Table 2 Continued

	Chemical or industrial process	Humans: Main type of exposure[a]	Humans: Target organ	Humans: Main route of exposure[b]	Animals: Animal	Animals: Target organ	Animals: Route of exposure
13	Cyclophosphamide	Medicinal	Bladder	p o , injection	Mouse	Hemopoietic system, lung	i p s c injection
						Various sites	p o
					Rat	Bladder[c]	i p
						Mammary gland	i p
						Various sites	i v
14	Diethylstilbestrol	Medicinal	Uterus, vagina	p o	Mouse	Mammary	p o.
					Mouse	Mammary, lymphoreticular testis	s c injection s c implantation
						vagina	Local
					Rat	Mammary, hypophysis bladder	s c implantation
					Hamster	Kidney	s c injection, s c implantation
					Squirrel monkey	Uterine serosa	s c implantation
15	Hematite mining (? radon)	Occupational	Lung	Inhalation	Mouse, hamster, guinea pig	Negative	Inhalation i t
					Rat	Negative	s c injection
16	Isopropyl oils	Occupational[c]	Nasal cavity, larynx	Inhalation	No adequate tests		
17	Melphalan	Medicinal	Hemopoietic system	p o , injection	Mouse	Initiator	Skin
						Lung, lymphosarcomas	i p
					Rat	Local	i p
18	Mustard gas	Occupational	Lung, larynx	Inhalation	Mouse	Lung	inhalation i v
						Local mammary	s c injection
19	2-Naphthylamine	Occupational[c]	Bladder	Inhalation, skin, p o.	Hamster, dog, monkey	Bladder	p o
					Mouse	Liver, lung	s c injection
					Rat, rabbit	Inadequate	p o
20	Nickel (nickel refining)	Occupational	Nasal cavity, lung	Inhalation	Rat	Lung	Inhalation
					Mouse, rat hamster	Local	s c , i m injection
					Mouse, rat	Local	i m implantation
21	*N,N*-Bis(2-chloroethyl)-2-naphthylamine	Medicinal	Bladder	p o	Mouse	Lung	i p
					Rat	Local	s c injection
22	Oxymetholone	Medicinal	Liver	p o	No adequate tests		
23	Phenacetin	Medicinal	Kidney	p o	No adequate tests[d]		
24	Phenytoin	Medicinal	Lymphoreticular tissues	p o , injection	Mouse	Lymphoreticular tissues	p.o., i p.
25	Soot, tars, and oils	Occupational, environmental	Lung, skin (scrotum)	Inhalation, skin	Mouse rabbit	Skin	Topical
26	Vinyl chloride	Occupational[c]	Liver, brain,[c] lung[c]	Inhalation, skin	Mouse, rat	Lung liver, blood vessels mammary, Zymbal gland, kidney	Inhalation

[a] The main types of exposures mentioned are those by which the association has been demonstrated, exposures other than tho mentioned may also occur

[b] The main routes of exposure given may not be the only ones by which such effects could occur

[c] Indicative evidence

[d] The induction of tumors of the nasal cavities in rats given phenacetin has been reported recently (S Odashima, person communication, 1977)

nary tumors in rats The causative agent in hematite mining has not been identified, and the role of radon is suspected Ferric oxide was not carcinogenic in mice, guinea pigs, or hamsters when given by inhalation or intratracheally.

Correlations between human and animal data should be somewhat easier for the remaining 21 compounds, because in most of these cases a single identified chemical is involved. One notable exception, however, is arsenic compounds Occupational exposure or exposure of the general population to drinking water containing high levels of arsenic or to arsenic-containing drugs is associated with the occurrence of skin cancer, while lung cancer is also associated with occupational exposure. No definite carcinogenic effect has been observed in the available results from experimental studies.

For 5 of the remaining 20 compounds, namely, benzene, chloramphenicol, isopropyl oil, oxymetholone, and phenacetin, no adequate carcinogenicity tests were available for evaluation at the time that the monographs were prepared However, recent unpublished results indicate that phenacetin is carcinogenic in rats (S. Odashima, personal communication, 1977). The other 15 compounds were carcinogenic in at least one, but mostly in more than one, animal species.

Comparison between target organs in humans and animals confirms that the carcinogens have, in some cases, the same organ specificity in humans as that in experimental animals In most cases, the chemicals were tested in more than one animal species, but the similarity in organ specificity may be limited to only one of the animal species tested The chances for similar target organs are apparently greater if similar routes of exposure are used (Table 2). However, chemicals that were found to be carcinogenic in both humans and animals were carcinogenic in the latter also when administered by routes different from the one by which humans are exposed The target organs in animals are more often multiple than in humans.

The evaluation of the carcinogenic risk to humans of these 26 chemicals or processes was based on evidence provided by epidemiological studies or case reports, and experimental evidence of carcinogenicity was not used in the formulation of the evaluation For several chemicals (aflatoxin, 4-aminobiphenyl, bis(chloromethyl) ether, diethylstilbestrol, melphalan, mustard gas, and vinyl chloride), experimental evidence of carcinogenicity preceded human evidence and a similar effect in humans could have been predicted The case of bis(chloromethyl) ether is slightly different from the others The first observations in humans, indicating an unusual clustering of lung cancer in occupationally exposed workers, were made as early as 1962 (45, 46) Evidence of a carcinogenic effect in animals was first published in 1968 and preceded the publication of the first 2 epidemiological studies, which appeared in 1973 (25)

Chemicals Carcinogenic to Experimental Animals. While in 1968 it was considered that lists of carcinogens should not be prepared without an in-depth evaluation of the available evidence, which differs both quantitatively and qualitatively from compound to compound, an attempt is now made to separate chemicals evaluated in the first 16 volumes of the IARC monographs into those for which some evidence of carcinogenicity in experimental animals was found and those for which the data were judged inadequate for evaluation

Of the 368 chemicals evaluated in Volumes 1 to 16 of the monographs, the 26 associated with cancer induction in humans have been referred to previously For 221 of the remaining 342 (Table 3), some evidence of carcinogenicity in 1 or more animal species was found. It should be stressed that for these chemicals (marked with an asterisk) no attempt was made to distinguish between those for which "strong evidence" and "weak evidence of carcinogenicity, following the criteria discussed in the last part of this paper, existed or those for which additional confirmatory carcinogenicity studies are needed For the majority of these chemicals, evidence of human exposure exists but no evaluation of the carcinogenic risk to humans was made, either because no epidemiological studies or case reports were available (205 compounds) or because the results were inconclusive. (Some case reports were available for 7 compounds. BHC/lindane, carbon tetrachloride, chlorambucil, dimethyl sulfate, iron dextran, tris(aziridinyl)-*p*-benzoquinone and tris(1-aziridinyl)phosphine sulfide. Results of some epidemiological studies were available for 9 compounds. amitrole, beryllium compounds, DDT, dieldrin, dimethylcarbamoyl chloride, isoniazid, lead salts, phenobarbital, *N*-phenyl-2-naphthylamine.)

For the remaining 121 chemicals, the available studies were inadequate to make an evaluation of the presence or absence of a carcinogenic effect in animals or humans.

Conclusions and Discussion

For 26 chemicals (or industrial processes) of the 368 evaluated in the first 16 volumes of the IARC monographs, an evaluation was made of the positive association between exposure and occurrence of cancer in humans (Table 2) In these cases, the presence or absence of evidence of carcinogenicity in test animals was not used in the formulation of the evaluations as is shown, for instance, for benzene and arsenic compounds One important lesson from these human carcinogens is that experimental evidence has in some cases preceded human evidence, and a similar effect in humans might have been predicted.

For 221 of the 368 chemicals evaluated in the 16 monograph volumes, some evidence of carcinogenicity was found in at least 1 experimental animal species (Table 3) Humans are or can be exposed to the majority of these chemicals In some instances, results of epidemiological studies or case reports were available but provided insufficient evidence on which to base an evaluation In most instances, however, epidemiological studies or case reports were not available (the general scarcity of epidemiological studies noted throughout the monograph program must be stressed) In no case was an attempt made to interpret animal data directly in terms of human risk or in terms of the degree of carcinogenicity evidence provided by the experimental data However, a large number of food additives, pesticides, and herbicides have been reviewed for their toxicity by national and international agencies, and for a number of them the experimental evidence of carcinogenicity was considered sufficient to issue specific regulations or recommendations (39, 47) Therefore, insofar as

Table 3

List of chemicals for which there is some evidence of carcinogenicity in experimental animals only or for which the data were inadequate for evaluation of the presence or absence of carcinogenicity (IARC monographs, Volumes 1 to 16

For the 26 compounds evaluated as carcinogenic to humans, see Table 2

1 Acetamide[a,n]
2. Acridine orange
3. Acriflavinium chloride
4. Actinomycins*
5. Adriamycin
6 Aldrin
7. Amaranth
8. 5-Aminoacenaphthene
9. *p*-Aminoazobenzene*
10 o-Aminoazotoluene*
11 *p*-Aminobenzoic acid
12. 2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole*
13. 4-Amino-2-nitrophenol
14. Amitrole*
15. Aniline
16 Anthranilic acid
17. Apholate
18. Aramite*
19 Arsenic trioxide
20 Aurothioglucose*
21 Azaserine*
22. Aziridine*
23. 2-(1-Aziridinyl)-ethanol*
24. Aziridyl benzoquinone*
25 Azobenzene*
26. Barium chromate
27. Benz(a)acridine*
28. Benz(c)acridine*
29. Benzo(*b*)fluoranthene*
30. Benzo(*j*)fluoranthene*
31. Benzo(a)pyrene*
32 Benzo(e)pyrene*
33. Benzyl chloride*
34. Benzyl violet 4B*
35. Beryllium*
36. Beryllium oxide*
37. Beryllium phosphate*
38. Beryllium sulfate*
39. Beryl ore*
40. BHC (technical grades)*
41. Bis(1-aziridinyl)-morpholinophosphine sulfide*
42 Bis(chloroethyl) ether*
43 1,2-Bis(chloromethoxy)ethane*
44 1,4-Bis(chloromethoxymethyl)-benzene*
45. Blue VRS*
46. Brilliant blue FCF*
47. 1,4-Butanediol dimethane-sulfonate (Myleran)*
48 *β*-Butyrolactone*
49 *γ*-Butyrolactone
50 Cadmium acetate*
51 Cadmium chloride*
52. Cadmium powder*
53. Cadmium sulfate*
54 Cadmium sulfide*
55. Calcium arsenate
56 Calcium chromate*
57 Cantharidin*
58 Carbaryl
59 Carbon tetrachloride*
60. Carmoisine
61 Catechol
62 Chlorambucil*
63 Chlorinated dibenzodioxins
64 Chlormadinone acetate*
65 Chlorobenzilate*
66. Chloroform
67. Chloropropham
68. Chloroquine
69 *p*-Chloro-o-toluidine (hydrochloride)
70. Cholesterol
71. Chromic chromate*
72. Chromium acetate
73 Chrysene*
74 Chrysoidine*
75 C.I Disperse Yellow 3
76. Cinnamyl anthranilate
77. Citrus red No 2*
78. Copper 8-hydroxyquinoline
79 Coumarin*
80 Cycasin*
81 Cyclochlorotine*
82 2,4-D and esters
83 Daunomycin*
84. D & C Red No. 9
85. Dichlorodiphenyldichloroethane (DDD)
86. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene (DDE)
87. DDT*
88. Diacetylaminoazotoluene
89 *N,N*-Diacetylbenzidine*
90 Diallate*
91 2,4 Diaminoanisole (sulfate)
92 4,4'-Diaminodiphenyl ether*
93 1,2-Diamino-4-nitrobenzene
94. 1,4-Diamino-2-nitrobenzene
95 2,6-Diamino-3-(phenylazo)-pyridine (hydrochloride)
96 2,4-Diaminotoluene*
97 2,5-Diaminotoluene (sulfate)
98 Diazepam
99 Diazomethane*
100 Dibenz(a,h)acridine*
101 Dibenz(a,j)acridine*
102 Dibenz(a,h)anthracene*
103 Dibenzo(c,g)carbazole*
104 Dibenzo(*h,rst*)pentaphene*
105 Dibenzo(a,e)pyrene*
106. Dibenzo(a,*h*)pyrene*
107 Dibenzo(a,*i*)pyrene*
108 Dibenzo(*a,l*)pyrene*
109 1,2-Dibromo-3-chloropropane*
110. Dibutylnitrosamine*
111. o-Dichlorobenzene
112. *p*-Dichlorobenze
113 3,3'-Dichlorobenzidine*
114 *trans*-Dichlorobutene
115. 3,3'-Dichloro-4,4'-*diamino*-diphenyl ether*
116. Dieldrin*
117. Diepoxybutane*
118 1,2-Diethylhydrazine*
119 Diethylnitrosamine*
120 Diethyl sulfate*
121. Diglycidyl resorcinol ether
122 Dihydrosafrole*
123 Dimethisterone
124 Dimethoxane*
125 3,3'-Dimethoxybenzidine*
126 *p*-Dimethylaminoazobenzene*
127. *p*-Dimethylaminobenzenediazo-sodium sulfonate
128 *trans*-2-[(Dimethylamino)methylamino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole*
129 3,3'-Dimethylbenzidine*
130 Dimethylcarbamoyl chloride*
131. 1,1-Dimethylhydrazine*
132 1,2-Dimethylhydrazine*
133 Dimethylnitrosamine*
134 Dimethyl sulfate*
135 Dinitrosopentamethylenetetramine
136 1,4-Dioxane*
137. 2,4'-Diphenyldiamine
138 Disulfiram
139 Dithranol*
140 Dulcin
141 Endrin
142 Eosin (disodium salt)
143 Epichlorohydrin*
144 1-Epoxyethyl-3,4-epoxycyclohexane*
145 3,4-Epoxy-6-methylcyclohexylmethyl-3,4-epoxy-6-methyl carboxylate*
146 *cis*-9,10-Epoxystearic acid
147 Estradiol mustard*
148 Ethinylestradiol*
149 Ethionamide*
150 Ethylene dibromide*
151 Ethylene oxide
152 Ethylene sulfide*
153 Ethylenethiourea*
154 Ethyl methanesulfonate*
155 Ethyl Selenac
156 Ethyl Tellurac
157 Ethynodiol diacetate*
158 Evans blue*
159 Fast green FCF*
160. Ferbam
161 2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole*
162. Fusarenon-X
163 Glycidaldehyde*
164 Glycidyl oleate
165 Glycidyl stearate
166 Griseofulvin*
167 Guinea green B*
168 Heptachlor
169 Hexamethylphosphoramide*
170. Hycanthone (mesylate)*
171. Hydrazine*
172. Hydroquinone
173. 4-Hydroxyazobenzene
174 8-Hydroxyquinoline
175 Hydroxysenkirkine
176 Indeno(1,2,3-*cd*)pyrene*
177 Iron dextran*
178 Iron dextrin*
179 Iron oxide
180 Iron-sorbitol-citric acid complex
181 Isatidine*
182 Isonicotinic acid hydrazide*
183 Isopropyl alcohol
184 Isosafrole*
185 Jacobine
186 Lasiocarpine*
187 Lead acetate*
188. Lead arsenate
189 Lead carbonate
190 Lead chromate
191 Lead phosphate*
192 Lead subacetate*
193. Ledate
194 Light green SF*
195 Lindane*
196 Luteoskyrin*
197 Magenta*
198 Maleic hydrazide*
199. Maneb
200 Mannomustine (dihydrochloride)*
201 Medphalan
202 Medroxyprogesterone acetate*
203 Merphalan[a]
204. Mestranol*
205 Methoxychlor
206 2-Methylaziridine
207 Methylazoxymethanol acetate*
208 Methyl carbamate
209 *N*-Methyl-*N*,4-dinitrosoaniline*
210 4,4'-Methylenebis(chloroaniline)*
211. 4,4'-Methylenebis(methylaniline)*
212 4,4'-Methylenedianiline
213. Methyl iodide*
214 Methyl methanesulfonate*
215 *N*-Methyl-*N'*-nitro-*N*-nitrosoguanidine*
216. Methyl red
217 Methyl Selenac
218 Methylthiouracil*
219 Metronidazole*
220 Mirex*
221 Mitomycin C*
222. Monocrotaline*
223 Monuron*
224 5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)-amino]-2-oxazolidinone
225. 1-Naphthylamine
226. Native carrageenans*
227 Nickel carbonyl
228 Nickelocene*
229 Nickel oxide*
230 Nickel powder*
231 Nickel subsulfide
232 Niridazole*
233 5-Nitroacenaphthene*
234 4-Nitrobiphenyl
235 Nitrofuraldehyde semicarbazone
236 1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone
237 *N*-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide*

Table 3—Continued

238	Nitrogen mustard (hydrochloride)*	261	Phenoxybenzamine*	279	Propylthiouracil*	304	Succinic anhydride*		benzoquinone*
239	Nitrogen mustard *N*-oxide (hydrochloride)*	262	Phenylbutazone	280	Pyrimethamine*	305	Sudan I*	326	Tris(1-aziridinyl)-phosphine oxide
40	Nitrosoethylurea*	263.	*m*-Phenylenediamine (hydrochloride)	281	*p*-Quinone	306	Sudan II*	327	Tris(1-aziridinyl)-phosphine sulfide*
41	Nitrosomethylurea*	264	*p*-Phenylenediamine (hydrochloride)	282	Quintozene*	307.	Sudan III	328	2,4,6-Tris(1-aziridinyl)-*s*-triazine*
242	*N*-Nitroso-*N*-methylurethan*	265.	*N*-Phenyl-2-naphthylamine*	283	Reserpine	308.	Sudan brown RR	329	1,2,3-Tris(chloromethoxy)-propane*
243	Norethisterone*	266	Polychlorinated biphenyls*	284	Resorcinol	309	Sudan red 7B	330	Tris(2-methyl-1-aziridinyl)phosphine oxide
244	Norethisterone acetate*	267	Ponceau MX*	285	Reforsine*	310	Sunset yellow FCF	331	Trypan blue*
245	Norethynodrel*	268	Ponceau 3R*	286	Rhodamine B*	311.	2,4,5-T and esters	332	Uracil mustard*
246	Norgestrel	269	Ponceau SX	287	Rhodamine 6G*	312	Tannic acid*	333	Urethan*
247	Ochratoxin A	270	Potassium arsenite	288	Riddelliine	313	Terpene polychlorinates*	334	Vinyl cyclohexane
248	17β-Oestradiol*	271	Potassium bis(2-hydroxyethyl)-dithiocarbamate*	289.	Saccharated iron*	314.	Teslosterone*	335	2,4-Xylidine (hydrochloride)
249	Oestriol	272.	Progesterone*	290	Safrole*	315.	Tetraethyl & tetramethyl lead	336	2,5-Xylidine (hydrochloride)
250.	Oestrone*	273.	Pronetalol hydrochloride*	291.	Scarlet red	316	Thioacetamide*	337.	Yellow AB
251.	Oil orange SS*	274.	1,3-Propanesultone*	292	Selenium compounds	317.	4,4'-Thioaniline*	338	Yellow OB*
252.	Orange I*	275	Propham	293	Semicarbazide (hydrochloride)*	318.	Thiouracil*	339	Zectran
253.	Orange G	276	β-Propiolactone*	294	Seneciphylline	319	Thiourea*	340	Zinc chromate hydroxide*
254.	Oxazepam*	277.	*n*-Propyl carbamate*	295.	Senkirkine	320	Thiram	341.	Zineb
255	Oxyphenbutazone	278	Propylene oxide*	296.	Sodium arsenate	321.	*o*-Toluidine (hydrochloride)	342.	Ziram
256	Parasorbic acid*			297.	Sodium arsenite	322	Trichloroethylene*		
257.	Patulin*			298.	Sodium dichromate	323	Trichlorotriethylamine hydrochloride		
258	Penicillic acid*			299	Sodium diethyldithiocarbamate	324	Triethylene glycol diglycidyl ether*		
259	Phenacarbazide*			300	Sterigmatocystin*	325.	Tris(aziridinyl)-*p*-		
260	Phenobarbital sodium*			301	Streptozotocin*				
				302	Strontium chromate*				
				303.	Styrene oxide				

* Asterisk, chemicals for which there is some evidence of carcinogenicity in experimental animals only (see also text, p 881).

food additives or chemical residues in food are concerned, the value of experimental results to predict a similar effect in humans has been accepted as valid.

The criteria used in the preparation of the draft monographs, in judging the adequacy of the data and in evaluating the carcinogenic risk of chemicals to humans, were first established in 1971 and, with minor modifications, have been adopted by all the working groups whose deliberations have resulted in the first 16 volumes of the IARC monograph series. Adherence to this basic uniform background and maintenance of a certain rigidity in observing the rules set out in the preamble to the monographs permitted a relative uniformity of the evaluations formulated by the working groups.

The growing success and overall acceptance of this program have certainly not prevented suggestions and criticisms. Criticisms mostly refer to the fact that, except for the few instances in which an association between exposure to a chemical and occurrence of cancer in humans has been clearly confirmed, the monographs do not give a clear indication as to whether exposure to a chemical does or does not represent a hazard to humans because no attempt was made to evaluate the potential human risk. In most cases, in fact, the monographs only evaluate the carcinogenic risk of chemicals to experimental animals without making any attempt to interpret the results in terms of a possible risk for humans.

It was for these reasons that an *ad hoc* working group, jointly called by IARC/WHO, was convened in October 1977 in Lyon to update and revise the criteria on which the carcinogenicity of chemicals to humans and/or experimental animals is assessed and on which the evaluation of the possible carcinogenic risk that they may represent for humans is made.

The report resulting from this meeting will appear as the "Preamble" of Volume 17 of the IARC monograph series which is presently in preparation (38) and will replace the introductory section called "Background and Purpose of the IARC Program on the Evaluation of the Carcinogenic Risk of Chemicals to Man," which appeared since 1971 with only minor modifications in all the 16 published monograph volumes. We would like to mention briefly here only the more significant changes that will henceforth influence the formulation of the evaluations, and the reader is referred to IARC Monograph, Volume 17, for the text in its entirety.

While it was recognized that no adequate criteria are presently available to interpret experimental data on carcinogenicity directly in terms of their carcinogenic potential to humans, it was also noted that extrapolations to a possible human risk can be reasonably approximated by utilizing data from appropriate animal tests. These data, however, may represent different degrees of evidence, this drawback being mainly due to our present insufficient knowledge of the mechanisms of carcinogenesis. "Strong evidence" of carcinogenicity is indicated by the unquestionable production of malignant tumors, while "weak evidence" of carcinogenicity reflects the qualitative and/or quantitative limitations of the experimental results of which a particular case could be, for instance, the induction solely from benign tumors in mice. In the presence of appropriate experimental carcinogenicity data and in the absence of adequate human data, it is reasonable to regard chemicals for which there is "strong evidence" of carcinogenicity as if they were carcinogenic to humans. Chemicals

for which there is weak evidence of carcinogenicity in experimental animals will, in general, require more experimental and epidemiological investigation.

It was recognized that there are no acceptable methods for quantifying the possible errors in making an approximate quantitative evaluation of human risk at some given exposure level on the basis of data that provide strong evidence of carcinogenicity in experimental animals. The limited data available, however, suggest that such a relationship may exist, at least within certain classes of carcinogenic chemicals, provided that account is taken of the nature of the chemical concerned and of the possible physiological, pharmacological, and toxicological differences between the test animals and humans.

More consideration than in the past is also given to indirect tests, most of which do not have the production of neoplasms in animals as the end point and are generally referred to as "short-term" tests. These tests are proposed to be used, (a) for the prediction of potential carcinogenicity when other carcinogenicity data are absent, (b) to contribute to the setting of priorities for chemicals to be tested in animals, (c) for the identification of active fractions from complex mixtures containing carcinogens, (d) for the identification of active metabolites of carcinogens in human body fluids, and (e) to help elucidate mechanisms of chemical carcinogenesis.

The last section of the monographs, which was originally headed "Comments on Data Reported and Evaluation," and comprised 2 subheadings, 1 for experimental data and 1 for human data, will now be called "Summary of Data Reported and Evaluation", it will have 3 sections, *i.e.*, a summary of experimental data, a summary of the human data, and the evaluation. The evaluation section will take into consideration all of the data in the monograph, particularly the summarized information on animals and humans.

The revised criteria for the evaluation of the carcinogenic risk of chemicals to humans have already been applied by the IARC working group that finalized the monographs scheduled to appear as Volume 17, which considers some *N*-nitroso compounds (38).

By applying the new criteria for the evaluation of the carcinogenicity of chemicals as they are described in the new preamble to the monographs, as well as acquiring further carcinogenicity and related data on chemicals and new knowledge on the mechanisms of carcinogenicity as it may become available, we hope that in the absence of epidemiological data a more clear distinction can be made between chemicals for which there is or is not evidence of a possible carcinogenic effect in humans.

We hope that in this way the critical analysis of the experimental and human data and the ensuing evaluations of environmental chemicals will make future IARC monographs more useful in assisting national and international authorities in formulating decisions concerning preventive measures.

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References

1. Agthe, C., and Tomatis, L. Evaluation of the Carcinogenicity of Environmental Chemicals and the Possibility of Cancer Prevention. In Homburger (ed.) The Physiopathology of Cancer, Vol. 2, pp. 345–3[illegible]. Basel: S. Karger AG, 1976.
2. Agthe, C., and Wilbourn, J. D. IARC Programme on the Evaluation of Carcinogenic Risk of Chemicals to Man. In P. Bucalossi, U. Veronesi, and N. Cascinelli (eds.), Proceedings of the Eleventh International Cancer Congress, Florence, 1974, Vol. 3, pp. 108–113. Amsterdam: Excerpta Medica, 1975.
3. Boyland, E. The Correlation of Experimental Carcinogenesis and Cancer in Man. *Progr. Exptl. Tumor Res.*, *11*: 222–234, 1969.
4. Cairns, J. The Cancer Problem. *Sci. Am.*, *233*: 64–78, 1976.
5. Carcinogenesis Program, National Cancer Institute. Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Publ. Health Service Publication No. 149, 1968–1969. Washington, D. C.: U. S. Government Printing Office, 1971.
6. Carcinogenesis Program, National Cancer Institute. Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Publ. Health Service Publication No. 149, 1961–1967. Washington, D. C.: U. S. Government Printing Office, 1973.
7. Carcinogenesis Program, National Cancer Institute. Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Publ. Health Service Publication No. 149, 1970–1971. Washington, D. C.: U. S. Government Printing Office, 1974.
8. Carcinogenesis Program, National Cancer Institute. Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Publ. Health Service Publication No. 149, 1972–1973. Washington, D. C.: U. S. Government Printing Office, 1976.
9. Doll, R. Prevention of Cancer: Pointers from Epidemiology. Nuffield Provincial Hospitals Trust, 1967.
10. Doll, R. Strategy for Detection of Cancer Hazards to Man. *Nature*, *265*: 589–596, 1977.
11. Haddow, A. Proceedings of the Nineth International Cancer Congress, Tokyo, Japan, 1966. *UICC Monograph Ser.*, *9*: 111–116, 1967.
12. Hartwell, J. L. Survey of Compounds Which Have Been Tested for Carcinogenic Activity, Public Health Service Publication No. 149. Washington, D. C.: U. S. Government Printing Office, 1951.
13. Higginson, J. Present Trends in Cancer Epidemiology. *Can. Cancer Conf.*, *8*: 40–75, 1968.
14. Higginson, J. A Hazardous Society? Individual *versus* Community Responsibility in Cancer Prevention. *Am. J. Public Health*, *66*: 359–366, 1976.
15. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 1. Lyon, France: International Agency for Research on Cancer, 1973.
16. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 2. Lyon, France: International Agency for Research on Cancer, 1973.
17. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 3. Lyon, France: International Agency for Research on Cancer, 1974.
18. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 4. Lyon, France: International Agency for Research on Cancer, 1974.
19. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 5. Lyon, France: International Agency for Research on Cancer, 1975.
20. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 6. Lyon, France: International Agency for Research on Cancer, 1976.
21. IARC Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity, Vol. 7. Lyon, France: International Agency for Research on Cancer, 1978.
22. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals

icals to Man Vol 1 Some Inorganic Substances Chlorinated Hydrocarbons Aromatic Amines, N Nitroso Compounds and Natural Products Lyon France International Agency for Research on Cancer, 1972
23 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man Vol 2, Some Inorganic and Organometallic Compounds Lyon, France International Agency for Research on Cancer, 1973
24 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man Vol 3, Certain Polycyclic Aromatic Hydrocarbons and Heterocyclic Compounds Lyon, France International Agency for Research on Cancer, 1973
25 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 4, Some Aromatic Amines, Hydrazine and Related Substances, N-Nitroso Compounds and Miscellaneous Alkylating Agents Lyon, France International Agency for Research on Cancer, 1974
26 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 5, Some Organochlorine Pesticides. Lyon, France International Agency for Research on Cancer, 1974.
27 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 6, Sex Hormones Lyon, France International Agency for Research on Cancer, 1974
28 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man Vol 7, Some Anti-thyroid and Related Substances, Nitrofurans and Industrial Chemicals. Lyon, France International Agency for Research on Cancer, 1974
29 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 8, Some Aromatic Azo Compounds Lyon, France International Agency for Research on Cancer, 1975
30 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 9 Some Azindines, N-, S- and O-Mustards and Selenium Lyon, France International Agency for Research on Cancer, 1975
31 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 10, Some Naturally Occurring Substances Lyon, France International Agency for Research on Cancer, 1976
32 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 11, Cadmium, Nickel, Some Epoxides, Miscellaneous Industrial Chemicals and General Considerations on Volatile Anaesthetics Lyon, France International Agency for Research on Cancer, 1976
33 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 12, Some Carbamates, Thiocarbamates and Carbazides Lyon France International Agency for Research on Cancer, 1976
34 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 13 Some Miscellaneous Pharmaceutical Substances Lyon, France International Agency for Research on Cancer, 1977
35. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 14 Asbestos Lyon France International Agency for Research on Cancer 1977
36 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man Vol 15, Some Fumiganls the Herbicides 2 4 D and 2 4 5-T Chlorinated Dibenzodioxins and Miscellaneous Industrial Chemicals Lyon, France International Agency for Research on Cancer 1977
37 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Vol 16 Some Aromatic Amines and Related Nitro Compounds Hair Dyes Colouring Agents and Miscellaneous Industrial Chemicals Lyon, France International Agency for Research on Cancer, 1978
38 IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man Vol 17 Some N-Nitroso Compounds Lyon, France International Agency for Research on Cancer in press 1978
39 Public Law 85-929, The Delaney Amendment September 6 1958
40 Royal College of Physicians Smoking or Health London Pitman Medical Publishing Co . Ltd , 1977
41 Shubik, P and Hartwell, J L Survey of Compounds Which Have Been Tested for Carcinogenic Activity, Public Health Service Publication No 149, Suppl 1 Washington D C U S Government Printing Office, 1957
42 Shubik, P , and Hartwell J L Survey of Compounds Which Have Been Tested for Carcinogenic Activity, Public Health Service Publication No. 149, Suppl 2 Washington, D C U S Government Printing Office, 1969
43 Tomatis, L The IARC Program on the Evaluation of the Carcinogenic Risk of Chemicals to Man Ann N Y Acad Sci 271 396-409, 1976
44 Tomatis L The Value of Long-Term Testing for Implementation of Primary Prevention In H H Hiatt J D Watson and J A Winsten (eds), Origins of Human Cancer pp 1339-1357 Cold Spring Harbor, New York Cold Spring Harbor Laboratory, 1977
45 Weiss, W Chloromethyl Ethers Cigarettes Cough and Cancer J Occup Med , 18 194-199 1976
46 Weiss, W , and Boucot, K R The Respiratory Effects of Chloromethyl Methyl Ether J Am Med Assoc 234 1139-1142 1975
47 WHO Fifth Report of the Joint FAO/WHO Expert Committee on Food Additives Evaluation of Carcinogenic Hazard of Food Additives World Health Organ Tech Rept Ser , No 220 1961
48 WHO Report of a WHO Expert Committee Prevention of Cancer World Health Organ Tech Rept Ser , No 276, 1964
49 Wynder, E L Cancer Prevention A Question of Priorities Nature 268 284, 1977
50 Wynder E L , and Gori, G B Contribution of the Environment to Cancer Incidence An Epidemiological Exercise J Natl Cancer Inst 58 825-832 1977