Air Pollution and Health; Are Particulates The Answer?

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AIR POLLUTION & HEALTH

There are effects at levels experienced in US during 1990's

PM measures give greatest association

Other pollution measures can have greater associations

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AIR POLLUTION & HEALTH

Toxicology is limited

CAPs Studies show some particulate response

- **- Is response related to human response**
- **- Other toxicology studies find responses to gases**

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PM Fractions

There is evidence that all PM is not equally toxic

- **Differences across studies**
- **Toxicology results independent of mass**

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NMMAPS Study

- **NMMAPS looked at association between daily mortality and PM_{10} in 90 cities; morbidity in 14 cities**

- **Association was positive within most cities**

- **Association was significant in meta-analysis combining cities**

- **But**
  - **Association within a city decreased as PM_{10} levels increased: i.e., the higher the PM_{10} level in a city, the lower the association**

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ARIES Study Components

Detailed Air Quality Data →

ARIES Study

- **Daily Mortality**
- **Emergency Visits**
- **Heart Rate Variability (Personal Exposure)**
- **Arrhythmic Events Trans-Telephonic event monitor?**
- **Unscheduled Physician Visits**

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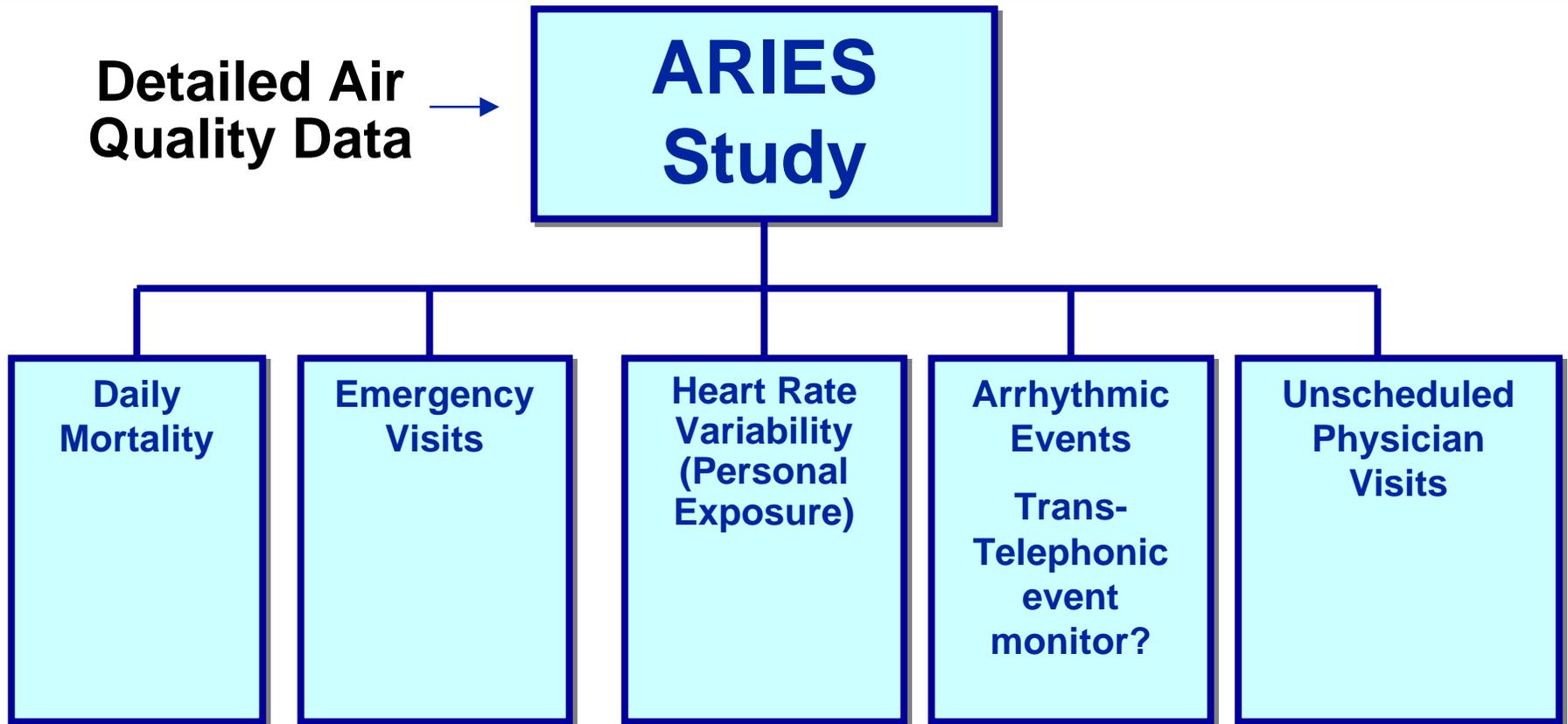
ARIES 24-hr Average Measurements

$PM_{2.5}$ **Mass, ions (sulfate, nitrate, chloride ammonium)**

                    Trace metals (Al-Pb)

                    Water soluble metals (Cr, Cu, Fe, Mn, Ni, V)

                    Organic carbon, elemental carbon

PM_{coarse} **Mass, ions, trace metals**

Biological   **Pollen and mold**

HEADS   **Ammonia and strong acidity**

VOCs   **Speciated HCs and oxygenates**

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ARIES Continuous Measurements

Gases O_3, NO, NO_2, NOy, HNO_3, SO_2, CO

$PM_{2.5}$ **Mass, sulfate, nitrate, ammonium, organic carbon, elemental carbon, light scattering, light absorption**

PM_{10}   **Mass, organic carbon, elemental carbon**

Meteorology   **Wind speed and direction, temperature, relative humidity, solar radiation, precipitation, barometric pressure**

Particle number   **User selectable size bins from 3 to 3000 nm**

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ARIES Air Quality Data

- **PM$_{10}$**
- **PM$_{2.5}$**
- **PM$_{10-2.5}$**
- **PM$_{2.5}$ components** — **Sulfates**
  Water-sol metals
  Acidity
  Organic matter
  Elemental carbon
- **Ultrafine PM**
- **O$_3$**
- **NO$_2$**
- **CO**
- **SO$_2$**
- **Polar VOCs**

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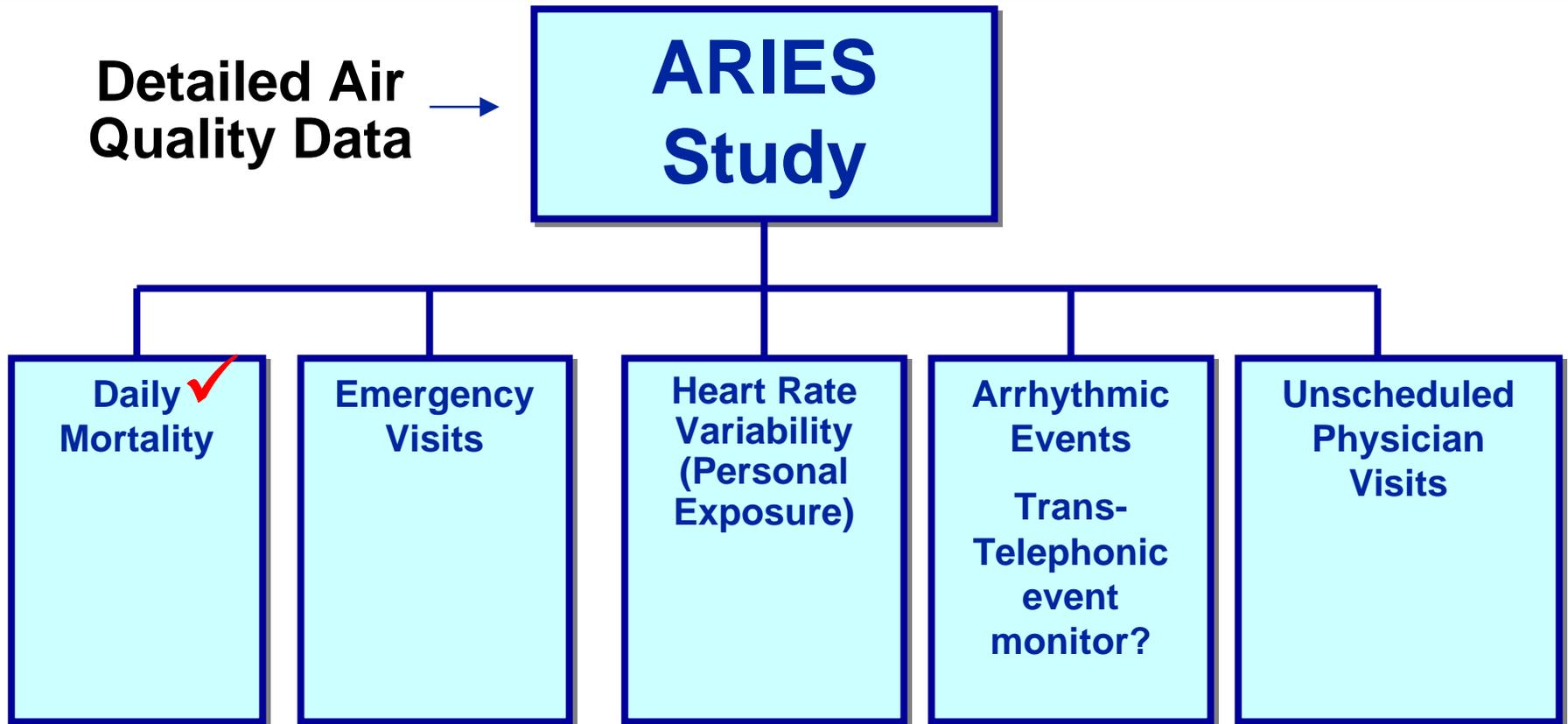
Mortality – 24 Month Data

Statistically Significant Associations

(Lag 0,1)

TOTAL MORTALITY   **>65 YRS.**

CO $PM_{2.5}$
 PM_{10}
                                "Coarse"
                                CO
                                EC
                                OC

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  Trans-Telephonic event monitor?
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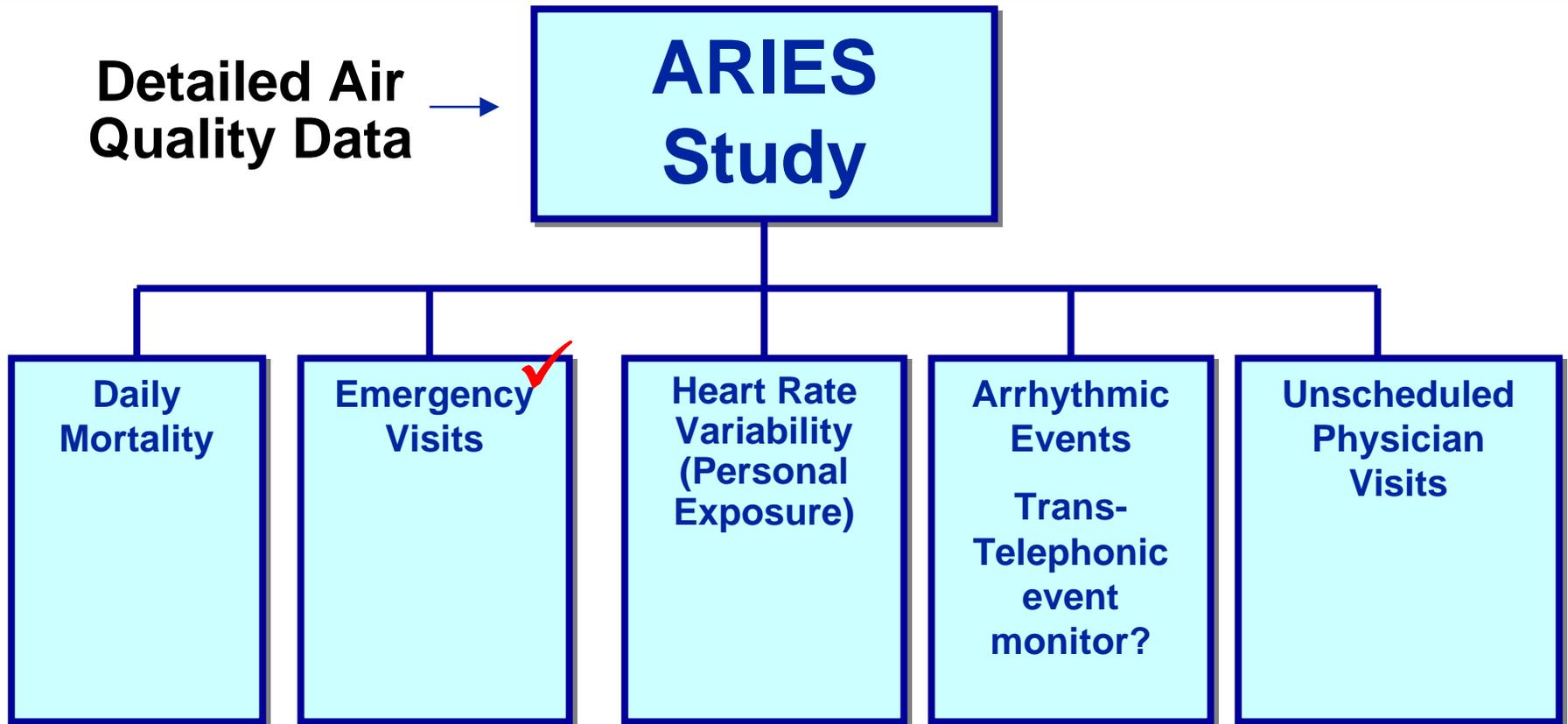
Case Group	Total number of ED visits (daily n)	
All RD	182,438	(239)
-- asthma	40,439	(53)
-- COPD	9,198	(12)
-- URI	109,795	(144)
-- LRI	23,366	(31)
All CVD	40,633	(53)
-- dysrhythmia	11,233	(15)
-- CHF	8,013	(11)
-- MI	4,687	(6)
-- cardiac arrest	3,526	(5)
-- peri/cerebro	9,897	(13)
ALL ED visits	1,865,061	(2,448)

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Hospital Emergency Room Admissions

Statistically Significant Associations

	Total Resp	Upper Resp	Lower Resp
PM Mass	PM_{10}	PM_{10}	-
Metals	-	-	-
Acids	-	-	-
Organics	-	-	OC
Sulfates/Nitrates	-	-	-
Gaseous Pollutants	$O_3; SO_2$	$O_3; CO$	SO_2

Hospital Emergency Room Admissions

Statistically Significant Associations

	Total CVD	Ishemic	Congestive Heart Failure
PM Mass	$PM_{2.5}$	-	-
Metals	?	-	-
Acids	-	-	-
Organics	Polar VOCs;EC;OC	OC	?EC;?OC
Sulfates/Nitrates	-	-	-
Gaseous Pollutants	NO_2;CO	-	NO_2 ;CO;SO_2

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Season-Specific Estimates

PM2.5 and CVD — Cold Season, Warm Season
PM10 and MI — Cold Season, Warm Season
OC and IHD — Cold Season, Warm Season
Risk Ratio per SD (0.80–1.20)
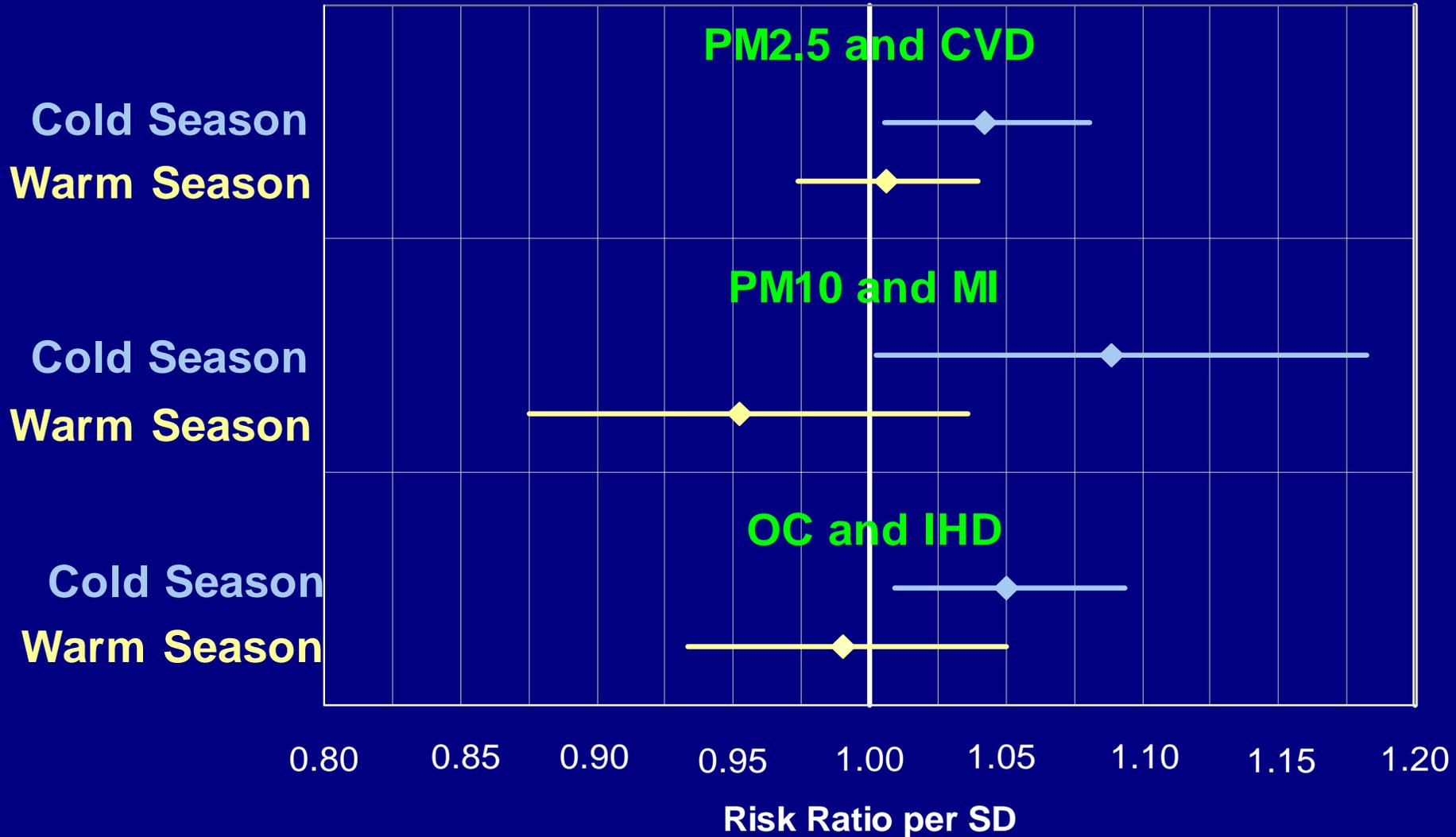
Source Allocation of Primary PM-2.5 Organic Carbon - ARIES Site
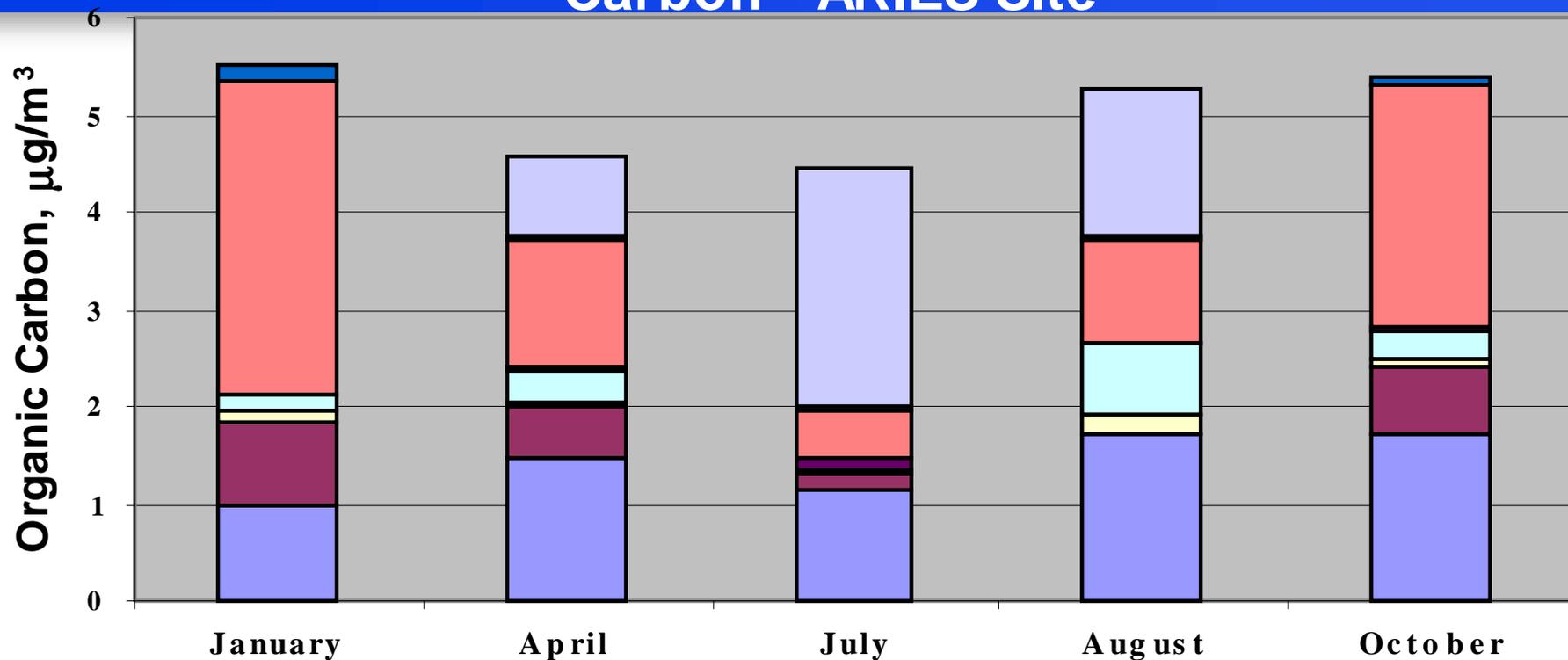
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ARIES Study Components

Detailed Air Quality Data →

ARIES Study

- **Daily Mortality**
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- **Unscheduled Physician Visits** ✓

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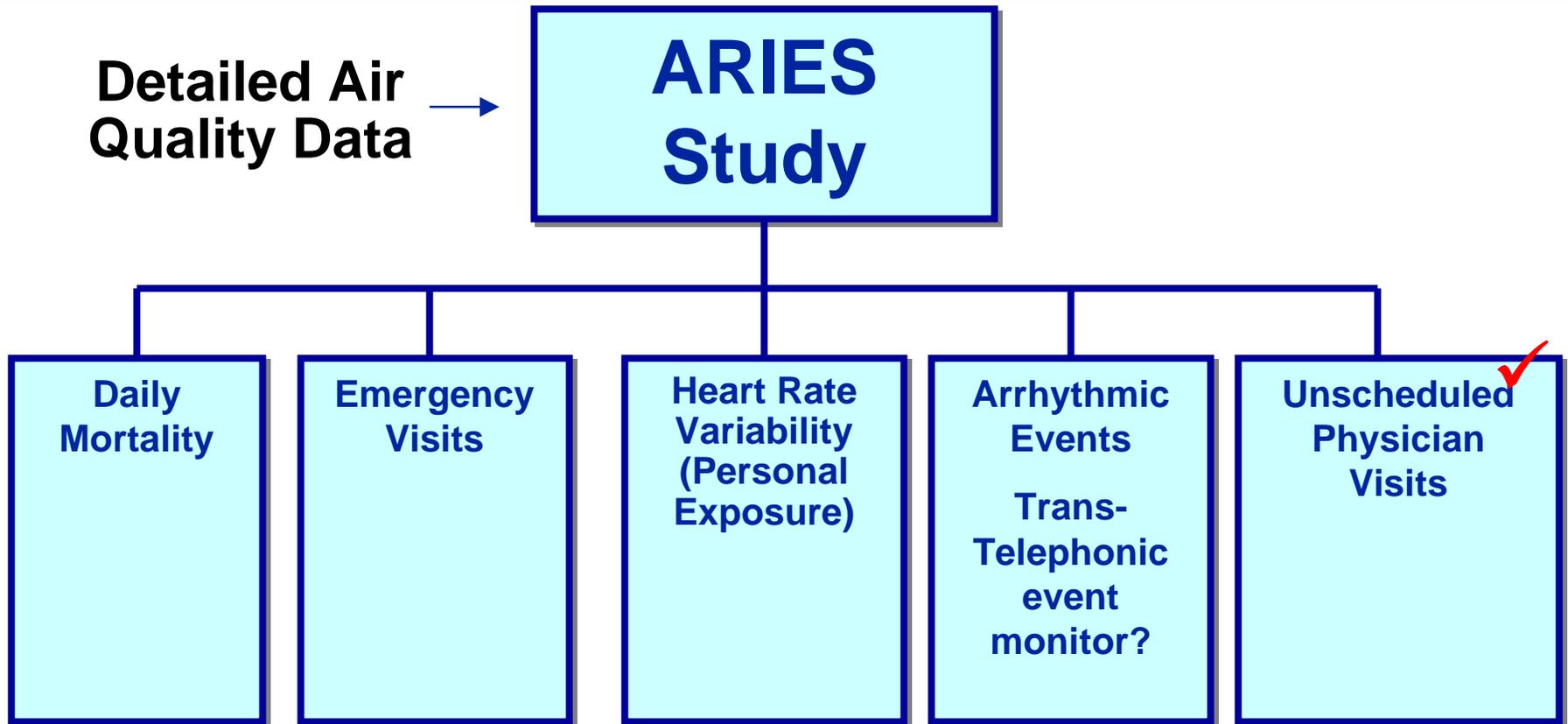
Mean, Standard Deviation, Minimum, and Maximum Visits* per Day, 8/98 – 8/00.

	Urgent				ALL			
	Mean	s.d.	Min.	Max.	Mean	s.d.	Min.	Max.
Asthma	30.0	16.6	2	89	49.3	28.6	2	134
Adult	11.7	6.8	0	38	22.6	13.7	0	66
Child (18 and under)	18.3	11.7	0	67	26.7	17.3	0	95
URI	263.0	138.8	37	837	363.4	208.7	37	1095
LRI	12.0	8.6	0	50	18.5	13.7	0	71

* Non-Network Visits

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Unscheduled Physician Visits

Statistically Significant Associations

Short Lags (0-2 days)

	Asthma	URI	LRI
PM Mass	-	"Coarse";PM_{10}	-
Acid	-	- ve	-
Organics	-	-	-
Sulfates	-	-	-
Gaseous Pollutants	-	NO_2	-

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Unscheduled Physician Visits

Statistically Significant Associations

Longer Lags (>2 days)

	Asthma	URI	LRT
PM Mass	"coarse"; PM_{10}	"coarse"; PM_{10}; $?PM_{2.5}$	"coarse"; PM_{10}
Acid	-	-	Acid
Organics	?EC	-	EC
Sulfates	-ve	-ve	-
Gaseous Pollutants	O_3; NO_2	NO_2	NO_2

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ARIES Study Components

Detailed Air Quality Data →

ARIES Study

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AICD Device

- Patients at risk for VT/VF

- Continuous monitoring of heart rate with ECG

- Discharges therapeutic shock or pacing when detects ventricular arrhythmia

- Records data on arrhythmic events and discharges

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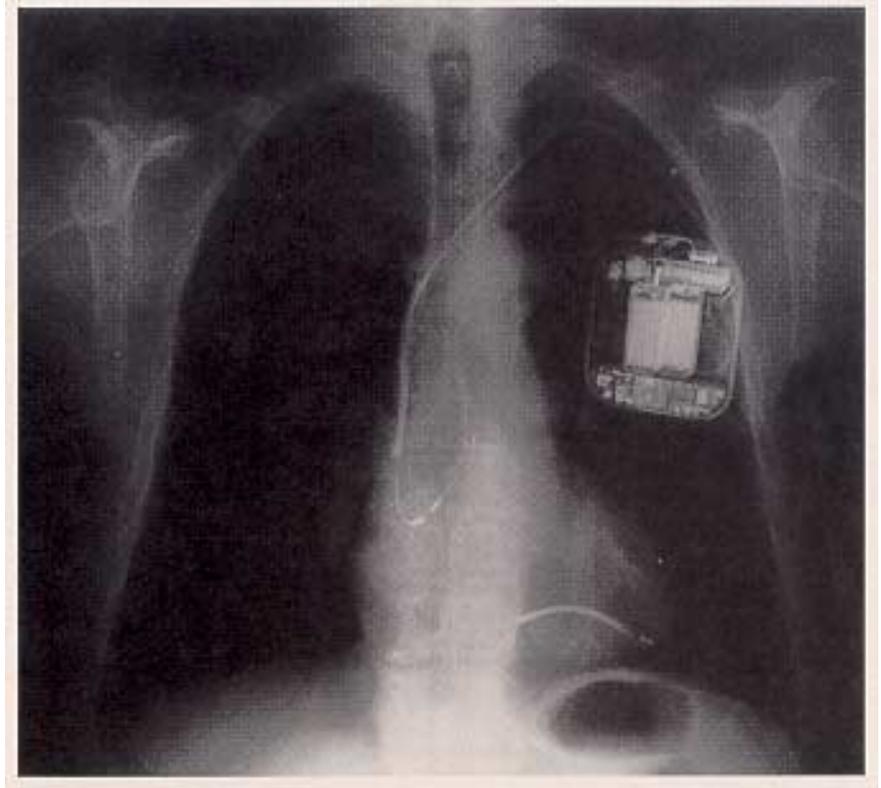
AICD Patient Descriptives
Preliminary AICD Data (1/1/1993-8/31/2000)

No. of patients	572
Mean age in years (range)	63 (18 – 88)
Proportion of males	79 %
No. of patients with 1+ event No. of patients with 10+ events	335 102
No. of patients with 1+ event requiring therapy No. of patients with 10+ event requiring therapy	256 54
No. of patients with 1+ event requiring shock No. of patients with 10+ event requiring shock	201 5

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AICD Air Quality Data Source

- **AIRS/State Network**
  - **1/1/1993-8/31/2000**
  - **Criteria pollutants: PM_{10}, O_3, NO_2, CO, SO_2**

- **ARIES Monitor**
  - **8/1/1998-8/31/2000**
 - **$PM_{2.5}$, $PM_{2.5}$ components, CP, ultrafine PM, polar VOCs**

AICD Results

Statistically significant associations between events and AQ variable (same day):

CO

"coarse" fraction

OC (within $PM_{2.5}$)

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ARIES Study Components

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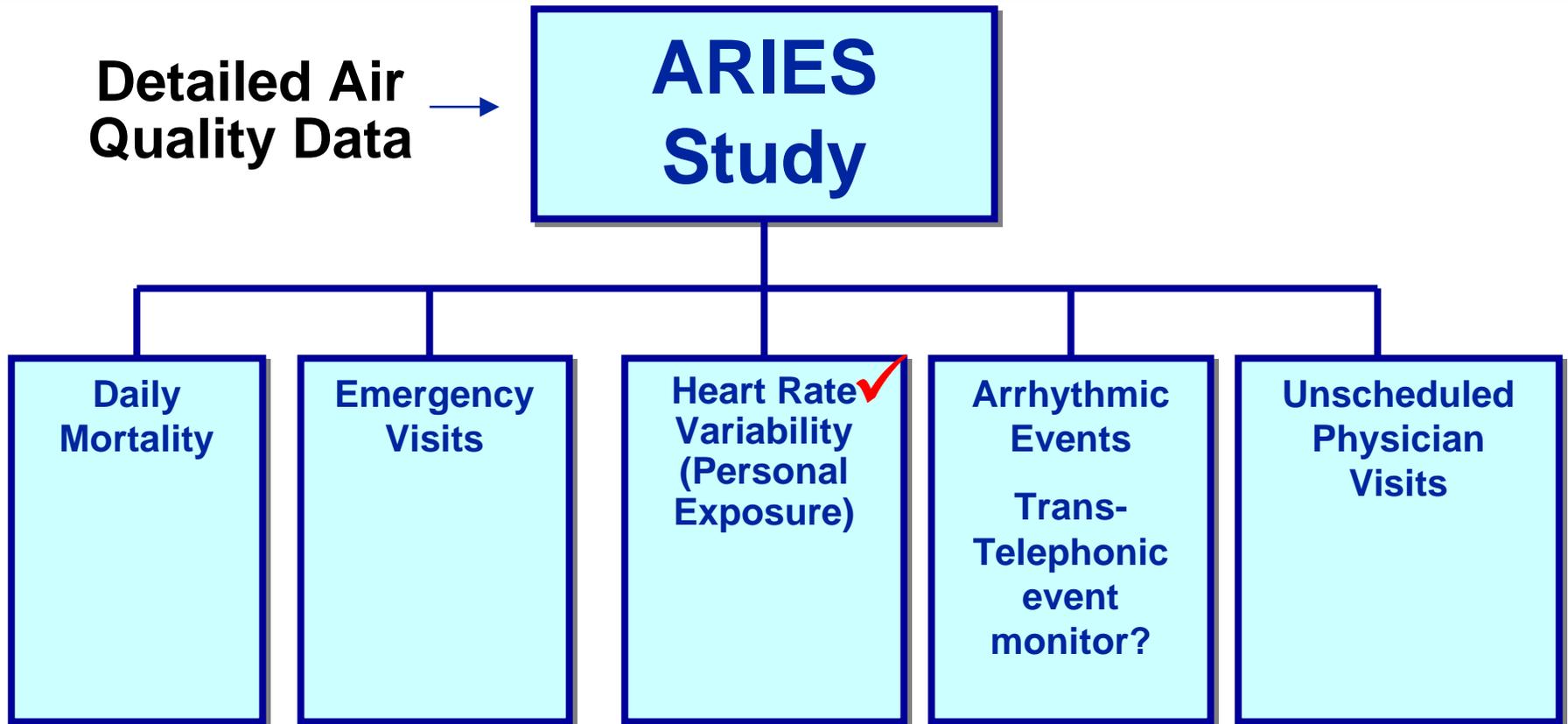
ARIES – More Detailed Organic Analyses Underway

- **Total Alkanes**

- **Total Alkenes**

- **Total Aromatics**

- **Other Non-Methane Hydrocarbons**

- **DCM – Soluble Fraction**

- **Acetone – Soluble Fraction**

- **Water – Soluble Fraction**

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CONCLUSIONS

Don't forget gases; they may be particularly important for respiratory outcomes

CONCLUSIONS

Chemistry is important; whenever $PM_{2.5}$ is implicated, EC and/or OC are implicated. Sulfates/nitrates are never significant

CONCLUSIONS

"Coarse" PM may be an issue, especially for respiratory endpoints