

# IARC Monographs on the Identification of Carcinogenic Hazards to Humans

## From nominations to evaluations

- Nominations: by scientists, government agencies, the public (since 2003)
- Identifying priorities: Advisory Group every 5 years
- Selection and timing of evaluations: IARC, following consultation with WHO

Priorities

Public engagement





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## Advisory Group recommendations on priorities for the IARC Monographs

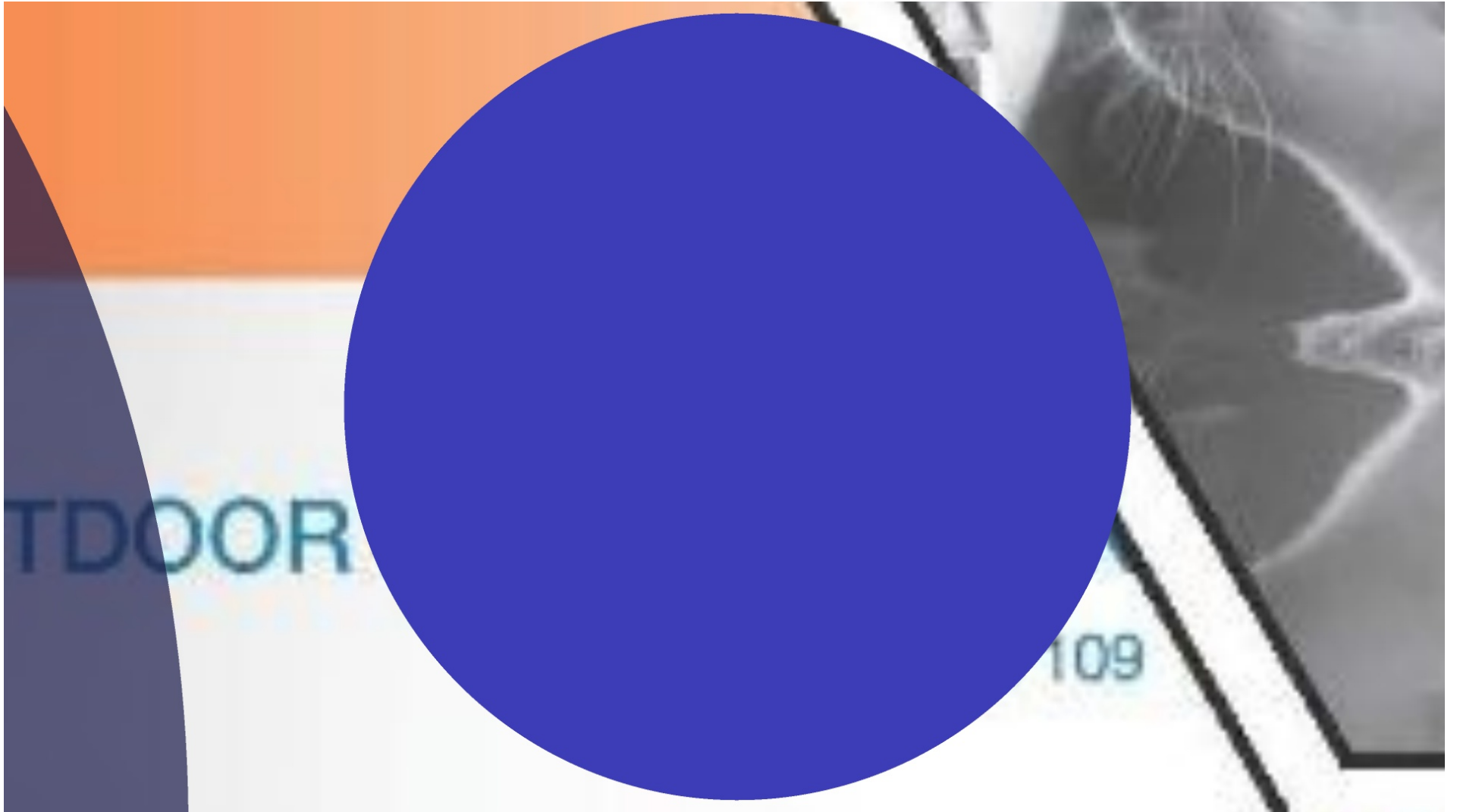
IARC Monographs Priorities Group <sup>†</sup> • [Show footnotes](#)

Published: April 17, 2019 • DOI: [https://doi.org/10.1016/S1470-2045\(19\)30246-3](https://doi.org/10.1016/S1470-2045(19)30246-3) •

References

Article Info

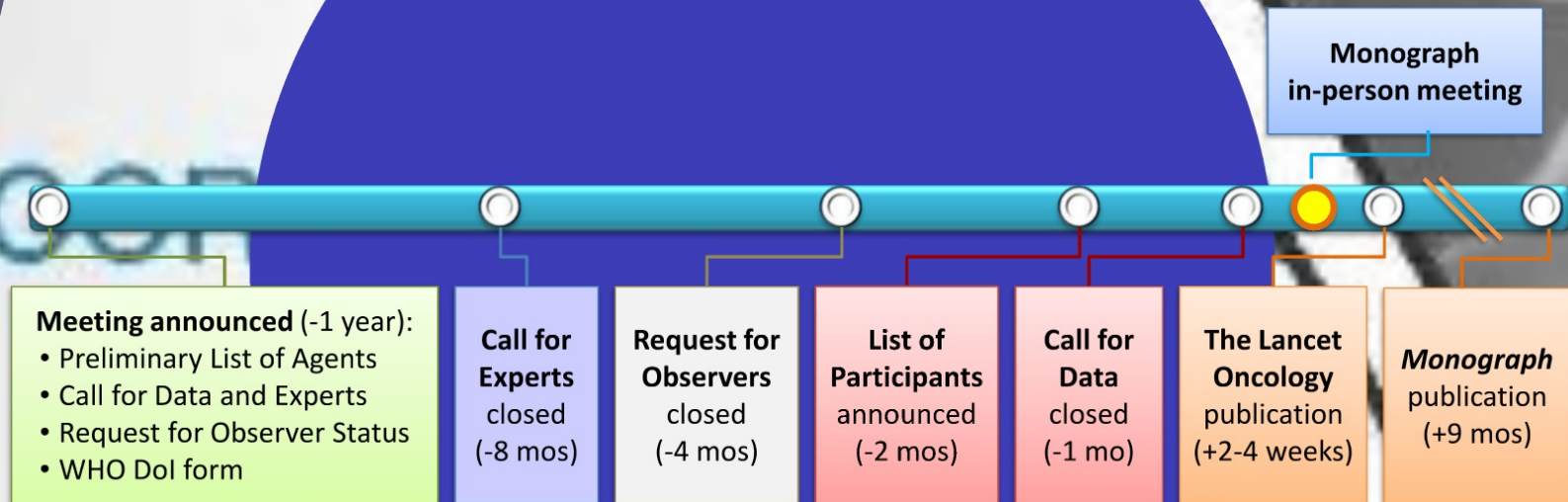
An Advisory Group of 29 scientists from 18 countries met in March, 2019, to recommend priorities for the International Agency for Research on Cancer (IARC) Monographs programme during 2020–24. IARC periodically convenes such advisory groups to ensure that the Monographs evaluations reflect the current state of scientific evidence relevant to carcinogenicity.<sup>1</sup> A detailed report of the Advisory Group will be published subsequently.<sup>2</sup>

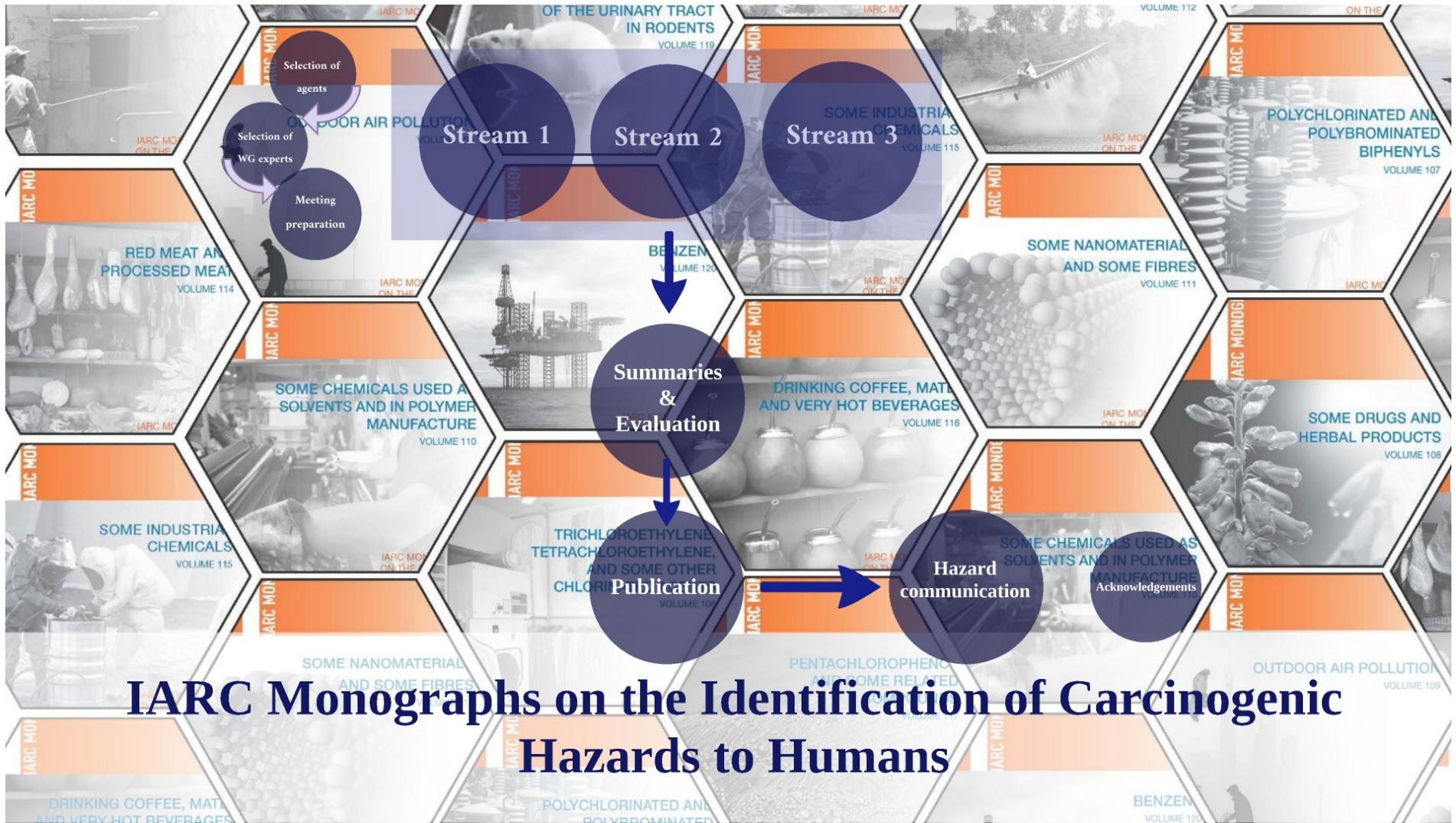




	Rationale
<b>Agents not previously evaluated by IARC Monographs</b>	
Haloacetic acids (and other disinfection byproducts)	Relevant human cancer, bioassay, and mechanistic evidence
Metalworking fluids	Relevant human cancer and bioassay evidence
Cannabis smoking, fertility treatment, glucocorticoids, <i>Salmonella typhi</i> , sedentary behaviour*, tetracyclines and other photosensitising drugs	Relevant human cancer and mechanistic evidence
Cupferron, gasoline oxygenated additives, gentian violet, glycidamide, malachite green and leucomalachite green, oxymetholone, pentabromodiphenyl ethers, vindaolin	Relevant bioassay and mechanistic evidence
Breast implants, dietary salt intake*, neonatal phototherapy*, poor oral hygiene*	Relevant human cancer evidence
Aspartame	Relevant bioassay evidence
Arecoline, carbon disulphide, electronic nicotine delivery systems and nicotine*, human cytomegalovirus, parabens	Relevant mechanistic evidence
<b>Agents previously evaluated by IARC Monographs†</b>	
Automotive gasoline (leaded and unleaded), carbaryl, malaria	New human cancer, bioassay, and mechanistic evidence to warrant re-evaluation of the classification
Acrylamide*, acrylonitrile, some anthracyclines, coal dust, combustion of biomass, domestic talc products, firefighting exposure, metallic nickel, some pyrethroids (ie, permethrin, cypermethrin, deltamethrin)	New human cancer and mechanistic evidence to warrant re-evaluation of the classification
Aniline, acrolein, methyl eugenol and isoeugenol*, multi-walled carbon nanotubes*, non-ionising radiation (radiofrequency)*, some perfluorinated compounds (eg, perfluorooctanoic acid)	New bioassay and mechanistic evidence to warrant re-evaluation of the classification
Oestrogen:oestradiol and oestrogen-progestogens‡, hydrochlorothiazide, Merkel cell polyomavirus, perchloroethylene, very hot foods and beverages	New human cancer evidence to warrant re-evaluation of the classification
1,1,1-trichloroethane, weapons-grade alloy (tungsten, nickel, and cobalt)	New bioassay evidence to warrant re-evaluation of the classification
Acetaldehyde, bisphenol A*, cobalt and cobalt compounds, crotonaldehyde, cyclopeptide cyanotoxins, fumonisin B <sub>1</sub> , inorganic lead compounds, isoprene, o-anisidine	New mechanistic evidence to warrant re-evaluation of the classification
Evidence of human exposure was identified for all agents. *Advised to conduct in latter half of 5-year period. †See current International Agency for Research on Cancer (IARC) list of classifications, volumes 1–123. ‡Group 1 carcinogen; new evidence of cancer in humans indicates possible causal associations for additional tumour sites (see Section 3 of Preamble to the IARC Monographs <sup>5</sup> ).	
<b>Table 1: Agents recommended for evaluation by the IARC Monographs with high priority</b>	

## Public Engagement during *Monographs* development





# IARC Monographs on the Identification of Carcinogenic Hazards to Humans



# Participants

**IARC Secretariat**  
Coordinates all aspects of the evaluation

**Working Group**  
*Independent scientists without conflict of interest*  
Review science and develop evaluations

*Attend meetings but do not draft text or contribute to evaluations*

**Invited Specialists**  
Scientists with relevant knowledge but a competing interest

**Representatives** of governments and health agencies

**Observers**  
Other scientists, who may have a competing interest: may observe but do not influence outcomes

**Table 1. Roles of participants at *IARC Monographs* meetings**

Category of participant	Role			
	Prepare text, tables, and analyses	Participate in discussions	Participate in evaluations	Eligible to serve as Chair
Working Group members	√	√	√	√
Invited Specialists	√ <sup>a</sup>	√		
Representatives of health agencies		√ <sup>b</sup>		
Observers		√ <sup>b</sup>		
IARC Secretariat	√ <sup>c</sup>	√	√ <sup>d</sup>	

<sup>a</sup> Only for the section on exposure characterization

<sup>b</sup> Only at times designated by the Meeting Chair and Subgroup Chairs

<sup>c</sup> When needed or requested by the Meeting Chair and Subgroup Chairs

<sup>d</sup> Only for clarifying or interpreting the Preamble

## WHO Declaration of Interest for IARC/WHO experts

To ensure public confidence that interested parties do not have links to the Working Group, IARC strives to identify and avoid conflicts of interests

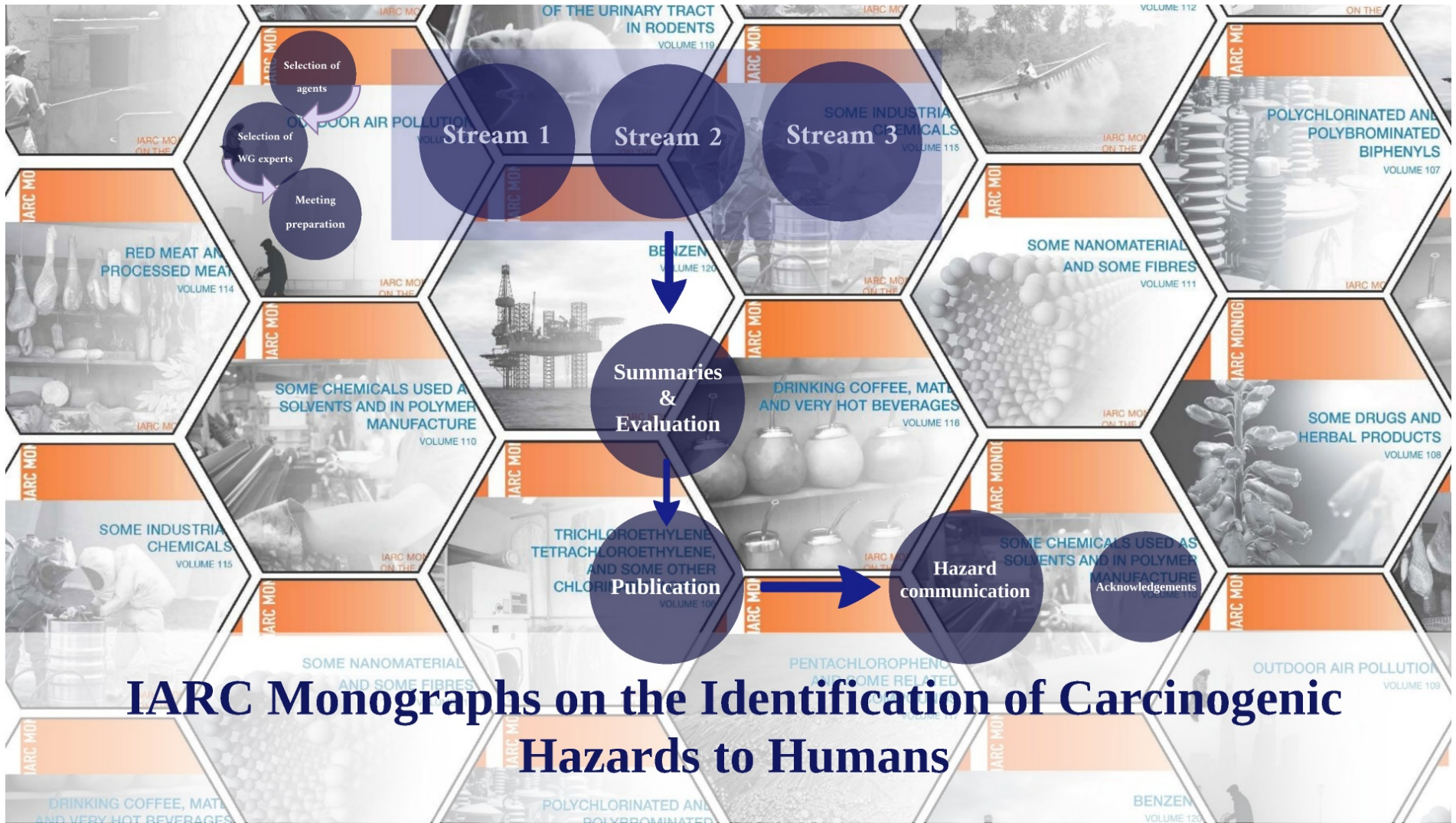
- Employment, research, and financial interests are declared before the official invitation, and are updated before the evaluation meeting

Pertinent interests are disclosed

- To meeting participants
- To the public (<http://monographs.iarc.fr/>)
- In the published Monograph

Working Group members also complete the conflict-of-interest form required by *The Lancet Oncology*





# IARC Monographs on the Identification of Carcinogenic Hazards to Humans







## Step 1. Identify relevant information

- Search authoritative databases (PubMed, PubChem)
- Document search terms (developed with librarian, and refined with expert Working Group input)
- Pertinent unpublished studies can be made available through relevant regulatory authorities



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NCBI Resources How To

PubMed.gov  
US National Library of Medicine  
National Institutes of Health

PubMed

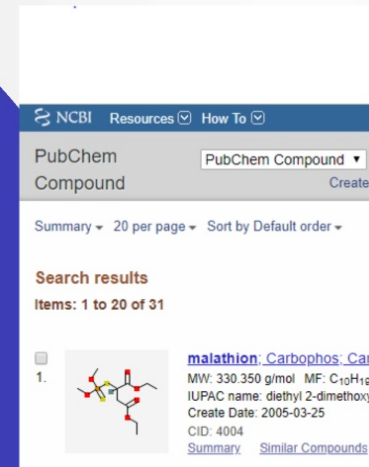
Format: Abstract

Lancet Oncol. 2016 Jul;17(7):877-878. doi: 10.1016/S1470-2045(16)00000-0

**Carcinogenicity of drinking coffee, r**

Loomis D<sup>1</sup>, Guyton KZ<sup>1</sup>, Grosse Y<sup>1</sup>, Lauby-Secretan B<sup>1</sup>, E

Agency for Research on Cancer Monograph Working Group

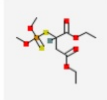


NCBI Resources How To

PubChem Compound

Summary 20 per page Sort by Default order

Search results  
Items: 1 to 20 of 31

1.  **malathion** Carbophos Car

MW: 330.350 g/mol MF: C<sub>10</sub>H<sub>19</sub>O<sub>6</sub>  
IUPAC name: diethyl 2-dimethoxy  
Create Date: 2005-03-25  
CID: 4004  
[Summary](#) [Similar Compounds](#)

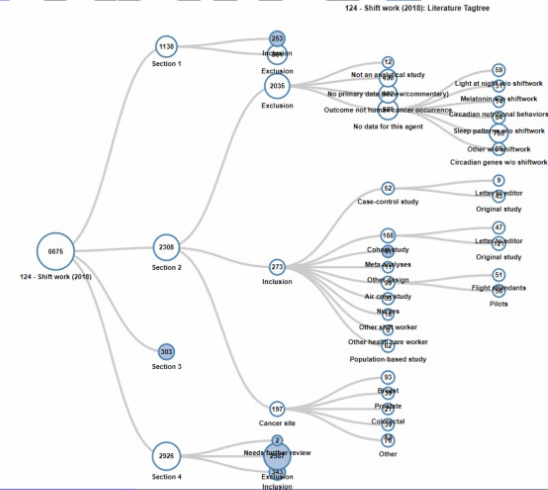
## Step 2. Screen, select & organize studies

- IARC screens literature for inclusion (title and abstract review) per pre-defined exclusion criteria
- Reasons for exclusion are recorded
- Included studies are organized per Preamble



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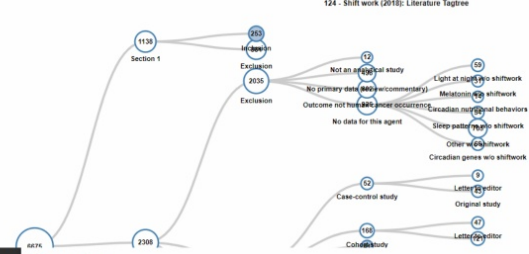
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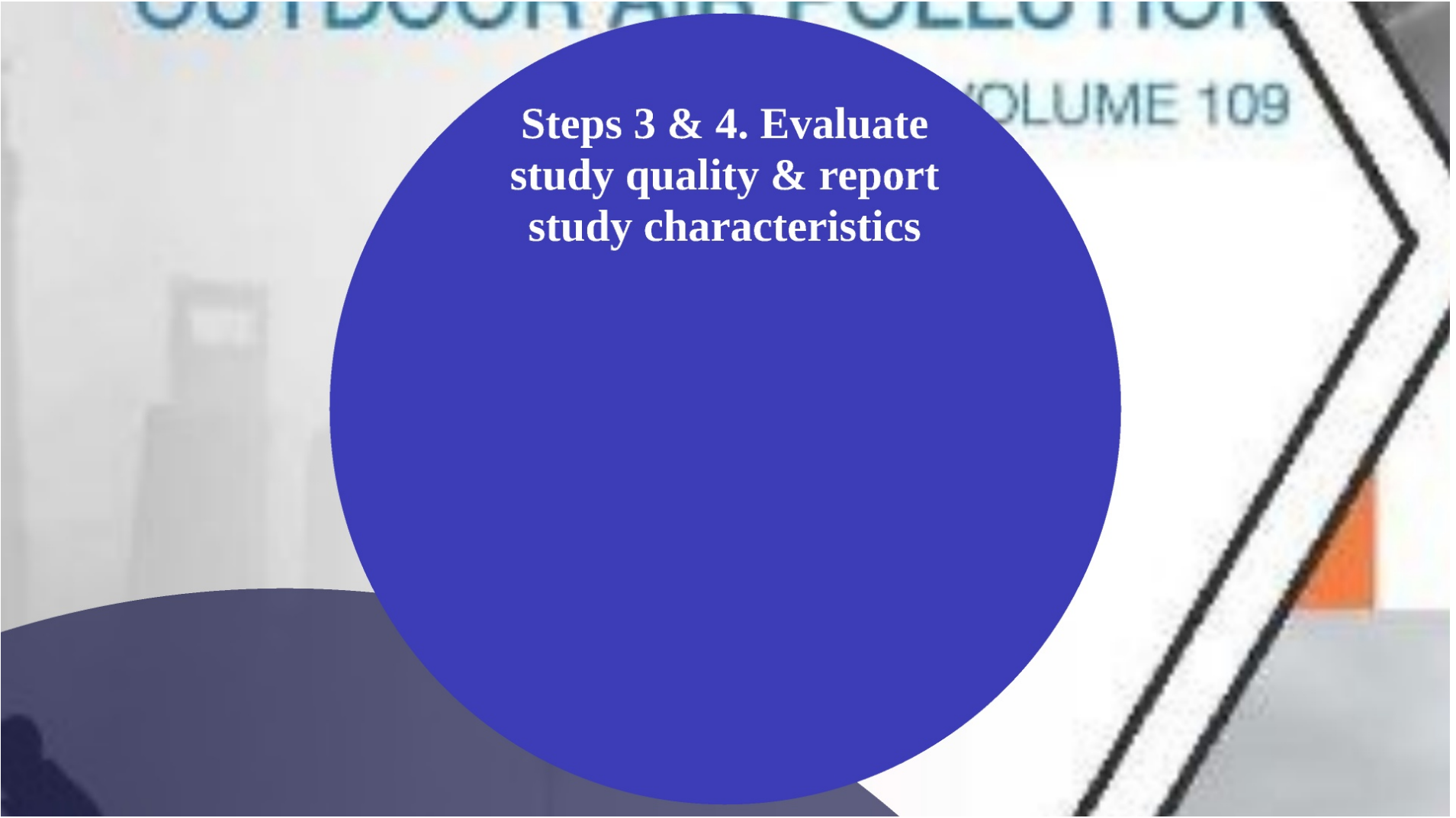


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A screenshot of the HAWC interface showing a list of references. The top reference is by Ballard T et al. (2000), titled 'Cancer incidence and mortality among flight personnel: a meta-analysis'. It is tagged with 'Section 2 &gt; Inclusion &gt; Meta-analyses'. Below it is a reference by Benabu JC et al. (2015), titled '[Night work, shift work: Breast cancer risk factor?]'. It is tagged with 'Section 2 &gt; Inclusion &gt; Meta-analyses &gt; Original study' and 'Section 2 &gt; Cancer site &gt; Breast'. The interface includes search filters, tags, and action buttons for each reference.



**Steps 3 & 4. Evaluate  
study quality & report  
study characteristics**

#### 4. MECHANISTIC AND OTHER RELEVANT DATA

4.1 Absorption, distribution, and excretion

concentrations (mostly hexavalent chromium, Cr(VI), followed by MIG-SS, TIG-SS, MIG-MS,

4.1.

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#### 2.1 Introduction

Welding is a by joining metals thro Welding processes particulate matter of metal liquefied (see Section 1.1 for national literature, together with flame related process wh used to cut a metal itant exposure to fumes, particles, an of joining m There is extens 2010). Weldin cancer from either classified as i to welding fumes whereas gas o control studies, at process numb of routinely collect gases such as IARC Monographs 1990), the number heat. Welding including weld and non-ioni studies has increas and non-ioni have also extend

#### 1.1 Description of major welding processes and materials

Welding is a broad term for the process aggregations, combining welding with related occupations were also excluded as they lack

are used as part of the welding process (e.g. the shielding gas) (SO, 2009).

While there are many welding processes routinely employed in occupational settings, the

### 2. CANCER IN HUMANS

#### 1. EXPOSURE DATA

### 3. CANCER IN EXPERIMENTAL ANIMALS

A previous IARC Monographs Working Group concluded in 1989 that there was *inadequate evidence* for the carcinogenicity of welding fumes in experimental animals (IARC, 1990).

#### 3.1 Mouse

See Table 3.1

##### 3.1.1 Inhalation

Groups of age- and weight-matched male A/J mice (age, 5 weeks) were exposed by whole-body inhalation to gas metal arc stainless steel (GMA-SS) welding fumes at 40 mg/m<sup>3</sup> of filtered air for 3 hours per day for 6 (n = 45 per group) or 10 (n = 55 per group) days (Zekler-Erdelyi et al., 2011a). The automated system for the generation of welding fumes consisted of a welding power source, an automated, programmable six-axis robotic arm, a water-cooled arc welding torch, a wire feeder, and an automatic welding torch cleaner. For the initial studies on characterization of fumes, GMA welding was performed using a SS electrode. Welding was performed on A36

manganese (13.8 wt%), nickel (8.8 wt%), and copper (0.2 wt%), with trace amounts of silicon, aluminum, and vanadium. The particle diameters ranged from ultrafine (0.01–0.10 µm) to coarse (1.0–10 µm), with most particles in the fine size range (0.10–1.0 µm). Gas generation, including carbon monoxide (CO) and ozone (O<sub>3</sub>), was continuously monitored. In the exposure chamber, carbon monoxide and ozone concentrations were not significantly higher than background levels (Antonini et al., 2006; Erdelyi et al., 2011). The 6- and 10-day inhalation regimes were estimated to be equivalent to 30 and 50 days of exposure, respectively, in a 75 kg person working an 8-hour shift using the previous threshold limit value time-weighted average of 5 mg/m<sup>3</sup> for welding fumes (Zekler-Erdelyi et al., 2011a). The deposited human dose was calculated as: fume concentration (5 mg/m<sup>3</sup>) multiplied by minimum volume (20 L/min × 10<sup>-3</sup> m<sup>3</sup>/L), exposure duration (8 hours per day × 60 minutes per hour), and alveolar deposition efficiency (0.16). The deposited human dose at these conditions is 7.7 mg/day. The proportional equivalent deposition in mice, assuming a mouse body weight

# Steps 3 & 4. Evaluate study quality & report study characteristics

#### 2.5 General population studies: childhood cancer

Volume 120: Benzene

Last updated: Aug 27th 2018, 11:13 am

Reference, location, follow-up/enrollment period, study-design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Crosignani et al. (2004) Province of Varese, Italy 1978-1997 Case-Control	Cases: 120; Cancer registry Controls: 480; Population-based, Health Service Archives Exposure assess. method: other	Leukemia: 204.0 - 208.9 (ICD-9) Lymphoid leukemia, myeloid	< 0.1 µg/m <sup>3</sup> 0.1-10 µg/m <sup>3</sup>	88 25	1 1.5 (0.9-2.5) 9 (1.4-11.3)	sex, age, socioeconomic status of municipality	Incidence: Cases: 0-14 y. <b>Strengths:</b> Population-based, exposure model. <b>Limitations:</b> Few cases, only address at diagnosis, non-differential misclassification of exposure	
Sokolon et al. (1990) Massachusetts, USA 1984-87 Case-Control	Cases: 197 (POPBASE ONE POPULATION BASED) White patients with clinically or histologically confirmed melanoma of the choroid, vitreous body or both, identified at local hospital or by mailing to ophthalmologists, diagnosed within previous year, aged 17-85 years. Controls: 385 (SERIES ONE POPULATION BASED) selected by random digit dialing, matched 2:1 by sex, age, city of residence Exposure assess. method: other; Telephone interview including constitutional factors, ocular and medical histories, and exposure to environmental factors including natural and artificial sources of UV	Eye	arc welding: no	179	18	yes	age, eye and skin color; ancestry, use of sun lamps, eye protection, outside work fluorescent lighting, southern residence, Years of intense exposure, moles	Series 1, population-based, 197 cases and 385 controls; Series 2, not population-based, 337 cases and 800 sibling controls, 143 cases were included in both series. Result for case series 1 also was reported by Ajani et al. (1992) using the same numbers but with fewer covariates in the logistic regression model (see below). <b>Strengths:</b> High participation rate in both cases and controls. Some information on exposures to UV-radiation. <b>Limitations:</b> No dose-response assessment
Siematycski et al. (1991) Montreal, Canada 1984-87 Case-Control	Cases: 16, histologically confirmed incident male cases of uveal melanoma, aged 35-70 years. Controls: 3058, 2025 cancer controls, 533	Eye	not exposed (ref.) exposed to arc welding fumes	12 4	12 4	yes	age, family income, cigarette index	French were the target population, 16 is the number of total eye melanoma cases (p 111, Table 1, Siematycski et al. (1991). Analysis was restricted to French Canadians and used cancer controls. <b>Strengths:</b>



## Step 5. Synthesize evidence → evaluation

### Cancer in humans

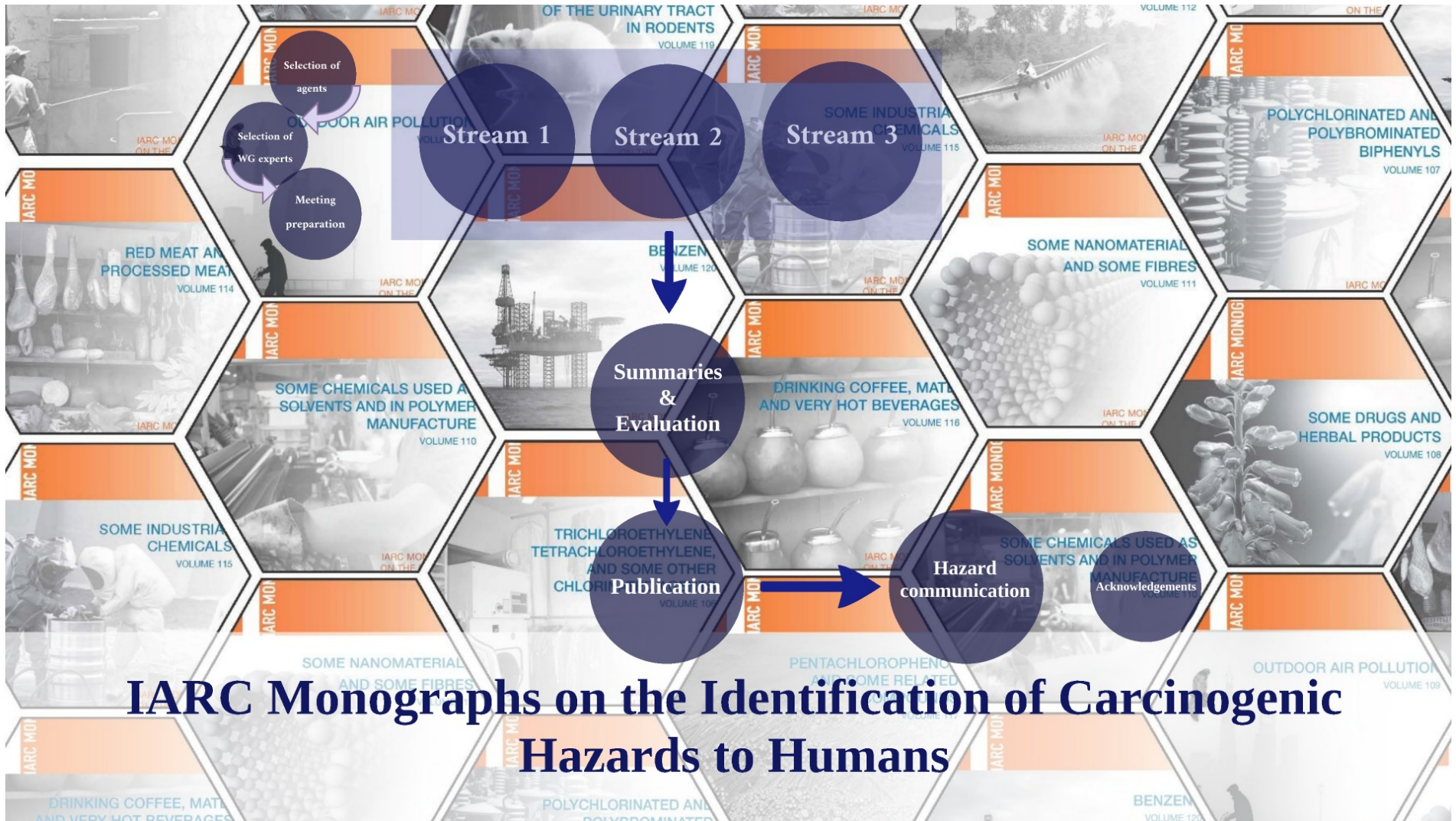
- *Sufficient evidence*
- *Limited evidence*
- *Inadequate evidence*
- *Evidence suggesting lack of carcinogenicity*

### Cancer in experimental animals

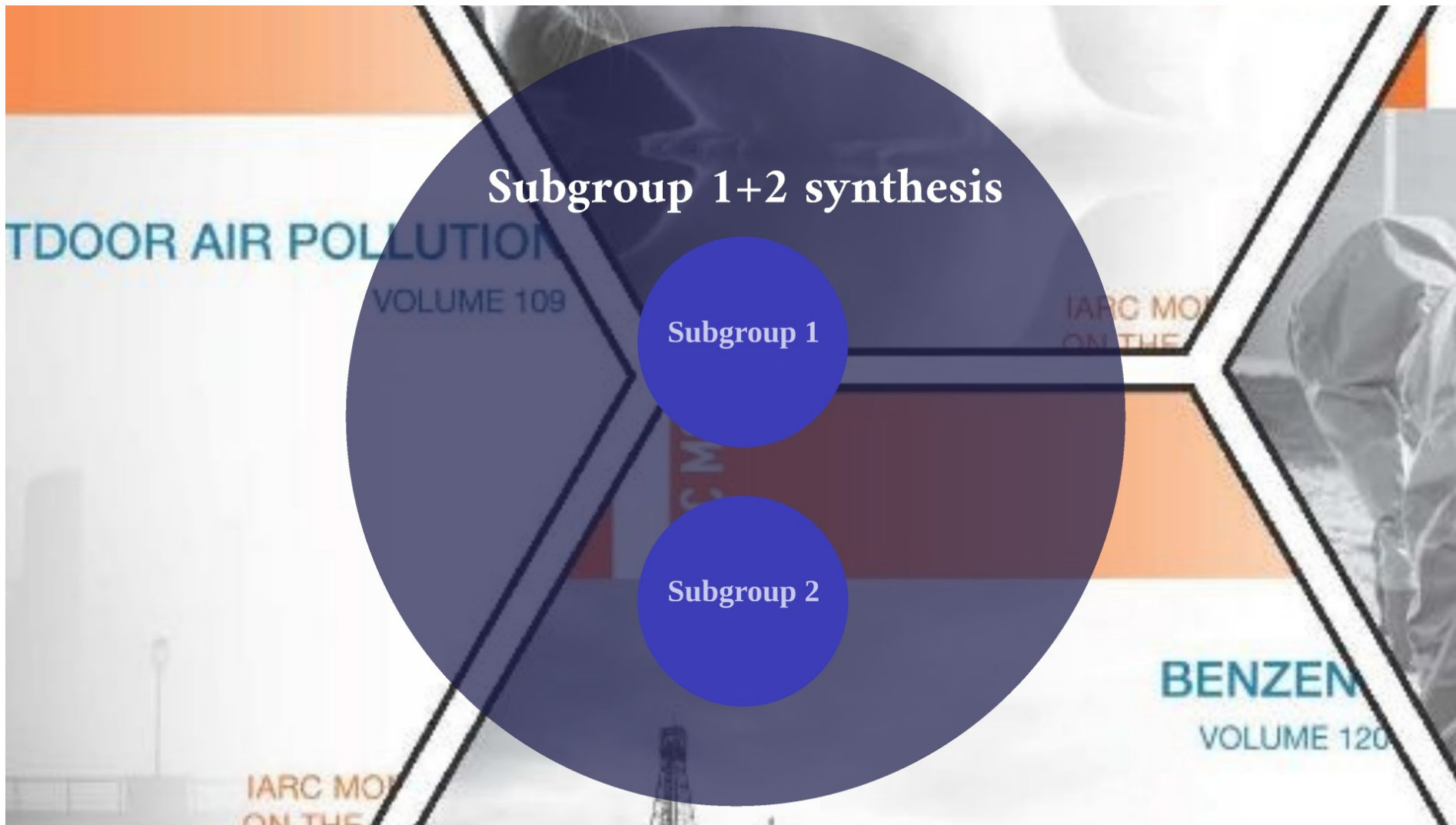
- *Sufficient evidence*
- *Limited evidence*
- *Inadequate evidence*
- *Evidence suggesting lack of carcinogenicity*

### Mechanistic evidence

- *Strong evidence*
  - *Mechanistic class*
  - *Key characteristics*
  - *Mechanism not relevant*
- *Limited evidence*
- *Inadequate evidence*



# IARC Monographs on the Identification of Carcinogenic Hazards to Humans





# Subgroup 1

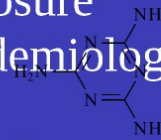
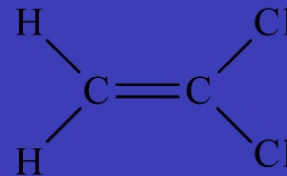
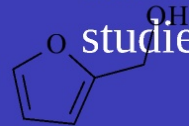
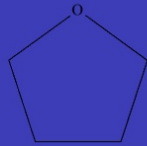
## Exposure characterization:

- Identification of the agent
- Detection and analysis
- Production and use
- Exposure
- Regulations and guidelines
- Critical review of exposure assessment in key epidemiological studies

# Subgroup 1

Exposure characterization:

- Identification of the agent
- Detection and analysis
- Production and use
- Exposure
- Regulations and guidelines
- Critical review of exposure assessment in key epidemiological studies



## What's new?

- Revised Preamble
  - Reinforces descriptive aims
  - Calls for enhanced LMIC coverage
  - New section on critical review of exposure methods in epidemiologic studies of cancer and mechanisms

## Subgroup 2

Studies of cancer in humans

- Causal inference for body of evidence, accounting for study quality & informativeness
- Increased attention to quality of exposure assessment

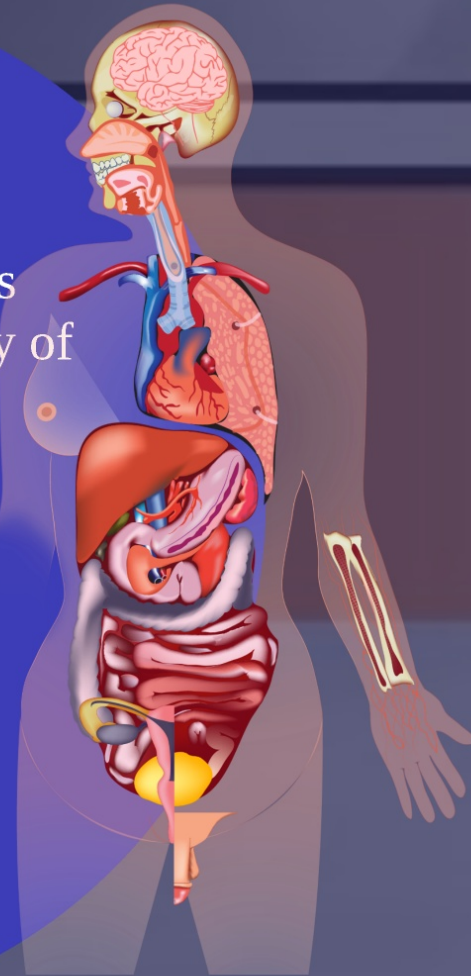


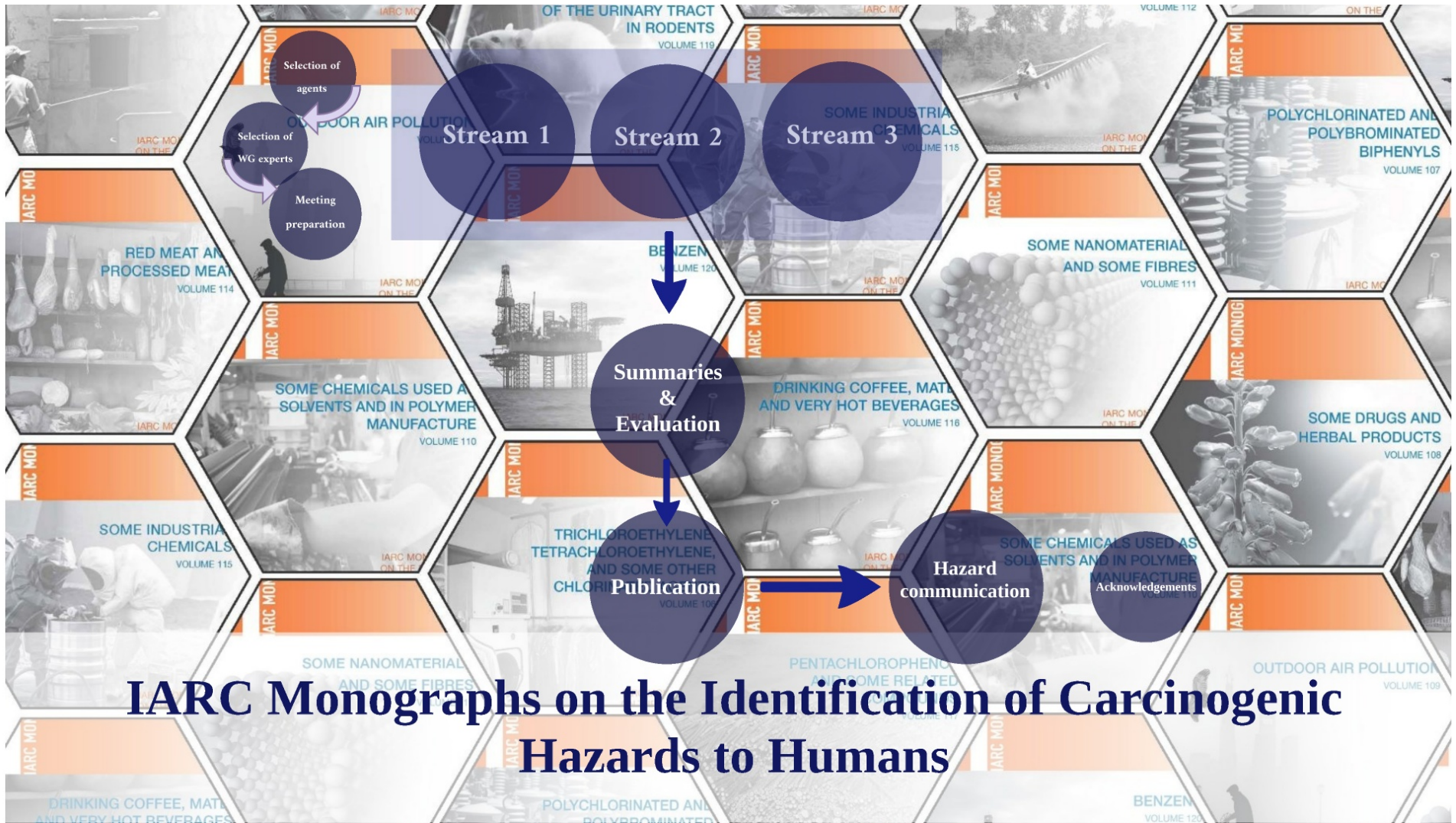
## What's new?

- Enhanced use of systematic review tools in evaluating studies
- Explicit consideration of study informativeness as well as quality in weighing evidence
- Emphasis on *impact* of bias and confounding

## Subgroup 2

of cancer in humans  
inference for body of  
evidence, accounting for  
quality &  
informativeness  
and attention to  
of exposure  
assessment





# IARC Monographs on the Identification of Carcinogenic Hazards to Humans



## Subgroup 3

Cancer in experimental animals

- Evidence of an increased incidence of malignant neoplasms (or of an appropriate combination of benign and malignant neoplasms) in high-quality studies



VOLUME 120



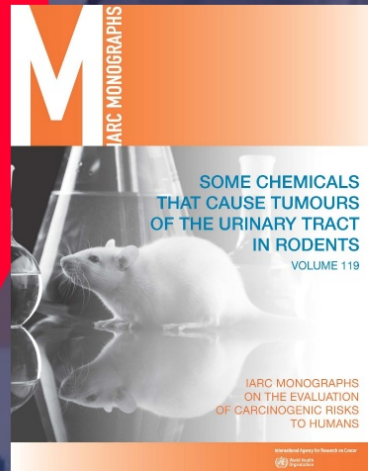
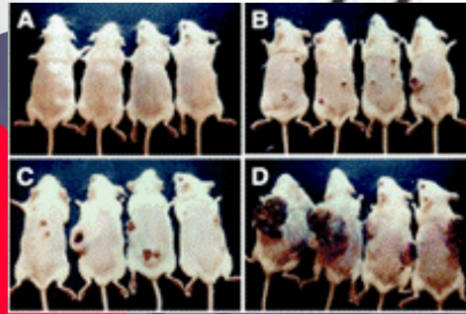
# Subgroup 3

**BENZENE**  
VOLUME 120

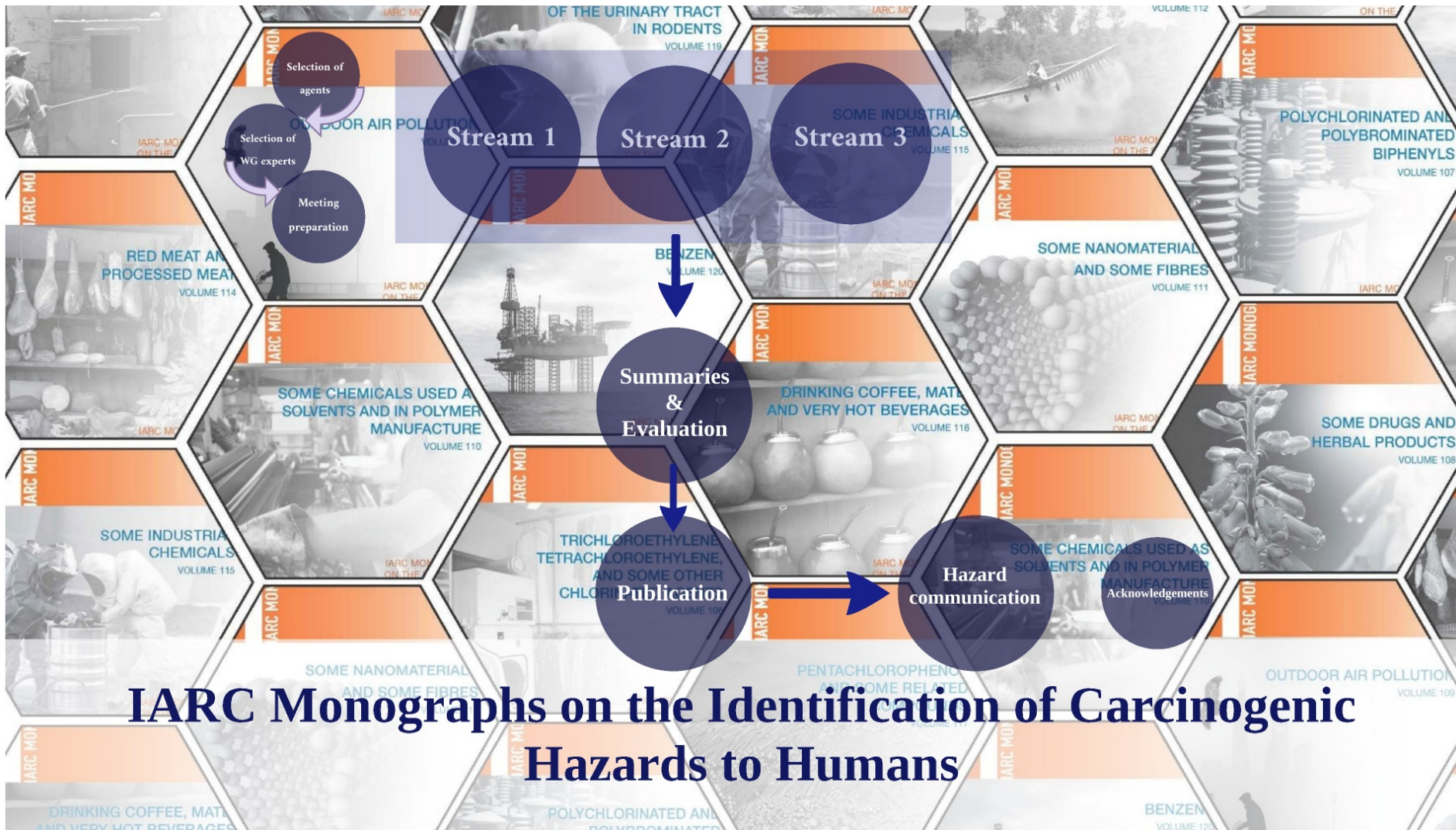
## What's new?

Eligibility of genetically modified animals (*Preamble*, 2019):

- Tg.AC (v-Ha-Ras oncogene), *Trp53*<sup>+/-</sup>, or *rasH2* (human *HRAS* proto-oncogene) mice
- Mice with targeted expression of viral genes (to animal tissue from which human cancer arises)
- Humanized mice implanted with human cells normally infected by the virus







# IARC Monographs on the Identification of Carcinogenic Hazards to Humans



## Subgroup 4

Mechanistic evidence

- Strength of evidence: mechanistic class; key characteristics of carcinogens; and relevance of mechanism for humans
- Study quality considerations

What's new?







## 10 Key Characteristics of carcinogens:

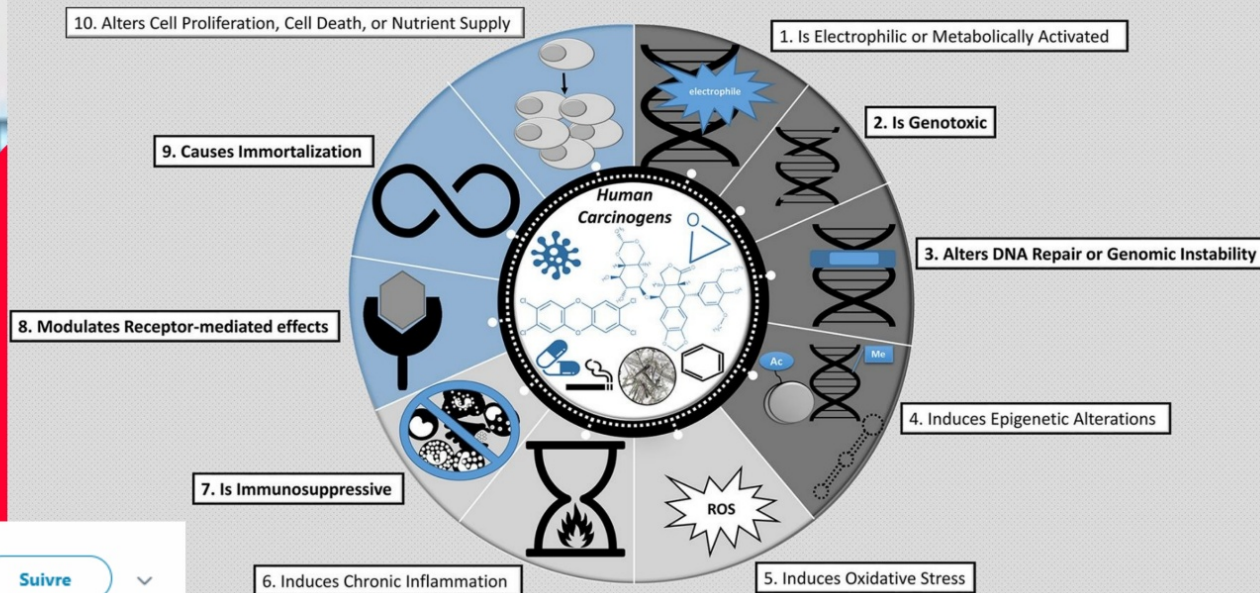
1. Is electrophilic or can be metabolically activated
2. Is genotoxic
3. Alters DNA repair or causes genomic instability
4. Induces epigenetic alterations
5. Induces oxidative stress
6. Induces chronic inflammation
7. Is immunosuppressive
8. Modulates receptor-mediated effects
9. Causes immortalization
10. Alters cell proliferation, cell death, or nutrient supply

- Chemical and biological properties of established human carcinogens
- Data on key characteristics can provide evidence of carcinogenicity
- Used to assemble data relevant to mechanisms of carcinogens– without needing an *a priori* hypothesis of the mechanism

- Smith MT, Guyton KZ, Gibbons CF, Fritz JM, Portier CJ, Rusyn I, DeMarini DM, Caldwell JC, Kavlock RJ, Lambert PF, Hecht SS, Bucher JR, Stewart BW, Baan RA, Coglianò VJ, Straif K (2016); Key characteristics of carcinogens as a basis for organizing data on mechanisms of carcinogenesis. *Env Health Persp.*, 124(6):713-21.
- Guyton KZ, Rusyn I, Chiu WA, Corpet DE, van den Berg, M, Ross, M, Christiani DC, Beland FA, Smith MT (2018); Application of the key characteristics of carcinogens in cancer hazard identification. *Carcinogenesis*, 39(4):614.
- IARC Scientific Publication No. 165: Tumour Site Concordance and Mechanisms of Carcinogenesis (2019). <https://publications.iarc.fr/578>.
- Smith MT, Guyton KZ (2020). Identifying carcinogens from 10 key characteristics: a new approach based on mechanisms. In: Wild CP, Weiderpass E, Stewart BW, editors. World Cancer Report: Cancer Research for Cancer Prevention. <http://publications.iarc.fr/586>.



## THE KEY CHARACTERISTICS OF HUMAN CARCINOGENS



IARC  
@IARCWHO


Suivre

What causes [#cancer](#)? An IARC collaboration offers a fresh approach to this tough question. The key characteristics of carcinogens help ID new cancer causes & make sense of suspected carcinogens. Read the article in [@ChemResTox](#) about progress & next steps

- Guyton KZ, Rieswijk L, Wang A, Chiu WA, Smith MT (2018); Key characteristics approach to carcinogenic hazard identification. *Chemical Research in Toxicology*, 31(12): 1290-1292.
- Smith MT, Guyton KZ, Kleinstreuer N, Borrel A, Cardenas A, Chiu WA, Felsher DW, Gibbons CF, Goodson WH, Houck KA, Kane A, La Merrill MA, Lebec H, Lowe L, McHale CM, Minocherhomji S, Rieswijk L, Sandy MS, Sone H, Wang A, Zhang L, Zeise L, Fielden M (2020). The key characteristics of carcinogens: relationship to the hallmarks of cancer, relevant biomarkers, and assays to measure them. *Cancer Epidemiol Biomarkers Prev.* 29(10):1887-1903.
- For more on the key characteristics of hazardous exposures, see: <https://keycharacteristics.org/>





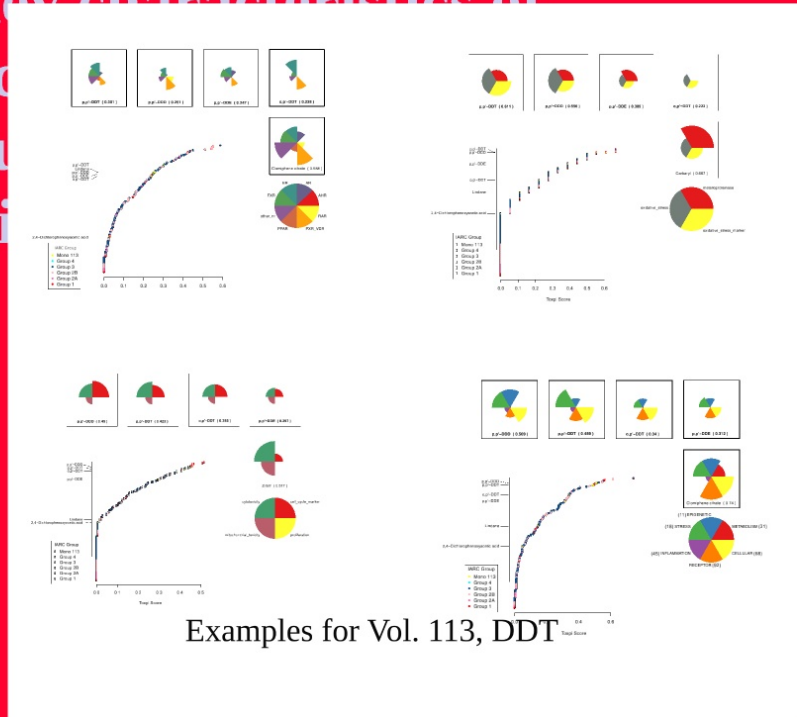


**Key characteristics of  
carcinogens can be  
used to interrogate  
high-throughput and  
high-content  
databases**

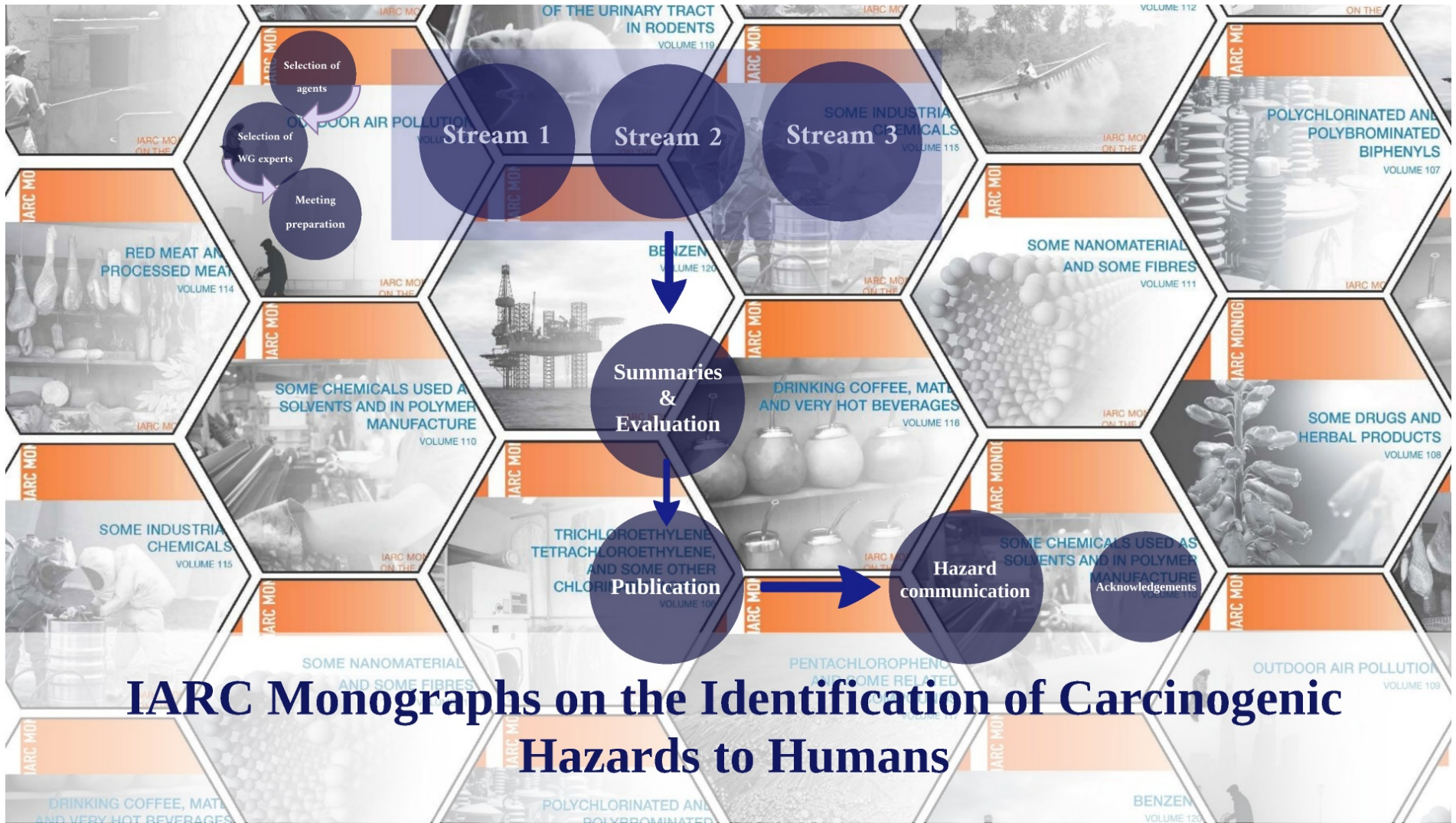
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# Key characteristics of

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# IARC Monographs on the Identification of Carcinogenic Hazards to Humans

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



What's new?

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited	Sufficient	Strong	Possibly carcinogenic (Group 2B)
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



What's new?  
Single step integration

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
Limited	Sufficient	Strong (exposed humans)	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong	
Limited	Sufficient	Strong (human cells or tissues) Strong (mechanistic class)	
Limited	Sufficient	Strong	Possibly carcinogenic (Group 2B)
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			

What's new?

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



## What's new?

4 possible classifications  
(Groups 1, 2A, 2B, 3)

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient		Probably carcinogenic (Group 2A)
Limited		Strong	
	Sufficient	Strong (human cells or tissues) Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



What's new?

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			

What's new?

Group 2B based on one stream of evidence

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited	Sufficient	Strong	Possibly carcinogenic (Group 2B)
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			

What's new?

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
		Strong (mechanistic class)	
Limited	Sufficient	Strong	Possibly carcinogenic (Group 2B)
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



## What's new?

Group 2A based on 2 streams of evidence, at least one in human cells

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient		Probably carcinogenic (Group 2A)
Limited		Strong	
	Sufficient	Strong (human cells or tissues) Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			

What's new?

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient	Strong	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong (human cells or tissues)	
	Sufficient	Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient	Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



## What's new?

Strong evidence of key characteristics - impact on Group 1, 2A, and 2B evaluations

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient		
Limited	Sufficient	Strong	
	Sufficient	Strong (human cells or tissues)	Probably carcinogenic (Group 2A)
		Strong (mechanistic class)	
Limited			
	Sufficient		Possibly carcinogenic (Group 2B)
		Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



Probably carcinogenic  
(up 2A)

Probably carcinogenic  
(up 2B)

Not classifiable



ably carcinogenic  
(up 2A)

ably carcinogenic  
(up 2B)

classifiable

Example  
classifications based  
on two evidence  
streams

ably carcinogenic  
(Group 2A)

ably carcinogenic  
(Group 2B)

Not classifiable  
(Group 3)

## With *inadequate* human cancer evidence

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
	Sufficient	Strong (exposed humans)	
Limited	Sufficient		Probably carcinogenic (Group 2A)
Limited		Strong	
	Sufficient	Strong (human cells or tissues)	
		Strong (mechanistic class)	Possibly carcinogenic (Group 2B)
Limited			
	Sufficient		Not classifiable (Group 3)
		Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



ably carcinogenic  
up 2A)

ably carcin  
up 2B)

classifiable

With *less-than-sufficient*  
bioassay evidence

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
Limited	Sufficient	Strong (exposed humans)	Probably carcinogenic (Group 2A)
Limited	Sufficient	Strong	
	Sufficient	Strong (human cells or tissues)	Possibly carcinogenic (Group 2B)
Limited		Strong (mechanistic class)	
	Sufficient	Strong	Not classifiable (Group 3)
	Sufficient	Strong (does not operate in humans)	
All other situations not listed above			

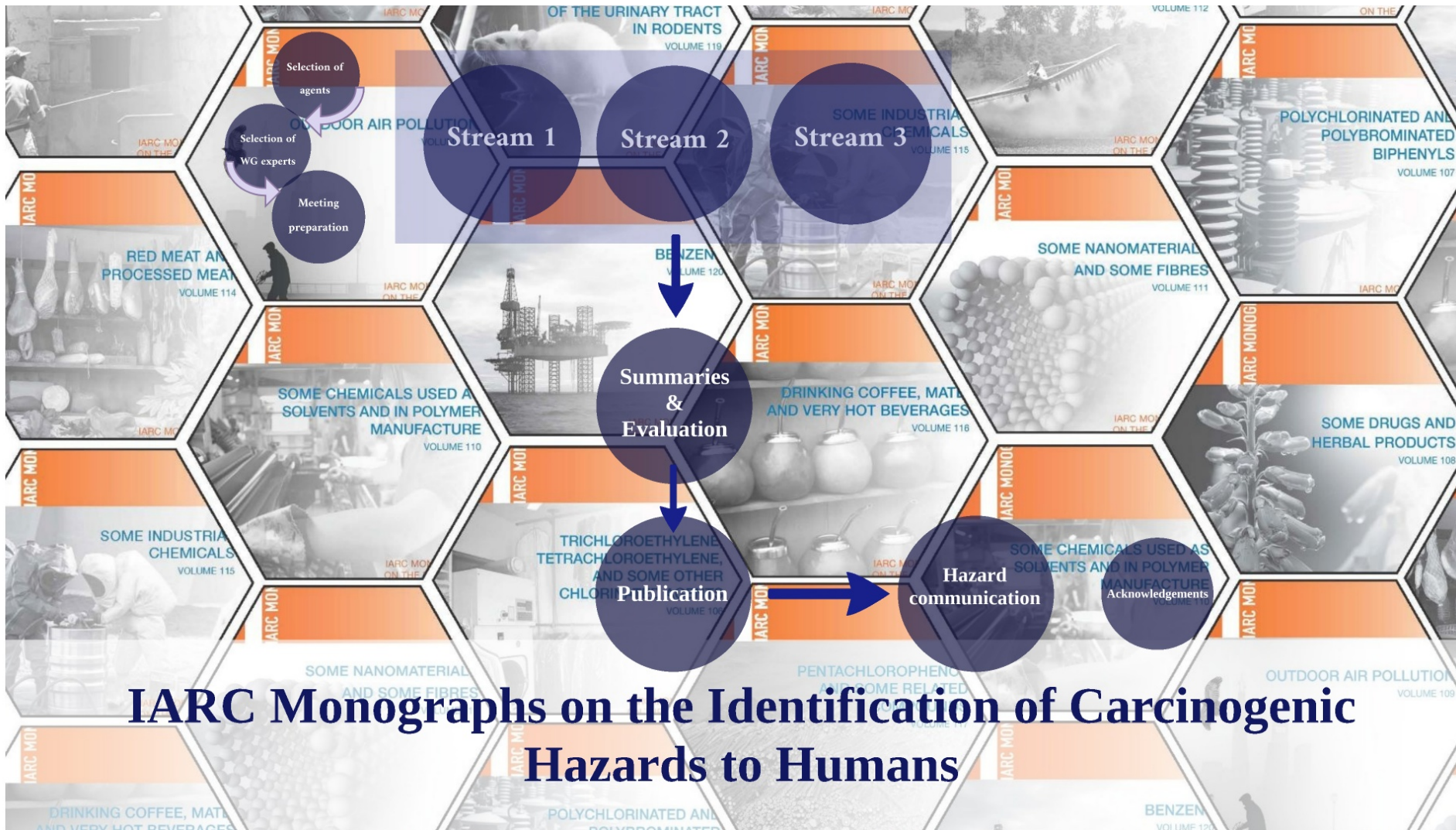
ably carcinogenic  
up 2A)

ably carcinogenic  
up 2B)

classifiable

## With *less-than-strong* mechanistic evidence

Evidence of Cancer in Humans	Evidence of Cancer in Experimental Animals	Mechanistic Evidence	Evaluation
Sufficient			Carcinogenic (Group 1)
Limited	Sufficient		Probably carcinogenic (Group 2A)
Limited		Strong	
	Sufficient	Strong (human cells or tissues)	
		Strong (mechanistic class)	
Limited			Possibly carcinogenic (Group 2B)
	Sufficient		
		Strong	
	Sufficient	Strong (does not operate in humans)	Not classifiable (Group 3)
All other situations not listed above			



# IARC Monographs on the Identification of Carcinogenic Hazards to Humans



Results of evidence synthesis and consensus evaluation are published in *The Lancet Oncology* after each meeting

THE LANCET Oncology Log in

NEWS | VOLUME 17, ISSUE 12, P1637-1638, DECEMBER 01, 2016

### Carcinogenicity of pentachlorophenol and some related compounds

Kathryn Z Guyton • Dana Loomis • Yann Grosse • Fatima El Ghissassi • Véronique Bouvard • Lamia Benbrahim-Talaa • et al. [Show all authors](#)

Published: October 23, 2016 • DOI: [https://doi.org/10.1016/S1470-2045\(16\)30513-7](https://doi.org/10.1016/S1470-2045(16)30513-7)

THE LANCET Oncology Log in

NEWS | VOLUME 19, ISSUE 12, PE661-EG62, DECEMBER 01, 2018

### Carcinogenicity of some nitrobenzenes and other industrial chemicals

IARC Monographs Vol 123 Group 1 • [Show footnotes](#)

Published: November 01, 2018 • DOI: [https://doi.org/10.1016/S1470-2045\(18\)30823-4](https://doi.org/10.1016/S1470-2045(18)30823-4)

In October, 2018, 14 experts from six countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to finalise their evaluation of the carcinogenicity of ortho-phenylenediamine and its dihydrochloride salt, 2-chloronitrobenzene, 4-chloronitrobenzene, 1,4-dichloro-2-nitrobenzene, 2,4-dichloro-1-nitrobenzene, 2-amino-4-chlorophenol, para-nitroanisole, and N,N-dimethylacetamide. These assessments will be published in Volume 123 of the IARC Monographs.<sup>1</sup>



Monographs are published online and printed...

## IARC Monographs on the Identification of Carcinogenic Hazards to Humans

IARC Monographs on the Identification of Carcinogenic Hazards to Humans identify environmental factors that can increase the risk of cancer. Interdisciplinary Working Groups of expert scientists review the published studies and evaluate the weight of the evidence. To date, 971, more than 1000 agents have been evaluated.

### CATEGORIES

Sort by: PUBLICATION YEAR (LATEST-EARLIEST)

View: 20

1 2 3 4 5

Classification of Agents (27)

Monographs on Identification of Carcinogenic Hazards to Humans (123)

Monographs on Prevention of Cancer (8)

Scientific Publications (181)

Technical Publications (57)

Handbooks of Prevention (17)

Working Group Reports (13)

Biennial Reports



**Some Nitrobenzenes and Other Industrial Chemicals**  
IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 123

IARC  
2020  
Formats: PDF

[DETAILS](#)

Monographs Programme

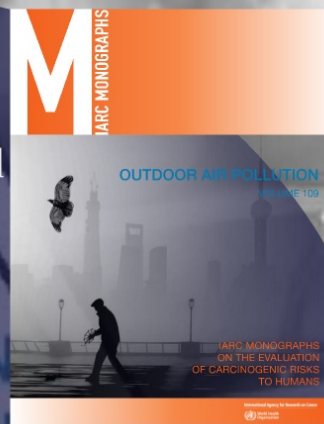


**Isobutyl Nitrite,  $\beta$ -Picoline, and Some Acrylates**  
IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 122

IARC  
2019  
Formats: Print Book, PDF

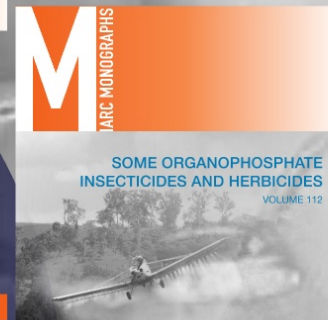
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Monographs Programme



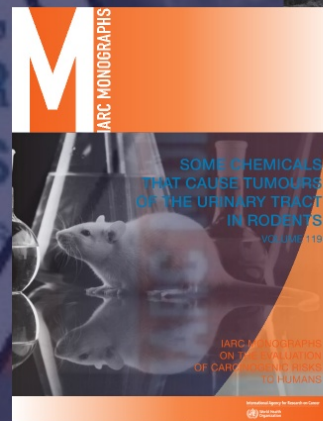
**OUTDOOR AIR POLLUTION**  
VOLUME 109

IARC MONOGRAPHS  
ON THE EVALUATION  
OF CARCINOGENIC RISKS  
TO HUMANS



**SOME ORGANOPHOSPHATE  
INSECTICIDES AND HERBICIDES**  
VOLUME 112

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**SOME CHEMICALS  
THAT CAUSE TUMOURS  
OF THE URINARY TRACT  
IN RODENTS**  
VOLUME 119

IARC MONOGRAPHS  
ON THE EVALUATION  
OF CARCINOGENIC RISKS  
TO HUMANS



**RED MEAT AND  
PROCESSED MEAT**  
VOLUME 114


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OF CARCINOGENIC RISKS  
TO HUMANS





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### IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

Lyon (FR): International Agency for Research on Cancer; 1988.  
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The IARC Monographs identify environmental factors that can increase the risk of human cancer. These include chemicals, complex mixtures, occupational exposures, physical agents, biological agents, and lifestyle factors. National health agencies can use this information as scientific support for their actions to prevent exposure to potential carcinogens.

Interdisciplinary working groups of expert scientists review the published studies and evaluate the weight of the evidence that an agent can increase the risk of cancer. The principles, procedures, and scientific criteria that guide the evaluations are described in the Preamble to the IARC Monographs.

Since 1971, more than 900 agents have been evaluated, of which more than 400 have been identified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans.

#### Contents

2018

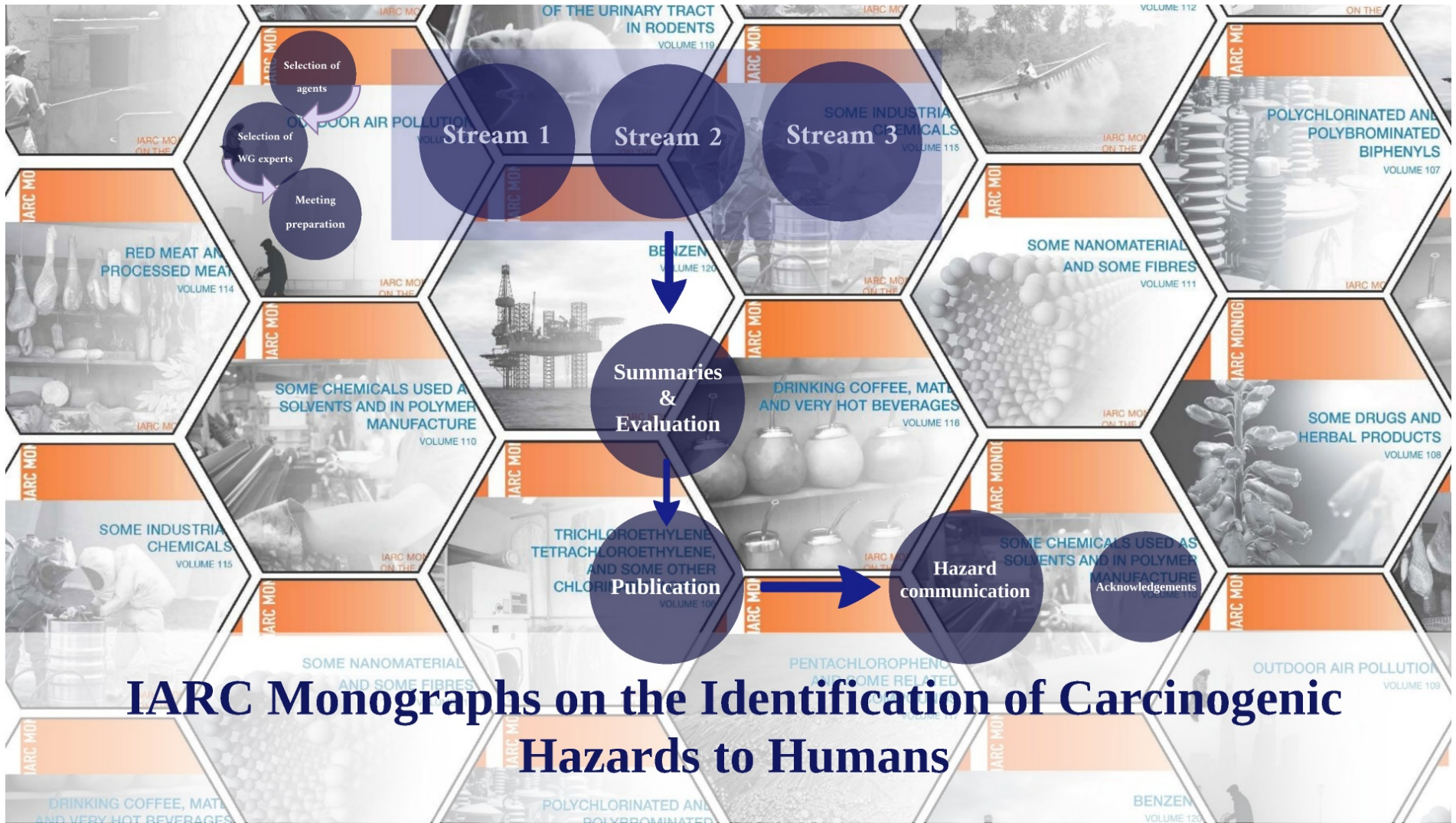
- [115. Some Industrial Chemicals](#)  
IARC Working Group on the Evaluation of Carcinogenic Risk to Humans.  
Lyon (FR): International Agency for Research on Cancer; 2018.
- [114. Red Meat and Processed Meat](#)  
IARC Working Group on the Evaluation of Carcinogenic Risk to Humans.  
Lyon (FR): International Agency for Research on Cancer; 2018.
- [113. DDT, Lindane, and 2,4-D](#)  
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Lyon (FR): International Agency for Research on Cancer; 2018.

2017

- [112. Some Organophosphate Insecticides and Herbicides](#)  
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Lyon (FR): International Agency for Research on Cancer; 2017.

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# IARC Monographs on the Identification of Carcinogenic Hazards to Humans





Hazard communication  
at all levels  
(institutional, major  
media outlets, public  
conferences, scientific  
seminars, etc.)

## IARC MONOGRAPHS CLASSIFICATION OF NIGHT SHIFT WORK

Night shift work is **PROBABLY CARCINOGENIC TO HUMANS (Group 2A)**  
 Limited evidence in humans. Sufficient evidence in experimental animals.



The IARC Monographs classification indicates the level of certainty that an agent can cause cancer (*hazard identification*).



Positive associations have been observed between night shift work and cancers of the:



Night shift work includes both working at night and working in a job that involves rapidly crossing many time zones.

### Specific types of workers



### Higher percentages of night shift workers are seen in



## IARC MONOGRAPHS VOL. 131

Cobalt, Antimony Compounds, and Weapons-Grade Tungsten Alloy (WGTA)  
 (2 – 18 March 2022)

27  
**Co**  
 Cobalt  
 58.93

51  
**Sb**  
 Antimony  
 121.76

74  
**W**  
 Tungsten  
 183.84

Co  
 Cobalt  
 58.93

Ni  
 Nickel  
 58.69

GROUP	Cobalt				Antimony		WGTA
	Cobalt metal*	Soluble cobalt(II) salts	Cobalt(II) oxide	Cobalt(II,III) oxide	Trivalent antimony	Pentavalent antimony	
	*Without tungsten carbide or other metal alloys				Cobalt(II) sulfide		
	Other cobalt(II) compounds						
	<b>Group 2A</b> Probably carcinogenic to humans	<b>Group 2A</b> Probably carcinogenic to humans	<b>Group 2B</b> Possibly carcinogenic to humans	<b>Group 3</b> Not classifiable as to its carcinogenicity to humans	<b>Group 2A</b> Probably carcinogenic to humans	<b>Group 3</b> Not classifiable as to its carcinogenicity to humans	<b>Group 2B</b> Possibly carcinogenic to humans
USES	Used in many industries, including in the manufacture of cutting and grinding tools, in pigments and paints, coloured glass, medical implants, batteries, and electroplating				Used in the production of flame retardants, plastics, lead-acid batteries, lead alloys, glass, pigments, and paints		WGTA (91–93% tungsten, 2–3% nickel, and 2–4% cobalt) is used in armour-penetrating munitions as a replacement for depleted uranium
POTENTIAL EXPOSURE	Production of hard metal		Production of cobalt powder		Production of flame retardants and electronic waste		Production or use of antileishmanial drugs
WHO? EXPOSURE	General population: exposed via ambient air, drinking-water, tobacco smoke, and food				General population: by inhalation of fuel and coal combustion products and road traffic dust and through drinking-water and consumer products such as toys and cosmetics		Production, firing or impact of the munitions; war-related injuries by alloy fragments

PENTACHLOROPHENOL  
 AND SOME RELATED

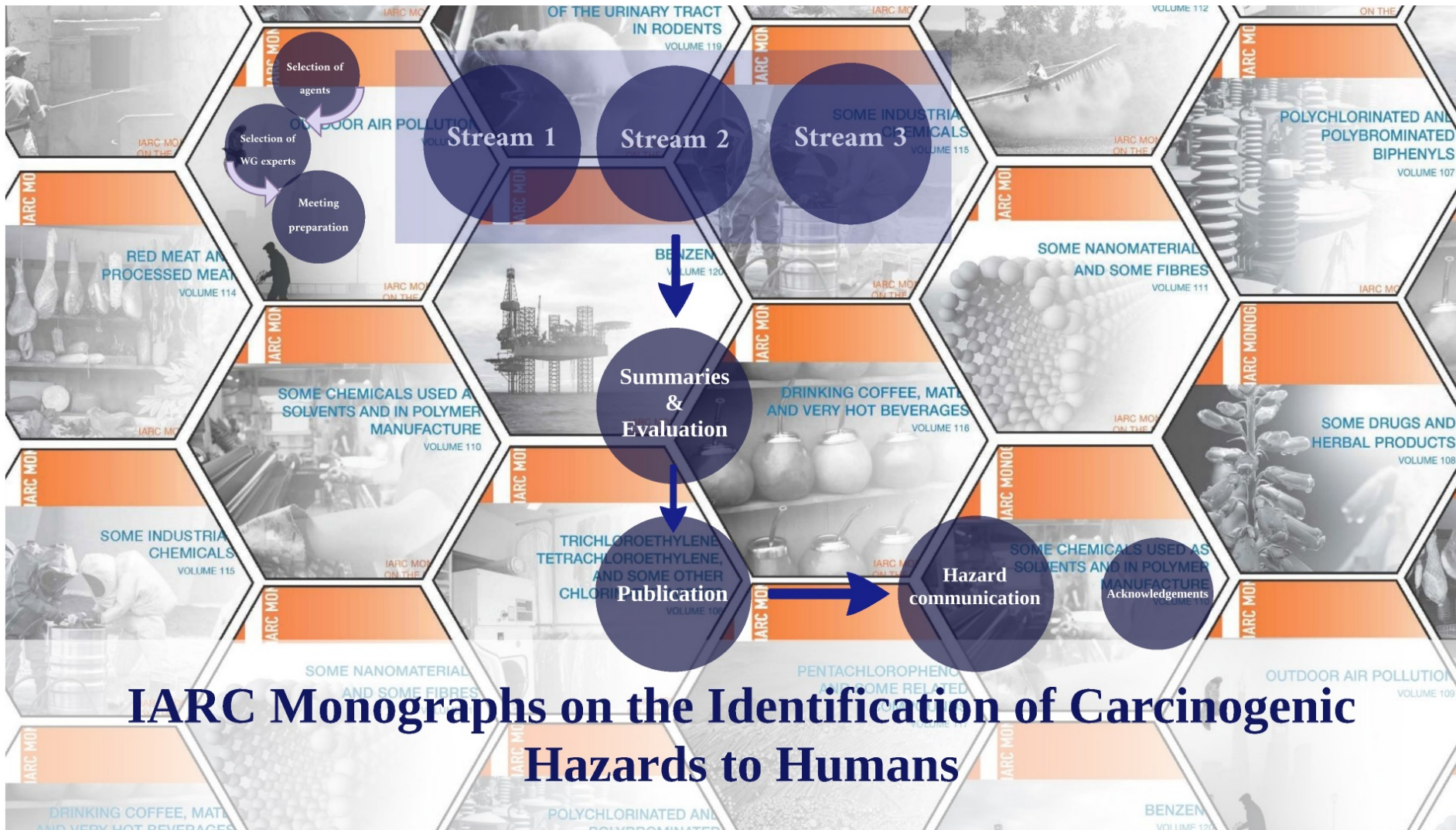


Hazard communication  
at all levels  
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seminars, etc.)









# IARC Monographs on the Identification of Carcinogenic Hazards to Humans



Advisory Group to Recommend an Update to the Preamble  
IARC, Lyon, France, 12–14 November 2018





The background of the slide is a collage of images related to the IARC Monographs programme. On the left, there is a photograph of a laboratory or industrial setting with various pieces of equipment. On the right, there is a photograph of a plant with white flowers. The text is overlaid on a dark blue circular shape in the center. The background also features some text from the monograph cover, including 'IARC MO', 'SOME CHEMICALS USED AS SOLVENTS AND IN POLYMER MANUFACTURE', and 'VOLUME 110'.

## *IARC Monographs programme*

Programme Head: Mary Schubauer-Berigan

Programme Secretary: Jennifer Nicholson

Scientists: Lamia Benbrahim-Tallaa; Nathan DeBono; Aline de Conti; Fatiha El Ghissassi; Yann Grosse; Federica Madia; David Richardson; Leslie Stayner; Eero Suonio; Susana Viegas; Roland Wedekind

Scientific Editor: Heidi Mattock

Technical Team: Sandrine Egraz (doc); Niree Kraushaar (production); Solène Quennehen (production & Prezi)

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- United States National Institute of Environmental Health Sciences
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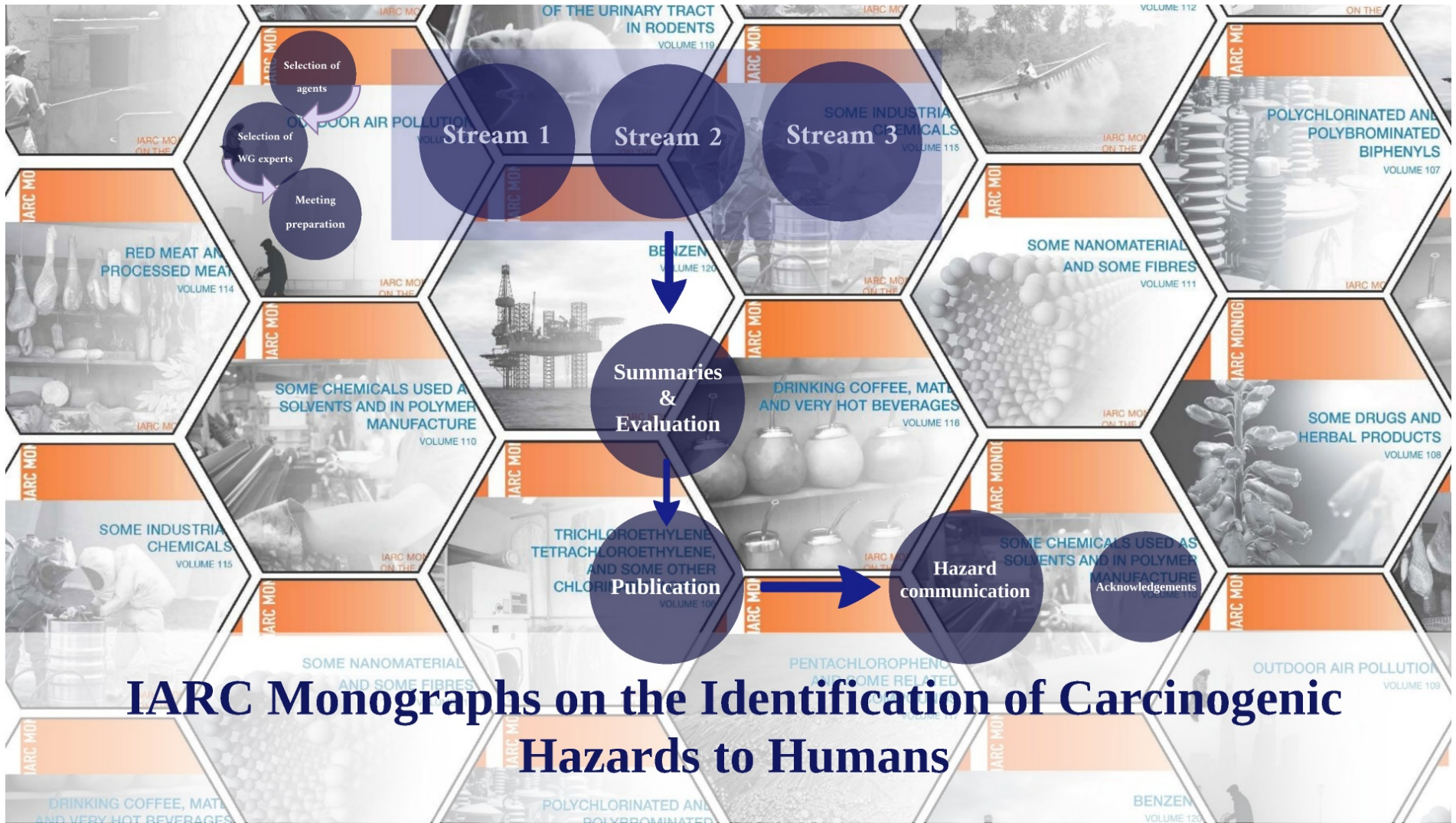
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Union Programme for Employment and Social Innovation, Easi





# IARC Monographs on the Identification of Carcinogenic Hazards to Humans