

THE CAUSES, NUMBERS AND LOCATIONS OF ATLANTIC TROPICAL CYCLONE FATALITIES

for the
2019 WMO Hurricane Workshop

by
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NATIONAL HURRICANE CENTER MISSION

To save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts and analyses of hazardous tropical weather, and by increasing understanding of these hazards.

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So, what IS the threat to life from tropical cyclones?

If you don't know where you're going, you won't know when you get there.

IMPORTANT DEFINITIONS

“Direct Death”

A direct death refers to a fatality attributable to the forces of the storm.

Examples include drowning in storm surge, freshwater flood from rain, or storm-driven waves. It also includes lives lost to physical trauma incurred from wind-borne debris or structural failure induced by wind (tornadic and otherwise).

“Indirect Death”

An indirect death refers to other fatalities that would not be expected to occur in the absence of the storm.

Examples include heart attacks, vehicle accidents, falls from a roof or ladder.

HISTORICAL OVERVIEW

Losses from Atlantic tropical cyclones
since discovery of New World

DEADLIEST ATLANTIC TROPICAL CYCLONES

(3,000 or more direct deaths; within past 100 years)

Name/Locations	Year	Deaths)
1. <i>The Great Hurricane</i> (Lesser Antilles, marine)	1780	22,000+
2. <i>Mitch</i> (central America)	1998	10,000+
3. <i>The Galveston Hurricane</i>	1900	8,000-12,000
4. <i>Fifi</i> (Honduras)	1974	8,000-10,000
5. Dominican Republic	1930	8,000
6. <i>Flora</i> (Haiti, Cuba)	1963	8,000
7. Point-a-Pitre Bay (Guadeloupe)	1776	6,000+
8. Grand Banks of Newfoundland	1775	4,000
9. Puerto Rico, Carolinas	1899	3,433+
10. Florida, Guadeloupe, Puerto Rico	1928	3,411+
11. Cuba, Cayman Islands, Jamaica	1932	3,107+
12. Central Atlantic	1782	3,000+
13. Martinique	1813	3,000+
14. El Salvador, Honduras	1934	3,000+
15. <i>Jeanne</i> (Haiti)	2004	3,000+
16. Western Cuba	1791	3,000

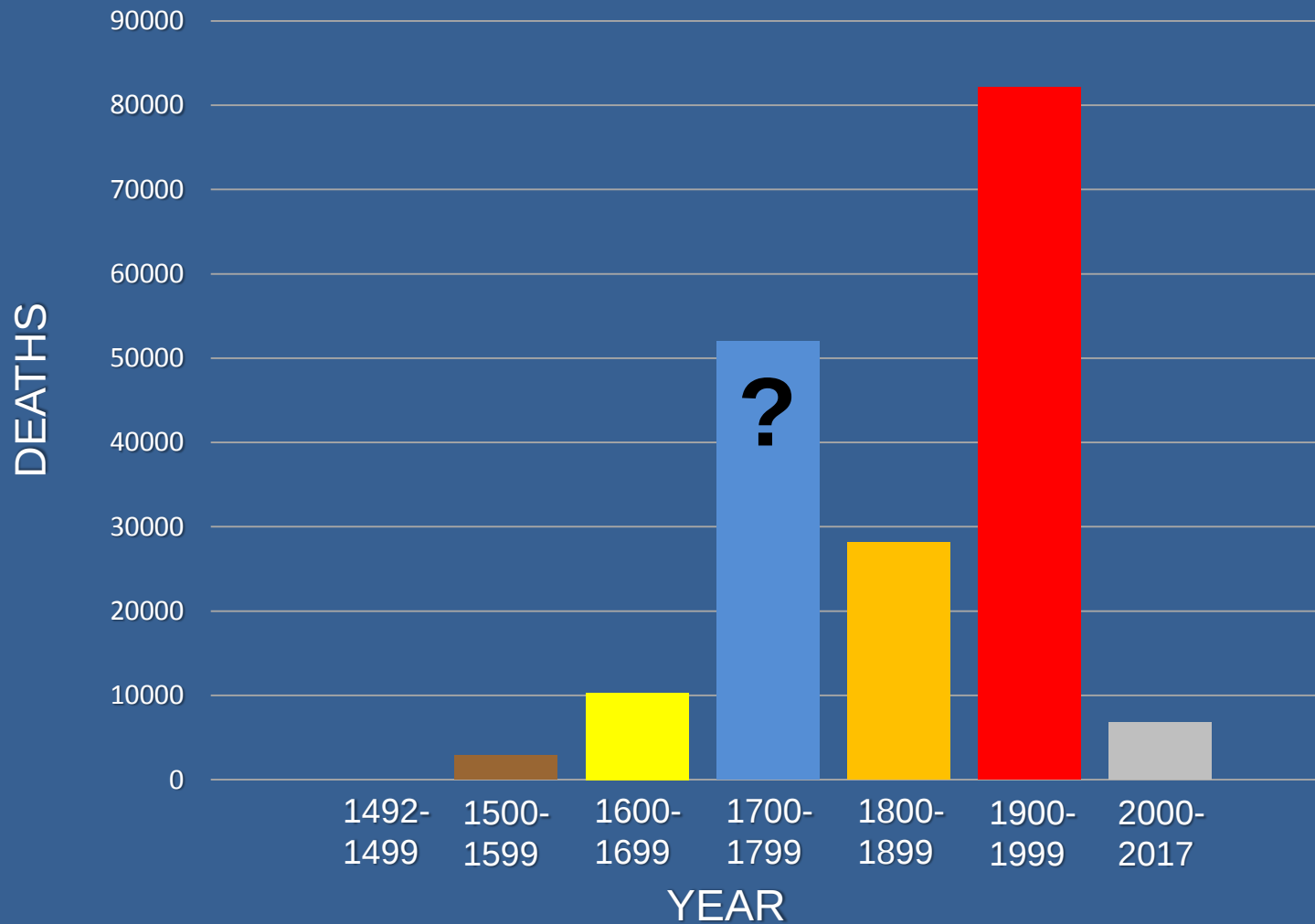
DEADLIEST ATLANTIC TROPICAL CYCLONES

(3,000 or more direct deaths; within past 100 years in **yellow**)

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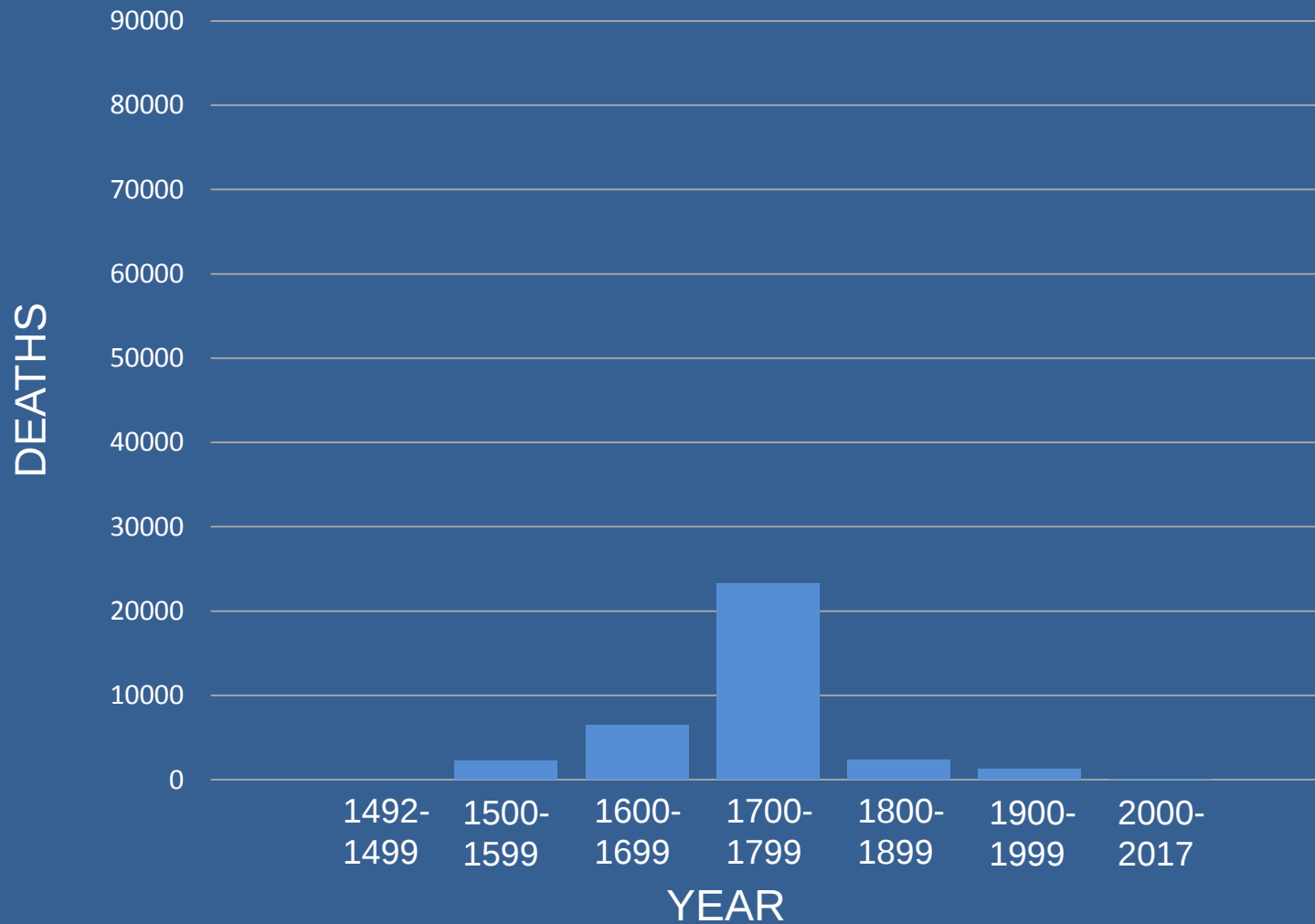
ATLANTIC TROPICAL CYCLONE DIRECT DEATHS BY YEAR

(totals from ~300 quantified cases of 25+ deaths)



ATLANTIC TROPICAL CYCLONE MARINE DIRECT DEATHS BY YEAR

(quantified cases only)



EARLY YEARS

The population *on* the Atlantic was the most vulnerable to storms through the 18th century
because
storms moved faster than the news of their approach and faster than the vessels
and
ships and crews were ill-equipped to ride out storms

STATEMENTS ON THE VULNERABILITY OF EARLY MARINERS

- *“It is doubtful if any sailing ship or any man aboard survived in this [center] sector of a really great hurricane.”* (Tannehill 1955)
- *“By these kind of Tempests the King of Spain hath lost at several times near 1000 sail of ships.”* (Ludlum 1963)
- It is estimated that three out of every five sailors offshore of New England during the period 1790 to 1850 drowned (Snow 1943).
- To 1825, *“more than five percent of the vessels in the [West] Indies navigation were lost due to shipwrecks; the biggest part due to bad weather...”* (Marx 1981, from Parliament Select Committee 1839).
- *“...the annual loss of life, occasioned by the wreck or foundering of British vessels at sea, may, on the same grounds [i.e., 'the boisterous nature of the weather and the badness of the ships'], be fairly estimated at not less than One Thousand persons in each year...”* (Parliament Select Committee 1839).

Question for the class

Rank the following areas by most direct deaths. Which area has had the most?

- (a) Greater Antilles
- (b) Lesser Antilles
- (c) Marine
- (d) Mexico and Central America
- (e) United States

Answer: On next slide

LOCATION OF TROPICAL CYCLONES DIRECT DEATHS (quantified cases only)



Total = 179,000

UNQUANTIFIED CASES

Examples of some of the likely largest losses...

Hispaniola, 1508: “...many men were lost in this city and in the greater part of the island...”;
“...destroying...the entire population of Buenaventura”

Near Azores, Aug. 1591: “Over a hundred ships, galleons and merchant ships...were wrecked,
their crews drowned” (Spanish galleons ~200 men; 1580 English ship carried 480)

Western Cuba, Sep. 1640: “36 vessels affected; 4 thrown on shore; “...nearly all the sailors
drowned, **excepting** 260 that were saved”

Nevis, 1689: “A dreadful mortality swept away one-half of the inhabitants of Nevis.” (Pop. est. 5,000)

Guadeloupe, Oct. 1766: “...twelve inbound slave ships from Africa were also totally lost.”
Most slave ships carried 100-700 slaves. $12 \times 400 = \sim 5,000$ in one storm

New England, Sep. 1815: “...the loss of life so heavy that the newspapers did not have space
enough to give all the details of the marine disasters.”

Loss in 287 unquantified cases of possibly 25+ direct deaths = 50,000? 150,000? 250,000?

Total Number of Atlantic tropical cyclone deaths?

Direct

Estimated from quantified events:	179,000+
Estimated from unquantified events:	150,000?
Estimate from undocumented events:	<u> ?</u>
Estimated total Direct:	333,000 - 500,000

Indirect

Estimated total Indirect*:	267,000 - 400,000
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Estimated total deaths: 1/2 million – 1 million

* Indirect = ~0.8 Direct (Rappaport 2016)

U.S. ATLANTIC TROPICAL CYCLONE DIRECT DEATHS 1963-2012

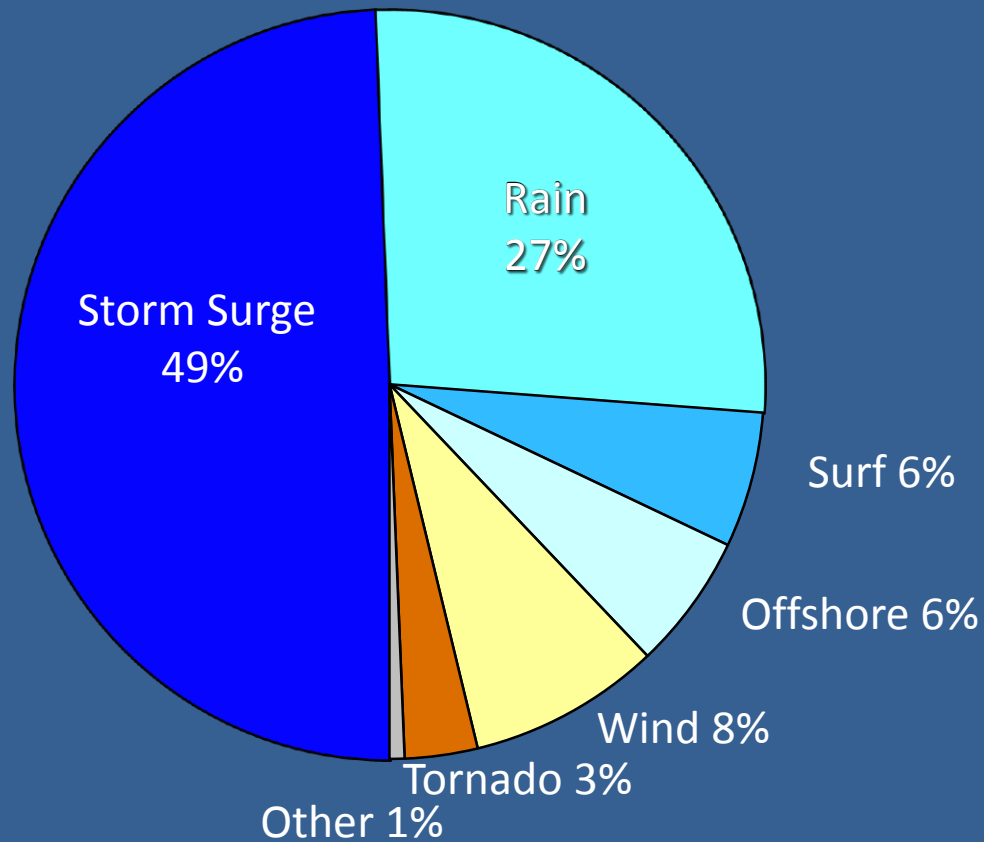
Question for the class

Which tropical cyclone hazard has been the most deadly in the United States over the past ~50 years?

- (a) Rainfall
- (b) Storm Surge
- (c) Tornado
- (d) Wind (non-tornadic)

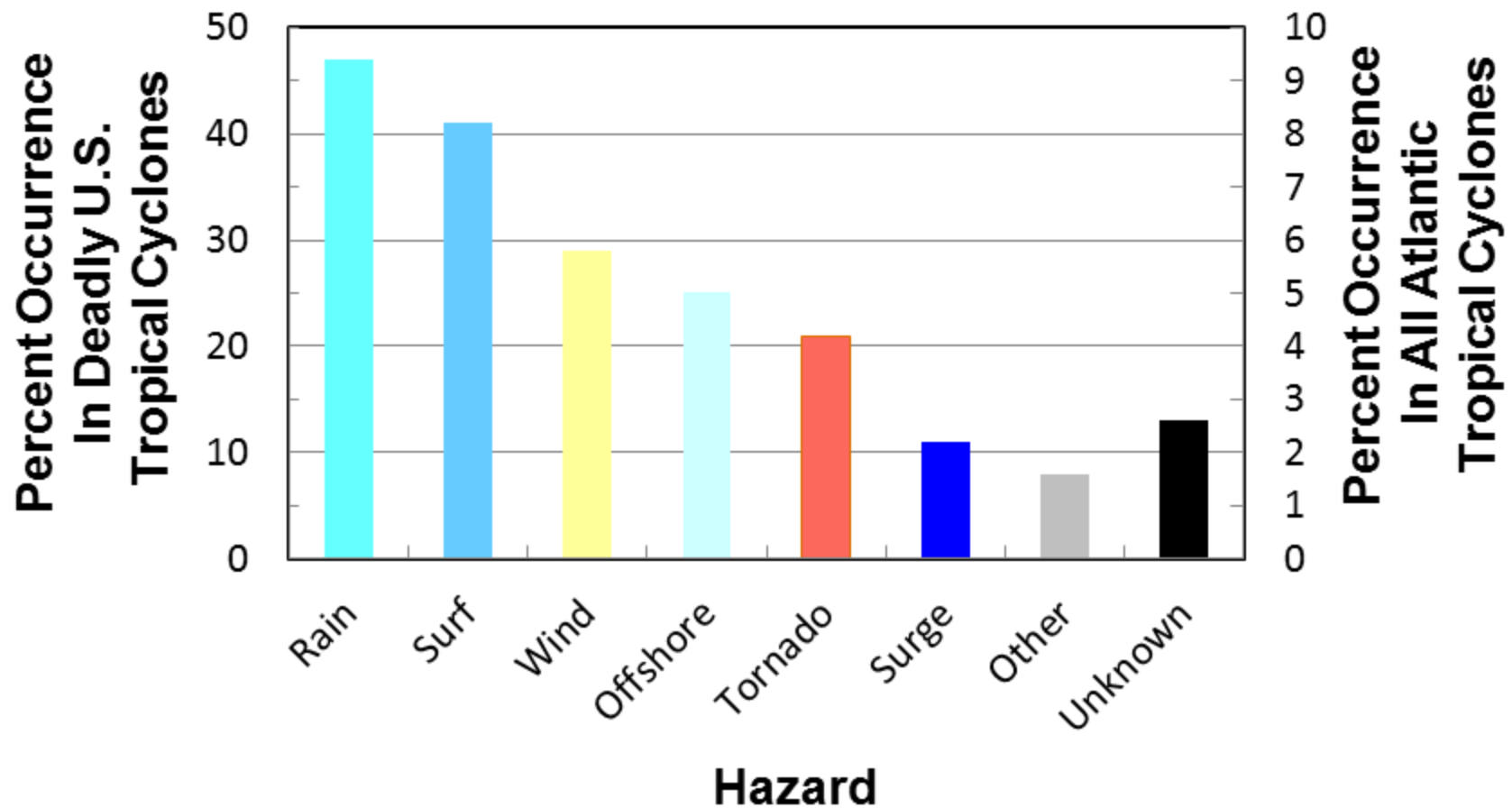
Answer: (b) Storm Surge

U.S. ATLANTIC TROPICAL CYCLONE DIRECT DEATHS 1963-2012



U.S. ATLANTIC TROPICAL CYCLONE DIRECT DEATHS 1963-2012

Distributed by Storm Frequency



U.S. DIRECT DEATHS (1963-2012)

Slide 1 of 2

Key Findings

- Average 40-50 direct deaths per year
- Large storm-to-storm and year-to-year variability
- On average: 1 out of 5 or 6 Atlantic tropical cyclones cause U.S. deaths
2 or 3 fatal storms per year
- Deadliest storms not always the strongest:
Only 3 of the 10 deadliest were major hurricanes
6 of the 10 were tropical storms or Category 1 hurricanes
- Six storms (1% of total storms) accounted for about 2/3 of the deaths
- More males than females by 71 to 29%

U.S. DIRECT DEATHS (1963-2012)

Slide 2 of 2

Key Findings

- Around 90% due to water, most by drowning
- Storm surge responsible for most
- Freshwater flood from rain responsible for second most
- Deaths from flooding rains occur in more storms than any other hazard

U.S. INDIRECT DEATHS (1963-2012)

Key Findings

- Average around 36 per year, **almost as many as direct deaths**
- Can occur before, during or after the storm
- Four primary contributing factors, sometimes in combination.

Question for the class

Which event is associated with the most *indirect* deaths in U.S. tropical cyclones?

- (a) Evacuation Process
- (b) Fire
- (c) Heart Attack
- (d) Power outage
- (e) Vehicle accident

Answer: (c) Heart Attack

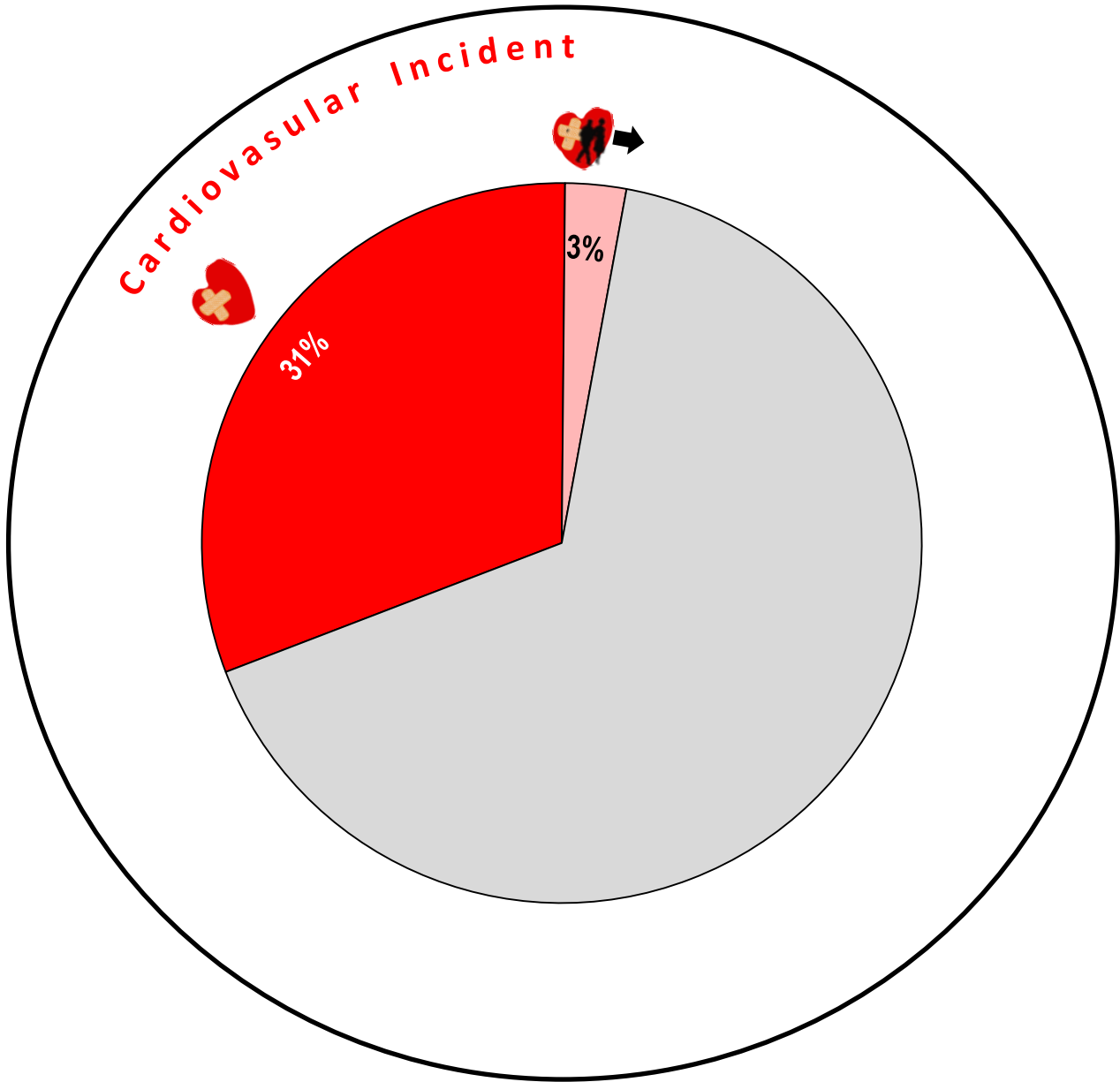
U.S. Atlantic Tropical Cyclone Indirect Deaths, 1963-2012



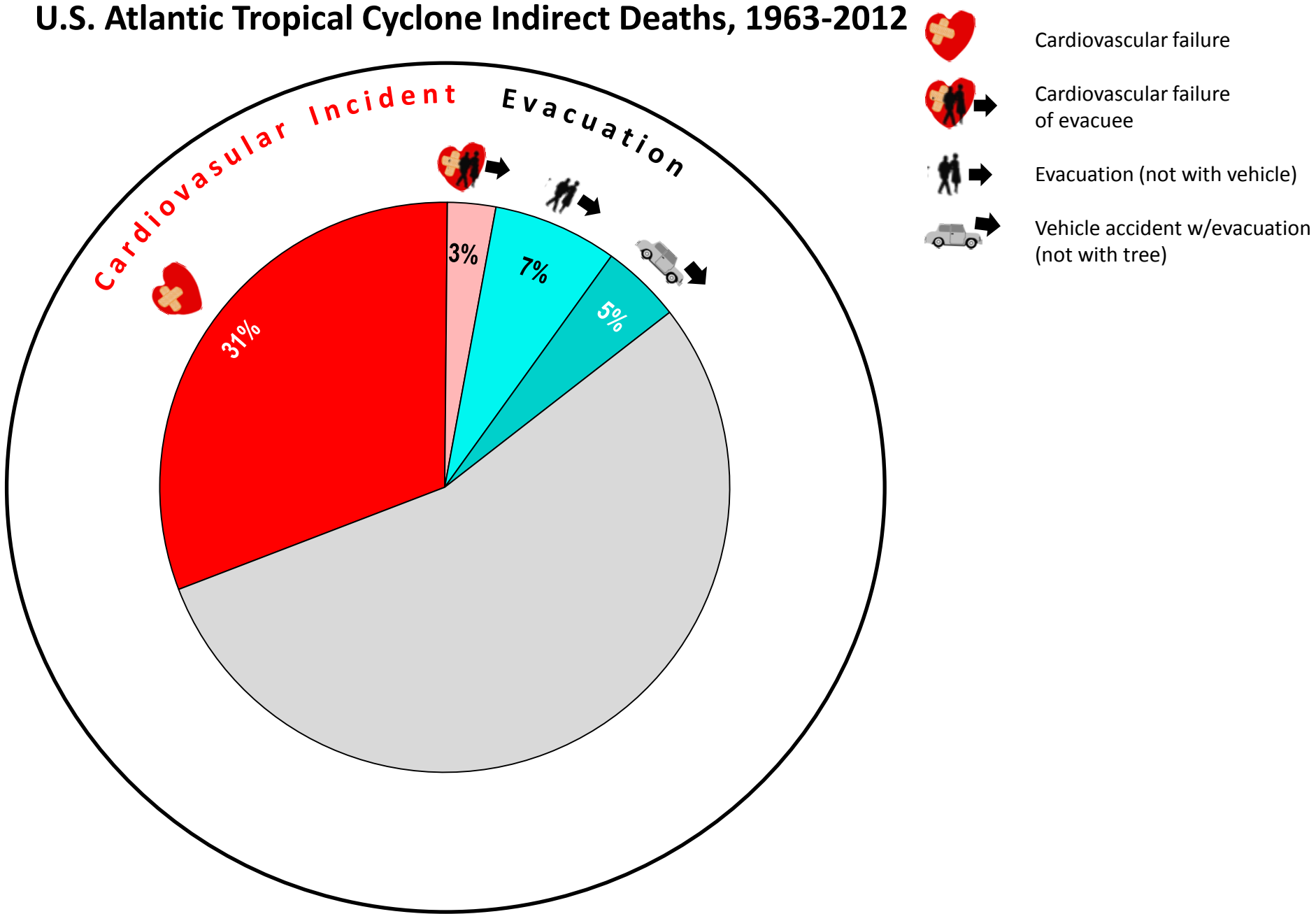
Cardiovascular failure



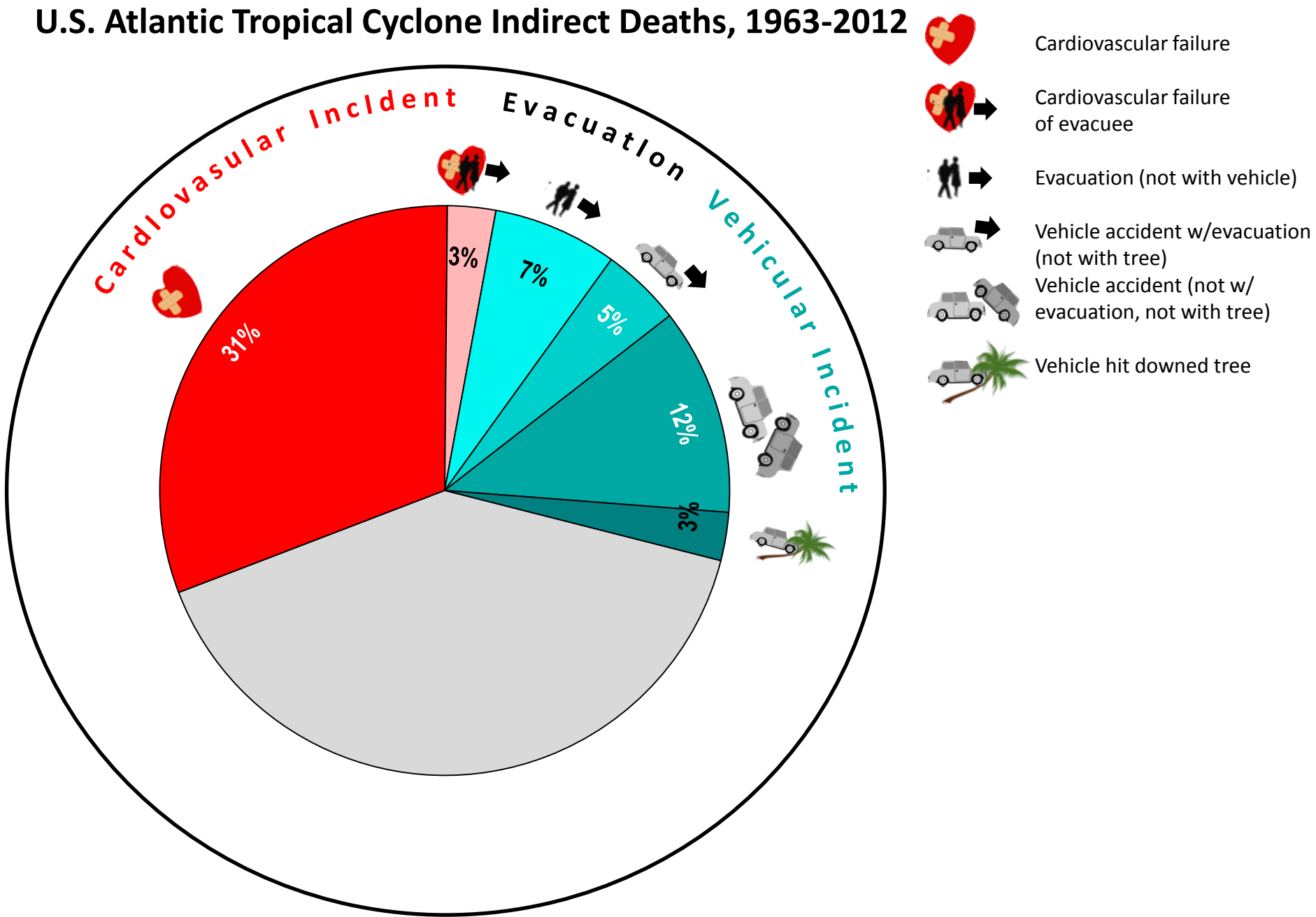
Cardiovascular failure
of evacuee



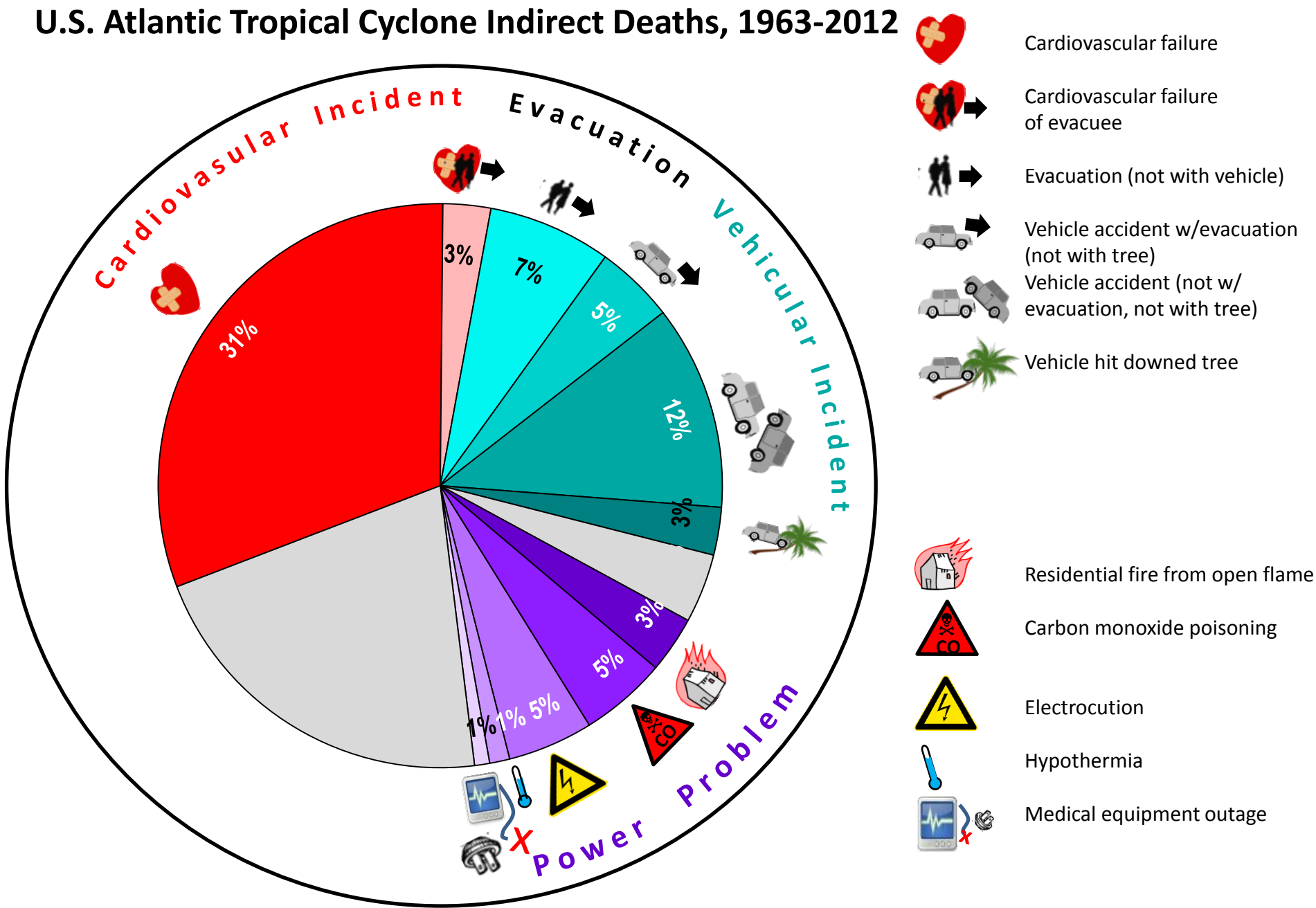
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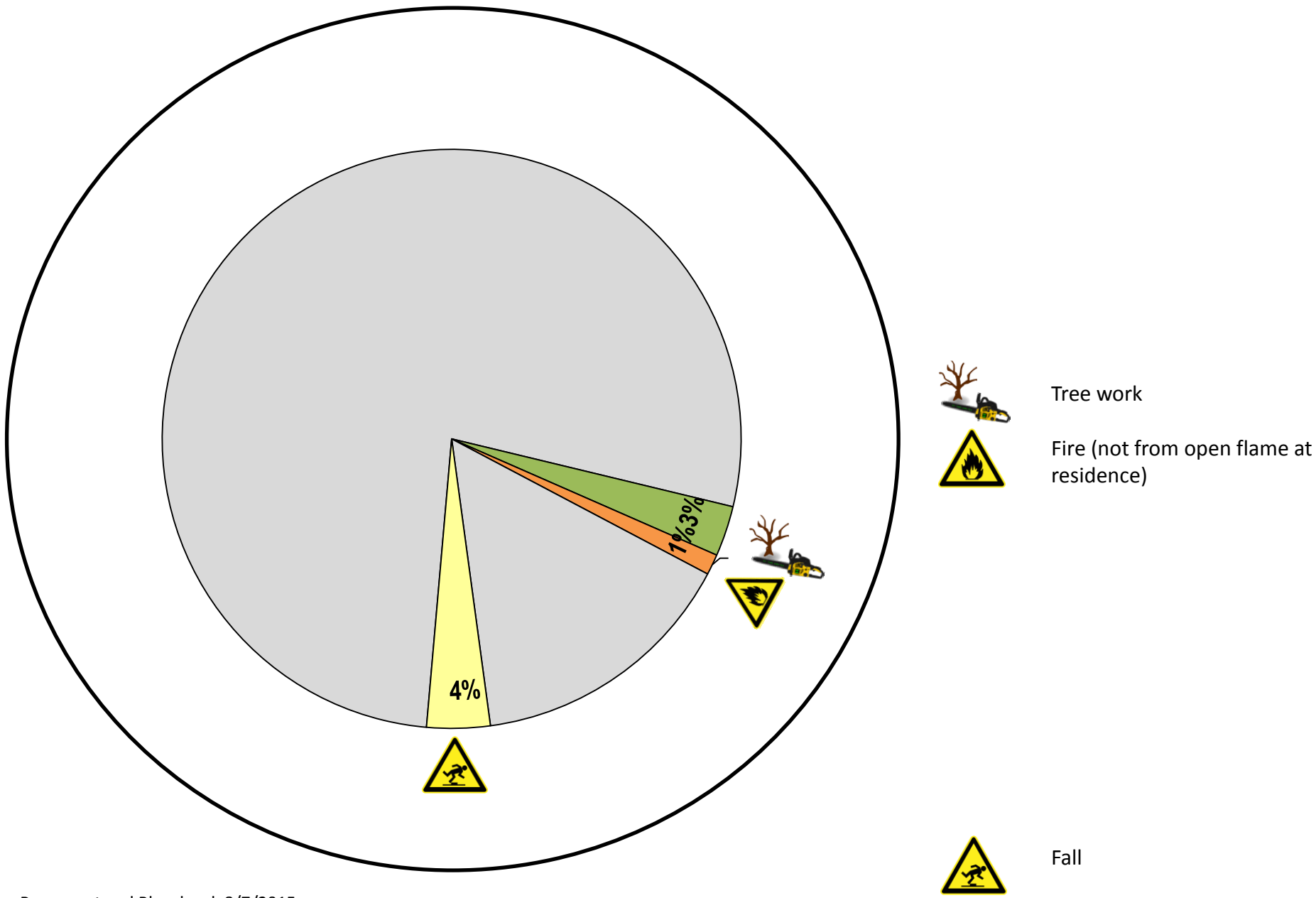
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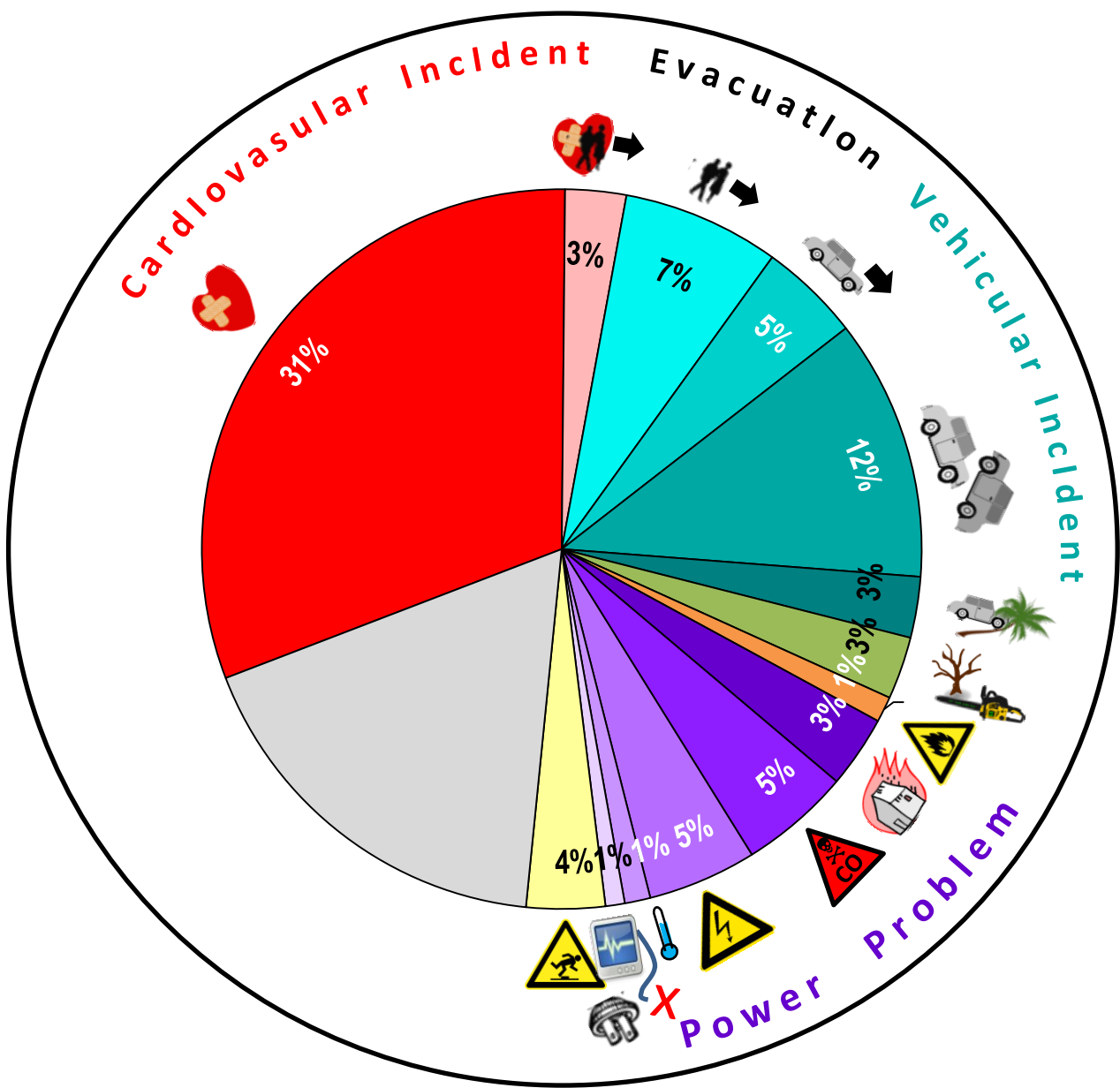
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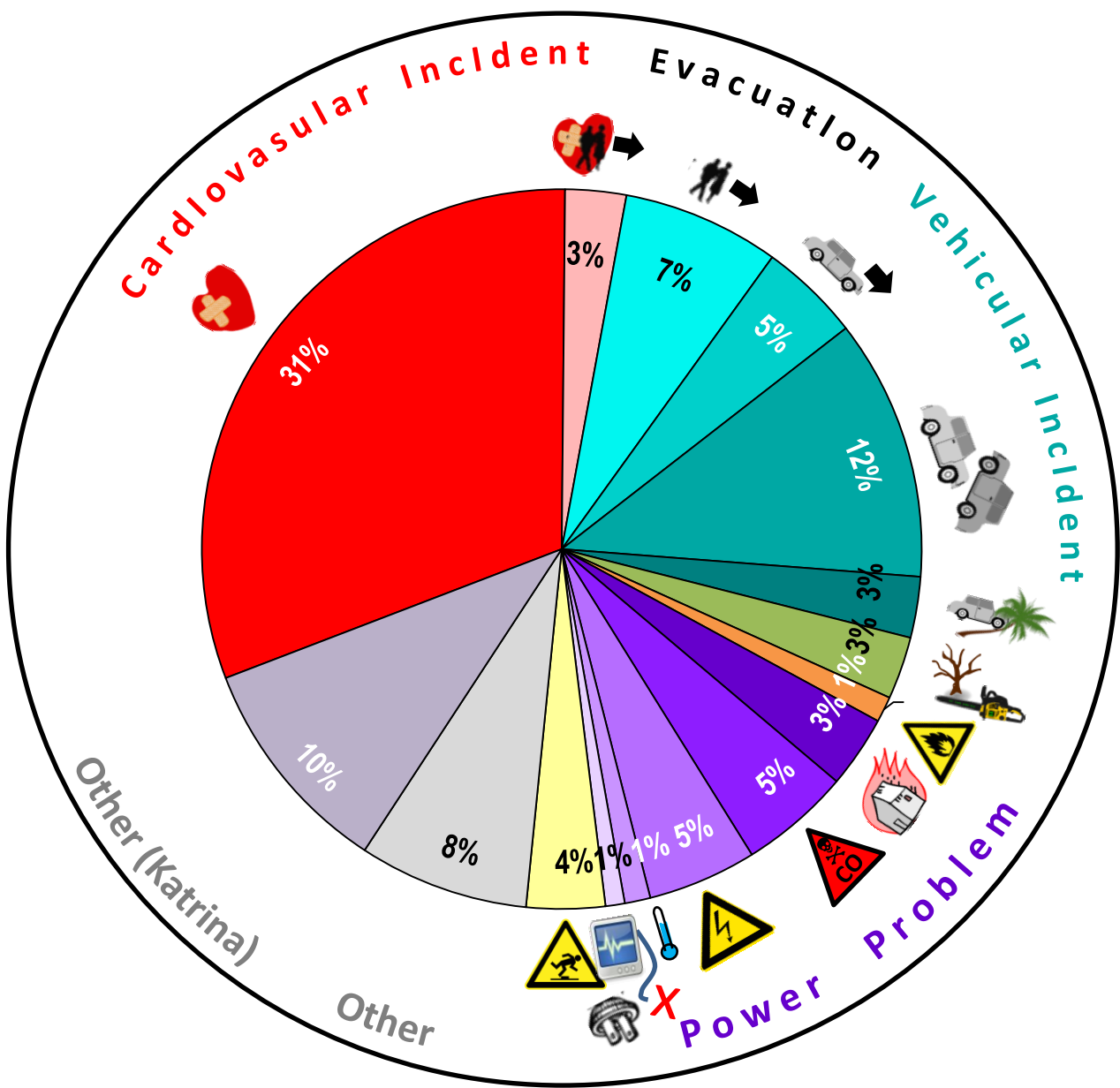


U.S. Atlantic Tropical Cyclone Indirect Deaths, 1963-2012



- Cardiovascular failure
- Cardiovascular failure of evacuee
- Evacuation (not with vehicle)
- Vehicle accident w/evacuation (not with tree)
- Vehicle accident (not w/evacuation, not with tree)
- Vehicle hit downed tree
- Tree work
- Fire (not from open flame at residence)
- Residential fire from open flame
- Carbon monoxide poisoning
- Electrocution
- Hypothermia
- Medical equipment outage
- Fall

U.S. Atlantic Tropical Cyclone Indirect Deaths, 1963-2012



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Question for the class

When do most *indirect* deaths occur?

- (a) Before the storm
- (b) During the storm
- (c) After the storm

Answer: (c) After the storm.

(Two to three times as many post-storm deaths as pre-storm deaths)

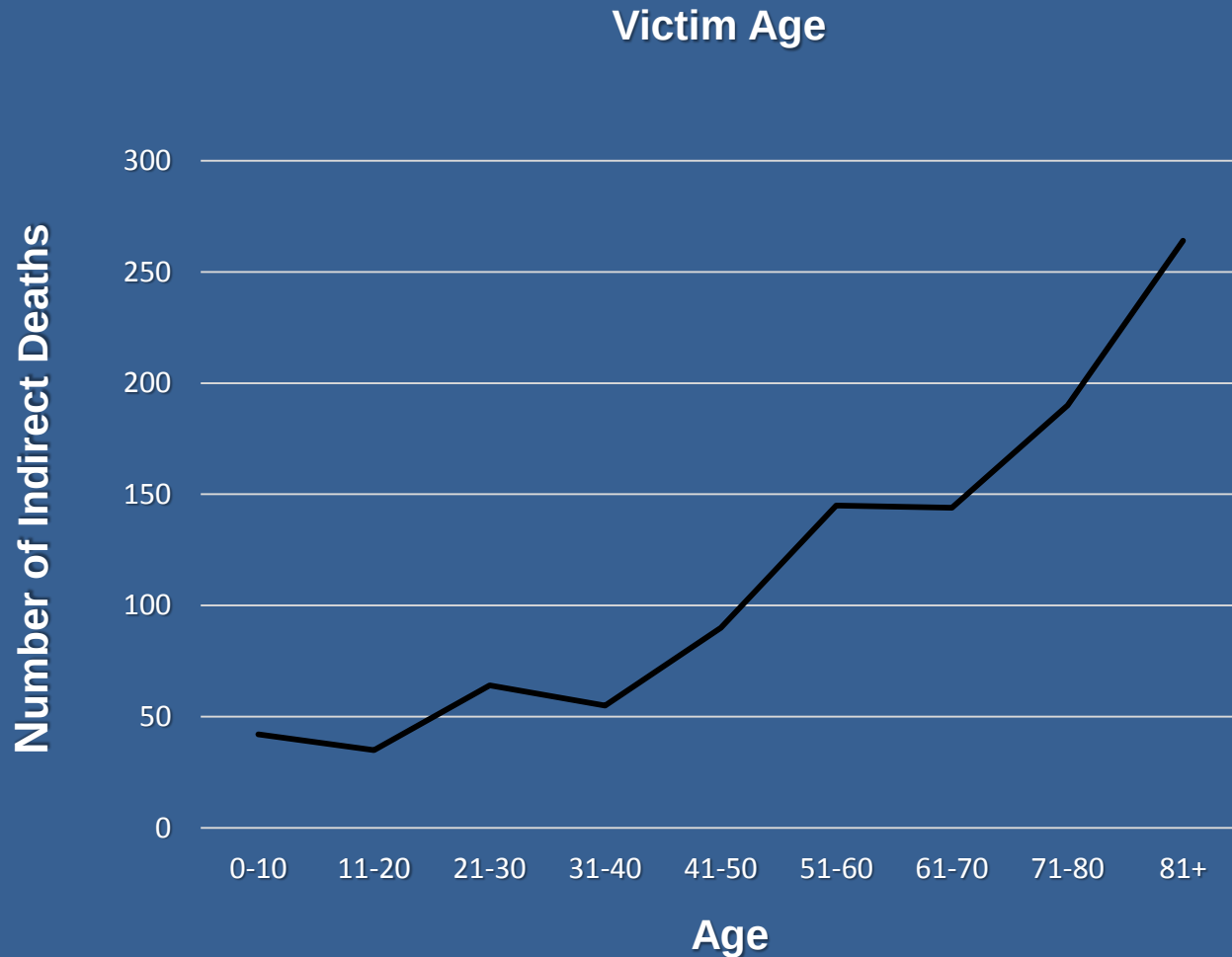
Question for the class

Which age group incurs the most indirect deaths?

- (a) < 21 years old
- (b) 31-70 years old
- (c) > 70 years old

Answer: (c) > 70 years old.
(See next slide.)

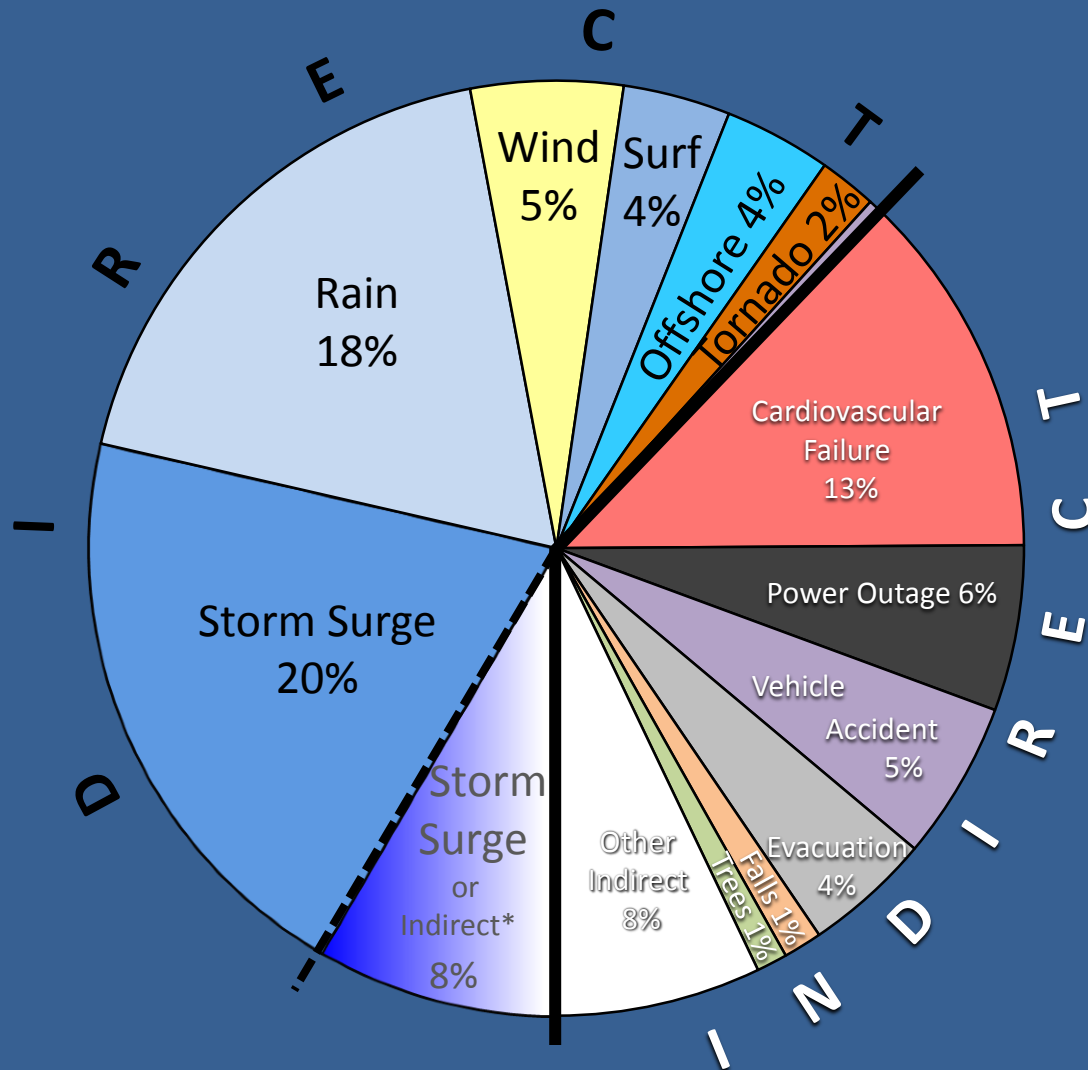
U.S. INDIRECT DEATHS (1963-2012)



Number increases generally with age.

Eight times as many victims over 70 years old as under 21 (influence of heart attacks)

U.S. Atlantic Tropical Cyclone Direct and Indirect Deaths, 1963-2012



* Indeterminate in Katrina using
LA Office of Epidemiology data

ATLANTIC TROPICAL CYCLONE FATALITIES

Key Findings

- Possibly one-half million to one million deaths since discovery of New World
- Losses followed the population, from:
 - on the sea (waves) in 18th century, to
 - the coast (storm surge) in 19-20th centuries, to
 - inland (rainfall) increasingly 20th-21st centuries
- For the contiguous United States over the past 50 years:
 - Average around 40-50 direct deaths and 30-40 indirect deaths per year; Maria would skew this to more indirect than direct deaths if Puerto Rico included.
 - 90% of direct deaths due to water; storm surge takes most lives, freshwater flood 2nd
 - Most frequent factors in indirect deaths: cardiovascular failure, evacuation, vehicle accident and loss of electricity...sometimes in combination
 - Number of indirect deaths increase greatly with age. Not the case for direct deaths
 - Around 2/3 male, 1/3 female