tentatively.

6.3 'Enlarged cyanogen pool' theory : an assessment

By postulating chronic poisoning by cyanide which is slowly released from haemoglobin bound MIC, it suggests that at the cellular level in practically all the organs oxygen utilisation has been impaired. The bewildering and apparently unconnected wide range of symptoms can be explained with the help of this theory. Our findings per se pose no serious problems to this theory.

This is very interesting but then excess cyanide radicals in the body fluids have not been demonstrated. Its presence is inferred from increased levels of urinary thiocyanate following injection of sodium thiosulfate. This however is not its main handicap. Nor is the 'cyanogen pool' theory suffering from the handicap of uncompromising dogmatism which characterises 'the pulmonary theory'. From the very beginning, until now unlike 'the pulmonary theory' it does not claim to be the only theory which can explain everything in Bhopal. It readily accepts that at least a part of the human suffering may well be because of direct damage to the lung tissue and eyes by MIC gas. Its main problem lies in a different area.

Events postulated and substantiated very tenuously to be taking place at the cellular level cannot be directly connected to events occuring (symptoms) in a large proportion of individuals in the community. The chain of links that connects the two must be demonstrated at least tentatively. This has not been done. We therefore now turn to a critique of the 'cyanogen pool' theory.

There are two kinds of evidence both indirect, to suggest chronic cyanide poisoning, (1) Inadequate utilisation of oxygen and removal of carbon dioxide indicates a metabolic block at cellular level. There is also some evidence that carbon dioxide removal from tissues is increased after injection of sodium thiosulfate, (2) The clear rise in the urine output of thiocyanate following injection of sodium thiosulfate perhaps indicates an enlarged cyanogen pool.

However the data available on both the types of studies (changes in the blood gases and urinary thiocyanate following sodium thiosulfate) is very scanty and fragmentary, which makes informed and in depth examination of these studies almost impossible. *Furthermore these studies are done on hospitalised patients. To extend the findings and lessons of these studies to home based ambulatory persons as ICMR does is not acceptable on methodological grounds.*

We find ourselves not equipped enough to appraise more critically the meaning and interpretation of blood gas studies but we do offer our criticism of the way a potent tool of epidemiological research such as sodium thiosulfate has been used so far resulting in non-illumination of many critical areas of toxic effects on the human population.

In the double blind clinical trials carried out by ICMR and others on 30 hospitalised patients in Jan.-Feb.1985 two outcomes were observed, one, clinical improvement and two, urinary thiocyanate levels following sodium thiosulfate or glucose as placebo (14). The released information so far does not say clearly as to what was observed in the clinical outcome. However if we go by clinical criteria used in subsequent studies (not double blind trial) which are made public, we can make a reasonable guess as to what was probably observed, i.e. (i) weakness and breathlessness at rest and (ii) increase even after mild exertion (14). From our point of view these are only pulmonary symptoms constituting only a small proportion of all symptoms. They do not include non pulmonary symptoms like blurring of vision, nausea, anorexia, flatulence, fatigue, weakness, headache, etc. And yet the minutes of the ICMR meeting of 14-2-1985 (16) contained detailed guidelines for categories of patients to be given injection sodium thiosulfate which included patients suffering from acute and/or chronic symptoms relating to respiratory, gastrointestinal and neuromuscular systems following MIC gas exposure.

This is clearly far from satisfactory. There is no published evidence by ICMR which says that a significant proportion of non pulmonary symptoms are relieved also. We are therefore, bound to question the explanatory power of the 'cyanogen pool' theory to account for high rates of non pulmonary symptoms. Also ICMR data related to hospitalised patients, cannot say much about the community where large numbers of persons have wide ranging symptoms. Based on such a few and limited studies how can the cyanogen theory explain these symptoms in the community ?

Have there been community based trials focussing on the whole range of symptoms so that, even if indirect, evidence for existence of an enlarged cyanogen pool and its extent in the community may be established ? No.

This is not all. Significantly increased urinary output of thiocyanate in patients who are given sodium thiosulfate compared to those who are given only glucose is not a finding which is non problematic. This is so, because we do not know the effect of sodium thiosulfate on the urinary output of thiocyanate in a healthy population.

Going by whatever evidence ICMR has published so far, it is not adequate enough to explain the wide range of symptoms in a high proportion of the ambulatory population as revealed by our study.

This criticism clearly leads one to suggest that ICMR does not have adequate evidence to substantiate the 'Cyanogen pool' theory or if it has got it for some unknown reasons it has not made public full details 5 months after the disaster.

ICMR cannot make a claim that necessary information is being generated, for how can it then issue two press releases giving details of guidelines for thiosulfate therapy for the symptoms including non pulmonary symptoms ?

To summarise our arguments : On the night of 3rd December, between 100, 000 to 200, 000 persons in Bhopal got severely exposed to MIC gas (14,18,12). A vast majority of them are still complaining of serious, debilitating symptoms indicating involvement of many systems.

According to the cyanogen pool theory each of these exposed persons has an enlarged cyanogen pool in his/her body leading to chronic cyanide poisoning. This whole population may be made up of different categories of people from the point of view of the state of the cyanogen pool in their bodies and its manifestations in the form of various symptoms.

There may be some who have been ill enough to be hospitalised, those who have attended OPD only and those who belong to neither group, but have serious symptoms nevertheless. Of course there may be various degrees of overlap here. Similarly there may be various categories of symptom complexes in each of the above described groups.

The idea is not to work out all possible permutations and combinations! But along the two axes of symptom complexes and degree of seriousness of symptoms a limited number of concrete epidemiological groupings/profiles may be present which can be and must be identified.

The whole point of our criticism is that out of all such existing epidemiological groupings who together make the total population of gas victims, the ICMR has chosen to study rigorouly only one tiny group: a seriously ill patients (hospitalised), whose pulmonary symptoms have been kept in focus. The rest have been ignored. They remain unidentified, unknown and the existence or otherwise of an enlarged cyanogen pool in these groups remain untested, although such a potent tool of epidemiological investigation as sodium thiosulfate is available all through out!

Our arguments must not be understood to mean that our aim is to reject the 'cyanogen pool' theory. The theory is to be rejected only when the arguments advanced in its support are found wanting, untenable. Here we are not criticising and rejecting the arguments which have been advanced in support of cyanogen pool theory. On the contrary we are complaining, bitterly, that the possible, sensible and comprehensive arguments in support of 'cyanogen pool' theory have not been advanced because they have not been developed. Without these arguments the cyanogen theory remains untested and weak. And this is because ICMR has not bothered to develop this theory and to build up the arguments by following relevant lines of research so clearly suggested by the theory and the nature of problem facing us.

This is the criticism of methodology, perspective, orientation and objectives of research strategy. This has helped more than anything else to put the theory under the shade before it was given a fair and rigorous trial. This is not a criticism of the theory per se. Many have expressed fears that by this criticism we might be forced to oppose the mass treatment of sodium thiosulfate. Far from it.

This fear arises in part from the fact that if gaps in evidence are highlighted then the theory may suffer and with that sodium thiosulfate therapy might be rejected and condemned. We do not agree. As we have tried to argue above, the

gaps in the evidence because of lack of efforts to build up evidence is not the same as negative evidence. The theory cannot be rejected before it is properly tested. The whole point is that the evidence can be and must be built up if the theory is sound and is to be properly tested.

There may be some hesitation on account of the fear—again not really sound that further trials may mean further delay in treatment and that it may not be ethical to carry out such trials.

Taking the second point first : It is not ethical not to give benefit of treatment to the remaining groups. It is perfectly ethical to give them treatment especially when we know that on the one hand there is a disturbing possibility of chronic cyanide poisoning in such a vast number of people, and on the other hand sodium thiosulfate is such a harmless drug.

Coming to the first point : Used as we are to a division and distance between research and action, we may not be quick enough to grasp that this division and distance is artificial and has no connection with the real world where efforts to understand and solve the problems almost simultaneously is possible !

The science of clinical trials has advanced so much that with the help of well established statistical methods like Sequential Analysis, a series of quick, short duration, rigorous trials in the relevant epidemiological groups described above can be easily mounted. From a minimum of data, reliable and valuable conclusions can be drawn. We do not have to wait for a long time for the results of clinical research to come through before the treatment is initiated.

It is also possible to initiate mass treatment on the one hand since no ethical problems are involved and launch well planned, comprehensive programmes of research in the chosen epidemiological groups on the other hand so that the whole scientific case to support 'cyanogen pool' theory may be built up and the treatment is based on rational, scientific, foundations. Specific care should be taken that all who are getting treatment should have proper records showing identity of person, precise clinical description and outcomes.

These strange and inexplicable lapses of ICMR have other implications and far reaching consequences not only for establishing the case for the 'cyanogen pool' theory, and treatment and relief as we have seen above but also for compensation damages for the gas victims and for continuing relevant research programmes.

6.4 Magnitude of the problem : an issue of damage/compensation

We undertook this small and modest study within the severe limitations imposed by man, material and time constraints. The purpose of the study was to bring into focus the real issues of health that seemed to be out of focus.

To design and implement a much larger and more comprehensive series of epidemiological studies (i) to elucidate and substantiate the 'cyanogen pool' theory (ii) to help the suffering gas victims of Bhopal by way of medical relief (iii) to help them put up claims for damages and compensation against the Union Carbide, cannot be undertaken by us.

The issue of compensation/damages for Bhopal gas victims is now before the American courts. The crucial question is : How can medical evidence for tens of thousands of gas victims be presented in the court? Fortunately American courts

accept epidemiological evidence in such cases as the Bnopal disaster. A representative case from each of the relevant epidemiological groupings may be presented before the jury. Once the jury is satisfied, it can then be given statistics of other similar cases, based on proper epidemiological studies. The damage for all the identified victims may then be awarded (20).

A detailed working out of epidemiological profiles and listing of the gas affected population assigning each to one of the profiles is thus crucial to claim damages from Union Carbide.

Easily between 50 to 70% of the ambulatory population in the severely affected areas of Bhopal are still complaining of one or more serious symptoms implicating different body systems like the respiratory/gastro intestinal/ ocular and neuromuscular systems.

It has been estimated that about 100,000 to 200,000 people of Bhopal suffered serious exposure to MIC gas (14, 18, 21). Since we have excluded children below 10 years from our study who constitute about 30% of the total population we can give an estimate of suffering in 70,000 to 140,000 population. By most conservative estimates the number of persons still suffering is between 30,000 to 60,000 at the lower end. We stress again that even the upper estimate is a severely conservative estimate especially since it excludes children below 10 years who are suffering also. Practically nothing has been thought about them let alone anything being done for them thanks to the exclusive focus on the hospital population.

6.5 Thiosulfate controversy

It is obvious that differences in theory can also lead to difference in the treatment. But in Bhopal the differences about treatment have clearly gone beyond academic differences.

The believers in the pulmonary theory in the beginning treated the gas victims with bronchodilators, steroids, antibiotics, oxygen etc. This was the most obvious line of treatment at first. However, the symptoms continued unabated inspite of treatment.

Later it was known that cyanide poisoning was a strong possibility and many including doctors themselves availed of thiosulfate injections to obtain relief. ICMR issued guidelines for such treatment by 14th February 1985 based on the findings of a double blind clinical trial which is accepted as one of the most rigorous scientific methods of study.

Inspite of all this the medical establishment of Bhopal held back the treatment from the gas victims and continued to put obstacles in the way of implementation of this recommendation. Why ?

The minutes of the ICMR meeting of 14th February (16, Appendix-III) specifically mentions that all participants (which included members of the opposing medical lobby as well) agreed finally to the guidelines and a decision to convey the same to the health authorities in Bhopal as well as the Ministry of Health at the Centre (to ensure adequate supplies of sodium thiosulfate) was also recorded. These minutes were circulated to all the staff of the medical college recommending necessary action on 18th February 1985. Nothing came of it. Sodium thiosulfate is still not being given on a mass-scale to the gas victims. Besides this, a bogey of

supposed ill effects of treatment is being raised. The evidence produced is worse than flimsy (2 out of 200 patients treated with sodium thiosulfate developed rash and nausea-vomiting and 2 patients severely moribund died after sodium thiosulfate treatment!).

At a symposium on pulmonary function held in the Medical College at Bhopal on 24th March 1985, when a senior Professor was asked by the mfc team why sodium thiosulfate was not being more widely used, when seniors like him had given their consent to it earlier (Ref. appendix-III ICMR minutes - 14-2-85), the matter was brushed aside by a denunciation of ICMR and questioning the validity of the double blind study. This reaction was indeed strange since if he had not been satisfied with the results or methods of the trial, the dissent or objections should have been raised and minuted in the proceedings of the meeting and ICMR should have been required to release further details of the controversial trial.

On 3rd April 1985, Hindu, Madras carried a news report. Another senior Professor Emeritus of the Medical College, Bhopal was asked by press reporters why victims of the gas exposure were still not being given injection sodium thiosulfate. The reply recorded was even more surprising. 'How do you expect me to administer sodium thiosulfate to gas affected persons when I am not convinced about the need for it - simply because someone however eminent he is, has said it and patients are asking for it ?'

Strange argument this! In invoking the doctors' right to choose the treatment one should not forget that this right is not arbitrary. The doctor is under obligation to take cognisance of well tested scientific facts. In this case it is not the opinion of the eminent person that is the issue. The issue is whether the opinion is based on a rigorous scientific trial and whether there exists equally strong arguments which contradicts the outcome of the trial. In the name of 'the doctors right to choose the treatment' a doctor cannot ignore existing scientific evidence. What is conveniently also glossed over is the fact that only a few months earlier most doctors had accepted meekly the dictates of the health department banning the use of sodium thiosulfate.

This is pathetic. Is there no one to pull up these 'eminent' people whose behaviour is both unethical and unscientific?

In our country we have a body of health professionals - the Indian Medical Association (I.M.A.). I.M.A. considers itself to be a custodian of health of the people. To fulfill this role it has also taken up the cause of merit in medical education. Thus not long ago it launched a tirade against introduction of village health workers in the health services in rural areas. 'How can these illiterate villagers be entrusted with such a sensitive and responsible task as diagnosis and treatment of ill persons?', it argued vehemently. Again, when it was a case of reserving a few seats in medical colleges for Scheduled Castes and Tribes, it promptly jumped into action on raising a hue and cry, to defend the cause of merit, supporting the anti-reservation agitation which raised such untruthful slogans as 'people's health is in danger', 'save lives, abolish reservations':

Now here in Bhopal, months after the disaster, months after the establishment of sodium thiosulfate as effective therapy, months later when thousands of gas victims are still complaining of debilitating symptoms forcing them to stay at home without jobs, without income what is I.M.A. doing to reprimand the medical estabishment in Bhopal which simply refuses to give a vital drug to the thousands? Nothing. Just looking the other way. A body which is so concerned about heatlh

and lives of people should have decided a clear policy on the thiosulfate issue long ago. It did nothing of the sort.

Emboldened by such tacit approval the medical establishment in Bhopal continues to behave in a strange and arbitrary fashion throwing all pretences of being scientific overboard and continues to deny a vital drug to gas disaster victims.

Strangely the ICMR too has chosen not to release the details of the study and to allow this important trial to be subjected to wider and open scientific scrutiny especially when its scientific worth is being questioned. Does it realise that by not releasing this crucial information and critical data which could have helped solve the controversy it has become partly responsible for the continuing suffering of countless unknown, unfortunate gas disaster victims whose health may have been further damaged — damaged even irreversibly ?

6.6 Implications for research

Because of ICMR's ambivalence and lack of openness even 5 months after the disaster and even after being in possession of a potent tool (sodium thiosulfate) not only to treat but also to investigate further the disease pattern, ICMR has apparently made no progress in this vital area of research which demands our maximum attention. Whatever information ICMR has released (ICMR update 10-3-85) so far on the research it has sponsored is scanty and fragmentary.

It is a sad commentary on these research efforts that 5 months after the disaster with a mass of population continuing to complain of serious symptoms, no comprehensive picture of morbidity pattern in the community is put together either by ICMR or the medical establishment of Bhopal.

A very large proportion of the exposed population have more than one system's involvement. Intrinsic connections to all those disturbances must be clearly understood. Based on this insight, a community based, integrated comprehensive research programme should be mounted. Only this will reveal the true extent of suffering and its pattern and probable causes. Quite a few research studies sponsored by ICMR lack this integrated approach (Ref. ICMR update 10th March 1985 - Part II)

The approach of examining say 200 eyes, or 200 lungs and so on independent of one another lacks this integration. Strange as it may sound, but it seems to derive its rationale—unconsciously—from the pulmonary theory model, wherein the toxic gas directly hits the target organ (lung, eye etc.) to produce damage without any intrinsic connections—which is at the heart of the 'cyanogen pool' model!

The focus of research should become suffering in the community (and not only hospital based patients). Only when this happens, ICMR will mount well designed, clinical trials in the community using the potent tool of sodium thiosulfate, to work out epidemiological profiles existing in the gas affected community:

i) to find out who among the affected are relieved by it and who are not relieved and to what extent.

ii) to find out the pattern of improvement and extent of improvement in various groups of symptoms

iii) to find out what is the natural history of the range of serious symptoms

iv) and to work out patterns and degrees of disabilities

A small sub-sample of persons from each epidemiological category may be selected to study the blood gases. We stress again that a series of such studies must be done on the ambulatory populaton among which there may be 85,000 who carry a serious morbidity load.

Using the potent tool of sodium thiosulfate in this way ICMR will be able to establish not only the 'cyanogen pool' theory but also treatment schedules for the suffering population.

Only from such studies we will have detailed epidemiological profiles of those wno are going to recover with sodium thiosulfate and those who are not. We would then need a mass survey to identify all such persons so that proper and just damages may be claimed from the Union Carbide. It is obviously not enough that Union Carbide be asked to pay damages for those who are dead. It must also be made to pay those who have been disabled - physically, mentally and socially. Mr. W. Anderson, Chairman of Union Carbide should not get away with statements that 'all is well' with Bhopal.

Industrialisation is creating a high-risk environment for everyone. But experience shows that it is the poor who face the highest risks and dangers. They get the dirtiest, most hazardous of jobs and poverty forces them to live in the dirtiest environments. Yet few people pay any attention to their plight, and even fewer are prepared to do anything about it.

The state of India's Environment
— a citizen's report
Centre for Science and Environment

CHAPTER 7

RECOMMENDATIONS

Around 90,000 gas affected persons in Bhopal continue to suffer from such debilitating symptoms as breathlessness on exertion, fatigue, headache, disturbed vision, loss of memory, loss of appetite and more.

The physical and mental disability has meant loss of jobs and consequent loss of income for the survivors (Fig.1). 65% of working persons in JP Nagar have reported a drop in income as against 9% in Anna Nagar. In atleast half of the working population the rate in drop of income has been 50% or more. This is by any standard a picture of massive socio-economic disruption. The suffering - atleast part of it continues not because there is no remedy for it. Many, if not all, might have been relieved if prompt and adequate treatment with sodium thiosulfate – an antidote to cyanide poisoning was given to them.

This was not done, and it is still being withheld from them. We have tried to make a case in the last chapter that the problem of medical relief, rehabilitation and damage to the thousands of victims has been turned into a tangle due to the unseemly conflict between the two medical theories.

Although outwardly the conflict is theoretical, it has little to do with scientific rigor and debate. The supporters of the pulmonary theory have dogmatically stuck to their lame and indefensible theory and have successfully stalled mass treatment by sodium thiosulfate, thanks to the support they have in decision making and power centres.

The supporters of cyanogen pool theory on the other hand after having made a brilliant and bold breakthrough have chosen to lapse into a kind of inaction not following up the theory to its logical end by undertaking relevant epidemiological research, allowing the theory to remain vulnerable to attack.

Indian Medical Association, 'the custodian of peoples' health', is of course looking the other way and lending indirect, if not direct, support to the pulmonary theory.

The right atmosphere to make relevant, comprehensive and people oriented recommendations is of course not there. Even then we would like to make recommendations based on our understanding of the problem situation so that, individuals, groups, organisations and the gas victims may be helped, even if in a small measure in their struggle to get justice and a better deal from the Union Carbide and from the Government of M.P.

Of all recommendations we believe the most decisive and central is the research-cum-action programme which is in a way linked to all the major issues of medical relief, rehabilitation and compensation for damages.

The whole scheme of recommendations follows logically from it.

7.1 Community Based Epidemiological Research

7.1.1. The research endeavour must shift its focus from the present hospital or dispensary based seriously ill patient orientation to a family and community based

ambulatory patient orientation so that the quantity and quality of the problem can be clearly demarcated. Epidemiological profiles of ill health and disability in the community need to be urgently built up. Well designed clinical trials using sodium thiosulfate not only as a therapeutic tool but a potent epidemiological tool as well need to be initiated on ambulatory patients in the community - to find out who is and who is not relieved, extent of improvement and natural history of the range of serious symptoms (e.g. breathlessness on exertion, disturbed vision, fatigue etc.) This will enable it to test and substantiate the 'enlarged cyanogen pool' theory, to help it establish mass therapy with sodium thiosulfate on a firmer scientific base than is the case today and to help refine, modify and consolidate profiles of significant epidemiological groupings so that classification of the entire gas affected population becomes possible.

7.1.2 Since the possibility of chronic cyanide poisoning in Bhopal is very high an ongoing surveillance programme covering the total affected population should assess the risk to the unborn and newborn babies.

7.1.3 Health problems related to women's reproductive system should be continually monitored.

7.1.4 Quite a high proportion of gas victims are suffering from psycho-social stress. They must be properly rehabilitated.

7.1.5 In view of the possibility of lung damage it is necessary to have monitoring of pulmonary functions for a much longer time since the process of lung fibrosis is insidious and takes a long time to develop fully. Special care must be taken for those whose pulmonary symptoms show no improvement after sodium thiosulfate treatment. Similarly a special watch must be kept on visual disturbances since it is closely related to work performance.

7.1.6. An important but neglected dimension of the existing research endeavour is the lack of informed consent. This is a minimum medical ethic which even in the unprecedented situation of Bhopal is reasonable, relevant and possible. People must be informed about the test being done, their rationale and their informal/formal consent be taken. This is their right and is the only way that medical research becomes an instrument of human welfare and does not degenerate into an instrument of exploitation of human suffering for esoteric research and career advancement.

6.2 Mass Relief Programme

As we have discussed in Chapter 5, while the epidemiological studies are underway, mass treatment with sodium thiosulfate can begin.

Special care must be taken to maintain medical records of each individual containing a record of his/her symptoms, amount of sodium thiosulfate given and outcome recorded in terms of improvement/no improvement of symptoms and urinary thiocyanate excretion if measured. The records system must be modified in the light of new information emerging. A copy of the essential contents of the record must be given to each individual.

7.3 Listing of the victims : claims for compensation

– A list of all gas victims, each assigned to one of the epidemiological groupings must be prepared. This is of vital importance for the claims of compensation for all the gas victims.

7.4 Health committees

The tasks described in 6.2 and 6.3 are huge ones. The Government machinery however big cannot accomplish these tasks. Involvement of voluntary groups working amongst people must become an integral part of the health service structure if these tasks have to be accomplished properly and in time. This will also ensure the people's right to know.

7.5 A communication strategy on health related issues

There is need to evolve urgently and immediately a continuing education strategy for medical personnel and a health education strategy for people exposed to the toxic gas as part of an overall community health approach to the disaster aftermath. A multi-pronged approach using different groups of people should be developed. The aim should be to translate existing knowledge and new knowledge derived from ongoing research effort into supportive intervention in the lives of the people. This will not only meet the people's need but also satisfy their right to information about their own health.

7.5.1 We recommend that all health personnel involved in relief/rehabilitation services should be continuously educated and kept informed through news letters. informal group meetings at regular intervals and other means and kept updated with latest research results and guidelines emerging out of these. For a start the content of this continuing education for health personnel must include

i) ICMR guidelines for sodium thiosulfate therapy and the scientific rationale for this line of treatment.

ii) Disaster induced psycho-social stress and methods of management-counselling and supportive psycho and chemotherapy.

iii) Possible risk to unborn foetus, need for surveillance of pregnant women. counselling about risk and helping couples with the decision to continue or to take the option for MTP.

iv) Family planning advice and need for contraception till detoxification is completed.

v) Role of Respiratory Physiotherapy.

vi) Low cost nutritious recipes for mothers whose babies have had to be weaned due to effects on lactation.

vii) Caution against overdrugging particularly steroids and antibiotics - their side effects and rationale for use.

viii) Need for open-minded surveillance of affected population especially high-risk groups to identify emerging chronic and long term effects.

ix) Importance of family based records and improving doctor-patient communication of findings and treatment.

7. 5. 2 We recommend that a dynamic, creative, non-formal health education of the affected community must also be initiated including open group meetings, posters and pamphlets with demystified health messages and audio-visuals. The health messages must be built around the life style, culture and the existing socio-economic situation of the people to have any impact or relevance. These should include most of the areas outlined in 7.5.1 (above) This is particularly relevant since the disaster aftermath has led to a socio-economic crisis in the life of the victims.

APPENDIX I

BHOPAL STUDY PROFORMA

Medico-friends circle, 17-25 March, 1985

SECTION I : INFORMATION REGARDING HOUSEHOLD

1. House Number : .....
2. Area/Basti : .....
3. Head of household : .....
4. Religion : .....
5. Type of cooking fuel used (tick whatever is used)
   - i) Firewood ☐
   - ii) Cowdung cake ☐
   - iii) Saw-dust ☐
   - iv) Coal ☐
   - (v) Kerosene ☐
   - (vi) LPG Gas ☐
   - (vii) Other (specify) .....

6. Composition of family: (start with household head – Do not include members who are dead or missing since Gag leak)

No.	Name	Age	Sex
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

	Before	After
Loan		
Compensation		

7. Information regarding family members dead or missing since gas leak (include all deaths after 3.12.1984)

No.	Name	Age	Sex	Date of death or * missing	Cause	Occupation	Smoking status	Chronic lung disease prior to 3/12/84	History of serious illness prior to 3/12/84	Staying in this basti since when	Was he/she present here during gas leak
1.											
2.											
3.											
4.											
5.											
6.											

* Specify whether dead or missing : M = missing
D = dead

Name of Investigator.....

Date .....

SECTION II : FOR INDIVIDUAL MEMBERS OF HOUSEHOLD

1. House No. : .....
2. Area/Basti : .....
3. Head of household : .....
4. Name of individual : .....
5. Staying in this basti since when (month & year) : .....

6. a) Occupation/job/ vocation (Before gas leak) ; .....
   b) Since when (years, months) : .....
   c) Has gas leak affected your job? (specify) : .....
   d) What is your present occupation : .....

7. Income data :

	Per day	Regular/ irregular	Per month
Before gas leak			
After gas leak			

8. Where were you during the gas leak :.....

9. Did you use any safety measures? How did you protect yourself? (water towel, direction of running with respect to UCIL, doors closed, open, etc.)

10. Smoking status;

Current	Past	Nonsmoker

11. Hospitalization for gas effect?
    When?
    For how long?

12. Chronic illnesses? Yes/No

Particulars	Chronic illness other than respiratory	Chronic respiratory illnesses				
		Asthma	TB	Bronchitis	Lung cancer	Other (specify)
Duration						

13. Number of episodes of the following in the past 3 months:

Disease	No. of attacks	Duration
1. Common cold		
2. Cough		
3. Fever		

Name of Investigator: _____

Date : _____

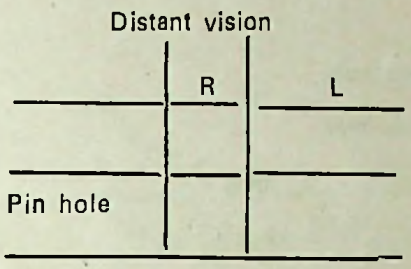
SECTION III : : EXAMINATION DETAILS

1. House No. : .....
2. Area/basti : .....
3. Head of household : .....
4. Name of individual : .....
5. Examination details: Age:

Symptoms	No.	Yes (Specify)	If yes, duration
1. Dry cough			
2. Cough with expectoration			
3. Blood in sputum (haemoptysis)			
4. Breathlessness at rest			
5. Breathlessness on accustomed exertion			
6. Lacrimation			
7. Fever			
8. Chest pain or tightness			
9. Skin problems (itching, burning, infection)			
10. Jaundice and its symptoms			
11. Blood in stool or vomit/malena			
12. Bleeding tendency			
13. Blurred vision and photophobia			
14. Headache			
15. Weakness in extremities			
16. Muscle aches			
17. Fatigue			
18. Loss of memory (amnesia) recent			
19. Tingling, numbness			
20. Anorexia			
21. Nausea			
22. Vomiting			
23. Pain in abdomen/burning			
24. Flatulence/heaviness			
25. Impotence			

6. General examination:
   i. Height cms
   ii. Weight kgs
   iii. Pulse rate
   iv. Respiratory rate

7. Eye examination:
   i. Cornea
   ii. Acuity of vision
   iii. Pupillary reflexes
   iv. Lens



Near vision

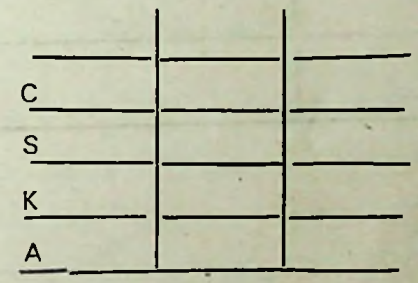
N8 — R PR NR

8. Jaundice (sclera)
9. Cyanosis
10. Skin examination
11. Oedema

12. Respiratory system:
    i. shift of mediastinum
    ii. air entry
    iii. foreign sounds

13. CVS

14. CNS
    i. Muscle power
    ii. Wasting
    iii. Plantar
    v. Knee



15. Alimentary system: i. Liver ii. Spleen iii. Ascites

16. Anxiety/depression
17. Diagnosis
18. Remarks

Name of investigator:
Date:

SECTION IV : LUNG FUNCTION TESTS

1. House No. : .....
2. Area/Basti : .....
3. Head of household : .....
4. Name of individual : .....
5. i) Height : cms
   ii) Weight : kgs
   iii) Surface area:

6. Lung function:

Recording	FEV_1	FVC
1		
2		
3		

Name of Investigator : .....

Date : .....

SECTION V : ADDITIONAL PROFORMA FOR WOMEN

1. House No. :
2. Area/basti :
3. Head of household :
4. Name of individual : Age:
5. Marital status :
6. Menstrual history:

Details	Past (since when)	Present (after gas leak)
1. Occurrence (cycle per month)		
2. Dysmenorrhoea		
3. Flow		
4. Peculiarities		
5. Leucorrhoea		
6. Itching		
7. Burning sensation with urination		

Doctors seen Yes/No

7. a. Whether pregnant during gas leak? Yes/No

   b. If yes, exposure during which month of pregnancy?

   c. Outcome of pregnancy:

Details	Remarks (when, how, any peculiarities?)
1. Spontaneous abortion	
2. MTP	
3. Still birth	
4. Premature delivery/live	
5. Full term	
6. Still pregnant (whether foetal movements normal)	

8. Lactation (milk output) Supressed (significant) Normal

Name of investigator:
Date:

SECTION VI : PATIENT'S PERCEPTION ABOUT AVAILABLE HEALTH FACILITIES

1. Where do you go for medical treatment?

   a. Government dispensary b. Private doctor c. Self-medication

2. Can you walk down to the government hospital/dispensary?

3. How long do you have to wait in the dispensary in the queue for your turn to come?

   a. examination

   b. getting medicines

4. How many days of medicines are given at a time?

5. a. Do you get all the medicines from the government dispensary? Yes/No

   b. If not, do you have to buy any medicines from the market?

   A few medicines/all the medicines

6. Were the medicines useful? (specify)

7. How was the behaviour of the government doctor?

   a. enquiry b. examination c. advice

8. Were you referred to the hospital anytime during this illness? Yes/No

   If yes, how was the experience at the hospital?

9. Did you go to a private doctor? Yes/No

   If yes, did he tell you anything different about your illness?

   How much did you spend for private treatment?

   a. Doctor's fees: b. Drugs

10. Has any doctor told you so far anything about the nature of your disease or has given any advice? Yes/No

    It yes, what was the advice?

APPENDIX II

An English translation of a Handout in Hindi distributed among the people of the bastis selected for the study.

To our brothers and sisters affected by the gas leak tragedy in Bhopal.

We are a team of socially-conscious doctors and health workers belonging to a group called the medico friend circle. As an expression of our concern for you all we have come to try and help you in our own small way. We have come to assess and find out whether there are any ways in which the medical relief and advice that is being given to you can be improved.

Soon after the disaster some of our members came to Bhopal and were involved in relief work. They also made suggestions to the government about medical relief work based on their own experiences. These suggestions are also available in Hindi. We have now come to investigate in detail what are the health problems you still have three months after the disaster and to try and find out what can be done for them. From these investigations and from an assessment of the treatment services being given to you, we hope to make suggestions to the government and to all those involved in health work of improvements that can be made.

All of you have been affected by the gas leak. To find out the health effects of this exposure it is not necessary to examine everyone of you. To find out the main effects on your health it would be adequate to do a complete survey on every tenth or twentieth house in the basti. From this survey it will become evident as to how many of you are suffering from the different illnesses caused by the gas exposure.

Whatever we find out on examination of each of you will be written out concisely in a note, a copy of which will be given to you. Apart from this we shall also send you a copy of whatever other general recommendations we have about improving your health status.

We shall explain to you what has been the effect of the gas on each and every part of your body and what you should do to tackle this situation. Which drugs are useful ? Which drugs are not useful ?

With your cooperation we shall try to decide whether there will be any improvement in your lungs by the use of respiratory exercises. We shall teach you these respiratory exercises. These exercises will also help to prevent further damage to your lungs.

Brothers and Sisters - We are not working for government or any other official agency. We have come here through the support of collections made from many others who have contributed as an expression of their concern for you. We are doing what we can through this low-cost venture and have come here voluntarily. We are confident that you will give us your whole-hearted cooperation in this work.

Yours
Bhopal Study Team,
medico friend circle

APPENDIX III

INDIAN COUNCIL OF MEDICAL RESEARCH
MINUTES OF THE MEETING ON THIOSULPHATE THERAPY IN MIC EXPOSED POPULATION HELD ON 14TH FEBRUARY, 1985 AT HEADQUARTERS NEW DELHI.

1.0 Participants

Dr. J.S. Guleria
Dr. N.P. Mishra
Dr. P.S. Narayanan
Dr. P.N. Pande
Dr. K. Ramachandran
Dr. A. Ramaiah
Dr. H.H. Siddiqui

ICMR Representatives

Dr. S. Sriramachari (Chairman)
Dr. C.R. Ramachandran
Dr. A.K. Prabhakar (Rapporteur)
Dr. R. Parhee (Rapporteur)

2.0 The Chairman, Dr. S. Sriramachari, Additional Director General, ICMR, welcomed the members on behalf of Prof. V. Ramalingaswami, Director-General, and on his own. He explained that the purpose of the meeting was to discuss the different aspects of use of Sodium Thio Sulphate (NTS) in MIC exposed population. He also reiterated that the preliminary results of the double blind study conducted at the 30 bedded community hospital at Bhopal had indicated the presence of "cyanogen pool" in the exposed persons. He pointed out the several physiological parameters and optimal time for urinary excretion of thiocyanate had since been worked out and the method of monitoring could thus be standardised. He informed that since the utility of NTS had been established, the criteria of selection and contraindications, if any of cases, details of dosage, duration of administration should be urgently worked out. Apart from the continuation of the Controlled Studies with Thiosulphate Therapy, the questions relating to the extension of the therapeutic measures to all patients with clinical symptoms should be decided.

On the basis of the double-blind trial conducted by Dr. Narayanan and Dr. A. Ramaiah at Bhopal Dr. Guleria and other members of the group emphasised that Sodium Thio Sulphate should not be withheld from affected victims and should be made available to all patients with clinical symptoms. However he cautioned that strict criteria for use need to be laid down. This should include specific criteria for selection of patients based on symptoms and severity of exposure; as well as guidelines for maintenance of records; investigations; monitoring for adverse reactions; and clinical and laboratory investigative follow up paramteers. In addition, contraindication for use should be clearly spelled out. He also mentioned that the final decision for use and/or stoppage of treatment with Sodium Thiosulphate should be left to the judgement of the clinician.

Dr. N.P. Mishra, presented, in brief, his earlier as well as recent observations on the use of NTS at Gandhi Medical College, Bhopal. He mentioned that he had observed adverse reactions in 2 persons among 200 individuals who had received one injection of NTS. Severe gastro intestinal symptoms of vomiting and nausea, with fever was observed within 10-20 minutes of injection. Dr. Mishra stressed that this drug should be administered to hospitalised patients. In this connection, Dr. P.S. Narayanan presented his experience with 322 injections of NTS administered to 76 patients. The only mild adverse reaction observed in 2 patients was feverishness experienced several hours after receiving the injection which was relieved with aspirin in one case. In view of this, the members of the group felt that NTS injections should be given to patients at hospitals, clinics and dispensaries under

medical supervision, with strict monitoring for adverse reactions. As it may not be possible to admit all patients while they are under therapy, it was considered advisable to keep the patients under medical observation for at least one hour after administering the injection.

Dr. Mishra informed that the predominant symptoms observed in patients suffering from effects of MIC relate to the respiratory, gastro intestinal and neuromuscular systems. In addition, patients with psychological symptoms are seen. Dr. Narayanan emphasised that some patients present themselves with relapse or recurrence of symptoms after having obtained almost complete relief from the acute phase.

After considerable discussion, it was agreed that NTS injections should be given to all patients with the following criteria;

1. Patients suffering from acute and/or chronic symptoms relating to the respiratory, gastrointestinal, and neuromuscular symptoms. The symptoms should be causally related to possible exposure to MIC gas;

2. Patients presenting with recurrence of symptoms after having obtained some measure of relief from the acute phase;

3. Recorded cases of acute pulmonary oedema and/or coma, that occured immediately following the episode, and who are currently symptomatic;

4. Patients who have a history of death in their family, and also those who reside within 2 km of the factory in the direction of the wind on the day of the tragedy or in the vicinity of the factory.

It was emphasised that baseline clinical and laboratory data should be obtained for all recorded cases. With regard to old cases, where records may be available fresh baseline data should be obtained.

Detailed discussion was held regarding dose and duration of treatment. It is generally understood that in acute or severe cyanide poisoning, 12.5 to 25 gm of NTS can be administered as a single dose intravenously. However in the preliminary trials, clinical improvement had been observed with I gm of NTS given as a single dose, or in 3 successive doses. Giving allowance for the time lag in the build up of the cyanogen pool after its first depletion, it was felt that the subsequent injections could be given after larger intervals. It was finally suggested that two regimens on administration of NTS should be followed, viz:-

A.	Day 1	- 2	gm	NTS,	intravenous
	Day 2 to 6	- 1	gm	NTS,	- do -
B.	Day 1	- 1	gm	NTS,	- do -
	Day 3	- 1	gm	NTS,	- do -
	Day 5	- 1	gm	NTS,	- do -

Children should receive lower doses appropriate to the body weight. Urine levels of thiocyanate should be monitored initially prior to the injection, and then daily, 3 hours after administration of the injection. Whenever possible, 24 hour urine output should be monitored. Mixture Alkaline Diuretic with sodium chloride

should be administered to the patient to facilitate excretion of thiocyanate, for the duration of therapy. Therapy may be terminated if thiocyanate excretion reaches or remains at normal levels. The members of the group agreed that the drug should not be administered routinely to pregnant women. The decision for use will depend upon the severity of the symptoms. Pulse rate, respiratory rate, response to exercise, and level of physical activity should be recorded during therapy and afterwards in order to evaluate the progress of improvement. Adverse reactions, if any, should be brought to the notice of the local senior physicians and health authorities including the ICMR.

It was also recommended that urine estimation of sodium thiocyanate should be standardised at all centres undertaking this investigation. For this purpose, Dr. A. Ramaiah was requested to help in standardising the procedure at the laboratory, of the Medico Legal Institute at Gandhi Medical College, Bhopal. For quality control periodical cross checking between the two laboratories should be worked out.

Finally, it was recommended that Dr. A. Ramaiah should prepare a detailed protocol on the laboratory monitoring of thiosulphate therapy in MIC affected population. This would be circulated to all members of the group at the earliest.

All the participants including Dr. N. P. Mishra and Dr. P. S. Narayanan agreed to the above recommendations. It was decided that the above information should be conveyed to the concerned health authority in Bhopal as well as Min. of Health so as to ensure adequacy of supply of NTS. The next meeting of the group would be held after 3-4 weeks to review the progress of the studies.

The meeting ended with a vote of thanks to the chair.

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APPENDIX IV

STUDY OF MEDICAL RELIEF TO GAS VICTIMS

Some members of the team visited various medical centres near JP Nagar—the basti selected for our study. These included:

i) a government polyclinic

ii) the DIG Hospital—a 30 bedded hospital specially established for care of disaster victims

iii) three non-governmental private clinics in the adjoining area.

From these visits and interviews with the doctors, some understanding of the dynamics of medical relief services emerged. The points specifically noted were staff pattern, timing, availability of drugs, standard guidelines if any and doctors' perceptions of the health problems etc.

Government Services

i) The polyclinic was kept open 24 hours of the day. It was an ordinary dispensary and did not consist of specialists from different branches as the name suggests.

ii) The DIG hospital was, however, staffed by specialists in medicine, obstetrics, ophthalmology, paediatrics, ENT and surgery. It had 14 doctors and a smaller number of paramedics. The out-patients department was open from 9.00 a.m. to 1.00 p.m. and for one hour in the evenings. About 600-800 patients were seen per day, resulting in long queues. There seemed to be no problem of drugs - these being available in adequate range and quantity.

There were no standard guidelines for investigating, diagnosing and treating gas victims. The doctors used their own lines of treatment. Most of the doctors interviewed had no definite knowledge about the role of sodium thiosulfate nor had seriously reviewed the problem of danger to the foetus and the option of MTP for pregnant women. There were no definite criteria for referring patients to bigger hospitals. Facilities for routine biochemical and microscopic investigations were available.

The DIG Hospital was also being used for the double blind clinical trial of ICMR on the rationale/ efficacy of sodium thiosulfate. It had facilities for blood gas analysis and measurement of urinary thiocyanate levels by spectrophotometry. These were being carried out on all patients being selected for a course of sodium thiosulfate injections.

iii) Our interviews with doctors about the range of symptomatology and clinical syndromes they were seeing each day in the OPD'S revealed that even though they thought that many patients were ill, they felt that many were exaggerating and implicating the gas in all types of complaints. The quality of reporting/recording these symptoms and findings of examination were poor and would therefore, not be of much use in any type of retrospective research studies.

On the whole though a medical service had been established and medical teams were available to the gas disaster victims, we felt that these had not been adequately oriented to meet the demands of the situation; there were no standardised guidelines for investigation or management; and no continuing education or on-going communication of research and other information to the treating doctors to support rational management. The doctors' attitudes were somewhat biased against the phenomena of multisystemic symptomatology with many of them perceiving this as malingering or compensation neurosis.

By and large due to inadequate planning the dispensaries were understaffed and the doctors overworked. This was particularly true of the DIG hospital.

Non-government clinics

Three such centres were available near the basti. One of them was a free clinic specially set up after the gas disaster with the help of a Muslim Charitable group. The therapist was using mainly homeopathic medicines but also had ayurvedic and allopathic medicines in his armamentarium. He used these 'depending on the case'. He made tall claims of cure for gas related diseases as well as other problems. Our intensive but informal talks with the basti people for three days did not reveal any cases of substantial relief with his treatment schedules.

Another general practitioner had a clinic about 1 km. from the basti. He was not an MBBS doctor but his clinic was overcrowded. He seemed courteous and soft spoken to his patients but hardly examined anybody in detail. Injections, antibiotics and prednisolone were liberally used. In his discussion with us he shared that antibiotics, antacids, bronchodilators and steroids had been used by him to treat the patients without much result. He did not know about the details of the use of Inj. sodium thiosulfate or the medical controversy about it. However, he thought that the advice given by a forensic expert (doctor of the dead as he described him) regarding cyanide poisoning should be taken with 'a pinch of salt'. He also felt that some of his patients who had been given injection sodium thiosulfate had not benefited. He also shared with us that he himself had been exposed to the gas and suffers from symptoms even now. Recently he had started taking an ayurvedic preparation with 'gratifying results'.

The third practitioner was a lady doctor working near the basti. She had closed down her clinic after the disaster for two months and could not tell us much. She had used antacids, cough mixture and antibiotics without much results. Most patients, she said, did not come back the next day in spite of their continued illness since "they were too poor to pay fees every day". When asked specifically about the problems of women, she felt that there had been an increased incidence of gynaecological problems but since she did not undertake gynaecological examinations, she could not give further details. Most of these cases were referred to her sister who was a trained gynaecologist. None of these practitioners had received any communication or guidelines from the government health service doctors or medical college and there was no coordination between them and the government polyclinics or dispensaries.

APPENDIX V

PEOPLE'S PERCEPTION ABOUT AVAILABLE MEDICAL FACILITIES

Forty out of the sixty families selected in our study of JP Nagar were included in the survey of people's perceptions of the available medical services. One person from each of the families was interviewed and the questions asked are given in Appendix I (study proforma, Section 6). The main findings of this survey were :

(i) **Choice of treatment** : Seventy percent had gone to government dispensaries and 82.5 percent had gone to private practitioners and only one was on self-medication. Ten persons had not gone to any government dispensary and five persons had not gone to any private practitioner. Many had decided to go to private practitioners because they were dissatisfied with the experience in the government hospitals.

The distances were not too much and most people said they could walk down to the government hospital or dispensaries

(ii) **Time at dispensary/hospital** : Six persons said they had to wait 1-2 hours for their turn in the hospital, 8 persons - 2-4 hours and 13 persons more than 4 hours. The delays were probably due to these service units being understaffed and to overcrowded.

(iii) **Medication** : Medicines were given mostly for 1-3 days in 70 percent of the cases whereas 6 respondents said they had received medication for more than three days. (This is inclusive of the practice in the private clinics).

Medicines were received free in the government dispensary by 70 percent of the respondents. 5 persons mentioned they had to buy a few medicines from the market.

Twenty five percent had no relief from the medication, 52.5 percent got some symptomatic relief while one respondent mentioned that he got substantial relief.

Interestingly the only therapy that was being given was drugs which were being prescribed faithfully by the doctors in large doses and repeatedly with no thought of over-medication. Many patients showed us platefuls of coloured capsules and tablets which they had received from different doctors in the same centres and in different centres. These were not very effective but were continuously being prescribed in a sort of routine conditioned reflex!

(iv) **Attitude of doctors and quality of care** : Forty percent said that the doctors hardly made any enquiries, whereas 42.5% mentioned that the enquiries were sympathetic. 15 percent said that no examinations were done, 37.5% had cursory examinations and 25 percent had proper physical examinations. 75 percent were given no advice other than instructions for medication. One received some reassurance and only one could recall being given some dietary advice.

(v) **Referrals to Hospital** : Nineteen respondents were referred to hospitals during the last few weeks. 9 felt the same after hospitalisation, 5 felt worse and 3 got better.

(vi) **Experience with private practitioners :** The experience with private practitioners, whom over 82.5 percent had consulted, was not very different except that the doctor-patient relationship was somewhat more satisfying. All of them got a medication but no other advice.

Ten respondents had spent upto Rs. 100.00 on treatment, 10 between Rs. 100. 00 and Rs. 500.00 and 13 had spent more than Rs.500.00. No doubt this was adding to the economic burden of the families and would be reflected in the loans taken by many families. One family had spent more than Rs. 3500/- on treatment.

(vii) **Health education :** Thirty seven of forty respondents had been given no inkling about the nature of the illness or any other supportive advise, e.g. no smoking for those with lung complaints, special advise to women who were pregnant, breathing exercises, psychological reassurance or counselling. One mentioned that he had been told 'it was a recurring illness'.

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medico friend circle

The medico friend circle (mfc) is a circle of friends with medical/non-medical backgrounds who share the common conviction that the present system of health services and medical education is lopsided in the interest of the privileged few and must be changed to serve the interests of the large majority, the poor. mfc fosters a 'thought current' upholding human values, people and community orientation of health care and medical education, demystification of medical science and a commitment to the guidance of medical interventions by peoples' needs and not commercial interests.

mfc offers a forum for dialogue/debate, sharing of experience and experiments with the aim of realising the goals outlined above, and for taking up issues of common concern for action.

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