1- **Title of the project : Linking and analyses of existing ICMR databases (1985 -2015) of Epidemiological, Clinical, Toxicological and Genetic Studies on Bhopal Gas Victims**

2- **Investigators:**

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Duration of Research Project : 2 Years(August,2018-August,2020)

3. **Introduction :**

Subsequent to the gas tragedy in the night of 2nd/3rd December 1984 at Bhopal Indian Council of Medical Research started about 20 research projects on epidemiological clinco-epidemiology, genetics, immunology of gas exposed persons under Bhopal Gas Disaster Research Centre (BGDRC) Bhopal. These projects were bound up during 1992 to 1994 after completion. Results of these studies were reported in the form of three Technical Reports of ICMR namely Epidemiological Studies, Clinical Studies & Toxicological Studies. Centre for Rehabilitation Studies(CRS), under Government of M.P. continued research activities (1995-2010) in the

fields of epidemiology & clinical areas. Second Technical report on Long term population based epidemiological study was published by NIREH in 2013. Although several reports like Annual Reports, Consolidated reports, Technical Reports on various research studies during 1985-2010 by BGDRC & CRS have been published, the voluminous scientific data of various resource projects need a fresh look for further in-depth analyses so as to make a data repository on Bhopal gas exposed people for future reference and to initiate new studies. Further, there is a need to link and analyse the data of various past studies to develop clinical profile of gas exposed individuals and to understand the cause and agent association. Though the samples of various studies, were drawn from the original cohort of long term population based epidemiological study (Fig -1) by stratified random sampling yet the linkage of data of various studies has not been attempted. The information regarding good number of common subjects enrolled in various past studies projects is available in different databases which need to be linked , so that analyses can be done by applying appropriate statistical methods. Six monthly epidemiological surveys are being carried out to collect socio, demographic profile ,morbidity and mortality profile of gas exposed cohort since 1985.Since population is dynamic ,owing to new births, immigration and emigration in any cohort bases study .

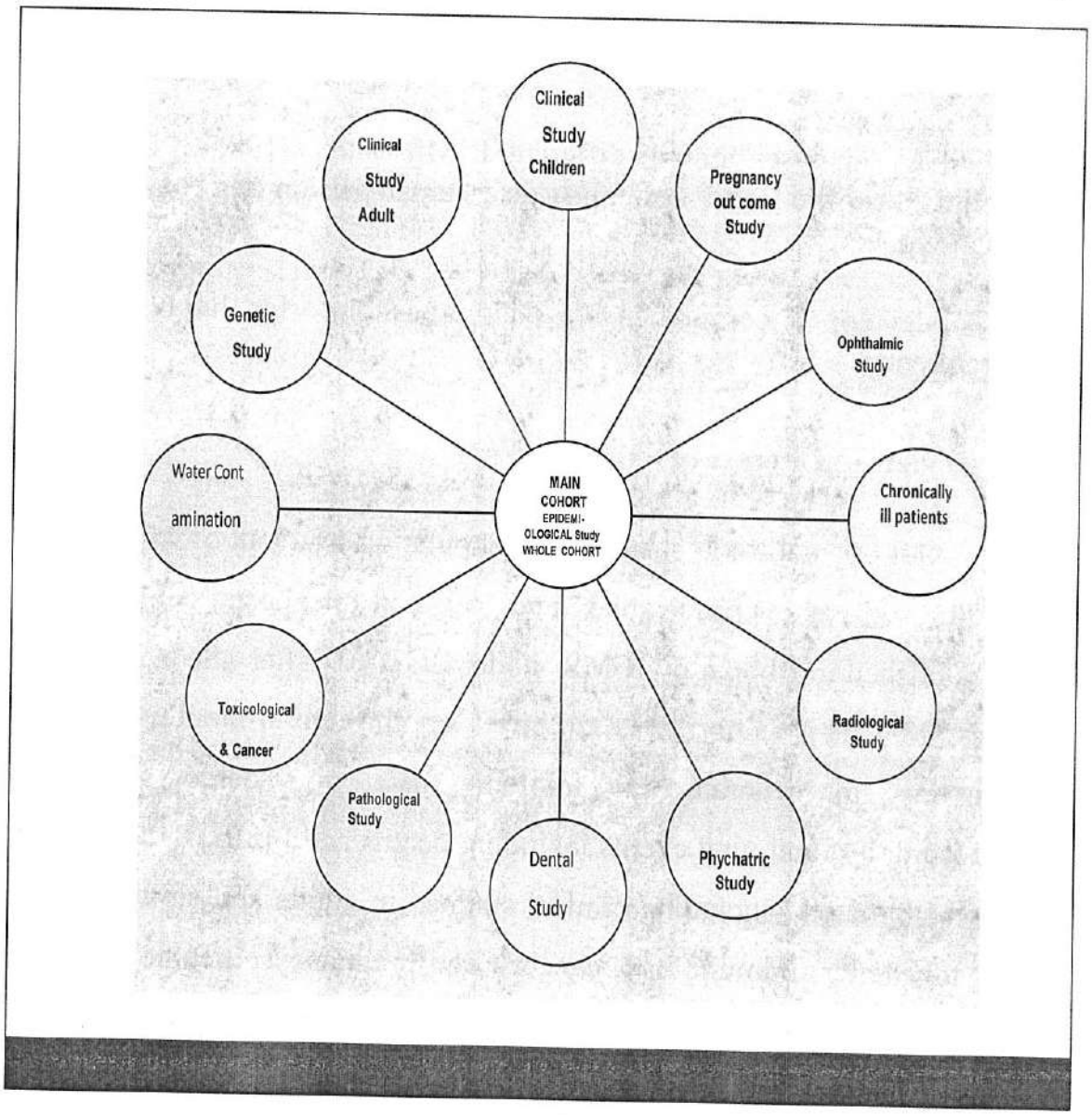


Fig.1 linkage between clinical and epidemiological studies through cohort

The proposed study aims to link databases related to toxicological, epidemiological, clinical and genetic studies undertaken during 1985-2015. So as to assess the health status, develop clinical profile and to understand the disease pattern among gas exposed individuals. Linked cohort population may be used for sub sample for future studies.

Objectives

a)- Linkage analyses among different ICMR studies(1985-2015) to develop clinical profile and establish disease patterns among toxic gas exposed individuals.

b)- To develop a comprehensive data repository for future research and reference.

4. Review of Literature:

Out of total toxic gas exposed population of about 559,835 a cohort of 80021 in gas exposed areas and 15931 in unexposed control areas was established in Bhopal by ICMR under BGDRC[1] after the toxic gas disaster in 1985. This cohort was followed up through 6-monthly door-to-door surveys to generate epidemiologic data viz: demographic profiles, morbidities, and vital events including deaths and births. Later other studies were initiated , including clinical studies[2] in adults and children, studies of cytogenetics, immunology, cancer[8], and pregnancy outcome etc. The main purpose of these studies was to carry out system specific in-depth clinical investigations to understand exact pathogenesis and clinical course of the effect of the toxic gas so that the modalities of treatment and management for the survival could be scientifically evolved.

Investigations including clinico-epidemiologic, autopsy, and toxicologic data were aimed at determining the immediate, late, and long-term health sequelae among those with severe, moderate, and mild exposures. The cohort population showed variation in mortality and morbidity related to the intensity of exposure. Chronic illnesses pertaining to respiratory system, G.I. system, eyes, and skin, as well as psychiatric disorders were recorded. Mortality[1] among the exposed population was much higher than the

unexposed population. Immediately after the acute exposure, pregnancy wastages (abortion, still birth) were 10-12 times higher among the exposed than among the unexposed population[1]. Clinical studies revealed that children in the exposed cohort had more respiratory ailments as well as slower growth and development[2]. Ophthalmic abnormalities, including allergic conjunctivitis, chronic conjunctivitis, and corneal opacity were higher in the exposed population[2]. Lungs appear to have been the most affected target organ due to the inhalation of the toxic gas. In a clinico-epidemiologic study of 3000 exposed persons, randomly selected from the exposed cohort, 40% showed obstructive lung disease; follow-up studies suggested little subsequent improvement[2,5,6]. Furthermore, most of the deaths among the exposed population were the result of respiratory ailments[1]. A toxicological study[3] of 18043 exposed and 1,079 unexposed individuals showed that urinary thiocynate was elevated 2-3 fold among the exposed[3]. Sister chromatid-exchange (SCE) and chromosomal aberrations were more frequent among the exposed.[10]

5. Material & Methods :

This study, initiated in August 2018, to link various available databases related to epidemiological, clinical, genetic and toxicological studies on gas exposed individuals, undertaken between 1985 and 2015, so as to assess the health status, prepare clinical profile and to understand the disease pattern among gas exposed individuals. Information collected in different past studies will be linked to the extent possible using locality identification number, ICMR family number ,individual ID number to make clinical profile of common individual in different studies. And further linked with socio economic variable and gas exposure .

Databases of ICMR Studies related to the gas victims:-

A cohort of 80021 in gas exposed areas and 15931 in unexposed control areas was established in Bhopal by ICMR after the gas disaster in 1985. This cohort was followed up through 6-monthly door-to-door surveys to generate epidemiologic data viz: demographic profiles, morbidities, and vital events including deaths and births. Later other studies were initiated , including clinical studies[2] in adults and children, studies of immunology, cytogenetics, cancer[8], and pregnancy outcome etc. Subsample of different studies were drawn from this cohort and formed a databases of clinical and other studies .There were many databases formed during three phases of studies time periods from 1985- 1994,1996-2010 and 2010-2015 respectively.

There are two major areas of databases pertaining to studies of the registered gas exposed individuals in Bhopal available viz, (i) Data base of the cohort and long term epidemiological studies containing details of all the registered 80021 gas exposed individuals and 15931 of unexposed control population (ii) Data base of Clinical studies having registered in cohort and taken as sub sample.

Clinical data base: The data base of 1985-2015 was considered in this study.

NIREH data base: A long term population based epidemiological study on a cohort of gas exposed survivors and unexposed individuals to document the consequences of gas exposure has been continuing since 1985 (1985 - 1994 under BGDRC of ICMR ; 1996 – 2010 under CRS, GOMP ; 2011 onwards under ICMR-NIREH), In this study questionnaire based morbidity and mortality of the individuals recruited in the cohort in 1985 was recorded at six monthly interval till today. However, since 2017 the frequency of survey has been changed to yearly, In 2017 during the 54h round of survey after data cleaning the actual size of the cohort available for follow up was 15,878 individuals (belonging to 6,251 families). Of this, 12,392 individuals (4,731 families) belonged to the exposed category (Severely exposed 4,194 individuals in 1,639 families; moderately exposed 4,531 individuals in 1,680 families and mildly exposed 3,667 individuals in 1,412 families) and 3,486 individuals (1,520

families) to unexposed category. The data belonging to the period of 1985-2015 of this study was considered in the present study.

Quantum of data : NIREH has got physical/computerized data related to following projects available with NIREH ; which was collected during 3 time periods/phases.

Sl.No.	Name of project	Status (quantum records/pages)	Linked status	Remarks
BGDRC (ICMR) DURING 1985 – 1994				
I	Clinical studies			
i)	Epidemiological study of long term effects of MIC gas on Respiratory System (Lung proforma)	7500	Yes	
ii)	Radiological Manifestations in the Skiagram of Chest and Follow-up Study of the MIC /Toxic Gas affected Population	7,500	Yes	
iii)	Mental health studies in MIC exposed population at Bhopal (1st rotational survey and follow up 1st, IInd and IIIrd rotational survey) Patient document file (case study)	3000 3000	Yes No	
iv)	Follow up studies on effects of MIC on children 0-5 years of	2638	Yes	

Sl.No.	Name of project	Status (quantum records/pages)	Linked status	Remarks
	MIC.			
v)	Study on Pulmonary effects of Toxic gas in children (6-15 years)	5201	Not linked	Name to be verified from original records
	Yearly follow up study (Phase II -B)	5000		
vi)	Epidemiological study on teratogenitic effects of MIC in exposed population at Bhopal.	5000	No	
vii)			No	
viii)	Study of ocular involvement in MIC gas affected population on long term basis.	8142	Yes	
Ix	Study on oral mucosal gingival and orodental anomalies in children whose mothers were exposed to MIC/Toxic gas during pregnancy.	5000	Not linked	
X	Genetic Risk Evaluation of MIC – Cytogenetic studies in population exposed to	1000 Lab + 1000	Yes	

Sl.No.	Name of project	Status (quantum records/pages)	Linked status	Remarks
	MIC at Bhopal – Proforma for clinical evaluation, Proforma for Laboratory results.	clinical		
II Epidemiological Studies				
i)	Long term epidemiological studies on the health effects of the Toxic Gas exposure through Community Health Clinics-)Family Index Card. (1985)	1,05,000	Yes	
ii)	Cohort Registration (1985)	3,80,000	Yes	
iii).	a)Socio Economic b) Eligible Female c)Outcomes of pregnancy record d) Death record e) Morbidity proforma f) Pregnancy Record 1986	1600000 512000 20000	Yes Yes Yes	

Sl.No.	Name of project	Status (quantum records/pages)	Linked status	Remarks
CRS (Gras Rahat Department M.P.) During 1995 – 2010				
a)	Epidemiological Studies Socio Economic b) Eligible Female c) Outcomes of pregnancy record d) Death record e) Morbidity proforma	1800000	Yes	
b)	Epidemiological Studies on cancer	1000	Yes	
c)	Water contamination studies	2000	Not linked	
d)	An Epidemiological Study of Symptomatic Morbidities in Communities Living Around Solar Evaporation Ponds And Behind Union Carbide Factory, Bhopal.	2000	Not linked	
e)	Epidemiological Symptomatic morbidities	2000	Not linked	
f)	Outcome of pregnancy record including congenital	5000	Not inked	

Sl.No.	Name of project	Status (quantum records/pages)	Linked status	Remarks
	malformation			
g)	Chronically ill patients	7800	Yes	
NIREH During 2011 – 2015				
a)	Epidemiological studies Socio Economic a) Socio Economic b) Eligible Female c) Outcomes of pregnancy record d) Death record e) Morbidity proforma	150000	Yes	
b)	Migration studies	1000	Yes	
c)	Congenital malformation	800	Yes	
d)	Mental health	1000	Yes	
e)	A study on the prevalence of morbidity of selected population/families with reference to drinking water	10827	Not linked	

Linking and data mining:

Data Mining and linking of BGDRC(ICMR),CRS(State Govt.) and NIREH databases, as mentioned above, was carried out to comprehend and document the existing status and pattern of morbidities, chronicity of diseases of the gas exposed survivors registered in cohort and present at home on 3rd December,1984 at the time of gas leak. These 93167 subjects were linked with BGDRC(ICMR) data base (1985-1994),CRS databases(1996-2010) and NIREH data bases (2011-2015) using unique ICMR number as the identifier.

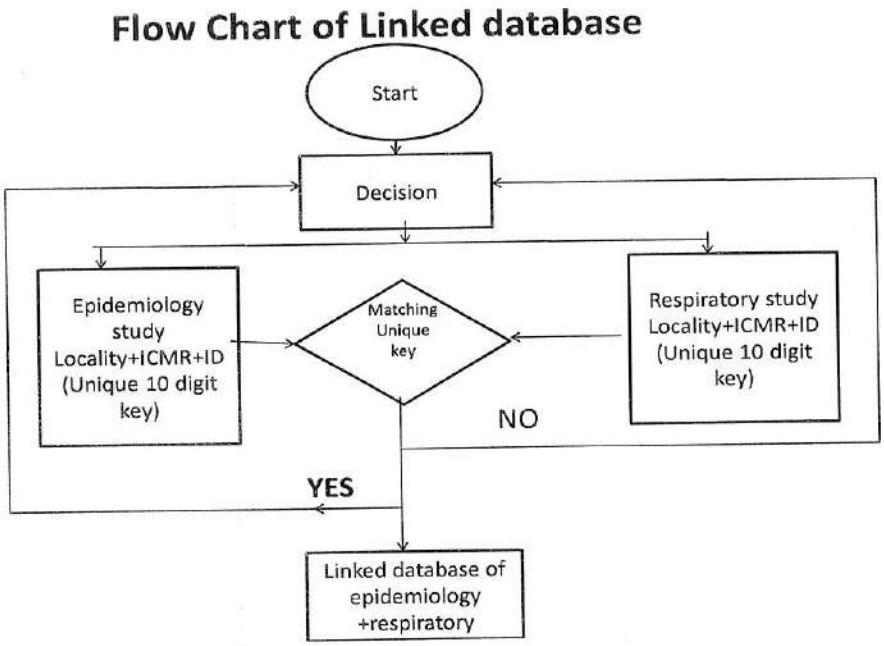
Steps in data linkage:

Discrepancies such as blank profile in the BGDRCs' CRSs' and NIREH's database were thoroughly checked and removed from analysis .From Clinicals' database, subject and from Cohorts' database, subjects were linked with Cytogenetics database. Once uniformity was achieved across the three databases, they were merged together to form a single master database. Master database consisted of 1000 fields which cover the following areas:

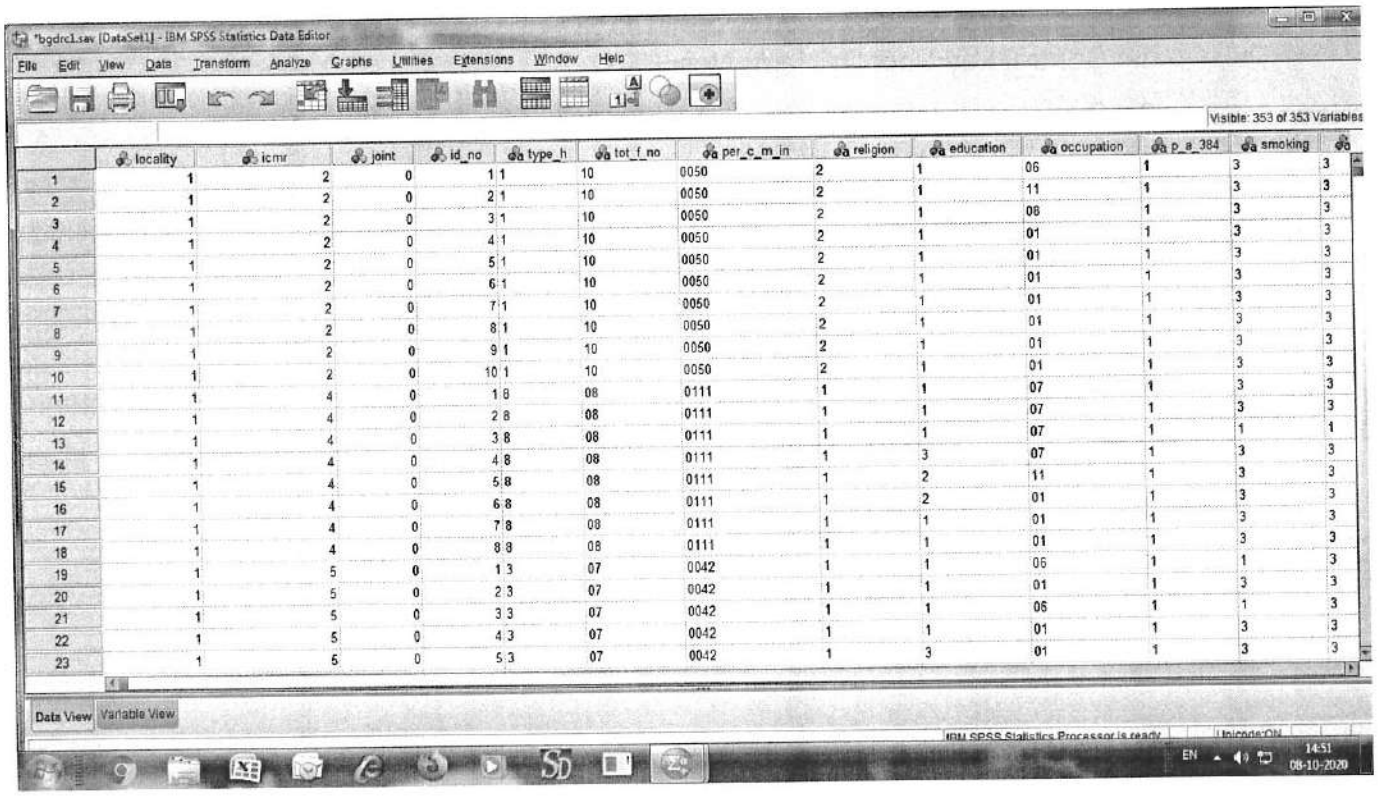
1- Control key(Locality+Icmr Nos,+ID)
2- Socio-economic variables
3- Follow-up of Morbidity and mortality variables for every 6 months(1984-2015)
4- Clinical Studies variables
5- Cytogenetics Study

This master database was further divided into three parts on the basis of intensity of exposure (subjects belonging to severely, moderately and mildly exposed areas) deciphered from the unique ICMR number or the address of the subjects.

Flow chart :



Snapshot of the master database:



A Comparative analyses of morbidity and mortality in original cohort and linked cohort population , covering following parameters will be done-

1. Morbidity status since 1985 to 2015
2. Mortality rate
3. Socio- economic and environmental variables and their effects on health and morbidity status
4. Cause of death
5. malformation
6. Sub sample for future studies.

In-depth data analysis will be carried out with the help of application and statistical softwares to understand the differences in morbidity and mortality patterns, if any, among linked cohort population and original cohort population.

Parameters of linkage analyses

Parameters in inclusion criterion for linkage sample frame

1. Since almost all the studies are being followed upon at specific intervals, like fort nightly, monthly ,3 monthly ,six monthly and once in a year owing to the identification numbers like locality number, ICMR family number and identity number of the individuals in their families, linkage of informations collected under different studies at different intervals may be establishes through the databases.

2. In case of hospital based studies ,individuals are first identified in the registered cohort by their names and address etc. and then only they can be linked.
3. Observations may be made through such type of linkages with the baseline data collected under present study to furnish information in relation to different socio-economic variables including history of gas exposure ,clinical parameters ,morbidity and mortality of the past studies.
4. Apart from lungs and eyes as the main organ system involved ,there has been evidence of widespread psychiatric problems amongst the affected population which be linked with longitudinal epidemiological study which is still continuing.
5. Under Teratogenic study majority of women who were exposed to the toxic gas during pre pregnancy were also identified in the main cohort.
6. Cyto-genetic study can also be linked to cohort based study.

Preliminary plan and strategies of linking of some of the parameters of studies

1. Chronic illnesses pertaining to respiratory system, G.I. system, eyes, and skin, as well as psychiatric disorders were recorded. Linkage of long term epidemiological study with their followed up from 1985 to 2015. Results may be generated for frequencies of contacted persons with their

morbidity, mortality analysis. Time trend analysis can also be done. Cancer cases in cohort may be explored.

2. Linkage of epidemiological parameters with clinical respiratory parameters like Fev, Fec and others will be carried out to know the chronic illness .
3. Ophthalmic abnormalities, including allergic conjunctivitis, chronic conjunctivitis, and corneal opacity were higher in the exposed population. Linkage of long term epidemiological study with ophthalmic study for variable like corneal opacity ,cataract, funds etc with morbidity variables and other clinical parameters may be carried out.
4. Linkage of psychiatric studies with long term epidemiological studies and analysis for frequencies distribution for both studies at 1985-1990 to 2010 for psychiatric illness.

Analysis:

Challenges faced during data linkage:

- Absence /lack of common unique identifier of the subject in the data bases was biggest stumbling block due to which 100% linkage could not be achieved.
- Massive data cleaning was required due to multiple errors in data entry in the database.
- Few clinical studies used their own numbers instead of common ICMR family numbers.

Result:-

Linkage Matrix:-

This study is attempting to link various available databases related to epidemiological, clinical, genetic and toxicological studies on gas exposed individuals, undertaken between 1985 and 2015, so as to assess the health status, prepare clinical profile and understand the disease pattern of gas exposed survivors. A linked databases containing profile of all registered cohort population from 1985 to 2015 is created. The linked cases from long term population bases epidemiological study with respiratory,ophthalmic radiology, genetic, mental and pediatrics study were found 6197,7529, 3824, 676, 14520, 475 respectively. All these database marged with cohort to formed master database.

Created Master Database with help of cohort and epidemiological and other studies during (1984-1994), (1995-2010) and (2011-2015):-

- Linkage between Psychiatric Patients with
  Morbidity of Epidemiological study = 14520.
- Linkage between medicine with
  Morbidity of Epidemiological study= 6197.
- Linkage between Ophthalmology with
  Morbidity of Epidemiological study= 7529
- Linkage between Radiology with.
  Morbidity of Epidemiological study= 3824.

- Linkage between Pediatrics with Morbidity of Epidemiological study= 475.
- Linkage between Genetics with Morbidity of Epidemiological study= 676.
- Chronically ill patient = 7800
- Chronically ill patient follow up = 1084
- Congenital malformation = 60
- Mental positive cases follow up = 403
- Linkage between Cancer with Morbidity of Epidemiological study= 49.

Table-1 Present status of main Linked Projects

Project No	Name	Population covered (1985-1990)	Data availability	Present status at 2019
02	Long term Epidemiological studies on the Health Effects of toxic gas exposure through Community Health Clinics	96513	Morbidity and mortality	13962
03	Epidemiological study of long term effects of toxic gas on respiratory system	6967	PFT and respiratory related	1137
05	Follow up studies of ocular changes in toxic gas affected population	8140	Ophthalmic	1324
10	Mental Health Studies in MIC/Toxic Gas Exposed Population at Bhopal	14802	Mental related	2971

Table-2 Main Projects Linkage Matrix
(Total cases)

Project no.	02	03	05	10
02	93137	6197	7529	14520
03	6197	6967	1201	350
05	7529	1201	8140	1375
10	14520	350	1375	14520

(b)- Mortality Analysis:

Mortality rate

The mortality rates were very high during the acute phase and later showed a decreasing trend with passage of time. The study reveals main cause of mortality among gas affected as well control areas as respiratory illness.

Death survival Analysis

Table-3

Exposure	Total N	No. of Deaths	Censored		Estimate	Std. Error	95% Confidence Interval	
			N	Percent			Lower Bound	Upper Bound
Severe	25003	1487	23516	94.1%	272.857	0.268	272.332	273.382
Moderate	33450	1723	31727	94.8%	274.114	0.212	273.699	274.530
Mild	18208	1200	17008	93.4%	272.635	0.303	272.042	273.228
Control	15666	793	14873	94.9%	275.304	0.276	274.763	275.845
Exposure	76661	4410	72251	94.2%	273.353	0.146	273.066	273.639
Overall	92327	5203	87124	94.4%	273.687	0.130	273.432	273.942

Figure -2

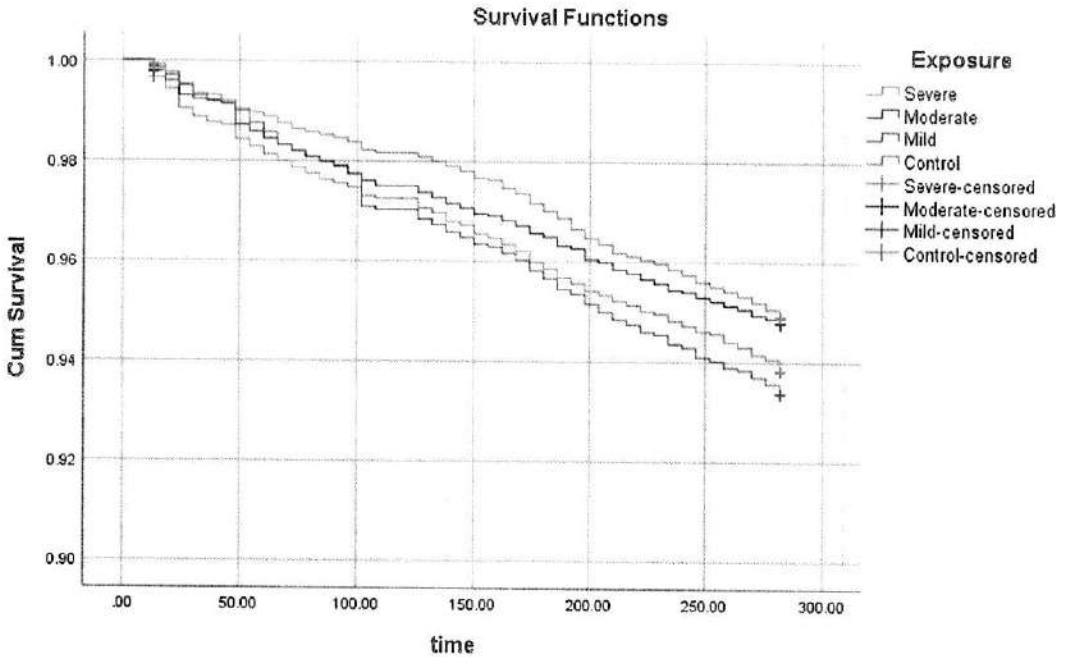
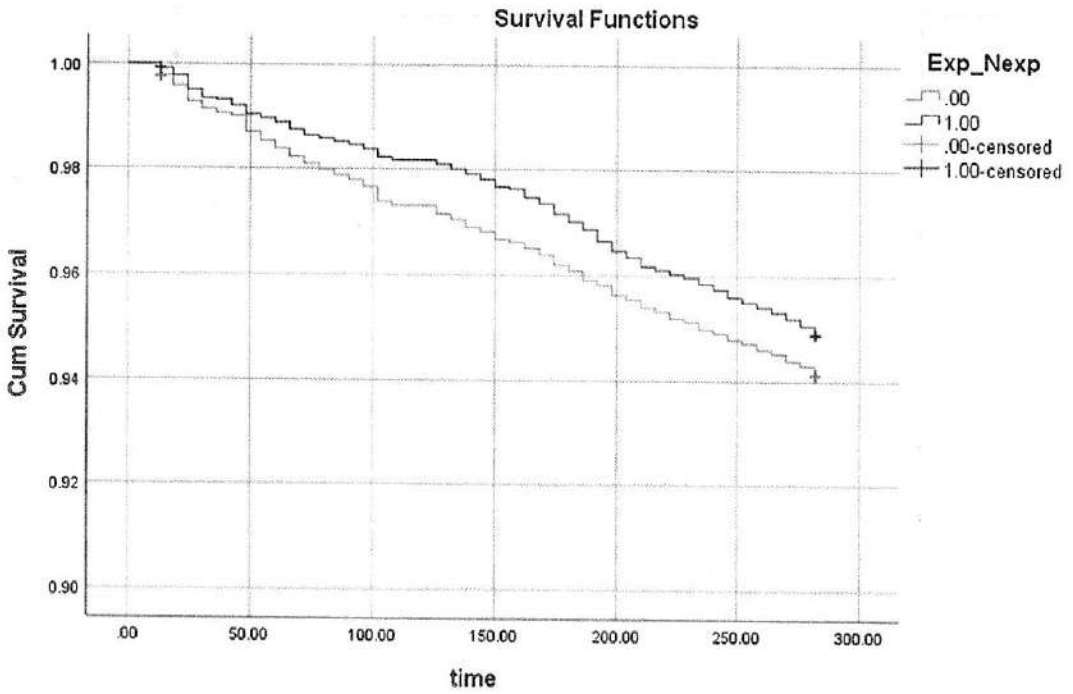


Figure -3



(b) Systemwise morbidity pattern:-

During the surveys information on morbidities were collected through a proforma enquiring about the forty symptoms.these symptoms forther re-grouped under the following systems:-

Symptoms (morbidities) with their codes(Annexure-I)

- Any morbidities- Overall morbidities(included all 40 symptoms)
- Respiratory - 1,2,3,4,5,28
- Ophthalmic - 19,20
- Gastro intestinal tract - 16,17,18,22,25,31,39
- Skin - 23
- Muscuskleton - 6,7,8,9
- Gyne - 30
- CNS - 10,11,12,36,38
- Others - 13,14,15, 21,24,29,26,27,29,33,34,35,37,40

Acute stage morbidities: During acute stage in all the three exposed areas 96-99% had both eyes and lung symptoms.

Chronic morbidities:

Respiratory Morbidities:-

i- **Respiratory morbidities:** During acute stage in affected area 96-98% people suffered with respiratory morbidities and since 1998 have remained below 20% till 2015.

ii- **Respiratory morbidities with durations of illness:**-Duration of illness of respiratory morbidities were increased in the follow up of cohort from 1986 to 2010. During the surveys information on duration of illness were collected through a performa enquiring about the symptom in months and days. These duration of illness were further regrouped under the categories of < 78 months as 2 , >78 and <86 months as 3 and >86 months as 4 respectively. It was revealed from table-1 that percentages

of duration of illness increased in categories 4(>86 months) in 2010 from percentages in 1986 in severe area 90% , in moderate areas49%, mild areas 98% as compared to control areas19 %.

Table-4 Lung Morbidity with duration of illness
(1986 – 2010)

			Duration of Illness		
SEVERE	YEAR	Total Case	S<78 Months	78-86 Months	> 86 Months
	1986	2505	1253(50.1%)	1252(49.9%)	0
	1991	1635	1056(64.6%)	509(31.1%)	70(4.3%)
	1996	2207	569(26.8%)	70(3.2%)	1568(71.1%)
	2010	978	93(9.6%)	07(0.4%)	881(90.1%)
Modeare	1986	1982	695(35.1%)	1287(64.9%)	0
	1991	2012	1595(79.3%)	390(19.4%)	28(1.4%)
	1996	2402	526(30.1%)	10(0.4%)	1367(56.9%)
	2010	641	327(51.0%)	02(0.3%)	313(48.8%)

Lung Morbidity with duration of illness
(1986 – 2010)

			Duration of Illness		
Mild	YEAR	Total Case	S<78 Months	78-86 Months	> 86 Months
	1986	658	506(76.9%)	152(23.1%)	0
	1991	1167	894(76.6%)	267(22.9%)	06(0.5%)
	1996	1568	234(14.9%)	18(1.2%)	1316(83.9)%)
	2010	608	13(2.1%)	01(0.2%)	594(97.7%)
Control	1986	196	49(25.0%)	147(75.0%)	0
	1991	718	627(87.3%)	69(9.6%)	23(3.2%)
	1996	349	295(84.5%)	01(0.3%)	53(15.2%)
	2010	147	119(80.9%)	00(0.%)	28(19.1%)

Ophthalmic morbidities: were seen in 98-99% of the affected population during acute stage.This proportion came down to less than 16% in affected area in 1996 and since 1999 have remained under 20% till 2010.

Gastrointestinal tract morbidities:

Which started with 74,26 and 15% in severely,moderately and mildly affected area respectively during acute stage came down to less than 8% in affected area by 1991 and since then have remained under same till 2010 with occasional slightly higher peaks in all area.

Skin morbidities : showed consistent pattern of less than 2% in all areas in all times.

Muscuskleton morbidities: showed consistent pattern of less than 3% in severe ,moderate and control except mild area were less than 6% in all times.

Table- 5 Musculoskeletal MORBIDITY STATUS YEAR WISE (1986 – 2010)

YEAR	POP. SEVERE	SEVERE	POP. MOD	MODERATE	POP. MILD	MILD	POP. CONT	CONTROL
1986		470		257		171		33
1991	8070	191 (2.4%)		187 (1.4)		372 (5.4)		125 (1.6)
1996	10816	278 (2.6%)		383 (2.7)		422 (4.4)		103 (1.3)
2001	6895	204 (3.0%)		176 (1.8)		277 (4.5)		64 (1.3)
2006	4961	112 (2.3%)		101 (1.7)		279 (5.8)		98 (1.8)
2010	5658	128 (2.3%)		171 (2.6)		198 (4.3)		121 (2.1)

Gyne related morbidity: showed consistent pattern of less than 1% in all areas in all times.

Table -6 GYNE MORBIDITY STATUS YEAR WISE
(1986 – 2010)

YEAR	SEVERE	%	MODERATE	%	MILD	%	TOTAL	%	CONTROL	%
1986	39	0.46	12	0.09	06		57		01	
1991	37	0.31	52	0.40	59	0.85	148		43	0.54
1996	34	0.29	13	0.10	22	0.23	69		14	0.18
2001	20	0.02	15	0.25	07	0.11	42		03	0.06
2006	01		06	0.10	19	0.40	26		01	0.02
2010	04	0.07	14	0.21	04	0.09	22		05	0.09

CNS related morbidity: During in 1991,9.0%,8.4%,and 7.5% suffered with CNS related morbidity in severely, moderately and mildly affected areas in comparison to 5.5% in control area. These CNS morbidity rates remained high in all affected areas(4.0%-13.3%) in comparison to control area(1.1%-5.5%)) throughout 1991-2010.

Table-7 CNS MORBIDITY STATUS YEAR WISE
(1986 – 2010)

YEAR	POP. SEVERE	SEVERE	POP. MOD	MODERATE	POP. MILD	MILD	POP. CONT	CONTROL
1986		234		116		82		03
1991	8070	728 (9.0%)	13150	1101 (8.37%)	6952	517 (7.43%)	7911	436 (5.51%)
1996	10816	985 (9.10%)	14137	562 (3.97%)	9527	241 (2.50%)	7990	220 (2.75%)
2001	6895	709 (10.28%)	9792	676 (6-90%)	6176	451 (7.30%)	5133	85 (1.65%)
2006	4961	659 (13.28%)	5834	402 (6.89%)	4814	464 (9.63%)	5338	97 (1.81%)
2010	5658	539 (9.53%)	6533	439 (6.71%)	4669	448 (9.59%)	5741	65 1.13%)

Other morbidity: In the severe area, the other morbidity was higher in all the follow-up periods compared to other two exposed and control area. These rates have been fluctuating between 6.8%-13.4% in severely affected area, between 3.9%-12.2% in moderately affected area and 1.4%-11% in mildly affected area in comparison to 3.4%10.3% in control area during 1991-2010.

Table-8 OTHER MORBIDITY STATUS YEAR WISE (1986 – 2010)

YEAR	POP. SEVERE	SEVERE	POP. MOD	MODERATE	POP. MILD	MILD	POP. CONT	CONTROL
1986		567		557		156		159
1991	8070	1083 (13.42%)	13160	1609 (12.23%)	6952	770 (11.07%)	7911	821 (10.37%)
1996	10816	745 (6.89%)	14137	560 (3.96%)	9527	247 (2.59%)	7990	345 (4.31%)
2001	6895	471 (6.83%)	9792	533 (5.44%)	6176	133 (2.15%)	5133	176 (3.42%)
2006	4961	514 (10.36%)	5834	291 (4.98%)	4814	77 (1.59%)	5338	192 (3.59%)
2010	5658	460 (8.13%)	6533	531 (8.12%)	4669	66 (1.41%)	5741	220 (3.83%)

(c) – Linked Clinical studies with cohort :-

Mental Health:-

Methodology:

In September 2011, the decision to understand the continuing psychiatric morbidity in the Bhopal population through home visit follow-up of the patients identified during the 1985-1994 survey for psychiatric disorders was taken. Of the total of 474 psychiatry patients, 90 patients were contacted by the research staff. Of the rest, the research staff reported that 82 had died, 280 had migrated and 22 could not be seen personally during their visits. The clinical evaluation was carried out by personal home visits and review of the treatment records, clinical interview and information from the family members by Prof. Srinivasa Murthy, retired Professor of Psychiatry, along with the respective research assistant and the ARO(Doctor).

Results:

In depth study

Table 9 describes the results of the follow up work in terms of the contact details and tracing of the ill individuals.

Table -9 Analysis of follow up evaluation of psychiatric patients through linkage:

Follow up of Psychiatric patients(474 cases)

Total number of Psychiatric patients (Mental health project1985-1992)	Persons contacted in year 2012		Persons could not be contacted because of			
			Migration		Death	
474	90(19%)		302(63.7%)		82(17.2%)	
	Affected	Control	Affected	Control	Affected	Control
	74	16	283	19	73	09

Findings on evaluation with regard to the follow up clinical status is presented in Table 10.

Table10: FOLLOW UP EVALUATION OF PSYCHIATRIC PATIENTS

	CLINICAL CONDITION	TOTAL	AFFECTED	CONTROL
a.	Completely well and not under treatment	15	05	10
b	Completely well and under treatment	08	06	02
c	Under treatment but not recovered	57	55	02
d.	Not under treatment but took treatment in the past	10	8	02
Total		90	74	16

Table 11: Type of treatment utilised (N=90)

	TYPE OF TREATMENT	TOTAL* N=90	AFFECTED* N=74	CONTROL* N=16
1.	Allopathic Treatment	73	67	06
2.	Ayurvedic Treatment	20	19	01
3.	Traditional Treatment	02	01	01
4.	Religious Treatment	03	02	01
5.	No Treatment	05	02	03
6.	Others	06	06	00
	TOTAL	109	97	12

*Multiple responses

Table 12: Expressed needs of the patients (N=90)

NEED		TOTAL* N=90	AFFECTED* N=74	CONTROL* N=16
Treatment	-	74 (82%)	59(80%)	15(94%)
Finance	-	70(78%)	55(75%)	15(94%)
Employment	-	55(61%)	43(58%)	12(75%)
Housing	-	52(58%)	38(52%)	14(88%)
Sanitation / Water Supply	-	64(71%)	51(69%)	13(81%)
Transportation	-	63(70%)	49(67%)	14(88%)
security	-	36(40%)	24(33%)	12(75%)
Other Facility	-	04(05%)	04(06%)	00(00%)

*Multiple responses
(In %)

Table13: Expressed needs of the family members

NEED	TOTAL*	AFFECTED*	CONTROL*	
		N=90	N=74	N=16
Treatment		73(81%)	57(77%)	16(100%)
Finance		77(86%)	61(83%)	16(100%)
Employment		66(74%)	51(69%)	15(94%)
Housing		51(57%)	37(50%)	14(88%)
Sanitation / Water Supply		66(74%)	51(69%)	15(94%)
Transportation		62(69%)	47(64%)	15(94%)
Security		41(46%)	28(38%)	13(81%)
Family Problem		33(37%)	28(38%)	05(31%)
Other Facility		03(04%)	03(04%)	00(00%)

*Multiple responses
(In %)

474 positive psychiatric cases in mental health project(1985-1992) linked with cohort- 1985.Out of 474 psychiatric cases, only 90 cases could be linked with psychiatric cases(2012), out of which 41 cases had anxiety disorder,44 cases had neurotic depression relate to mental health project(1985-1992).

Linkage with cohort and epidemiological study

Table 14. Contacted

Diagnosis	Total	Affected	Control
Anxiety	41	36	5
Dep. Neuro	44	35	9
Psychosis	3	2	1
Others	2	1	1
Total	90	74	16

Table 15

Linkage between Psychiatric Patients(90) with Morbidity of Epidemiological study

CONTROL

YEARS	1996		2001		2006		2010	
	MORBID	%	MORBID	%	MORBID	%	MORBID	%
LUNG	2	40.00%	1	14.29%	5	50.00%	8	53.00%
EYE	1	20.00%	0	0.00%	6	60.00%	9	60.00%
GIT	0	20.00%	0	0.00%	2	20.00%	1	6.67%
SKIN	0	0.00%	0.00%	0.00%	0	0.00%	0	0.00%
MORBID-POP	2	40.00%	1	14.29%	7	70.00%	10	66.67%
POPULATION CO	5		7		10		15	

Table 16

Linkage between Psychiatric Patients(90) with Morbidity of Epidemiological study

CONTROL

YEARS	1996		2001		2006		2010	
	MORBID	%	MORBID	%	MORBID	%	MORBID	%
LUNG	2	40.00%	1	14.29%	5	50.00%	8	53.00%
EYE	1	20.00%	0	0.00%	6	60.00%	9	60.00%
GIT	0	20.00%	0	0.00%	2	20.00%	1	6.67%
SKIN	0	0.00%	0.00%	0.00%	0	0.00%	0	0.00%
MORBID-POP	2	40.00%	1	14.29%	7	70.00%	10	66.67%
POPULATION CO	5		7		10		15	

Table 17

Linkage between Psychiatric Patients(90) with Morbidity of Epidemiological study

AFFECTED

YEARS	1996		2001		2006		2010	
	MORBID	%	MORBID	%	MORBID	%	MORBID	%
LUNG	30	46.88%	10	23.26%	10	26.32%	20	38.46%
EYE	25	39.06%	14	32.56%	15	39.47%	25	48.08%
GIT	8	12.50%	9	20.93%	10	26.32%	10	19.23%
SKIN	0	0.00%	0.00%	0.00%	0.00%	0.00%	1	1.92%
MORBID-POP	48	75.00%	24	55.81%	22	57.89%	30	57.69%
POPULATION CO	64		43		38		52	

Linkage of respiratory study with epidemiological study

Table 18

Linkage of respiratory study *with epidemiological study	
Area	No. of cases linked
Severe	1897
Moderate	2130
Mild	473
Total Affected	4500
Control	1697
Grand Total	**6197**

*Respiratory Epidemiology of MIC/Toxic gas affected population
Study Period 1985 -1988

Table 19

Linkage between cases of Respiratory study with Morbidity of Epidemiological study

Control Area

	1996		2001		2006		2011	
Year	Morbid	%	Morbid	%	Morbid	%	Morbid	%
Lung	85	7.7	31	4.6	51	7.5	43	5.8
Eye	82	7.4	42	6.3	74	10.9	71	9.5
Git.	52	5	21	3.2	21	3.1	31	4.2
Any Morbidity	210	18.9	101	15.1	143	20.9	151	20.2
Population	1107		671		683		747	

4500(abnormal PFT= 2695)cases from affected areas and 1697(abnormal PFT=339) cases from control areas and any morbidity(28%-36%) in affected areas, any morbidity(16-19%) in control areas have been matched based on cohort and respiratory study.

(d)- Clinically available information in master database:- Important clinical information like X-rays,FVC,FEV etc are available in master database.

Discussion:-

Survivors of the Bhopal toxic gas accident have been experiencing long term health consequences of exposure of gases. There is no systematic documentation of various morbid conditions the survivors are suffering. Studies related to Gas victim's data are not adequately linked to each other resulting in availability of fragmented information without much clarity. Though the clinical examination of gas survivors is the best and direct way to elucidate the information on their current health problems

yet the present study was undertaken to achieve this goal by linking the secondary information available in the form of major data bases related to the studies of health of the gas exposed survivors. After exposure to the mixture of toxic gases the initial symptoms developed in the exposed individuals were breathlessness, burning sensation in the eyes among others. After over three decades of Bhopal gas accident the population of the survivors has grown older over the period of time and so the disease profile and chronicity have changed. In fact the age of the youngest survivor is now over 35 years. As the years have progressed, the chronicity of the ailments has also increased many folds, However, it is difficult to ascribe the present spectrum of diseases being faced by the gas survivors exclusively to the ill effects of the gas exposure that occurred over 35 years ago. There might be many confounding factors like levels of pollution, waning immunity in the geriatric population, changes in life style, age etc. contributing to the present chronic diseases being experienced by the gas survivors.

Final Expected Outcome:

- A comprehensive data base and a ,data repository will be developed for future research.
- Morbidity and mortality pattern of linked cohort population will be known.
- Multi system involvement may be assessed.

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