



Sudden Infant Death Syndrome: Research and Safe Infant Sleep



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Children's Hospital Los Angeles**



No Conflicts of Interest to Disclose

California SIDS Program



**Deborah
Hunt**



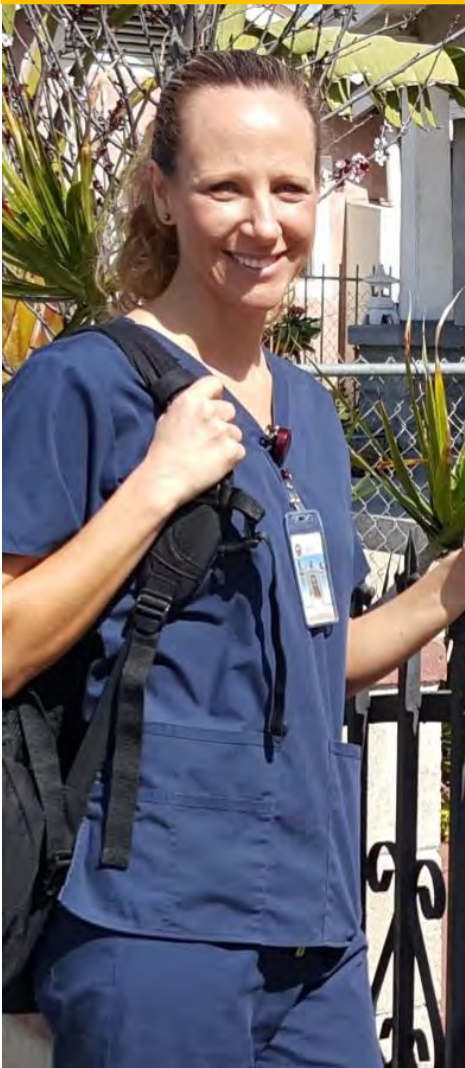
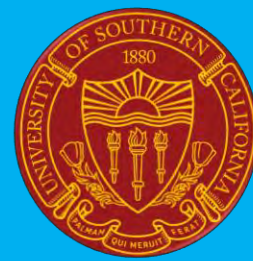
**Kay
Evans**



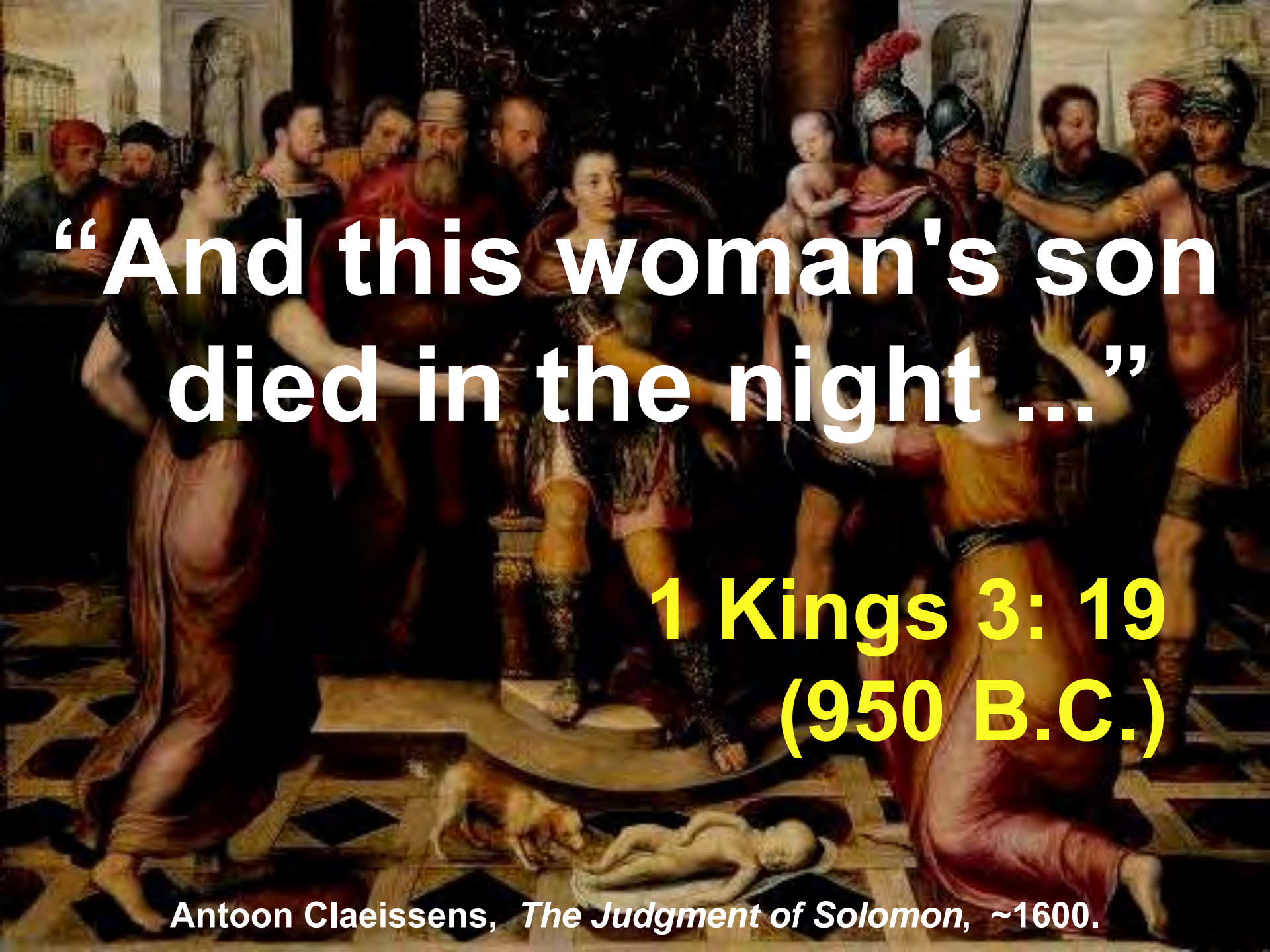
**Candace
Anderson**



Why is This Talk So Important for You?



- **The grief of SIDS parents is complicated by guilt.**
- **Because there is no explanation for the death, parents often believe that they killed their baby.**
- **Explaining SIDS to reduce guilt is *the most important thing* a PHN does to support SIDS parents.**
- **You must understand the science of SIDS to reduce guilt.**

The painting depicts King Solomon on a throne, surrounded by a crowd of people. In the foreground, a woman in a red dress is prostrate on the floor, her hands raised in a gesture of pleading or prayer. To her right, a man in a red tunic is also prostrate. In the center, a woman in a patterned dress stands before the throne, holding a child. To the right, a man in a helmet and armor is holding a child. In the background, a man in a red tunic is holding a child. The scene is set in a grand, ornate interior with a checkered floor and a large dog in the foreground.

**“And this woman's son
died in the night ...”**

**1 Kings 3: 19
(950 B.C.)**

Antoon Claeissens, *The Judgment of Solomon*, ~1600.

LAPSE OF TIME FROM MOMENT WHEN LAST SEEN ALIVE TO THE DISCOVERY OF DEATH (96 Cases)

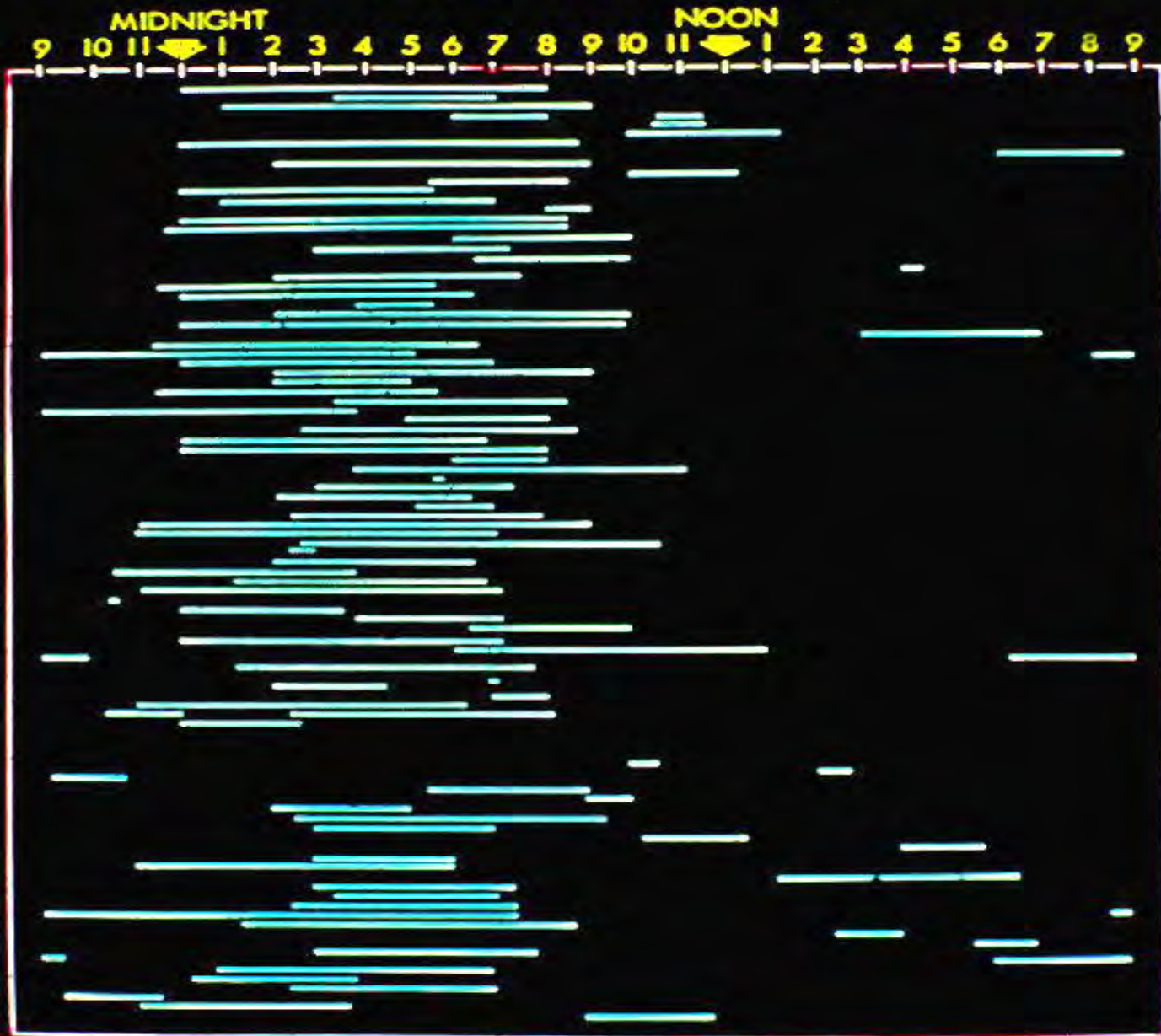


Figure Courtesy of Doctor Maria Valdes-Dapena



ACTION 10
NEWS

Baby Death Investigation

1400 blk of Corban

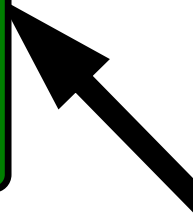
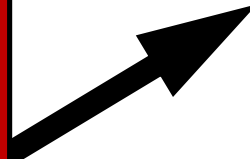
**Sudden
Death
of an Infant**

**Emergency
Responders**

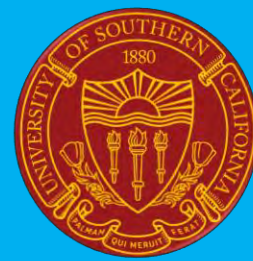
**Coroner's
Investigation**

**Determination
of the Cause
of Death**

Autopsy



Sudden Infant Death Syndrome



The sudden unexpected death of an infant, under one-year of age, with onset of the fatal episode apparently occurring during sleep, that remains unexplained after a thorough investigation, including performance of a complete autopsy, and review of the circumstances of death and the clinical history.



**Krous, H.F., J.B. Beckwith, R.W. Byard,
T.O. Rognum, T. Bajanowski, T. Corey, E. Cutz,
R. Hanzlick, T.G. Keens, and E.A. Mitchell.**

Pediatrics, 114: 234-238, 2004.

- **From blaming parents, Ancient Greece and Rome through the Middle Ages.**
- **To natural causes, Late 1800's and early 1900's.**
- **To blaming parents again, Early to mid 1900's.**
- **To natural causes again, Late 1900's and early 2000's.**
- **Now to unsafe, accidental causes.**



Second International Conference on the Cause of Sudden Death in Infants, 1969

This original definition of *SIDS* was developed by pathologists for two reasons:

- (1) to give a consistent name to the group of babies which were receiving widely disparate diagnoses at that time;
- (2) to focus research activities on these babies in an attempt to find a cause and/or cure.

Bergman, A.B., J.B. Beckwith, and C.G. Ray, eds. *Proceedings of the second international conference on the causes of sudden death in infants, Seattle Washington*. University of Washington Press, 1970.

Russell-Jones, D.L. *Arch. Dis. Child.*, 60: 278-281, 1985.

Cutz, E. *JAMA Pediatr.*, 170: 315-316, 2016.

Different Coroners Use Different Diagnoses for these Infants



**Coroners' Curriculum
Development Committee
California State Coroners Association**





SIDS Summit 2011



- **Coroners and Pathologists from around California attended.**
- **Working conferences to explore whether or not it is possible to achieve better consistency between counties on diagnosing the cause and manner of death in babies dying suddenly and unexpectedly.**
- **Attendees voted on cause of death and manner of death on a number of cases, to bring out areas of common ground and of difference.**

California State Coroners Association.

SIDS Summit 1; Studio City, California. October 19, 2011.

SIDS Summit 2: Indian Wells, California. September 23-24, 2016.



SIDS Summit 2011



“Pristine SIDS” Case

Cause of Death	%
SIDS	56
Undetermined	22
SUID	16
Asphyxia	6

Manner of Death	%
Accidental	0
Homicide	0
Natural	63
Undetermined	38

Some pathologists were persuaded to use “SUID” because it is recommended by the Center for Disease Control and Prevention.

California State Coroners Association.

SIDS Summit 2011. Studio City, California. October 19, 2011.



SIDS Summit 2011



- **Other cases were reviewed which had a variety of findings.**
 - **Complete consensus was not achieved on any case, but those with a positive finding had better agreement.**
- **The conference illustrated the complexity of cases Coroners currently see.**
 - **Increased observations revealed more questions.**
 - **Difficult to come to a definitive diagnosis.**
 - **Achieve “probable cause” or “certainty”**

California State Coroners Association.

SIDS Summit 2011. Studio City, California. October 19, 2011.

Different Coroners Use Different Diagnoses for these Infants

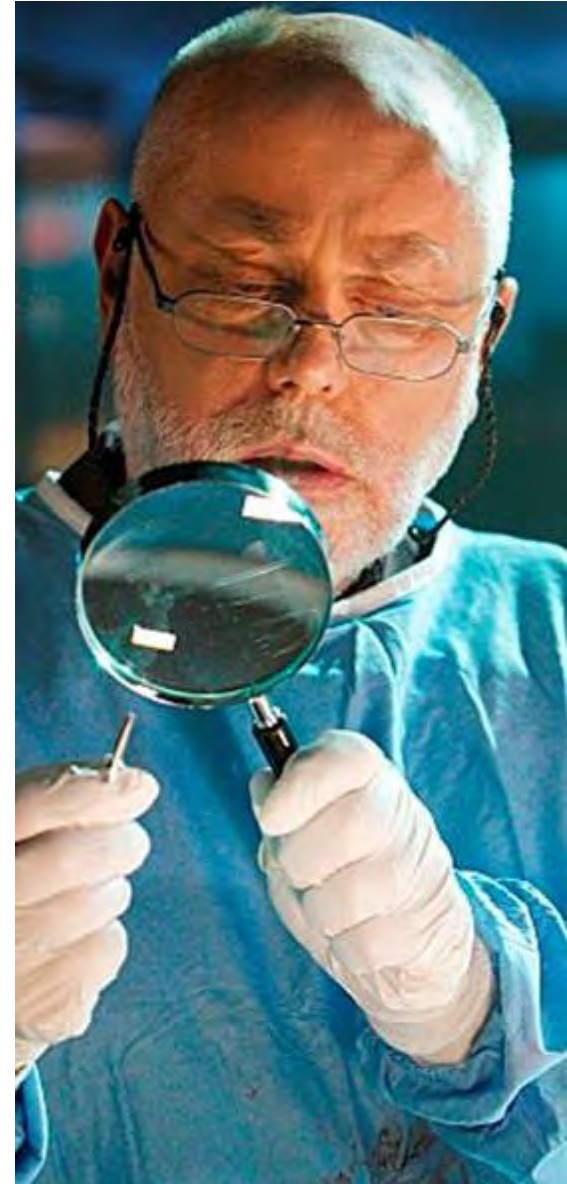


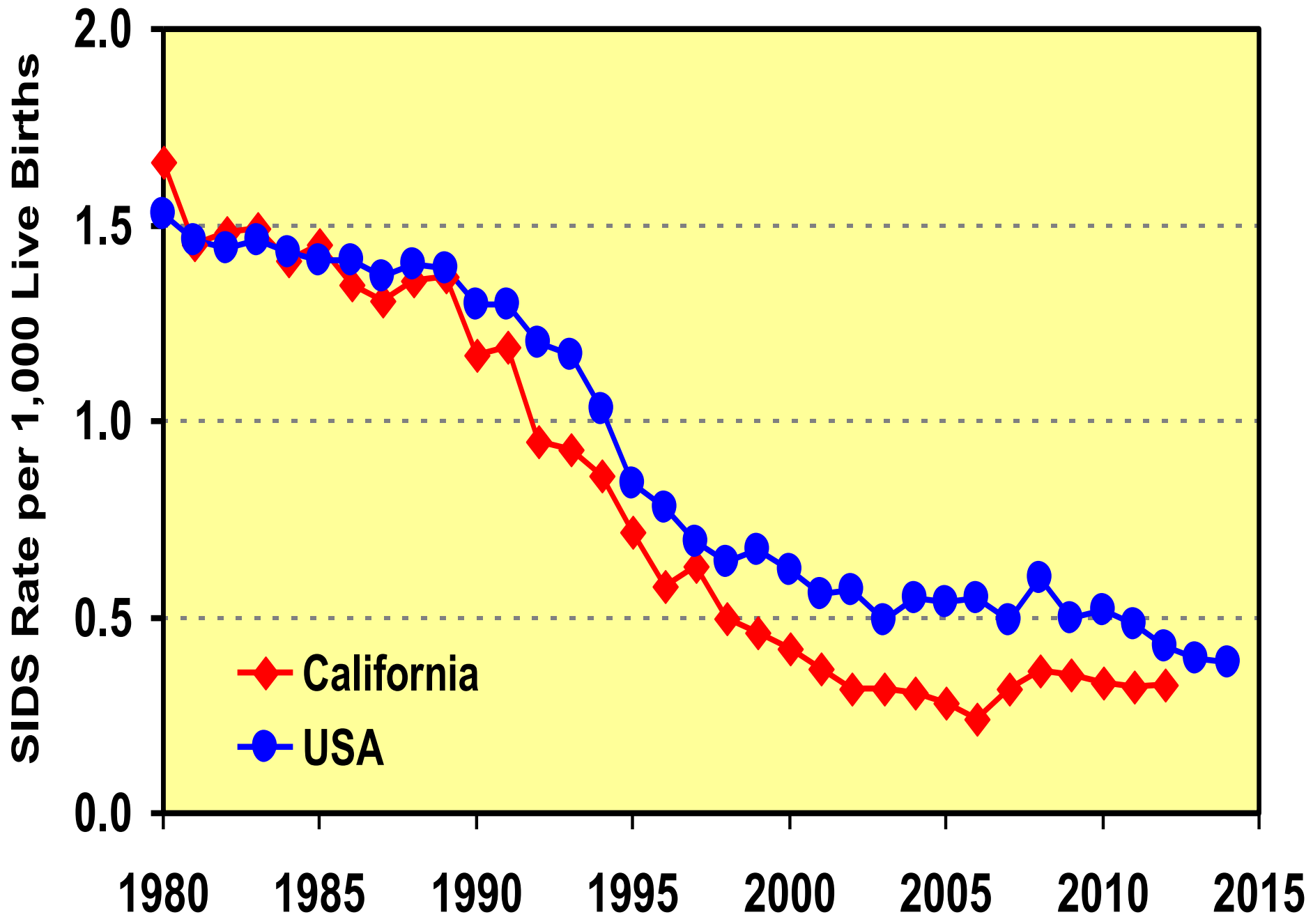
When diagnosing the cause of death in an individual infant, the following terms are considered synonymous:

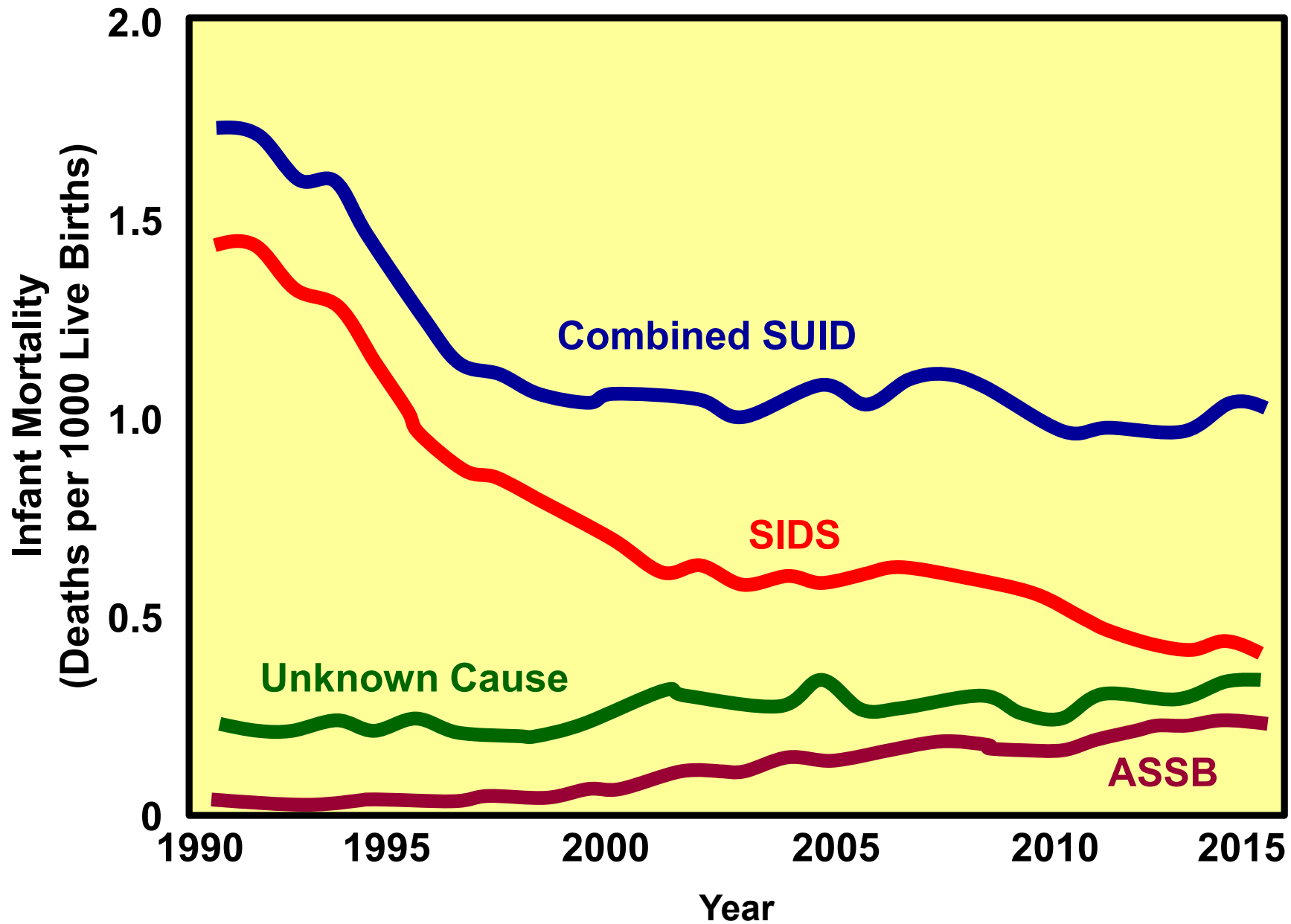
- **SIDS**
- **SUID**
- **SUDI**
- **Undetermined**

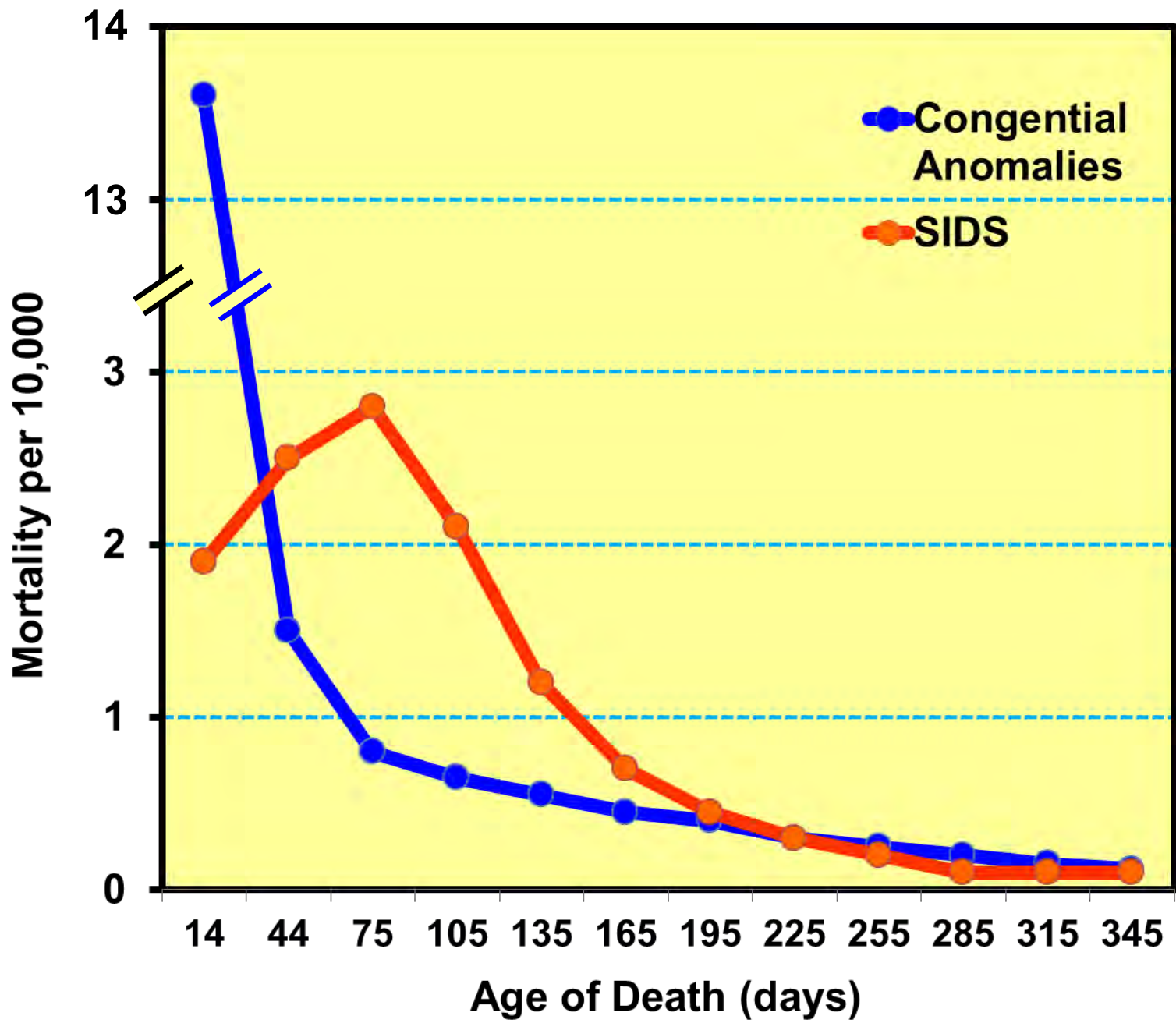
They all mean the same thing; that the infant's death is *unexpected* and *unexplained*.

Cutz, E. *JAMA Pediatr.*, 170: 315-316, 2016.

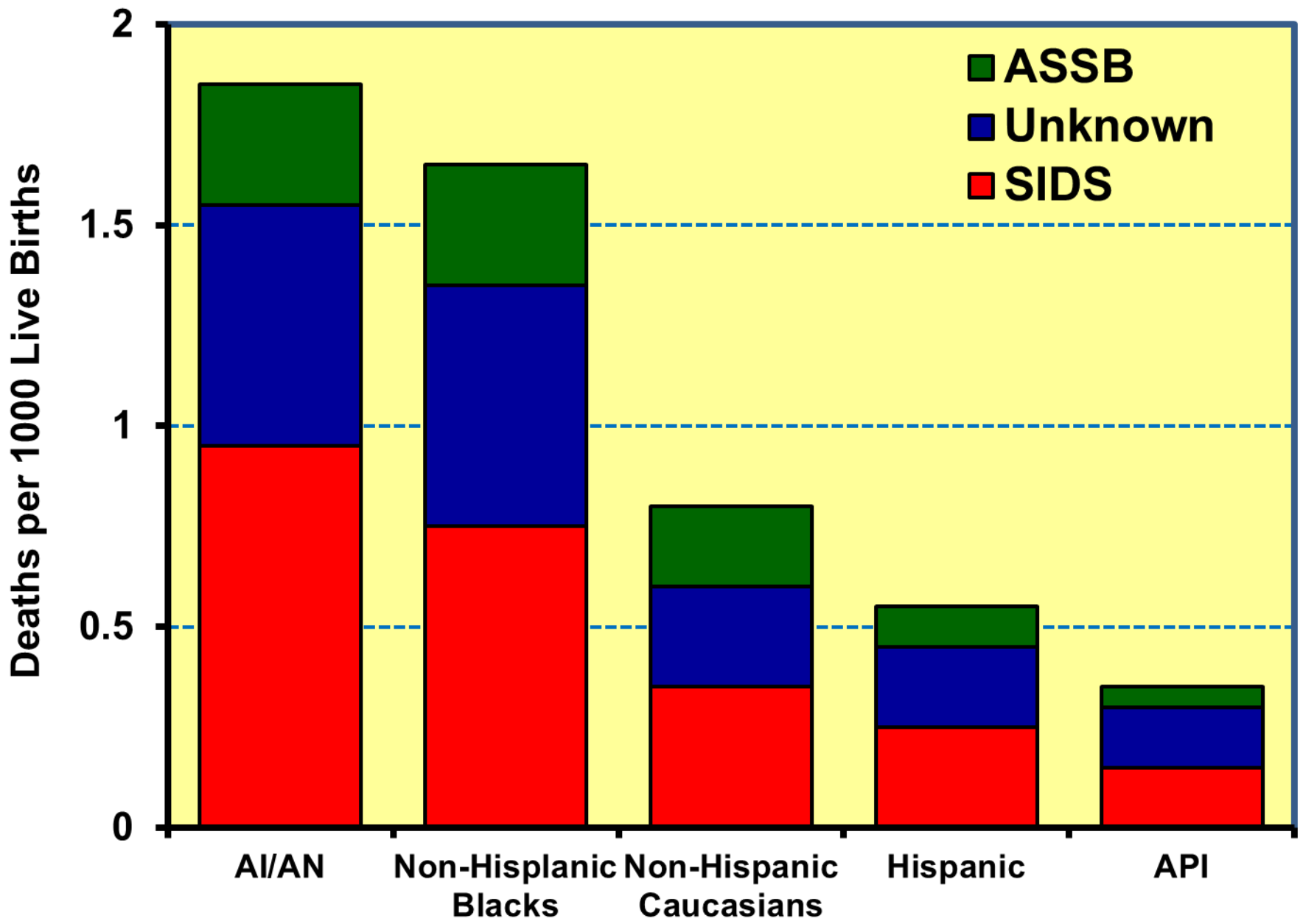






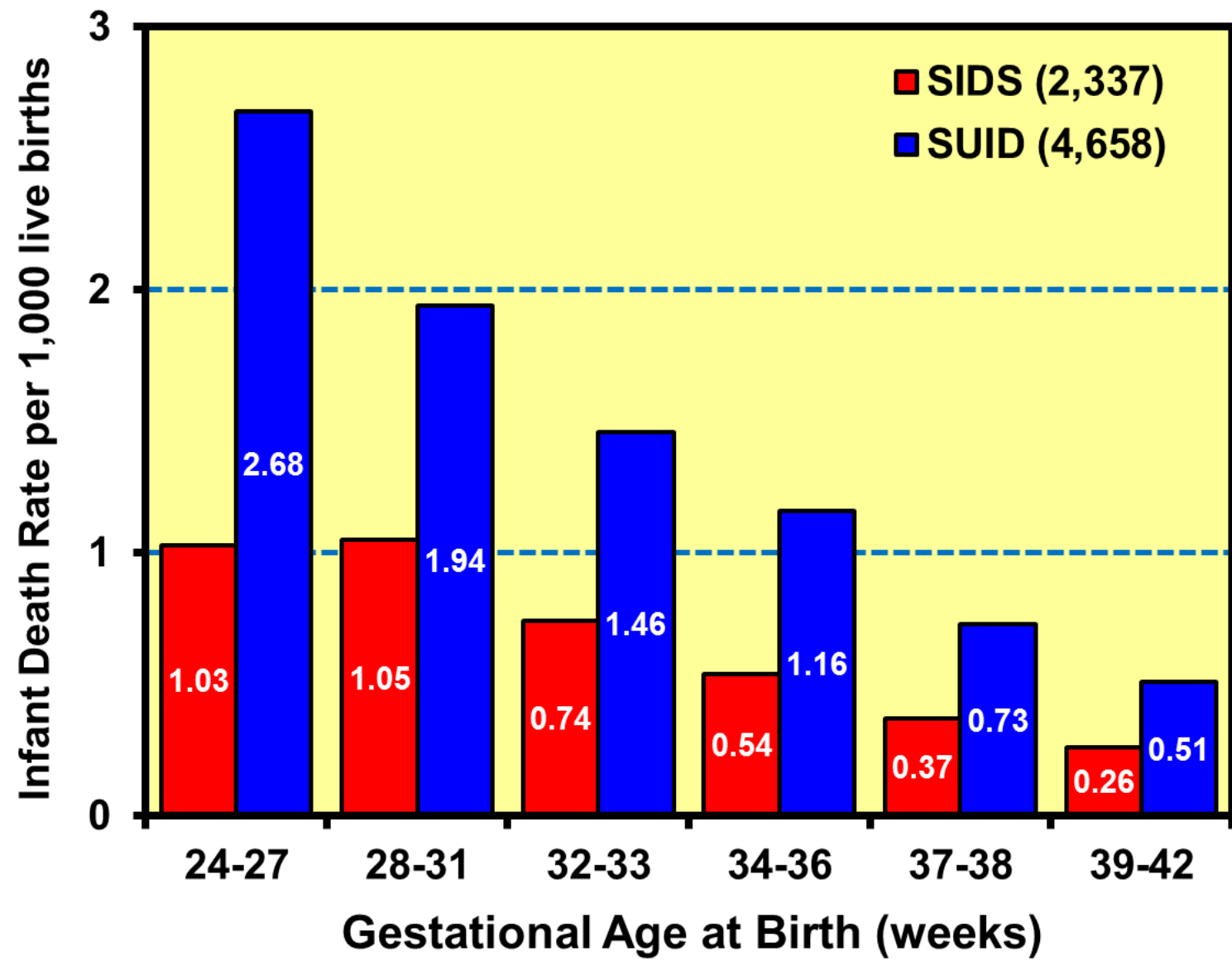


Guntheroth, W.G., and P.S. Spier. *Pediatrics*, 110: 110;e64, 2002.



<https://www.cdc.gov/sids/data.htm>

Infant Deaths by Gestational Age



Ostfeld, B.M., et al. *Pediatrics*, 140: e20163334, 2017.

- **No identifiable cause of death.**
- **No signs of severe illness.**
- **No signs of significant stress.**
- **Diagnosis of exclusion**

With the perseverance of Trojans ...

- Faithful.
- Scholarly.
- Skillful.
- Courageous.
- Ambitious.



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Southern California



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“Here are provided seats of meditative joy,
Where shall arise again the destined reign of Troy.”

Virgil, *Aeneid*

**Imagine a car driving up
a steep mountain road.**

The car has stopped.

**Why can't the car
continue up the hill?**

Imagine a car driving up a steep mountain road. The car has stopped.

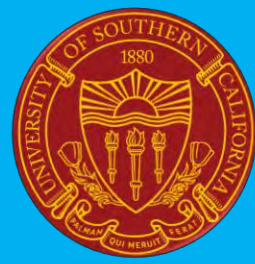
Why can't the car continue up the hill?

Medical Model.

- There is a flat tire.
- Identify the problem.
- Find a solution to the problem.
- Fix the problem.

Modified after Professor Jacopo P. Mortola. McGill University.

Medical Model of SIDS



- **Cardiac causes.**
- **Respiratory causes.**
- **Arousal disorders.**
- **Metabolic disorders.**
- **Infections.**
- **Vitamin deficiency.**
- **Environmental toxins.**



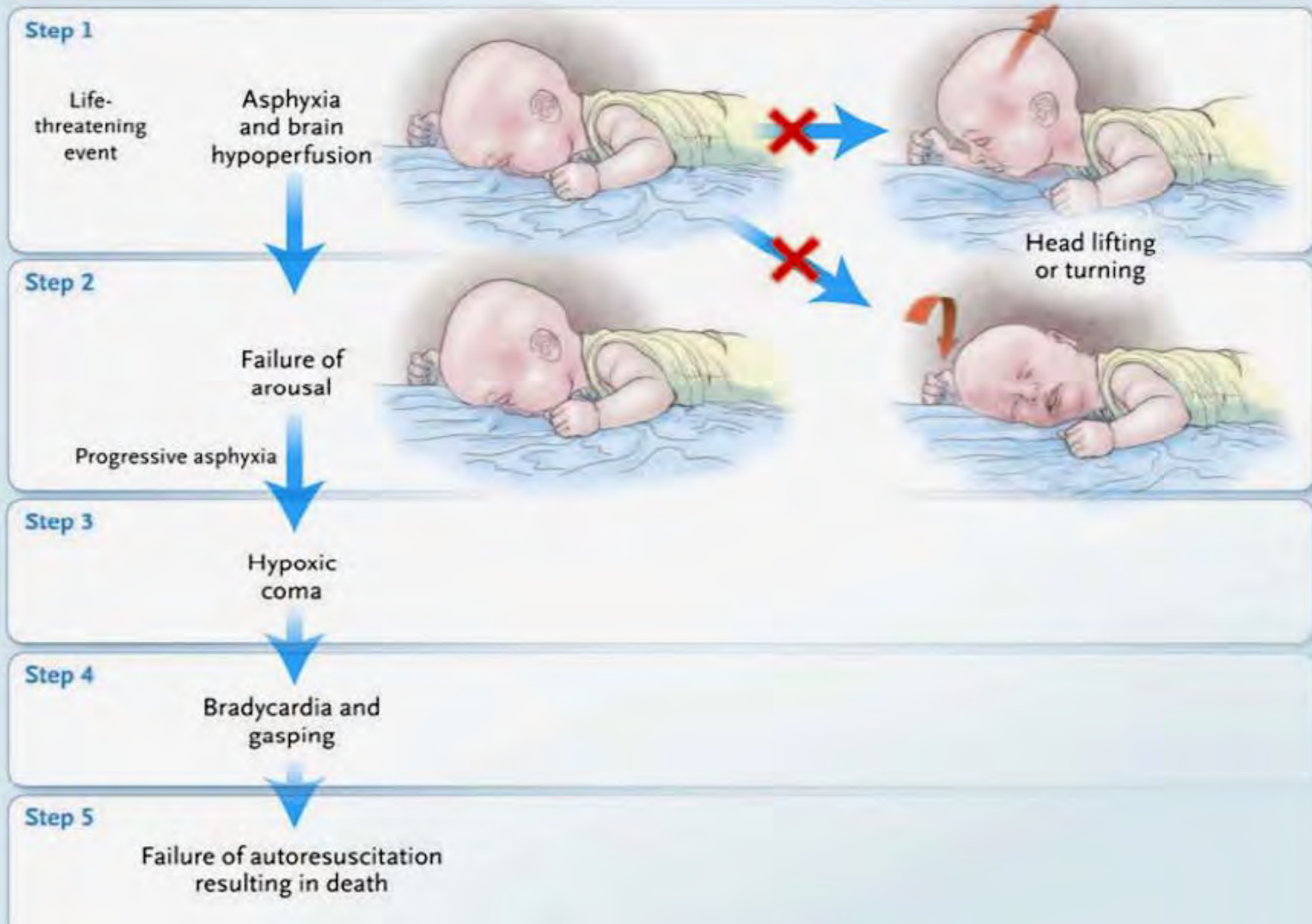
Imagine a car driving up a steep mountain road. The car has stopped.

Why can't the car continue up the hill?

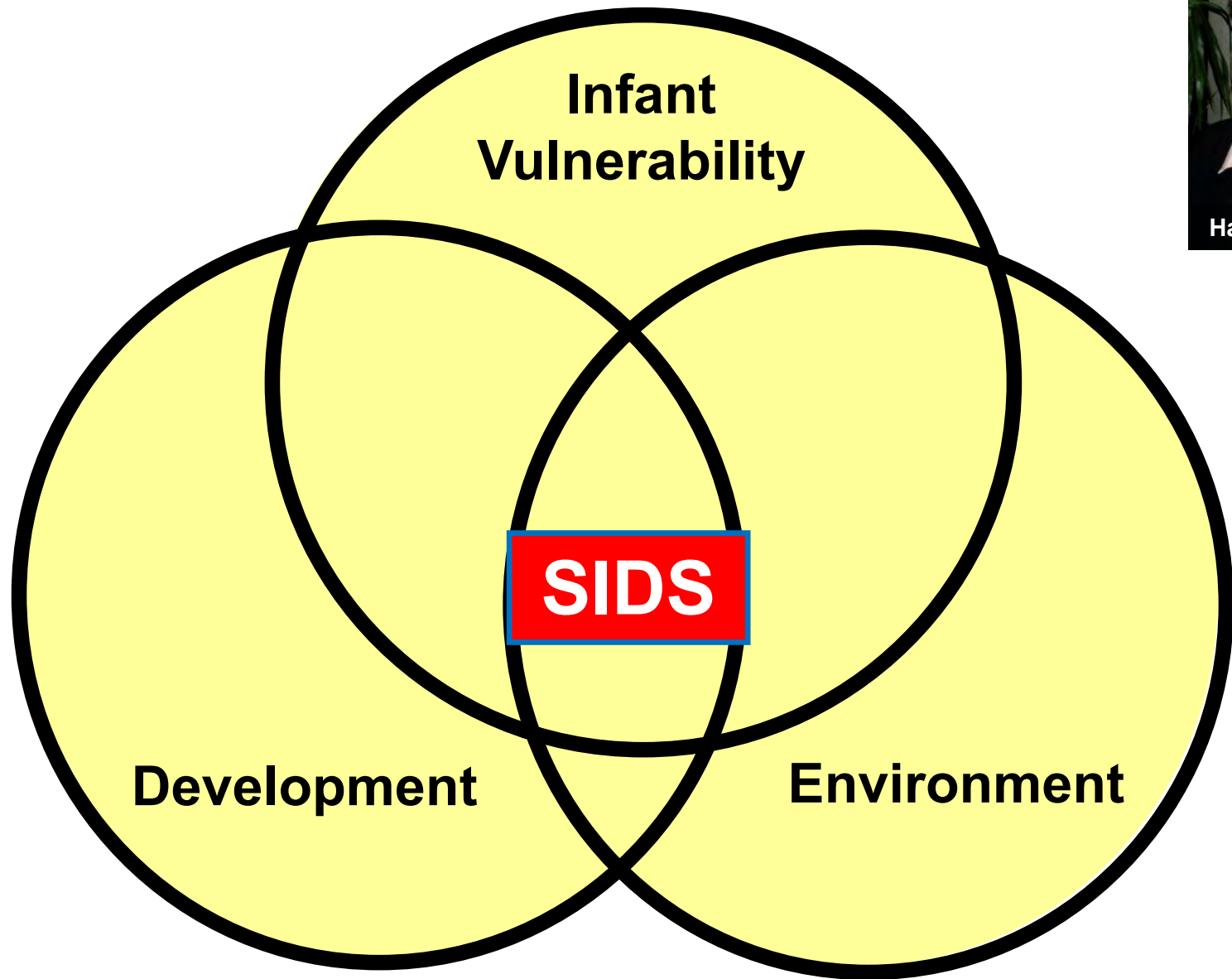
A New Way of Thinking.

- There are too many passengers.
- The engine is not powerful enough.
- The road is too rocky.
- The road is too steep.

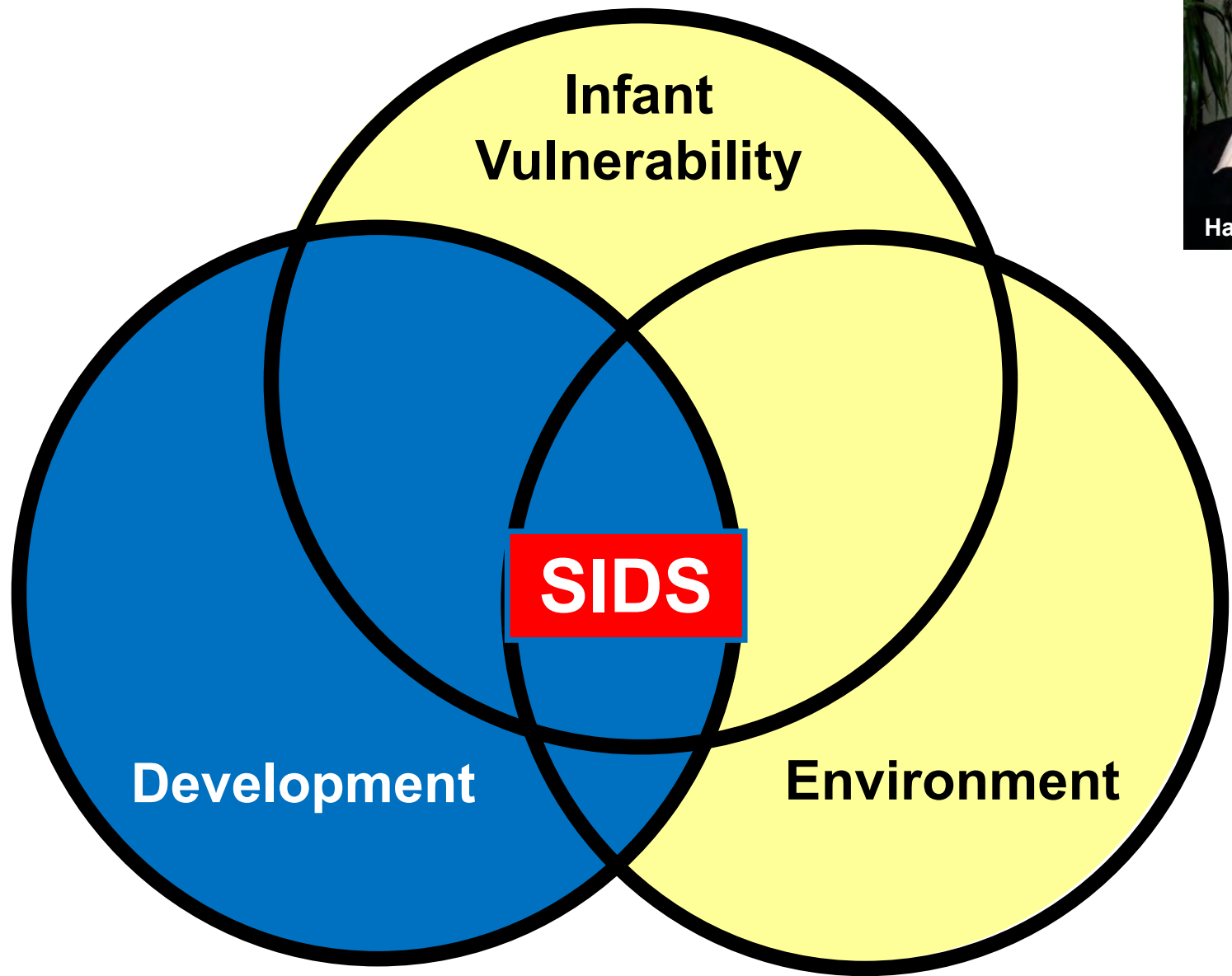
Modified after Professor Jacopo P. Mortola. McGill University.



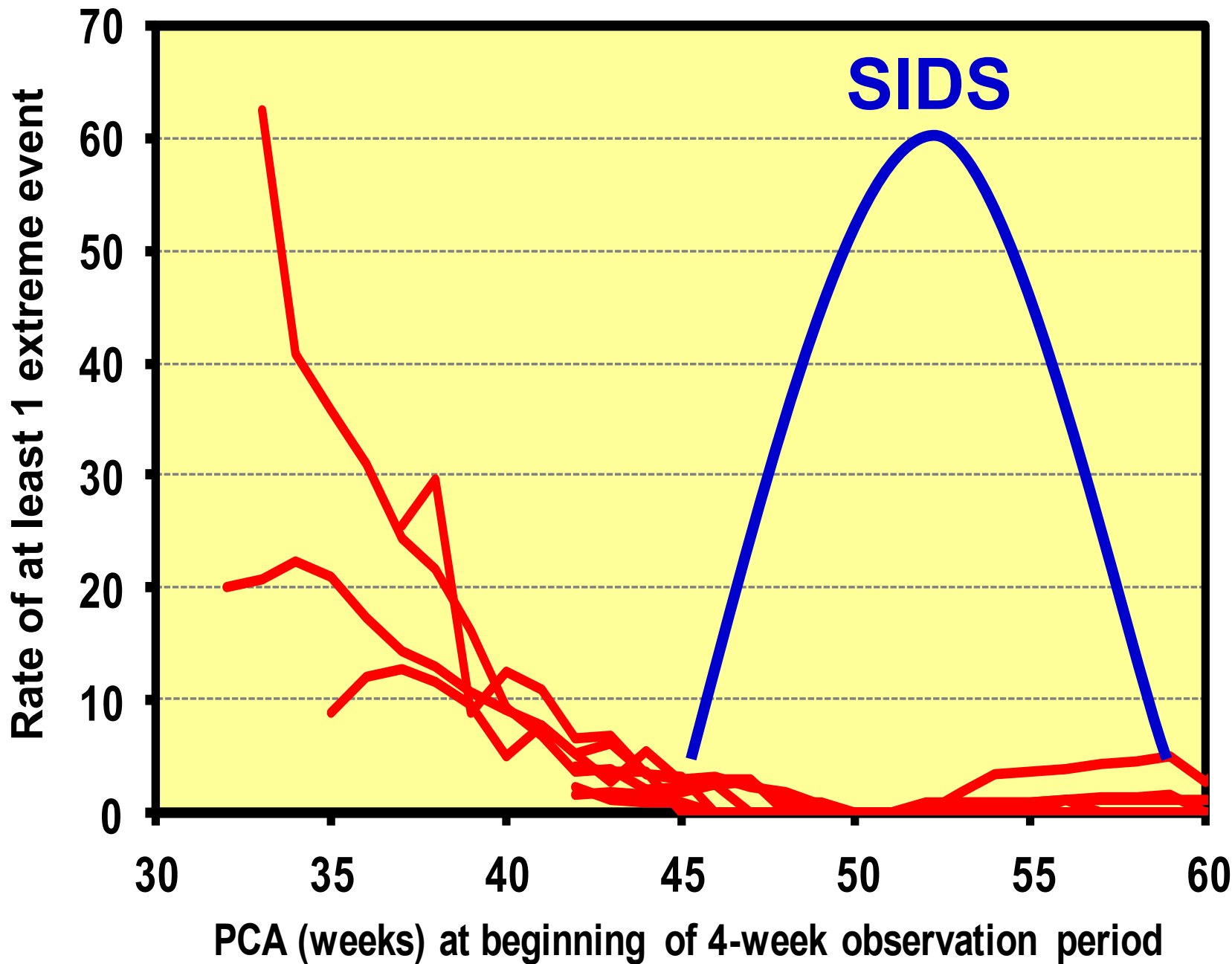
Kinney, H.C., and B.T. Thach. *N. Eng. J. Med.*, 361: 795-805, 2009.



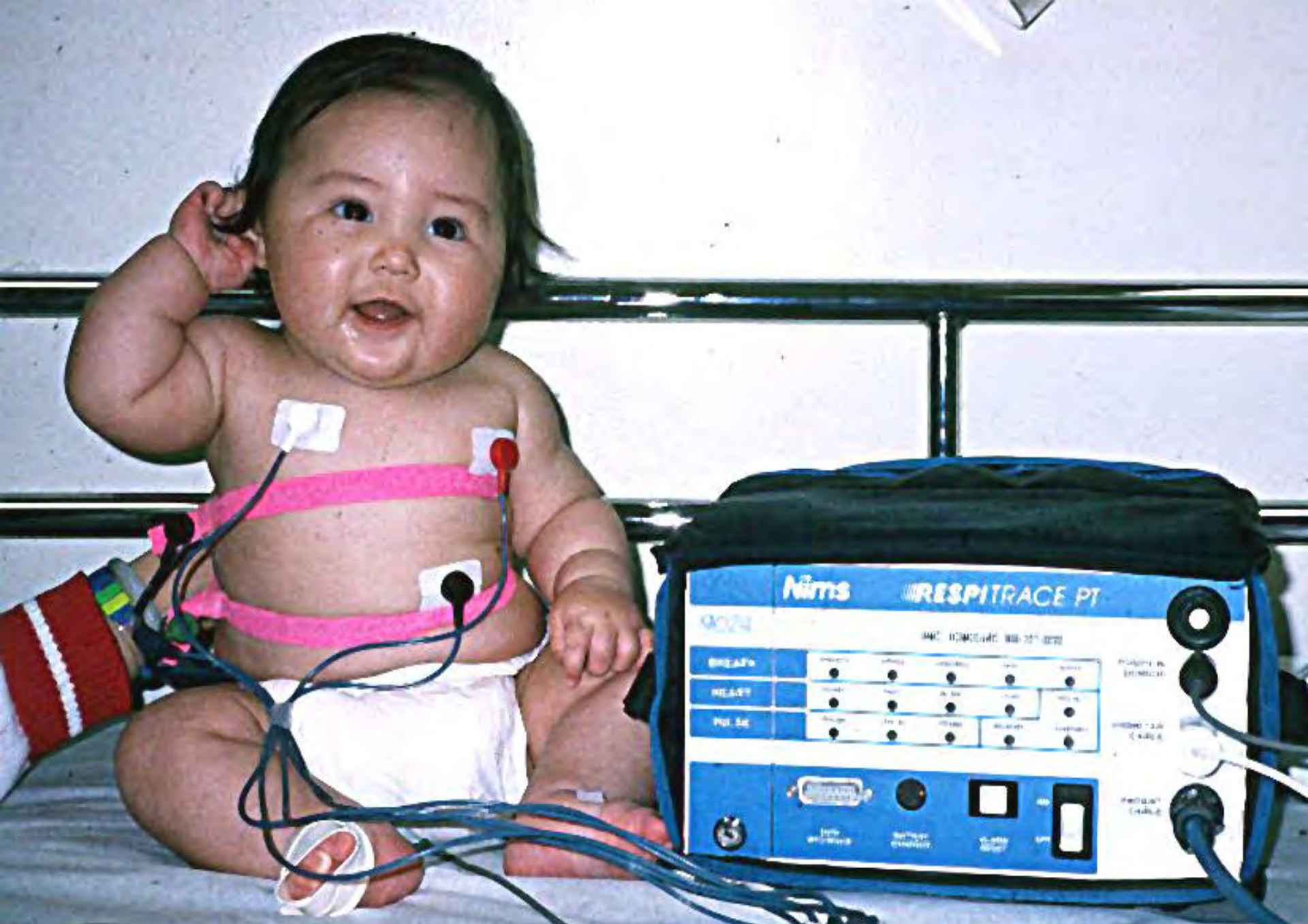
Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.



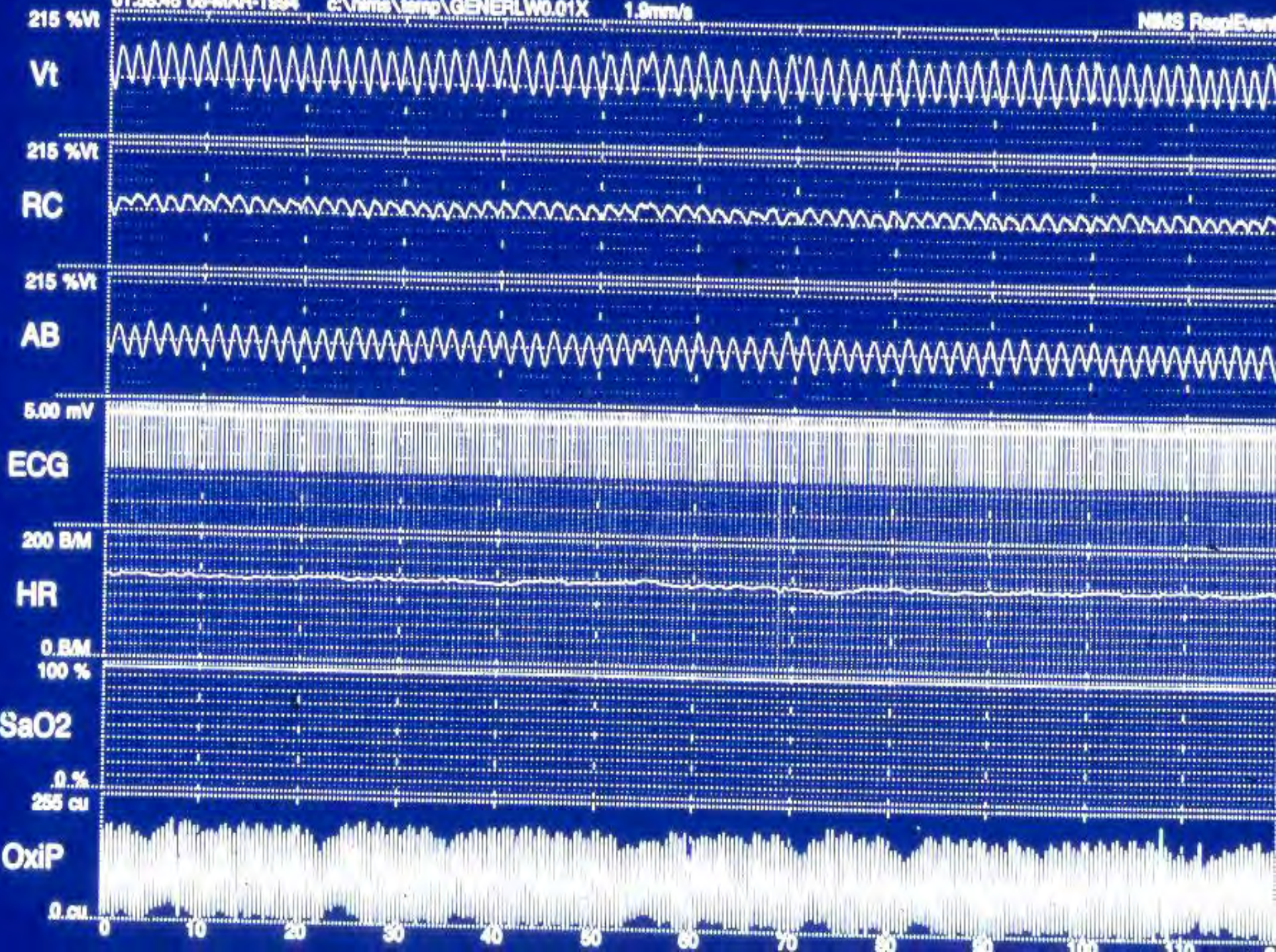
Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.

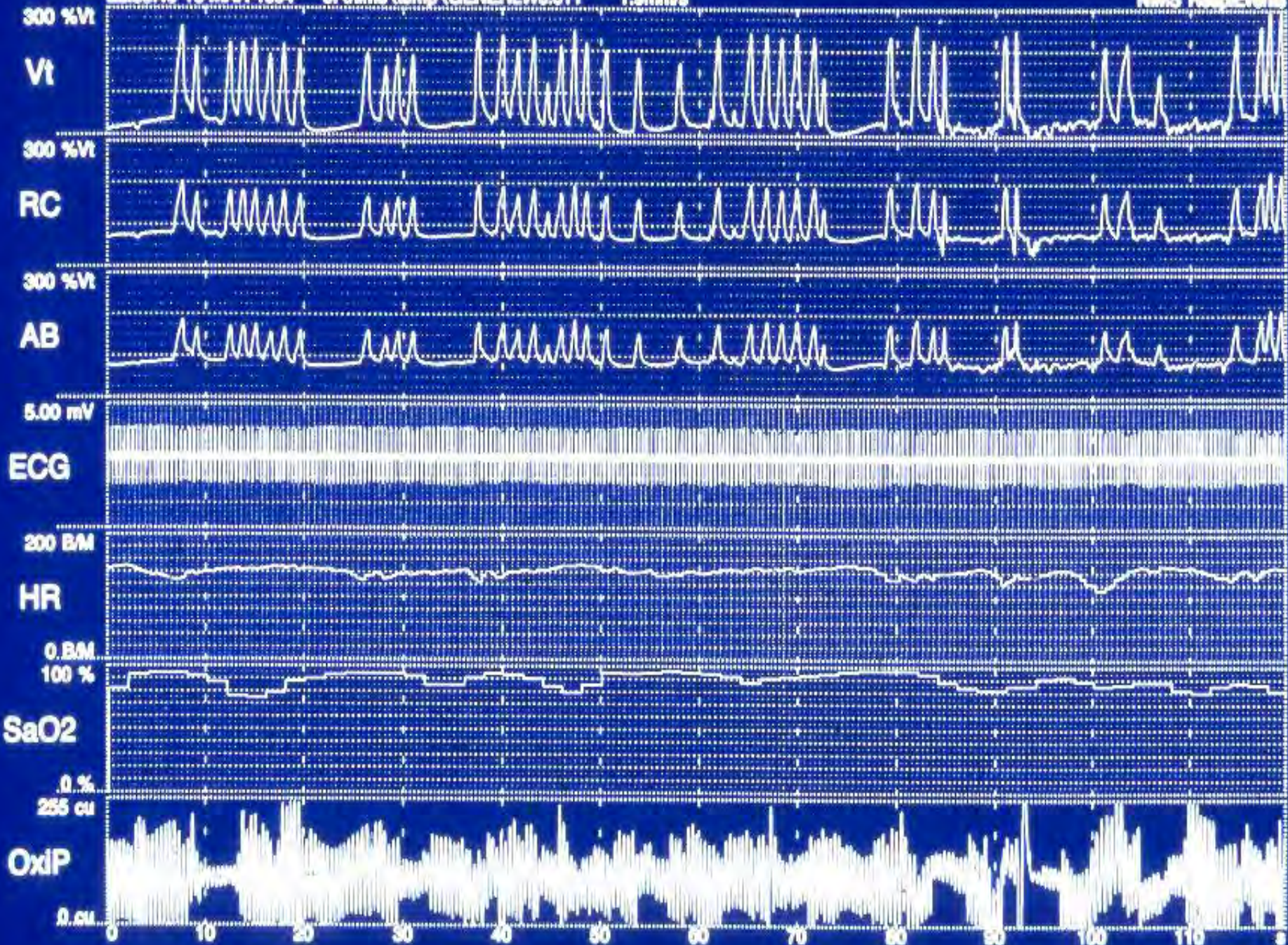


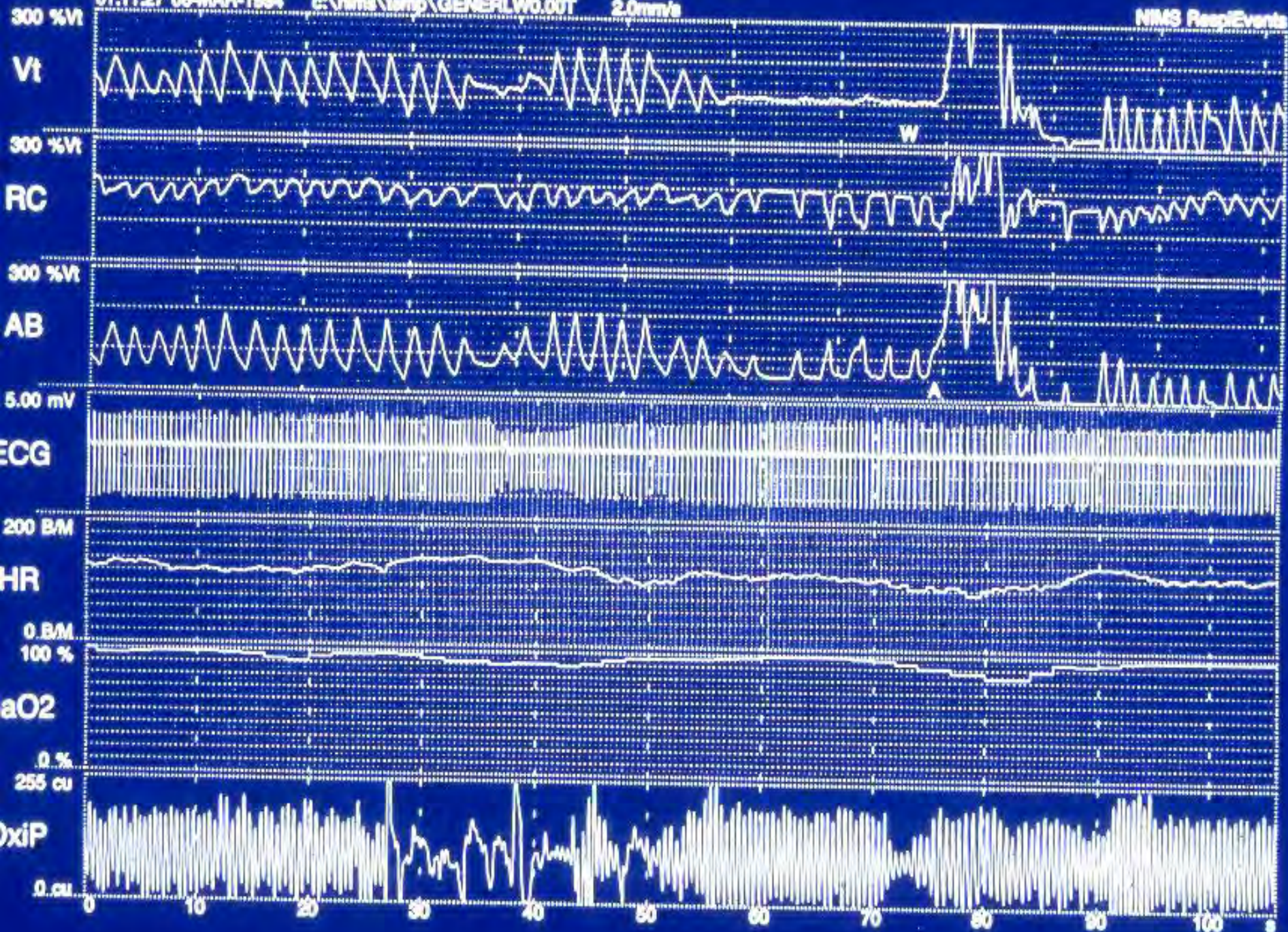
Ramanathan, R., and CHIME. *J. Amer. Med. Assoc.*, 285: 2199-2207, 2001.



Neuman, M.R., et al., and CHIME. *Physiol. Meas.*, 22: 267-286, 2001.



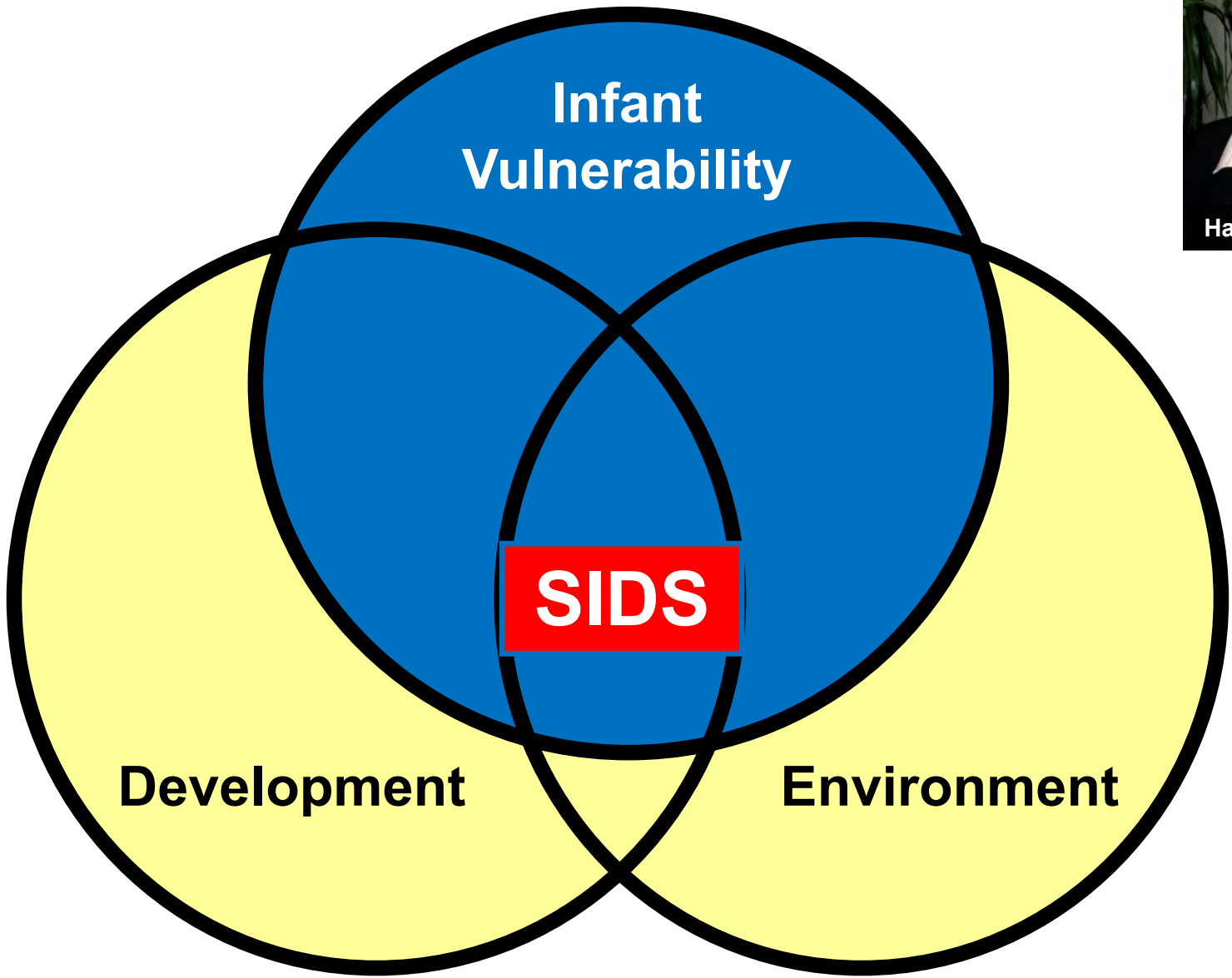




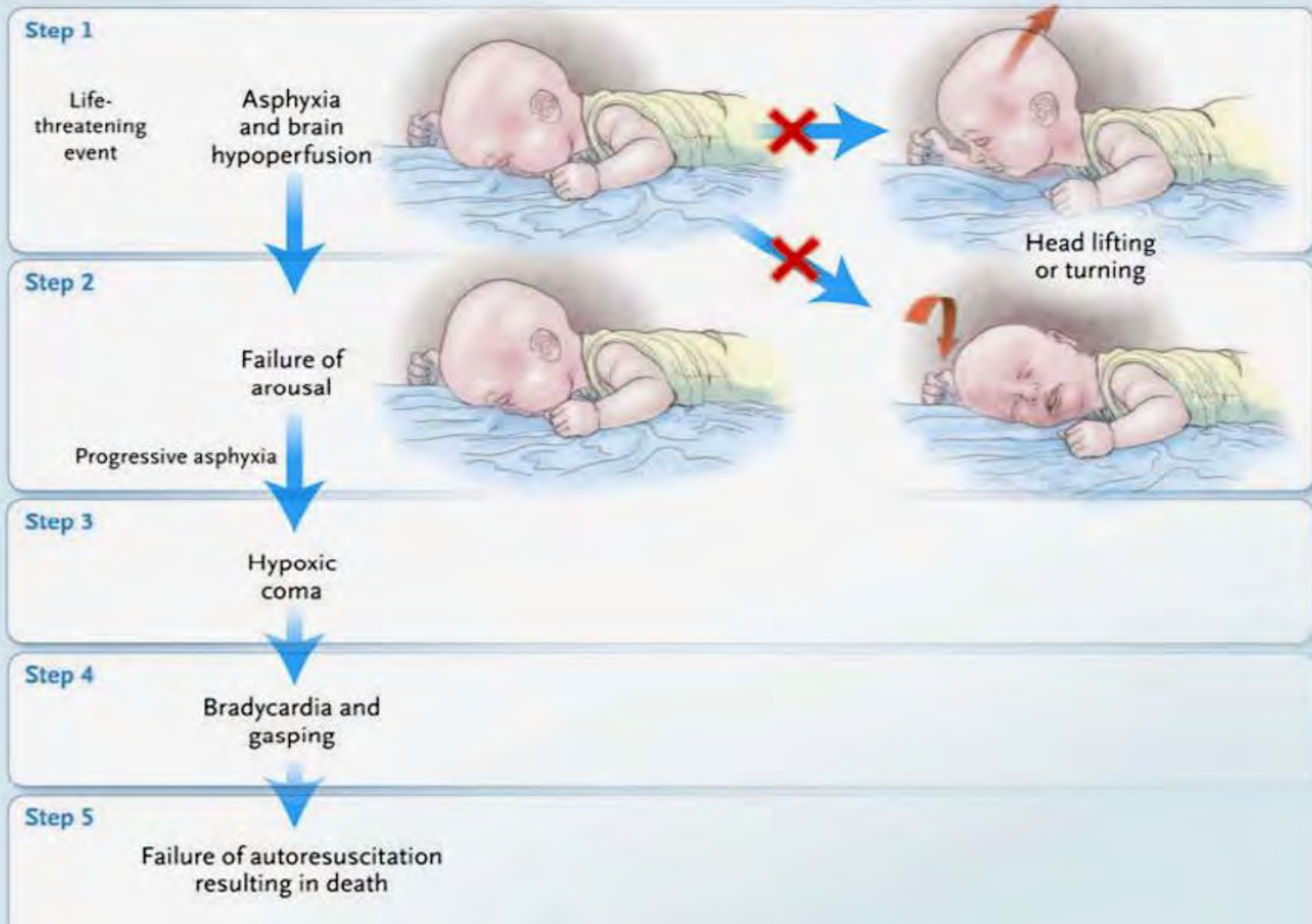
Is SIDS a Catastrophic Physiologic Crisis?



- **If normal infants do not precisely control breathing, heart rate, and oxygenation ...**
- **Then SIDS may not have to be a catastrophic physiological crisis.**
- **Maybe it just needs to be a small problem which nudges or pushes a vulnerable infant over the edge.**

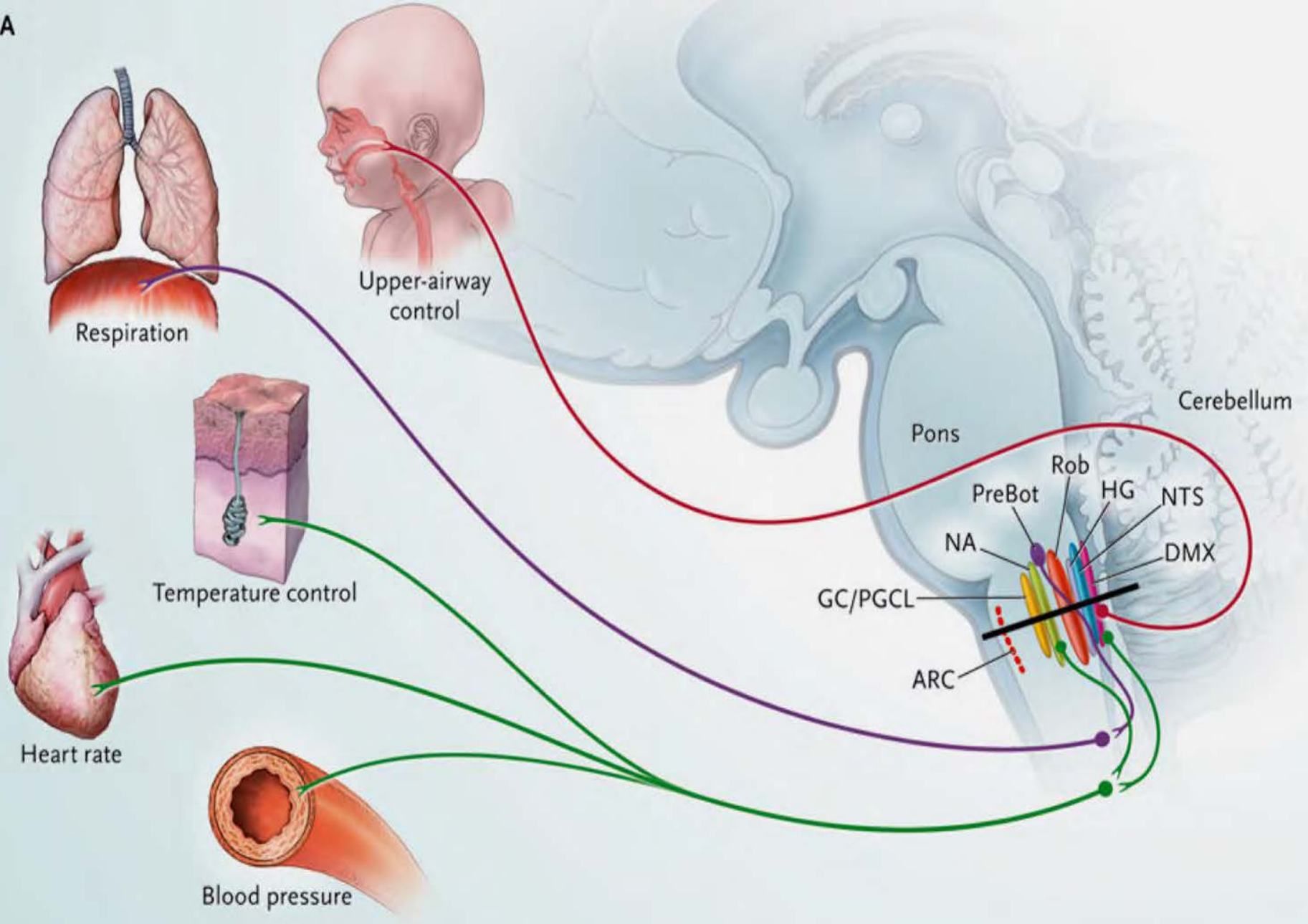


Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.



Kinney, H.C., and B.T. Thach. *N. Eng. J. Med.*, 361: 795-805, 2009.

A



Kinney, H.C., and B.T. Thach. *N. Eng. J. Med.*, 361: 795-805, 2009.



Brainstem Neurotransmitters in SIDS



- **Brainstem is the *life support* portion of the brain.**
- **Autopsy studies found decreased serotonin (5-HT) and serotonergic neurotransmitter receptor binding activity in brainstems of SIDS vs controls infants.**

Panigrahy, A., et al. *J. Neuropath. Exp. Neurol.*, 59: 377-384, 2000.

Kinney, H.C., et al. *J. Neuropath. Exp. Neurol.*, 60: 228-247, 2001.

Kinney, H.C., et al. *J. Neuropath. Exp. Neurol.*, 62: 1178-1191, 2003.

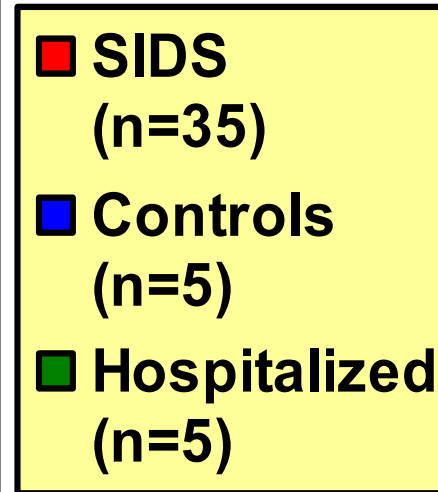
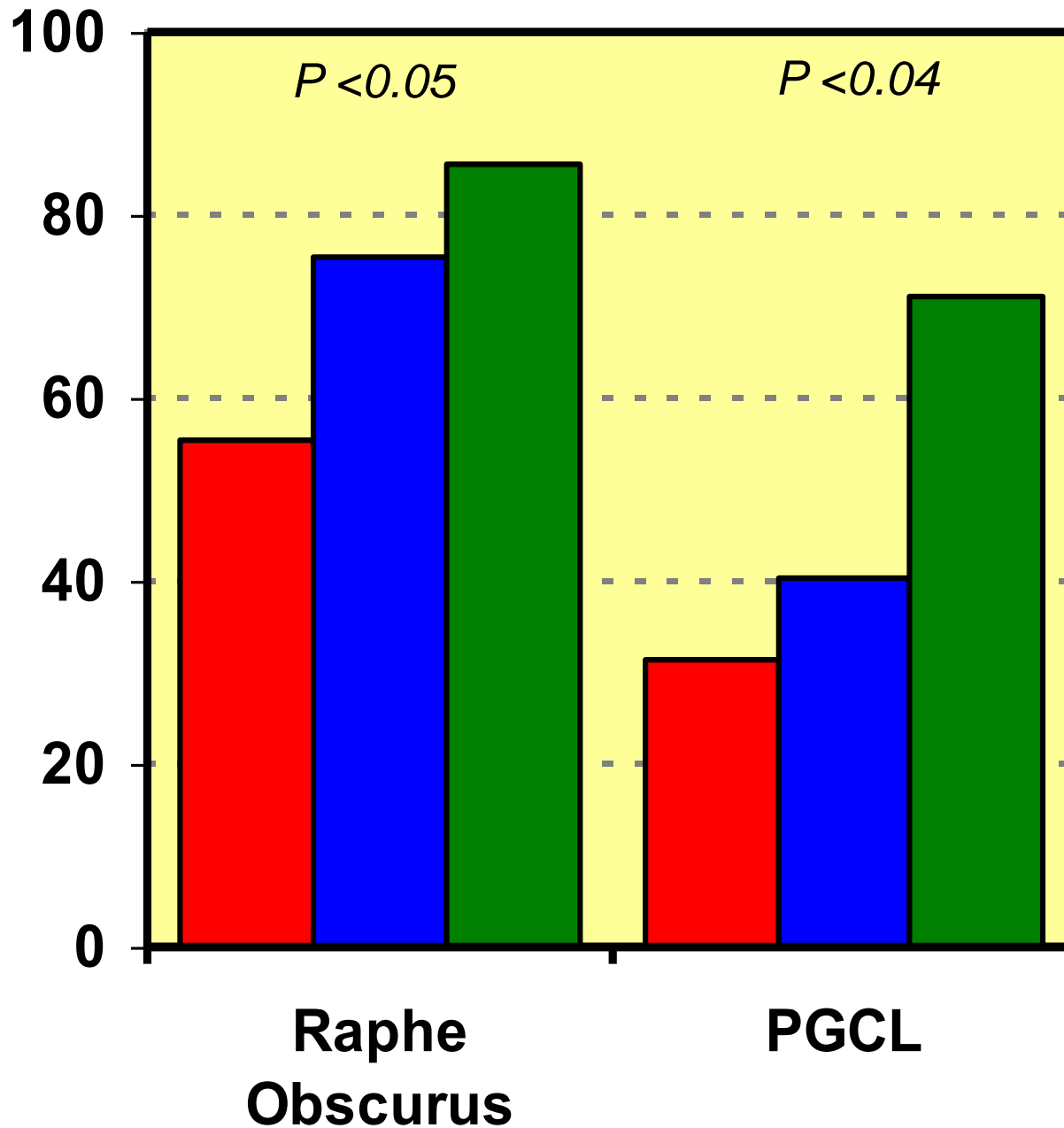
Paterson, D.S., et al. *J. Amer. Med. Assoc.*, 296: 2124-2132, 2006.

Duncan, J.R., et al. *J. Amer. Med. Assoc.*, 303: 430-437, 2010.

Randall, B.B., et al. *Pediatrics*, doi: 10.1542/peds.2013-0700. 2013.

Goldstein, R.D., et al. *Pediatrics*, 137: e20154661, 2016.

Brainstem Serotonin Concentration
(pmol/mg)

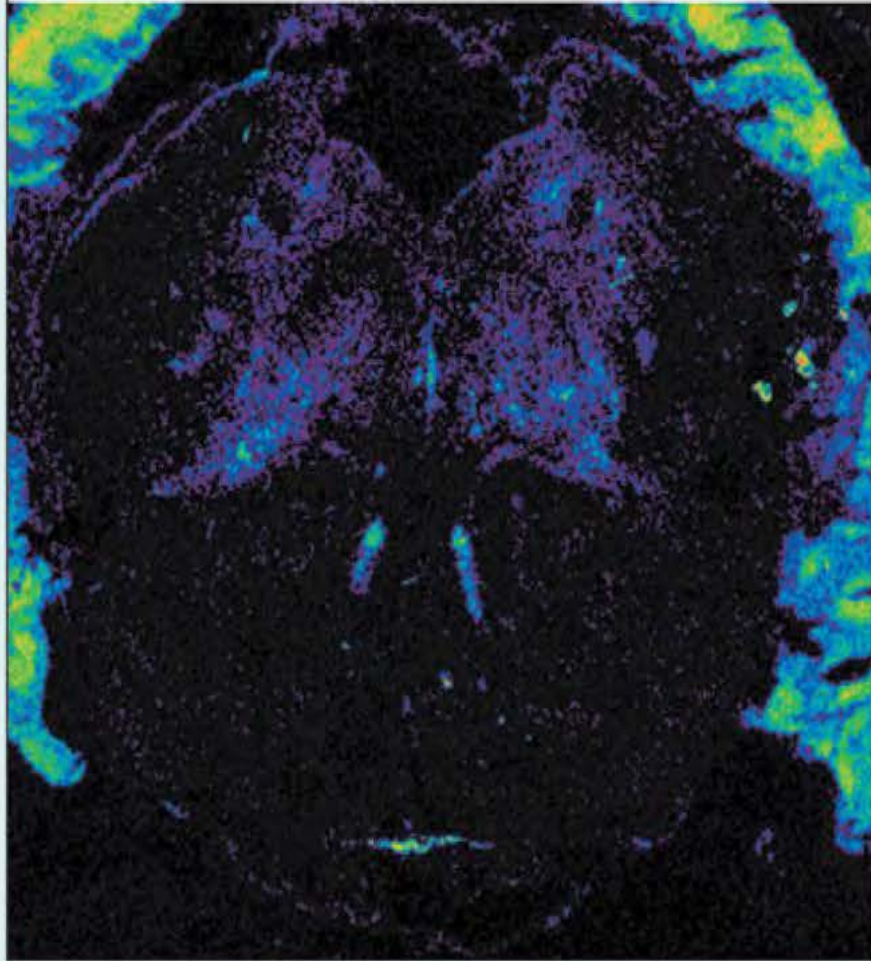




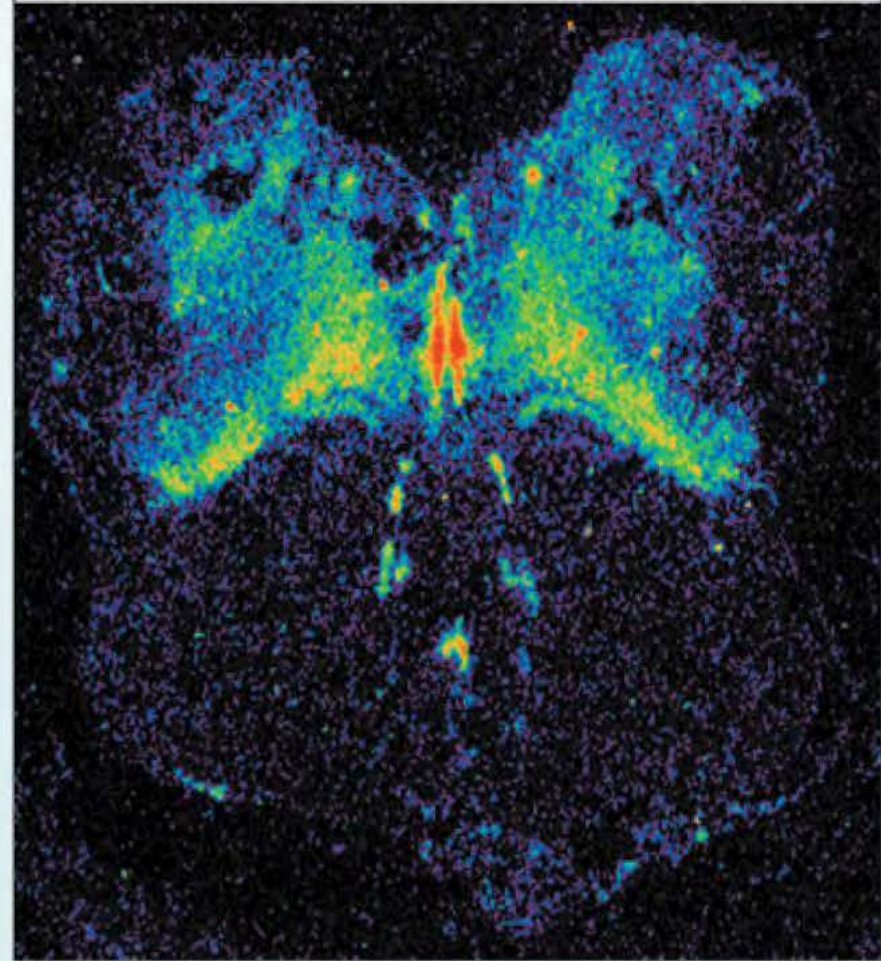
5-HT_{1A} Receptor Binding Density in the SIDS Mid-Medulla



B Infant with Sudden Infant Death Syndrome



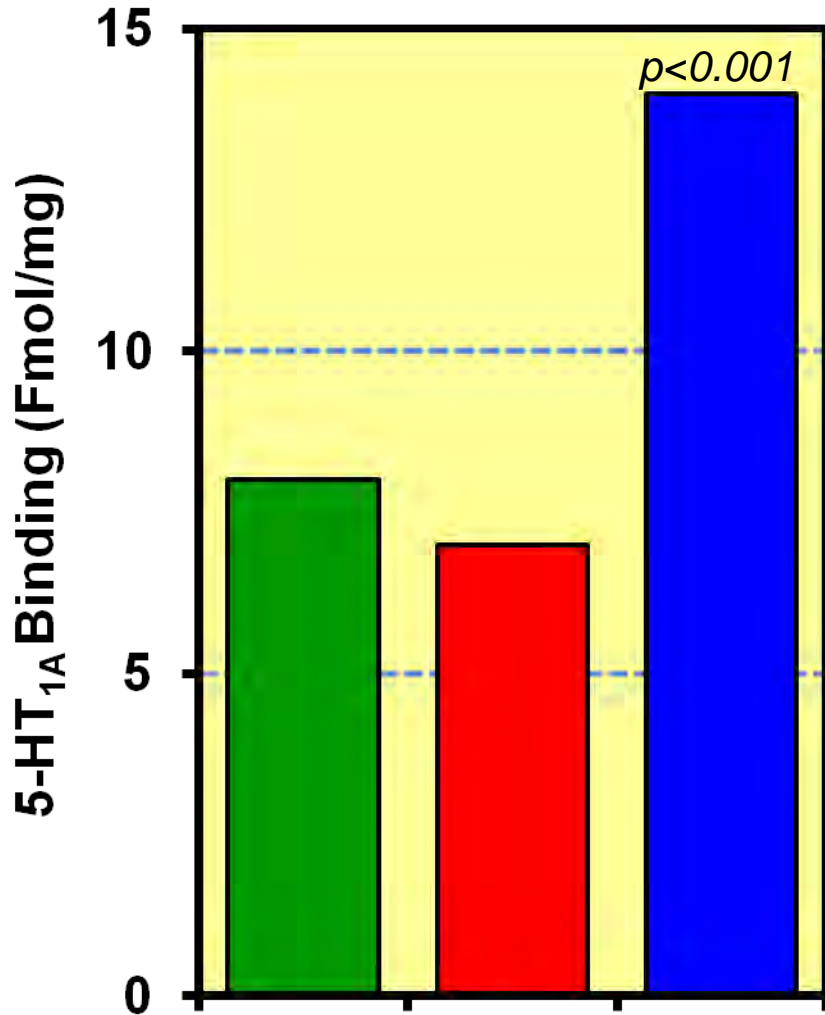
C Control Infant



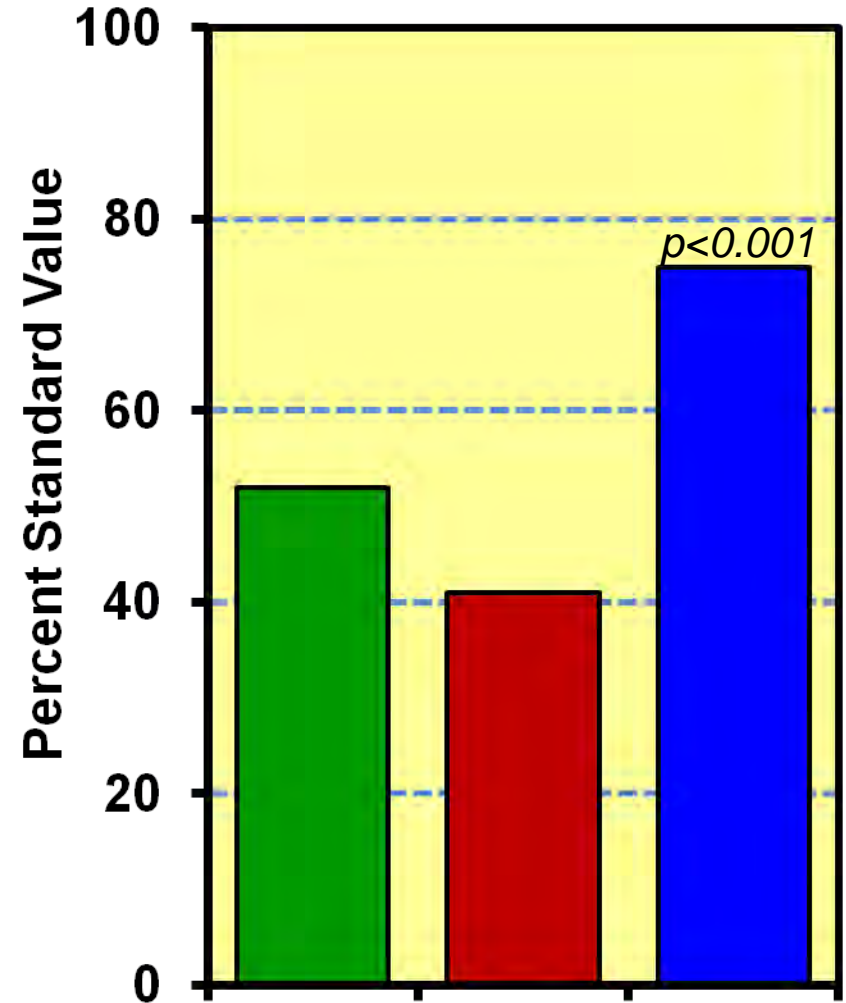
Paterson, D.S., et al. *J. Amer. Med. Assoc.*, 296: 2124-2132, 2006.

- Sudden death without Asphyxia
- Sudden death with Asphyxia
- Known Cause of Death

Solitary Tract Nucleus



Gigantocellularis



Brain Abnormality

Small

Intermediate

Severe

**Accidental
Asphyxia or
Suffocation**

**Sudden
Death with
Asphyxia**

**Sudden Death
without
Asphyxia**

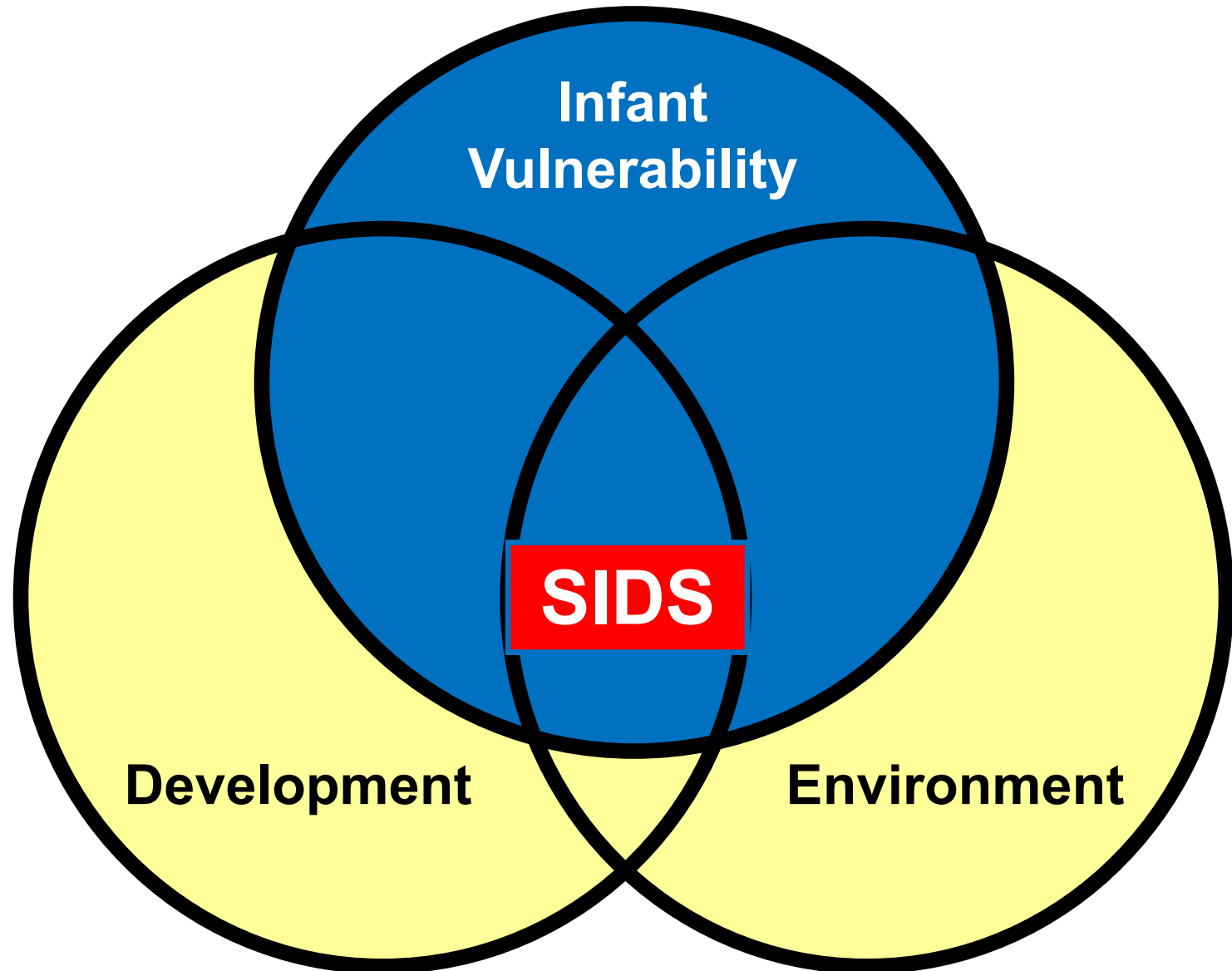
Asphyxial Insult

Severe

Intermediate

Small

Infant Vulnerability may have Many Causes



Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.

Imagine a car driving up a steep mountain road. The car has stopped.

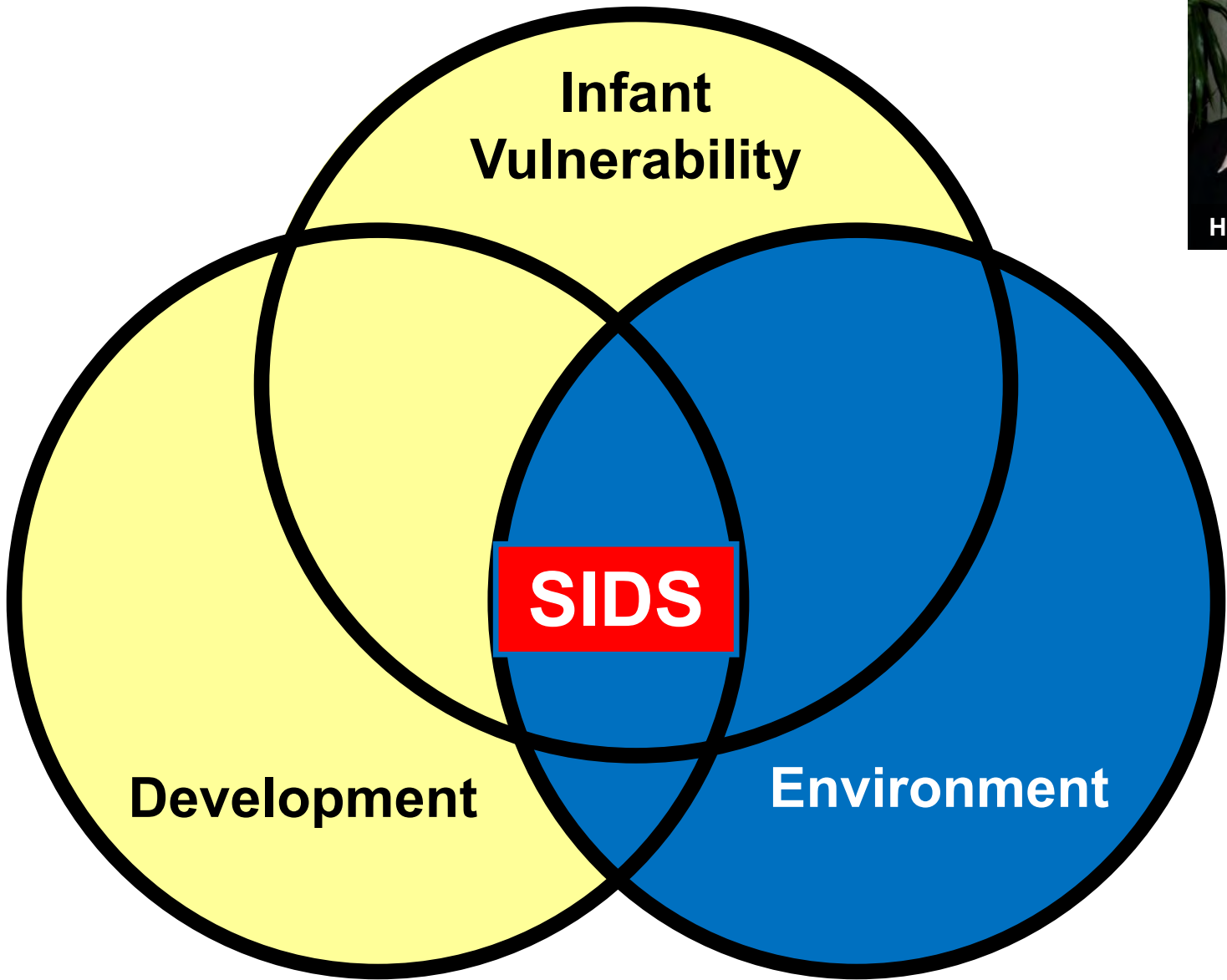
Why can't the car continue up the hill?

A New Way of Thinking:

- Some cars are Ferrari's.
- Some cars are Jeep's.

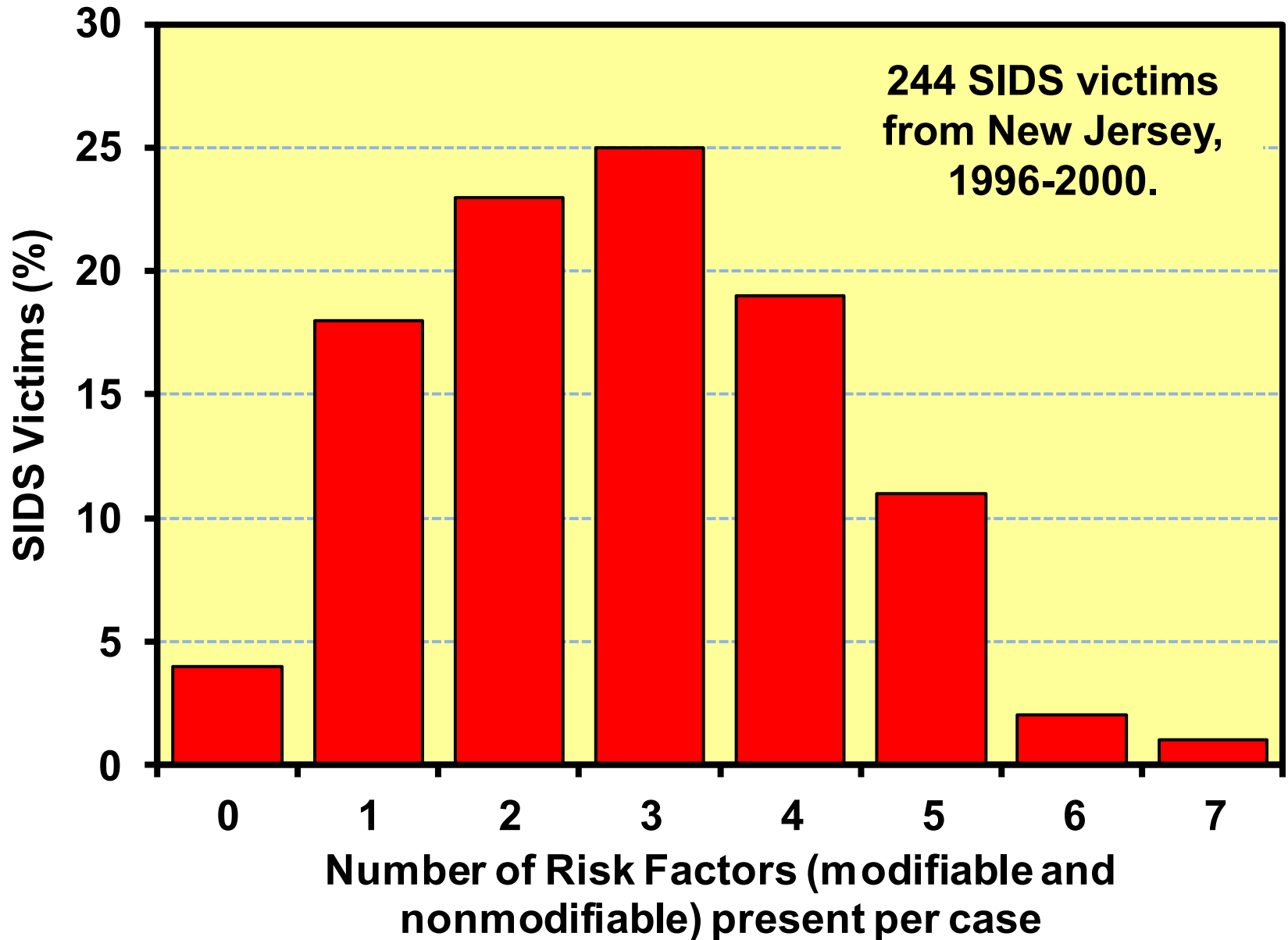


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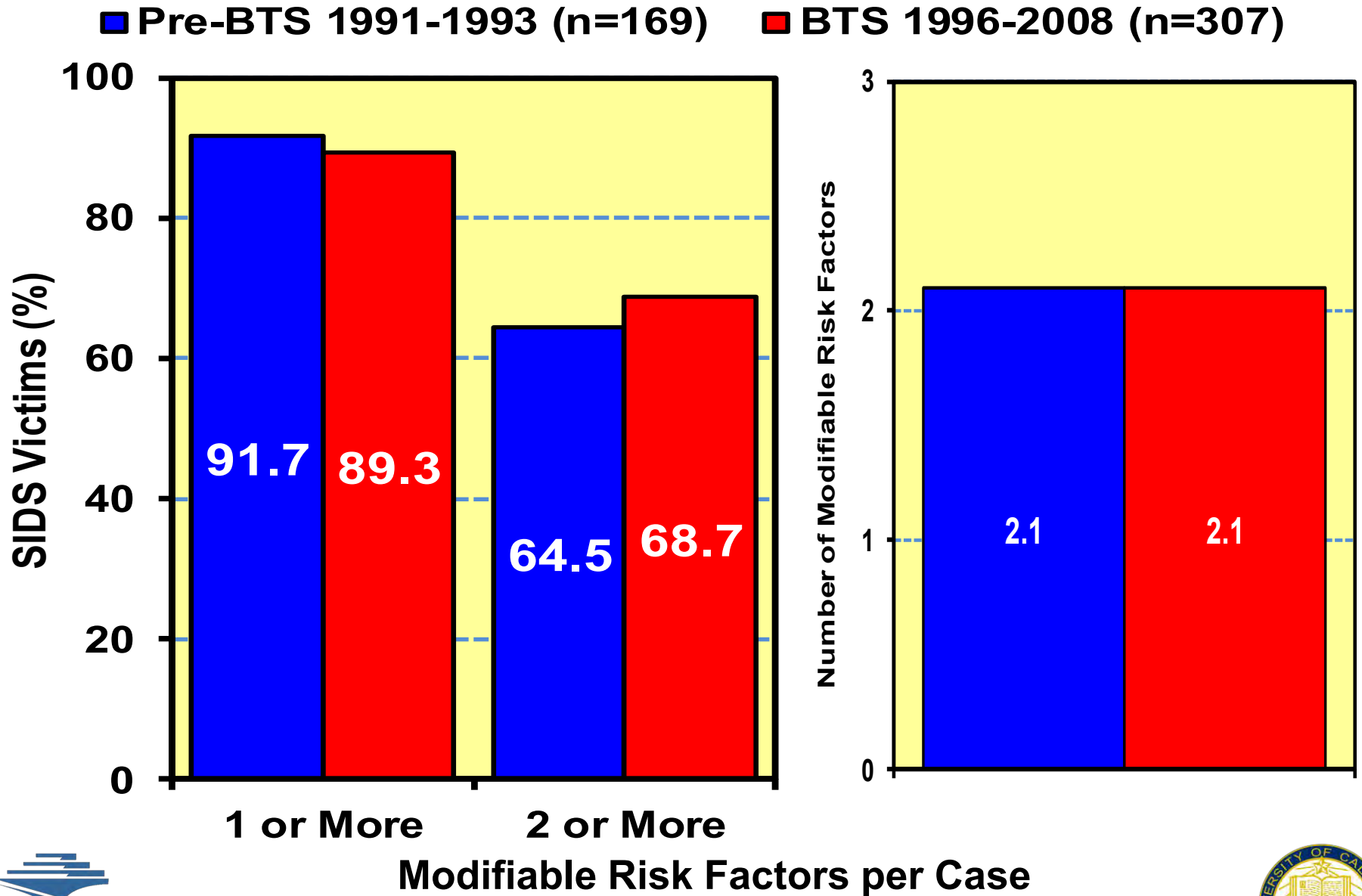
Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.

The majority of SIDS victims have ≥ 1 Risk Factor



Ostfeld, B.M., et al. *Pediatrics*, 125: 447-453, 2010.

The majority of SIDS victims have ≥ 1 Risk Factor



How can we, as a population, reduce the risks of SIDS?



Keck School
of Medicine
of USC



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University of
Southern California



Risk Factors \neq Causes

- **Most infants with risk factors will not die from SIDS.**
- **Some infants without risk factors will die from SIDS.**
- **However, infants with risk factors are at increased risk of dying from SIDS.**



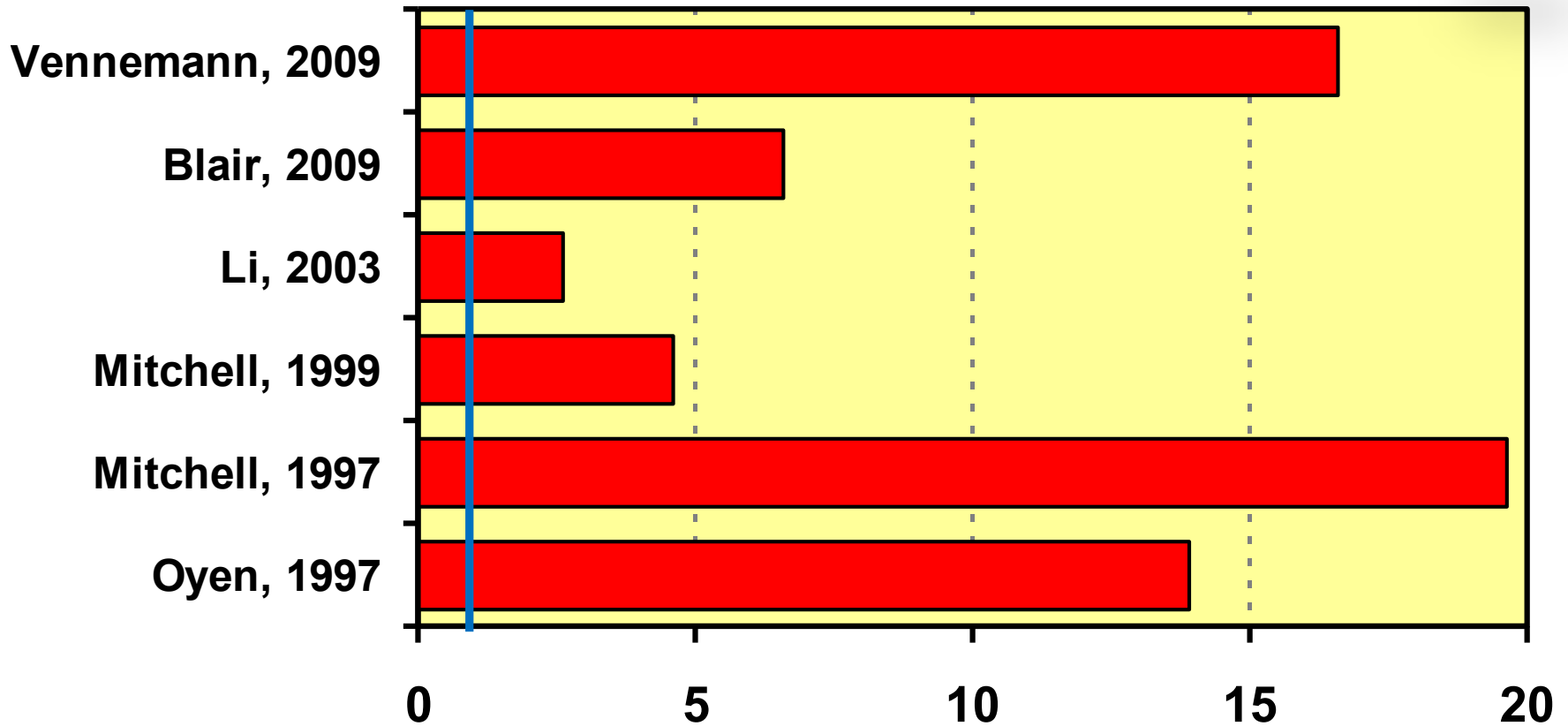
Babies Should Sleep on their Backs for Every Sleep



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

<http://www.medscape.com/features/slideshow/safe-sleep-principles?>

Prone Sleeping and SIDS (Odds Ratios vs Non-Prone Sleeping)



Vennemann, M.M., et al. *Pediatrics*, 123: 1162-1170, 2009.

Blair, P.S., et al. *B.M.J.*, 339: b3666, 2009.

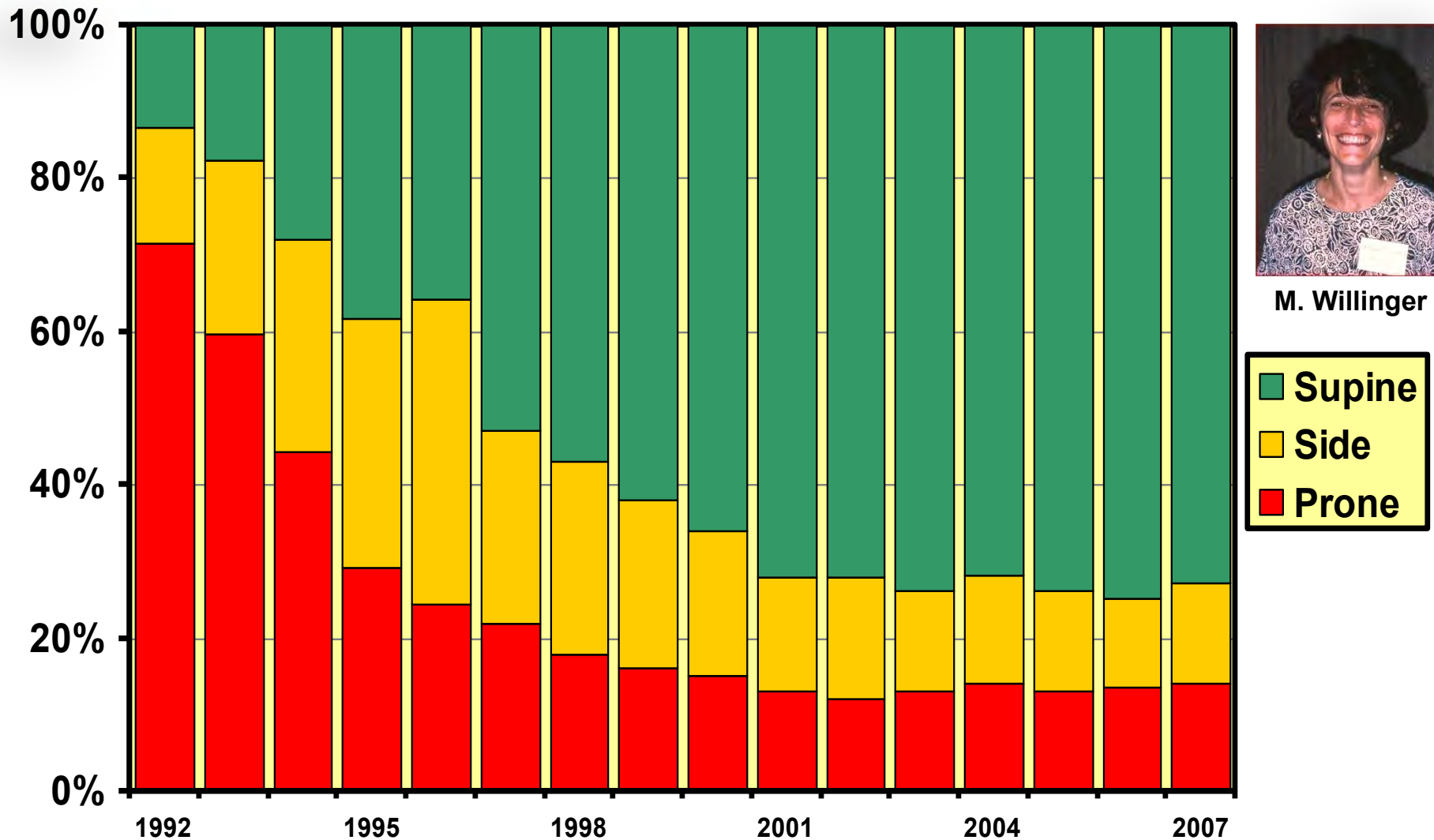
Li, D-K, et al. *Am. J. Epidemiol.*, 157: 446-455, 2003.

Mitchell, E.A., et al. *Arch. Pediatr. Adolesc. Med.*, 153: 1136-1141, 1999.

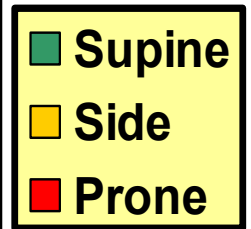
Mitchell, E.A., et al. *Pediatrics*, 100: 835-840, 1997.

Oyen, N., et al. *Pediatrics*, 100: 613-621, 1997.

National Infant Sleep Position Study (U.S.A.)

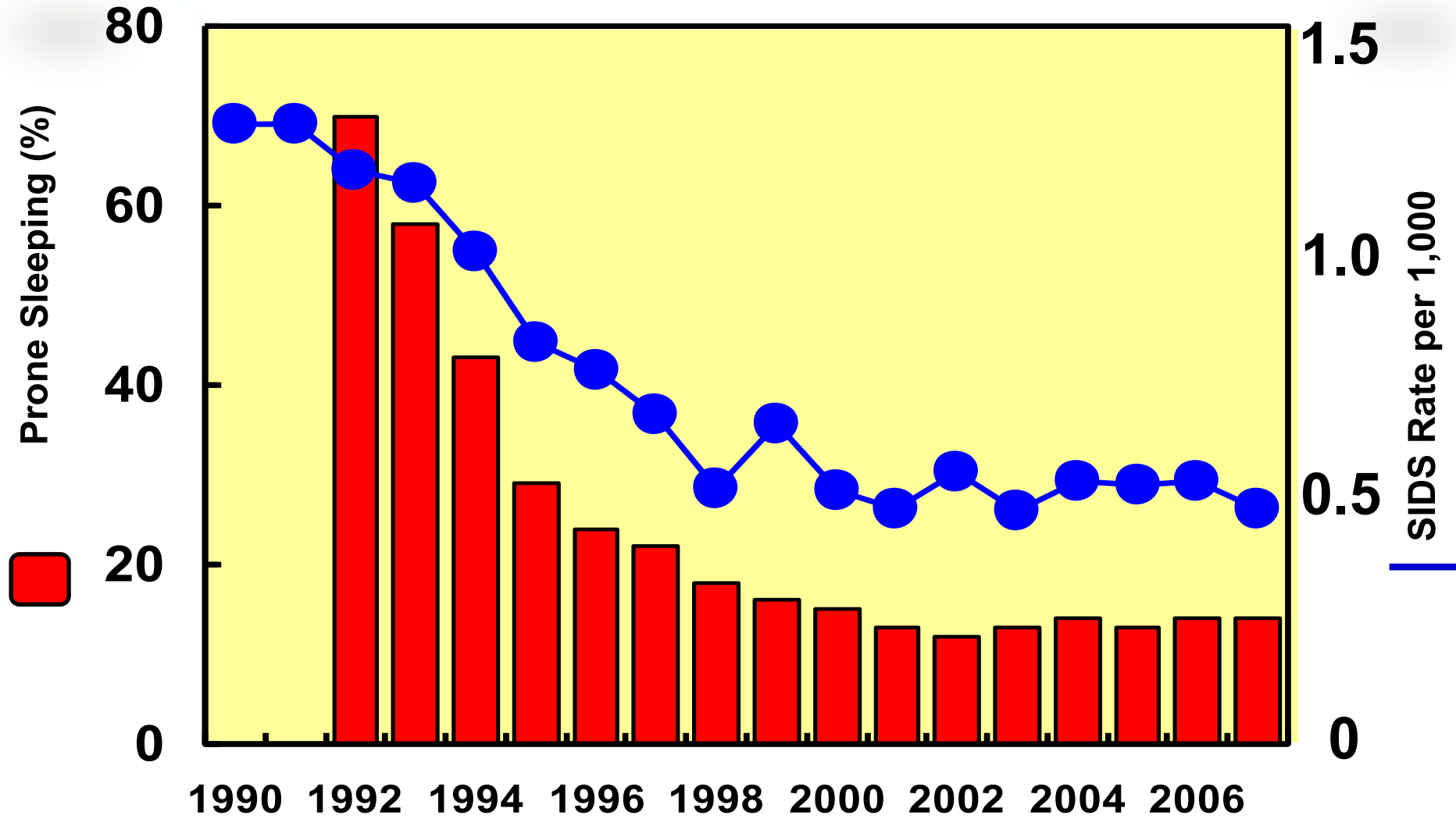


M. Willinger



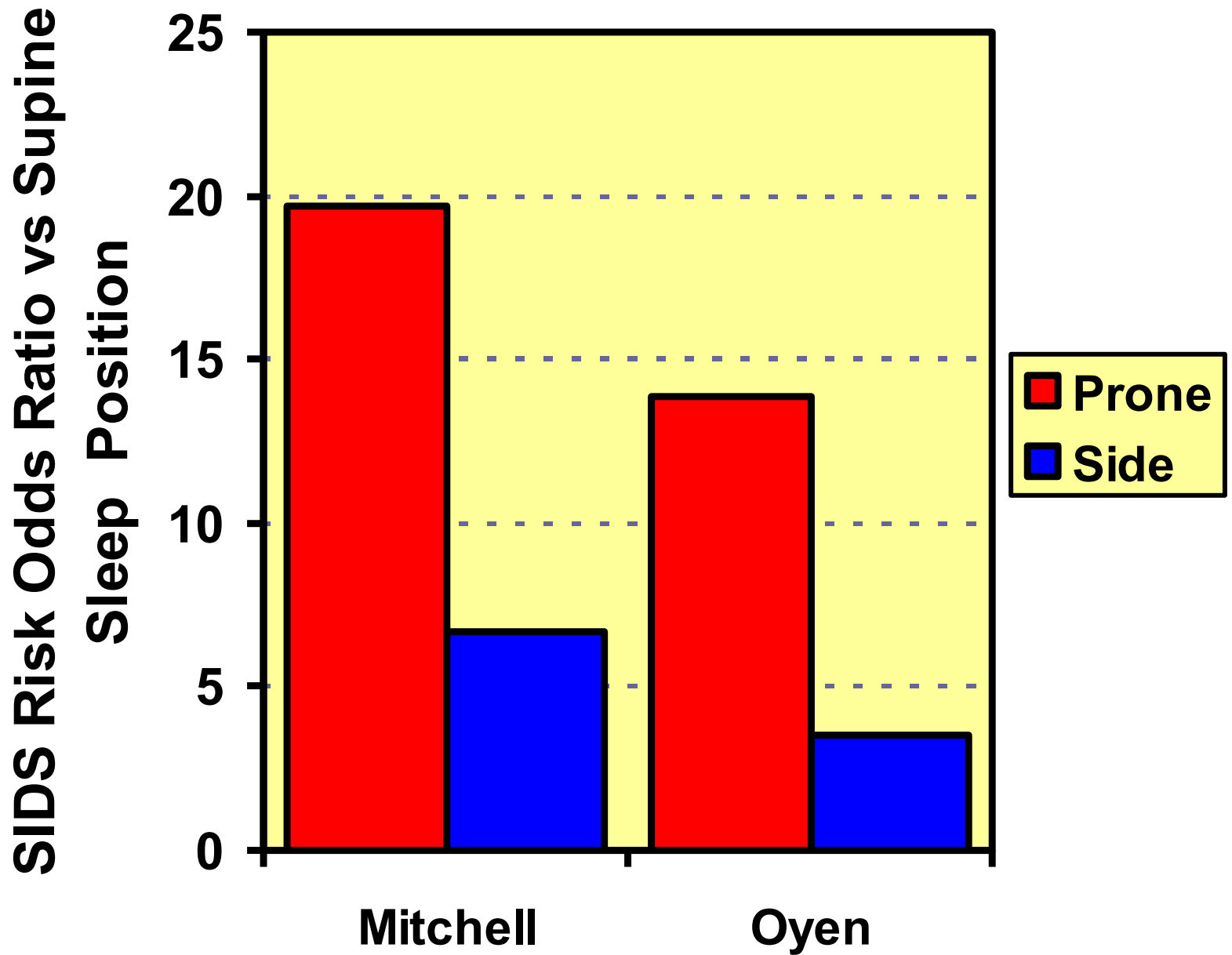
Willinger, M., et al. *J. Amer. Med. Assoc.*, 280: 329-335, 1998.

Colson, E.R., et al. *Arch. Pediatr. Adolesc. Med.*, 163: 1122-1128, 2009.



M. Willinger, et al. *J. Amer. Med. Assoc.*, 280: 329-335, 1998.

Colson, E.R., et al. *Arch. Pediatr. Adolesc. Med.*, 163: 1122-1128, 2009.

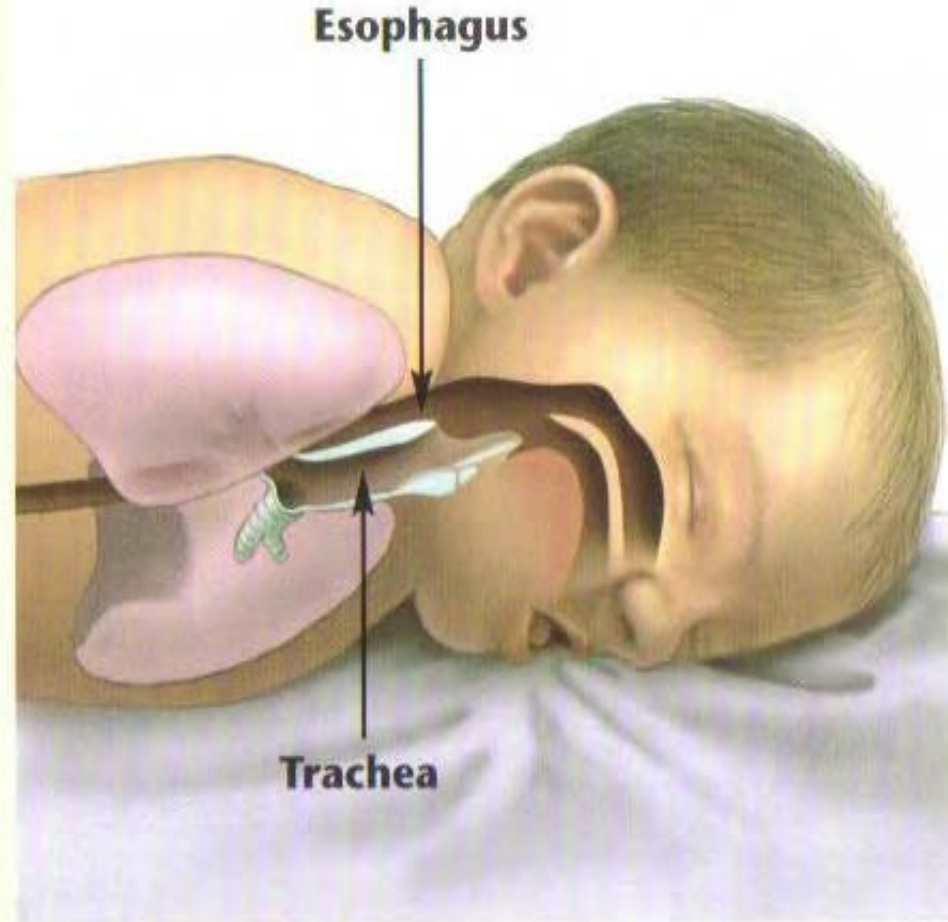
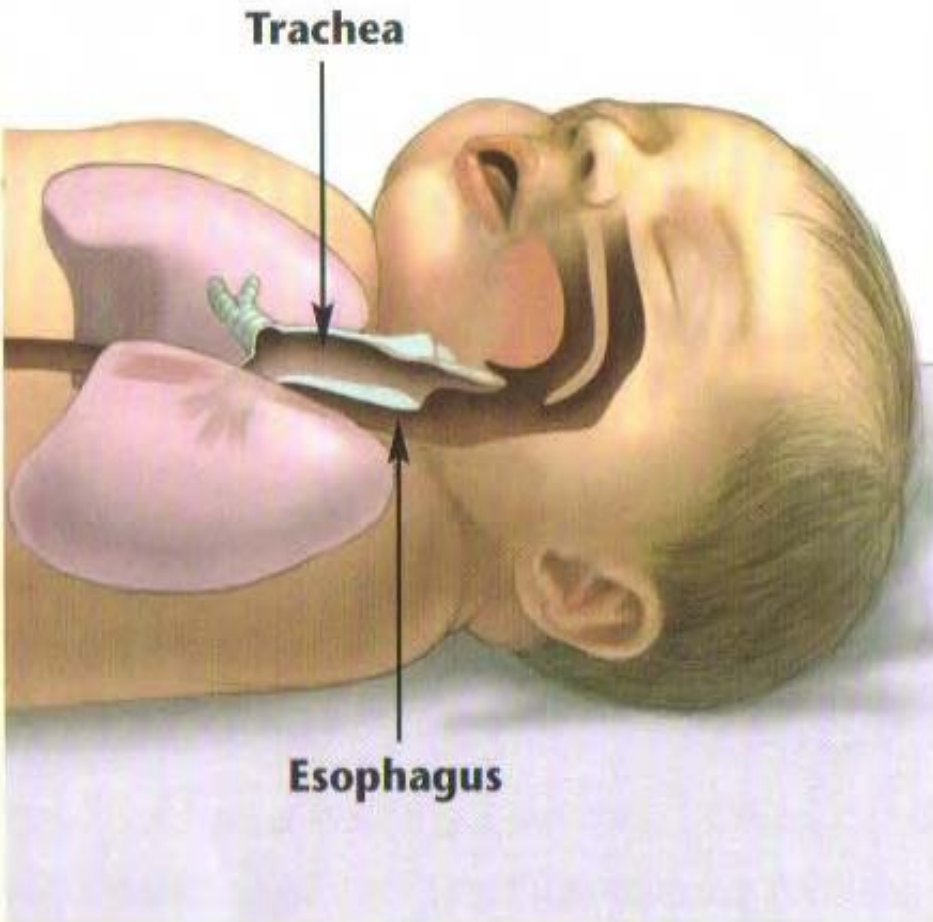


Mitchell, E.A., et al. *Pediatrics*, 100: 835-840, 1997.

Oyen, N., et al. *Pediatrics*, 100: 613-621, 1997.

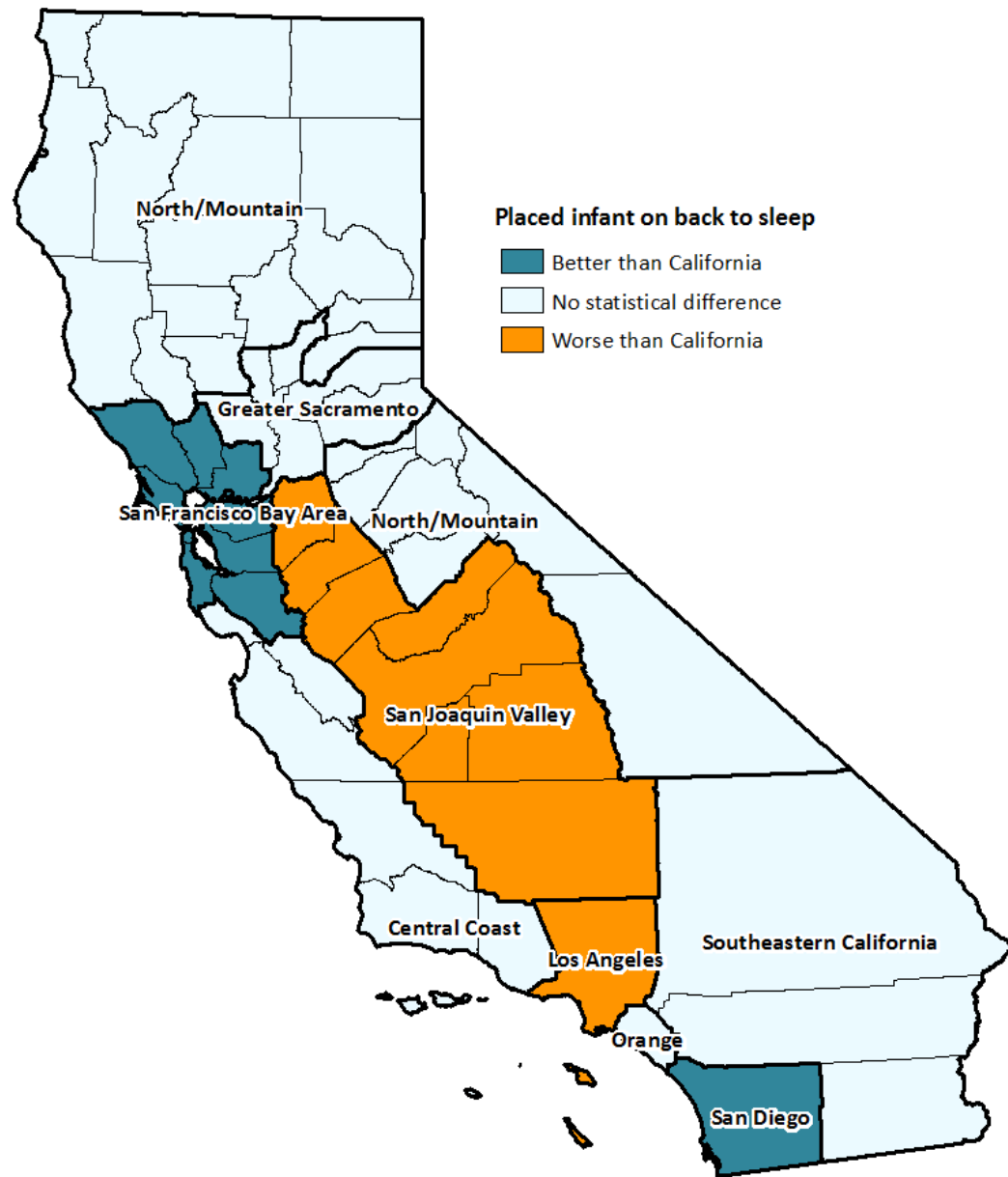
Supine

Prone



**SIDS Risk Reduction: Curriculum for Nurses, NICHD, 2006.
NIH Publication No. 06-6005.**

**California
Infants
Placed on
the Back to
Sleep:
76.1%**



Maternal and Infant Health Assessment Survey Prepared by: Maternal, Child and Adolescent Health Program, Center for Family Health, California Department of Public Health

<http://www.cdph.ca.gov/data/surveys/MIHA/MIHAComparisonMaps/CompareRegSleepPos2012.pdf>



Use a Firm Sleep Surface. Firm Crib Mattress and Fitted Sheet



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

<http://www.medscape.com/features/slideshow/safe-sleep-principles?>



Sitting Devices are Not Recommended for Routine Sleep



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.
<http://www.medscape.com/features/slideshow/safe-sleep-principles?>



Roomsharing, Without Bedsharing, is Recommended.



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

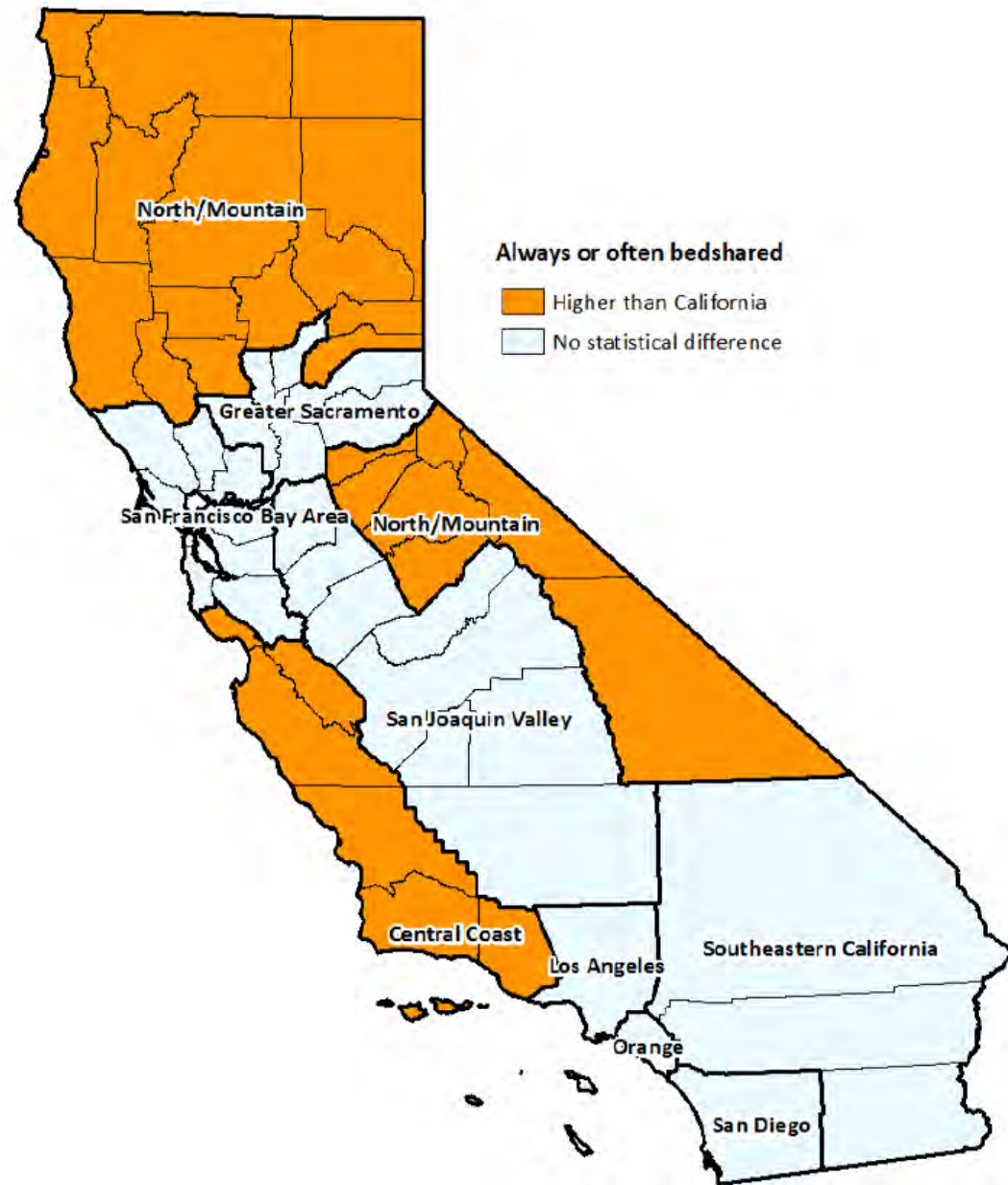
<http://www.medscape.com/features/slideshow/safe-sleep-principles?>

Early Study of Maternal Overlaying

- In 1892, a Scottish police surgeon, Templeman, first drew attention to the potential role of excessive alcohol consumption and overlaying.
- 258 cases of suffocation in infants.
- More than half of deaths occurred Saturday night.
- Postulated that intoxication impaired arousal responses of parents sleeping with infants, thus increasing the risk of accidental suffocation.

Templeman, C. *Edinburgh Med. J.*, 38: 322-329, 1892.

**California
Infants
Who
Always or
Often
Bedshare:
39.3%**



Data Source: Maternal and Infant Health Assessment Survey Prepared by: Maternal, Child and Adolescent Health Program, Center for Family Health, California Department of Public Health

<http://www.cdph.ca.gov/data/surveys/MIHA/MIHAComparisonMaps/CompareRegBedshare2011.pdf>



Bedsharing, Breathing, and Infant Sleep



- Increased breastfeeding, but not when compared to room-sharing.
- No decrease in apnea.
- No stimulation of breathing.
- Increased arousals (baby wakes mother).
- Decrease in deep sleep.
- No apparent physiological protection.

Richard, C., et al. *Sleep*, 19: 685-690, 214-219, 1996.

McKenna, J.J., et al. *Pediatrics*, 100: 214-219, 1997.

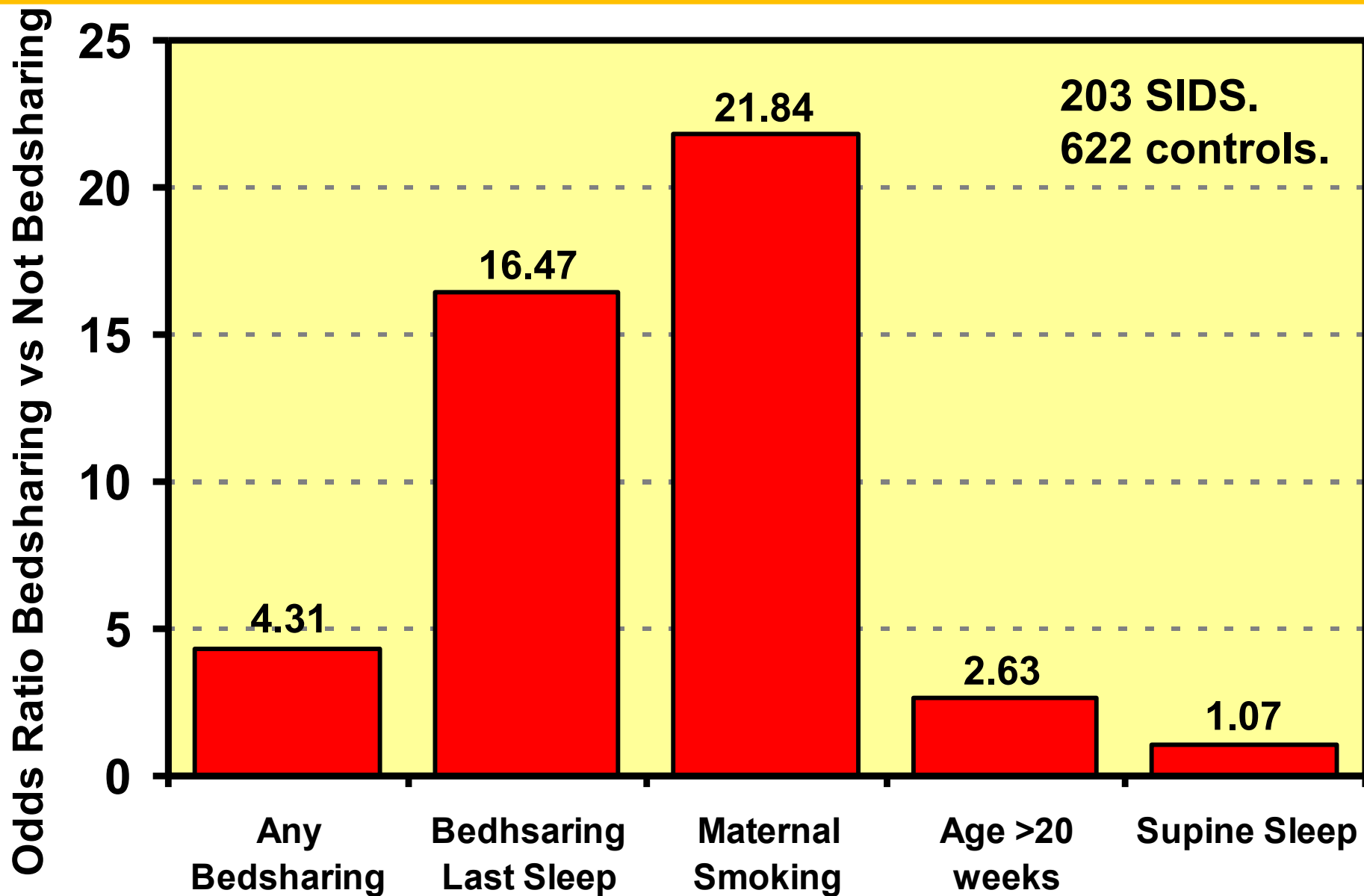
Mosko, S., et al. *Am. J. Physical Anthropol.*, 103: 315-328, 1997.

Richard, C.A., et al. *J. Appl. Physiol.*, 84: 1374-1380, 1998.

McKenna, J.J., and T. McDade. *Paediatr. Respir. Rev.*, 6: 134-152, 2005.

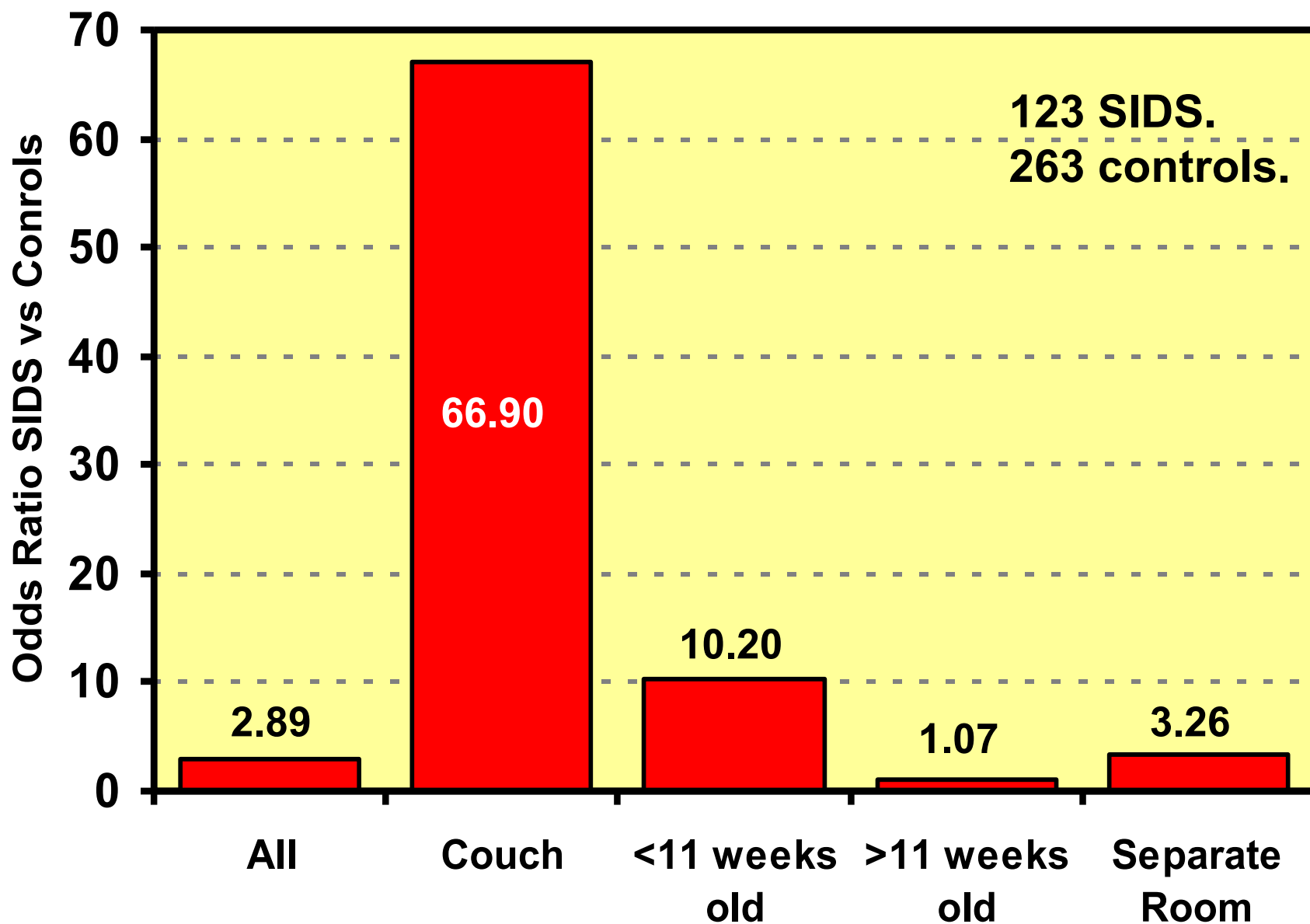
Ball, H.L., et al. *Arch. Dis. Child.*, 91: 1005-1010, 2006.

Bedsharing and SIDS in Ireland, 1994-1998



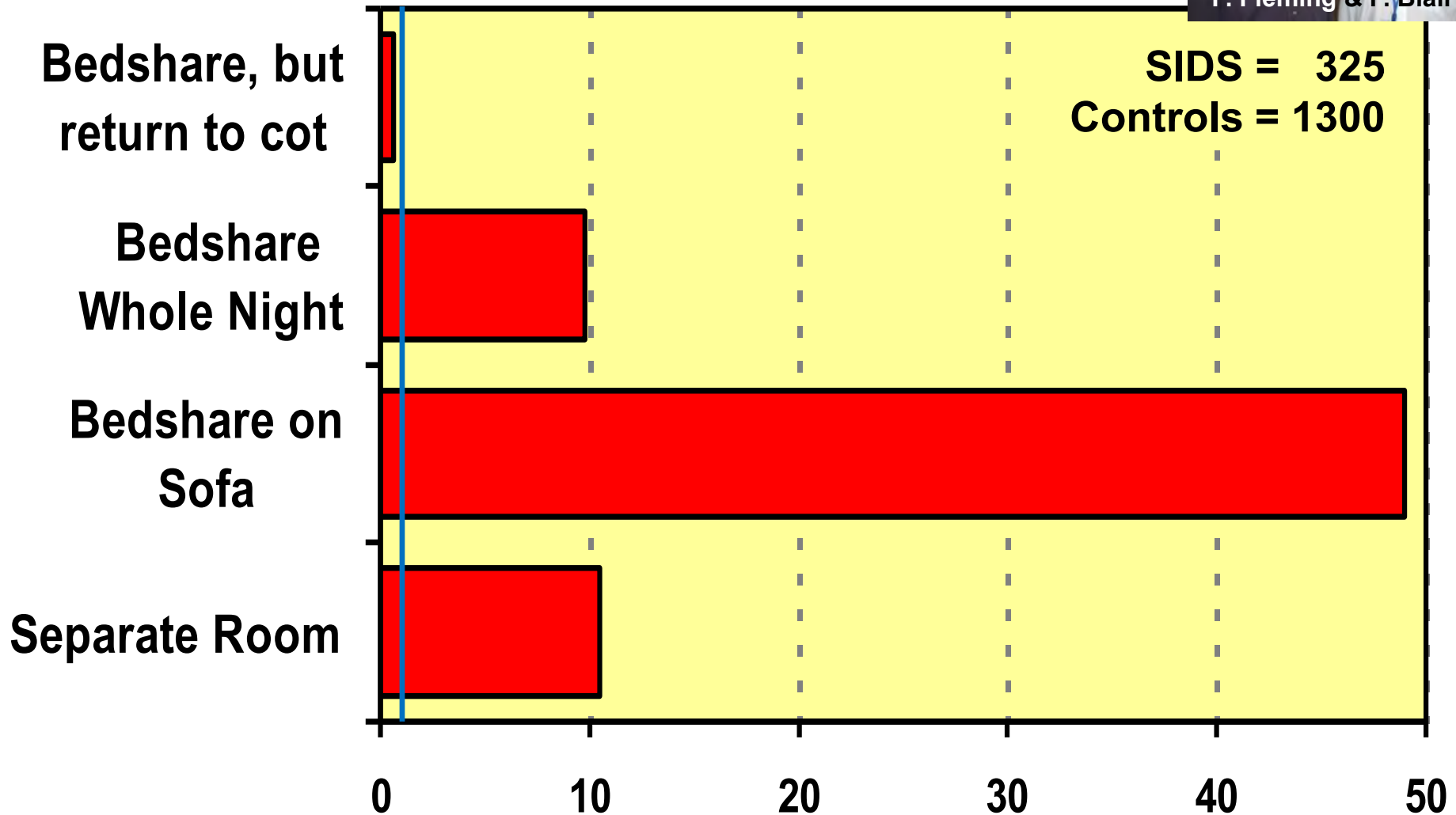
McGarvey, C., et al. *Arch. Dis. Child.*, 88: 1058-1064, 2003.

Bedsharing and SIDS in Scotland, 1996-2000



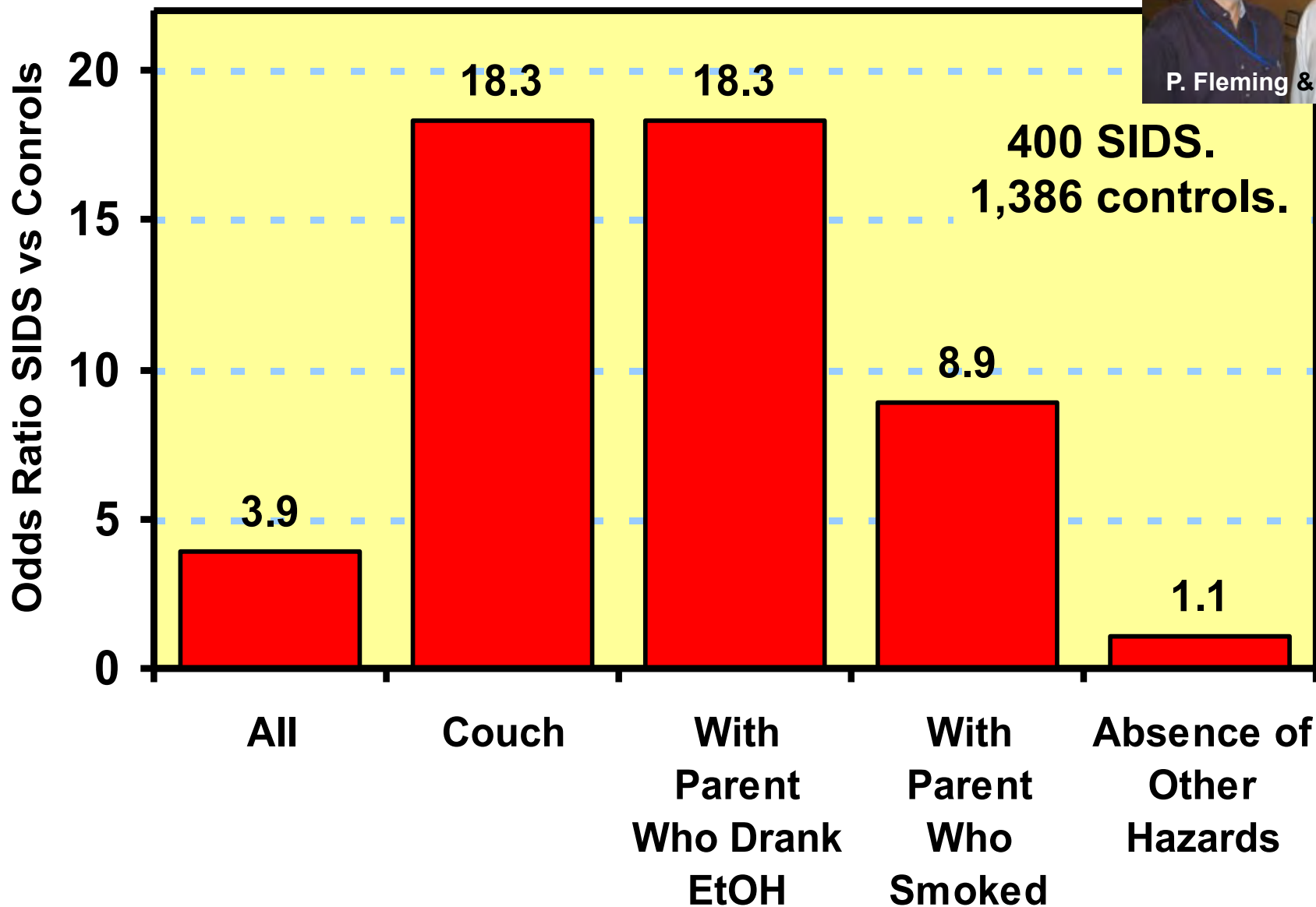
Tappin, D, et al. *J. Pediatr.*, 147: 32-37, 2005.

Bedsharing and SIDS Risk: CESDI Study (Odds Ratios vs did not sleep with an adult)



Blair, P.S., et al. *Br. Med. J.*, 319: 457-462, 1999.

Bedsharing and SIDS in the U.K.



Blair, P.S., et al. *PLoS ONE* 9(9): e107799. doi:10.1371, 2014.

Roomsharing



- **Infant's crib or bassinet should be placed in the parents' bedroom close to the parents' bed.**
- **Infant can be brought to bed for breastfeeding, but then returned to the crib.**
- **Devices promoted to make bedsharing "safe" are not recommended.**



Bedsharing is *Especially Unsafe with:*



- **Infant <3-months of age.**
- **Parent cigarette smoking.**
- **Parent is excessively tired; such as sleep deprivation (<4-hours sleep the previous night).**
- **Parent depressant medication or alcohol use.**
- **With non-parent or multiple persons.**
- **Soft or unsafe bed.**
- **Duvets, pillows, or soft covers.**
- **Sleeping on a sofa, armchair, or couch.**



AAP Recommendations



- **Roomsharing, with the infant in a crib in the parents' room next to the adult bed, is safest, and is safer than bedsharing.**
- **Infants brought to bed for breastfeeding should return to a separate crib.**
- **Do not bedshare if parents smoke cigarettes.**
- **Do not bedshare if the parents' arousal is depressed (alcohol, drugs, sleep deprived <4-hours sleep the night before).**
- **Do not sleep with an infant on a sofa or chair.**



Keep Soft Objects and Loose Bedding Out of the Crib



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

<http://www.medscape.com/features/slideshow/safe-sleep-principles?>





Consider Offering a Pacifier at Nap Time and Bedtime



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.



Avoid Cigarette Smoke Exposure During Pregnancy and After Birth



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

BREATHING AREA

NO SMOKING

NO VAPING





**Avoid Overheating and Head Covering;
Infants should not feel hot to touch.**



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.
<http://www.medscape.com/features/slideshow/safe-sleep-principles?>



**Infants Should be Immunized
according to AAP and CDCP Advice.**



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

<http://healthlevelup.com/vaccinations-and-children/>



Avoid Alcohol and Illicit Drug Use During Pregnancy and After Birth.



AAP Policy Statement. *Pediatrics*, 138:e20161889, 2016.



Avoid Use of Commercial Devices Inconsistent with Safe Infant Sleep



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.



Encourage *Tummy Time* when the Infant is Awake and Observed.



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

<http://www.medscape.com/features/slideshow/safe-sleep-principles?>



No Evidence to Recommend Swaddling to Reduce the Risk of SIDS



AAP Policy Statement. *Pediatrics*, 138: e20162938, 2016.

Infant Swaddling

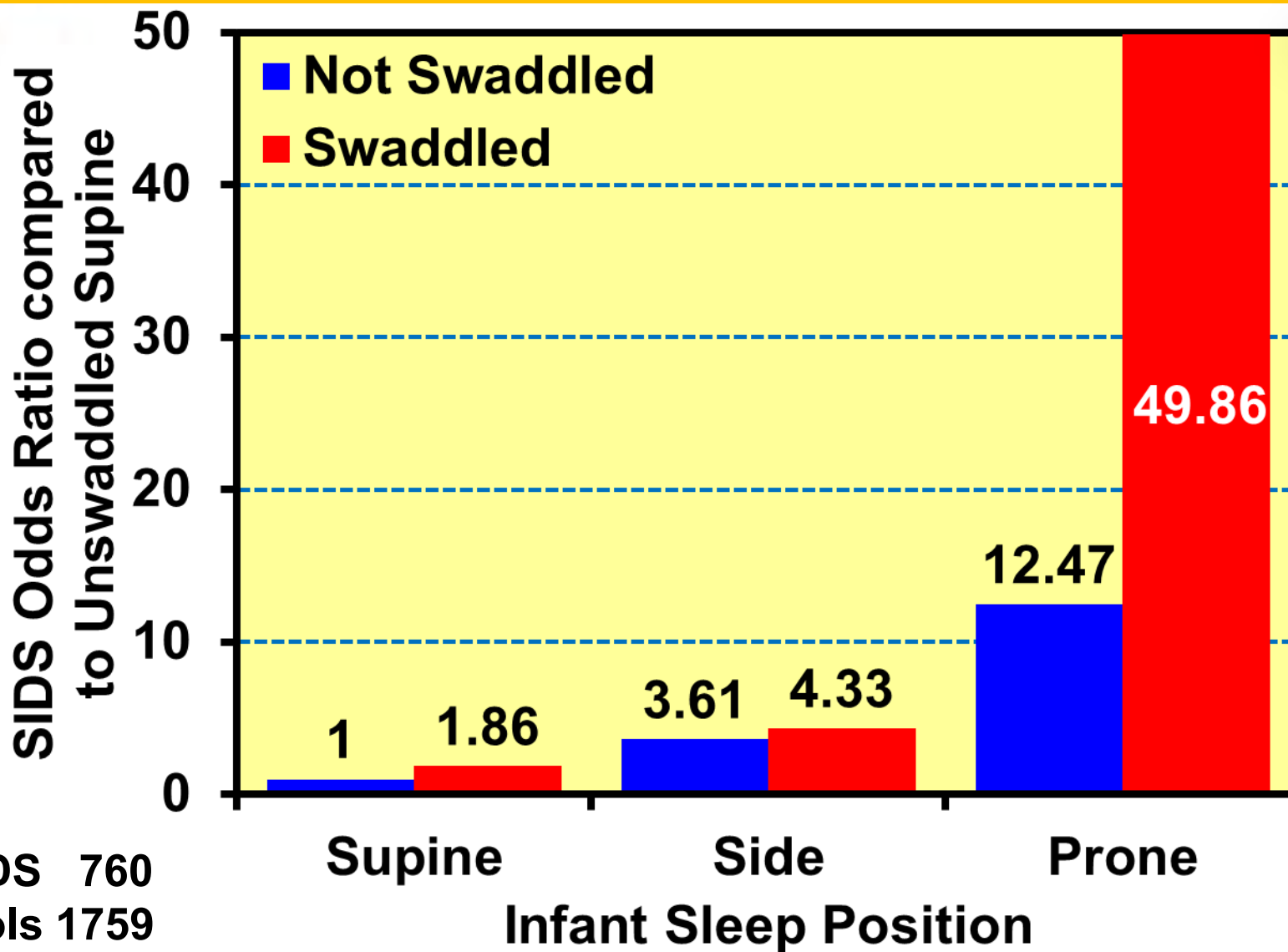


Infant Swaddling





Swaddling and SIDS



SIDS 760
Controls 1759

Pease, A.S., et al. *Pediatrics*, 137: e20153275, 2016.



Avoid Swaddling if ...



- **Prone sleeping position.**
- **Thick blankets.**
- **Face covered.**
- **For infants older than 3-months.**

There is a danger when infants begin to roll from supine to prone, the swaddled infant can not regain the supine position.

Ponsonby, A.L., et al. *N. Eng. J. Med.*, 329: 377-382, 1993.

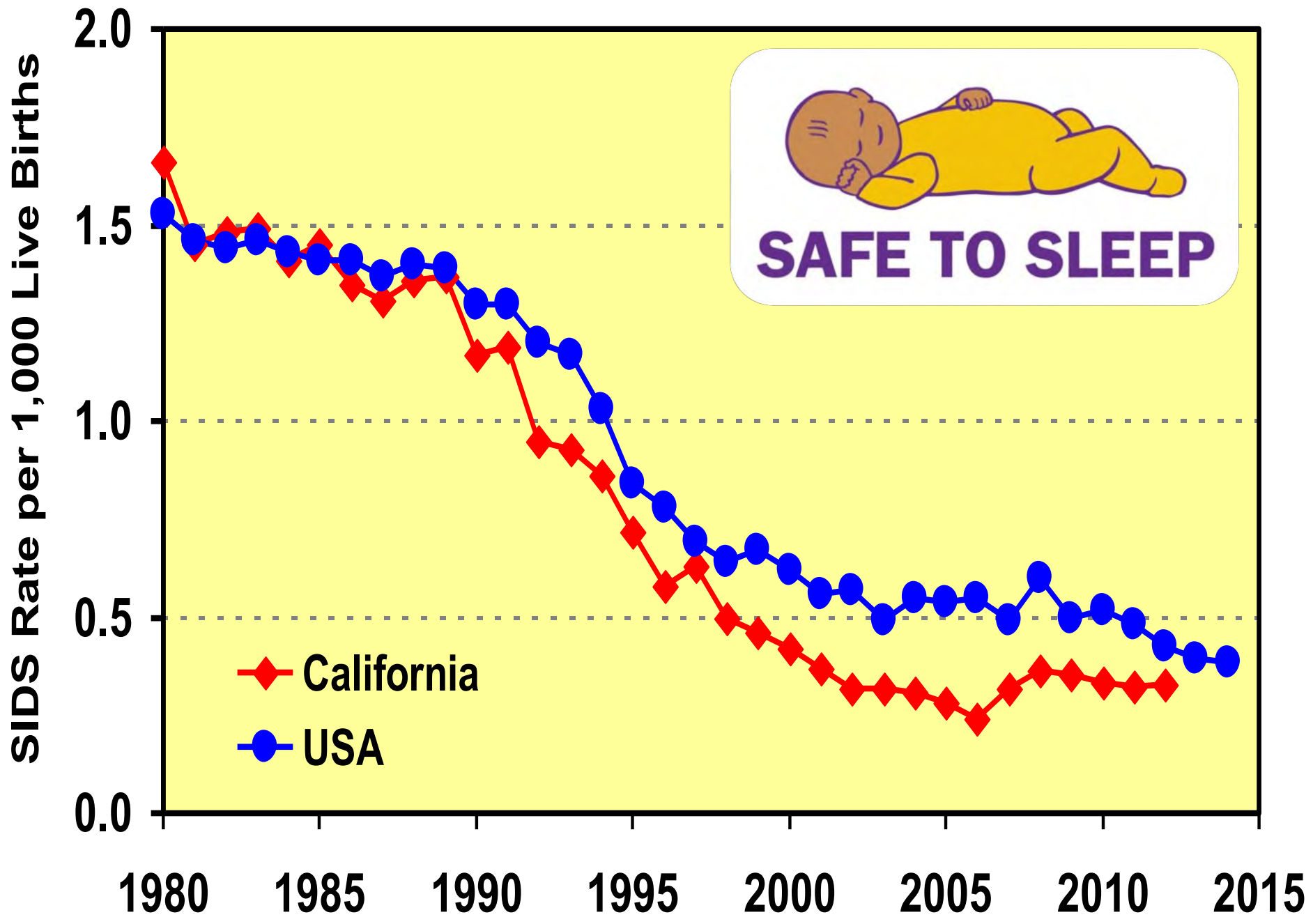
Wilson, C.A., et al. *J. Paed. Child Health*, 30: 506-512, 1994.

L'Hoir, M.P., et al. *Eur. J. Pediatr.*, 157: 681-688, 1998.

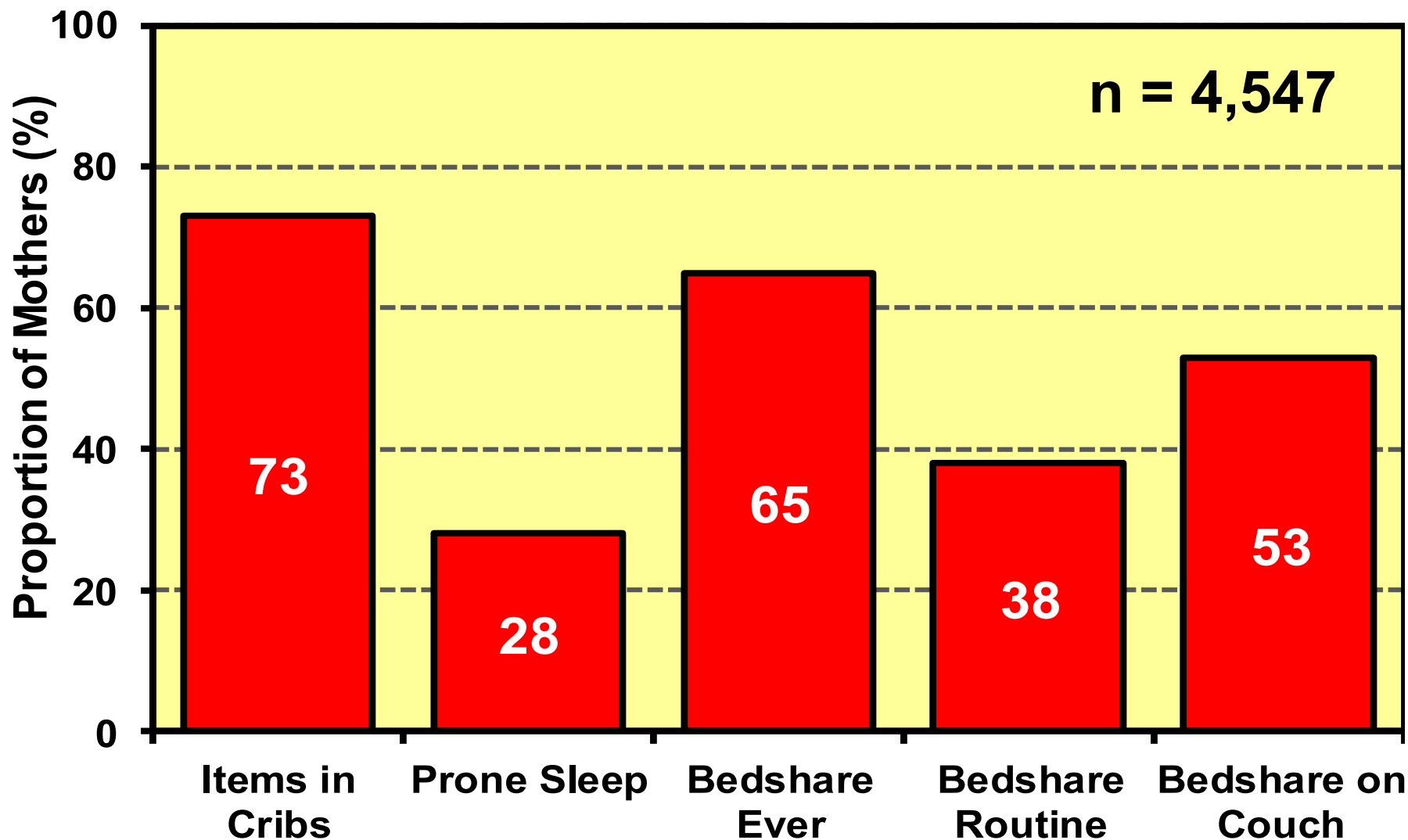
Van Sleuwen, B.E., et al. *Pediatrics*, 210: e1097-e1106, 2007.

Pease, A.S., et al. *Pediatrics*, 137: e20153275, 2016.

AAP Policy Statement. *Pediatrics*, 138: e20161889, 2016.



Parents Ignore Safe Infant Sleep Recommendations

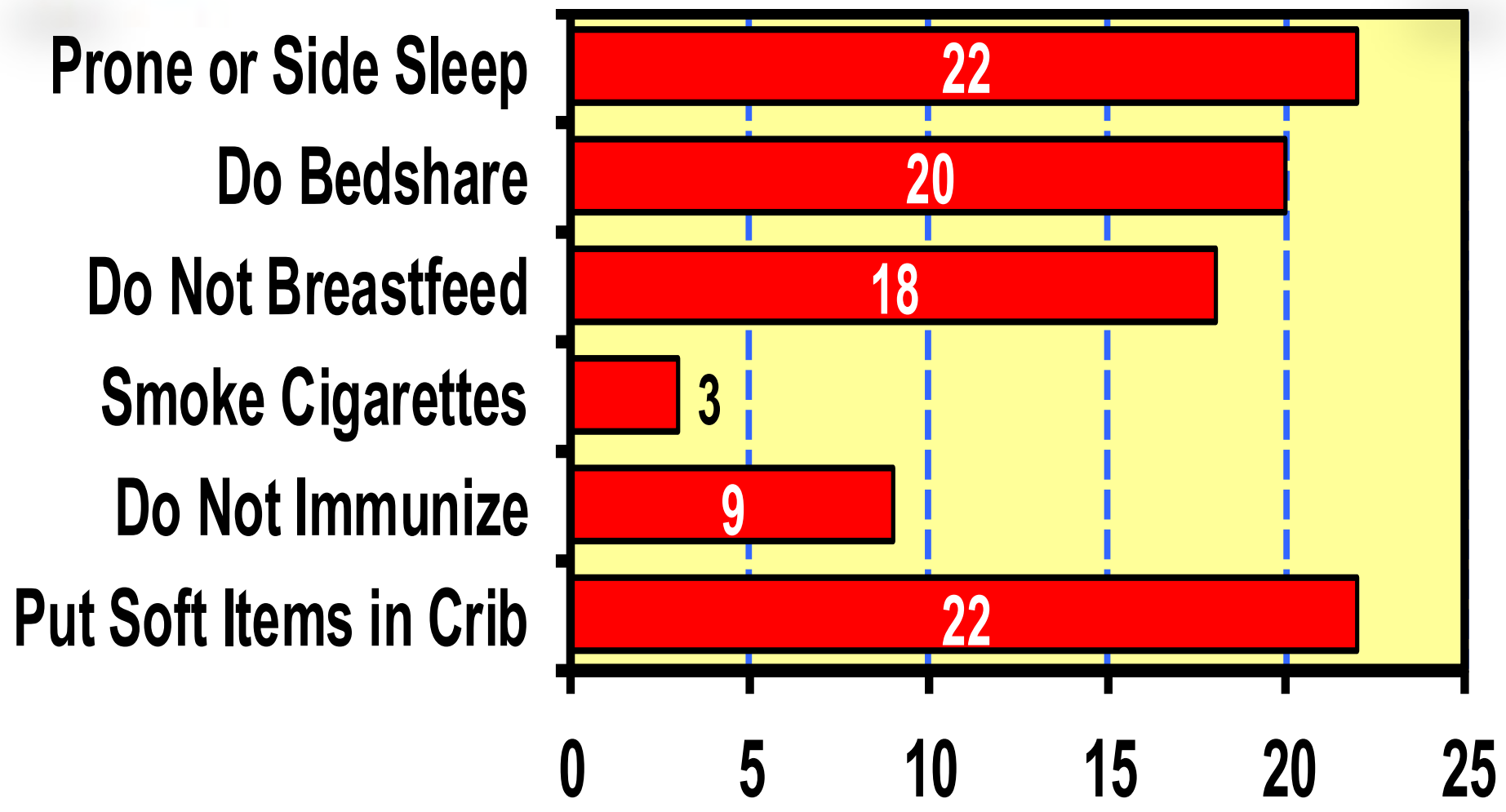


Dreisbach, S. *American Baby Magazine*, March, 2014, issue.

<http://www.parents.com/baby/safety/nursery/how-safe-is-your-babys-sleep/?page=3>



Many Parents Do Not Follow Safe Infant Sleep Recommendations



n = 121 parents

Parents of Newborn Infants (%)



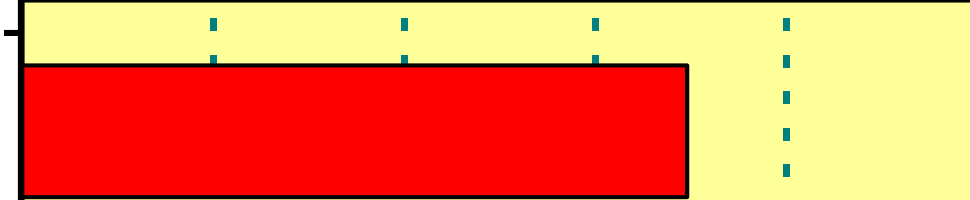
Primary Care Physicians Do Not Discuss SIDS Risk Reduction



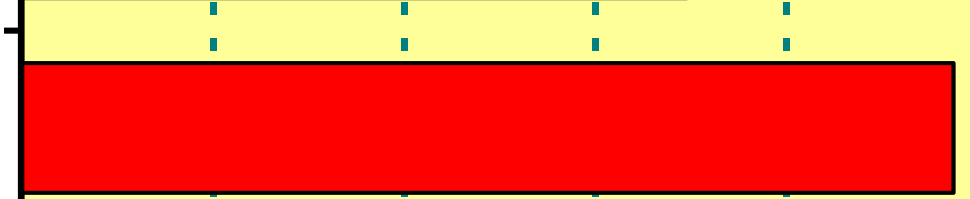
Behavior Can Reduce SIDS



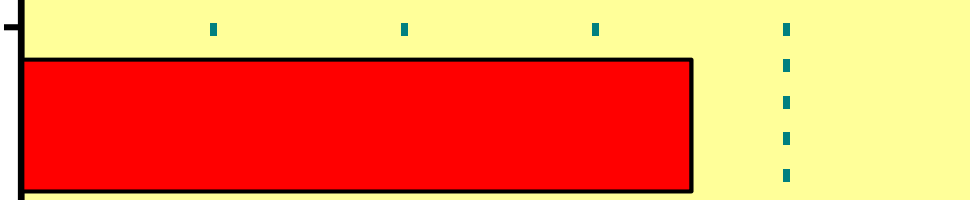
Knows Back Sleep Safest



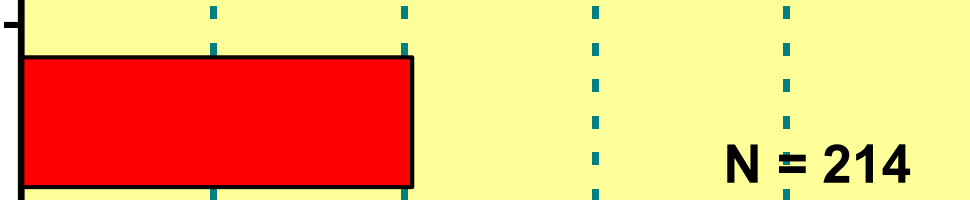
Should Discuss SIDS Risk



Do Discuss SIDS Risk



Give Written Material



N = 214

0 20 40 60 80 100

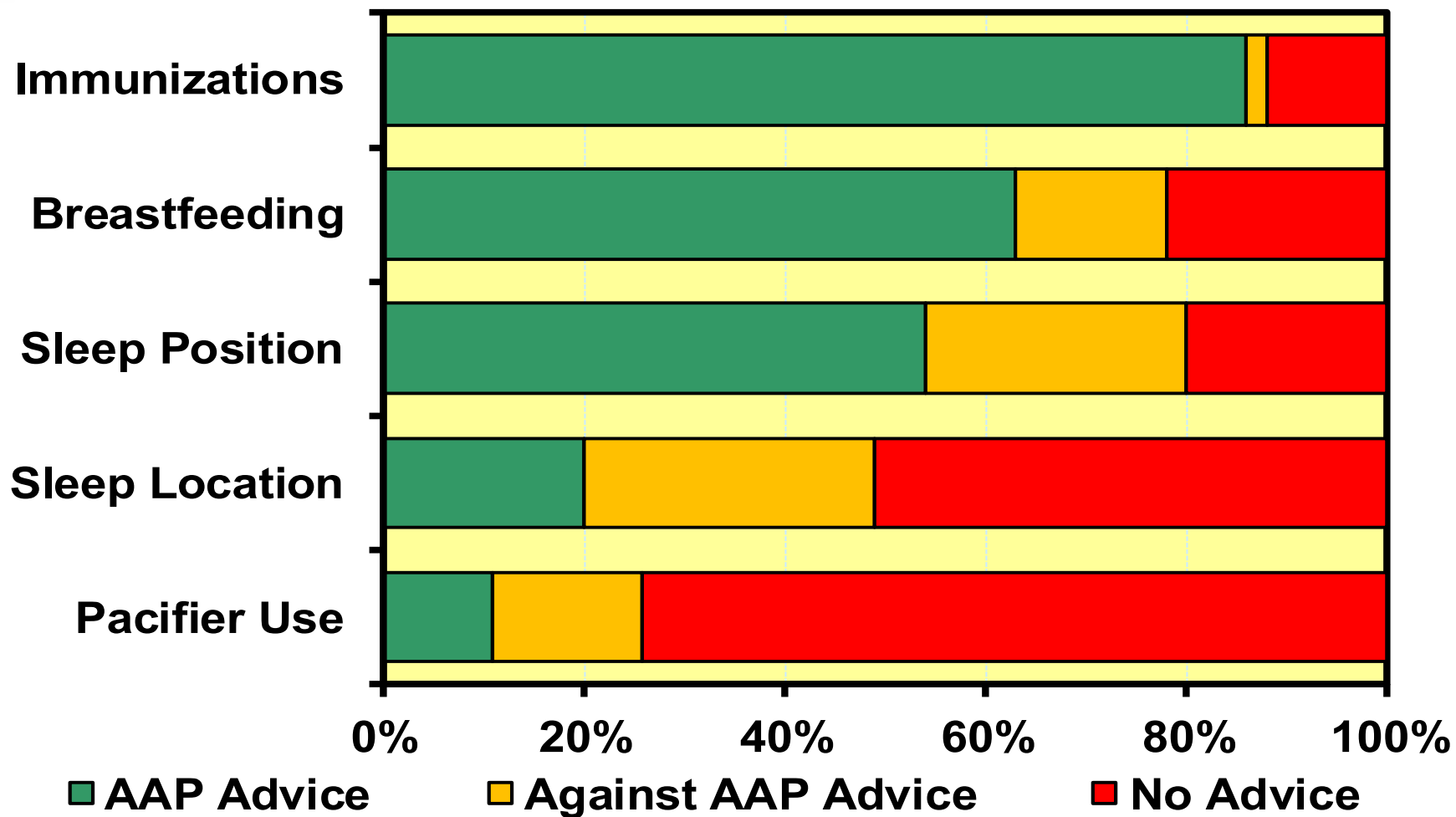
Eron, N.B., et al. *Health Promot. Pract.*, 10: 1-9. 2009.



Mothers Commonly Receive No Advice on Infant Care Practices



Advice from Physicians

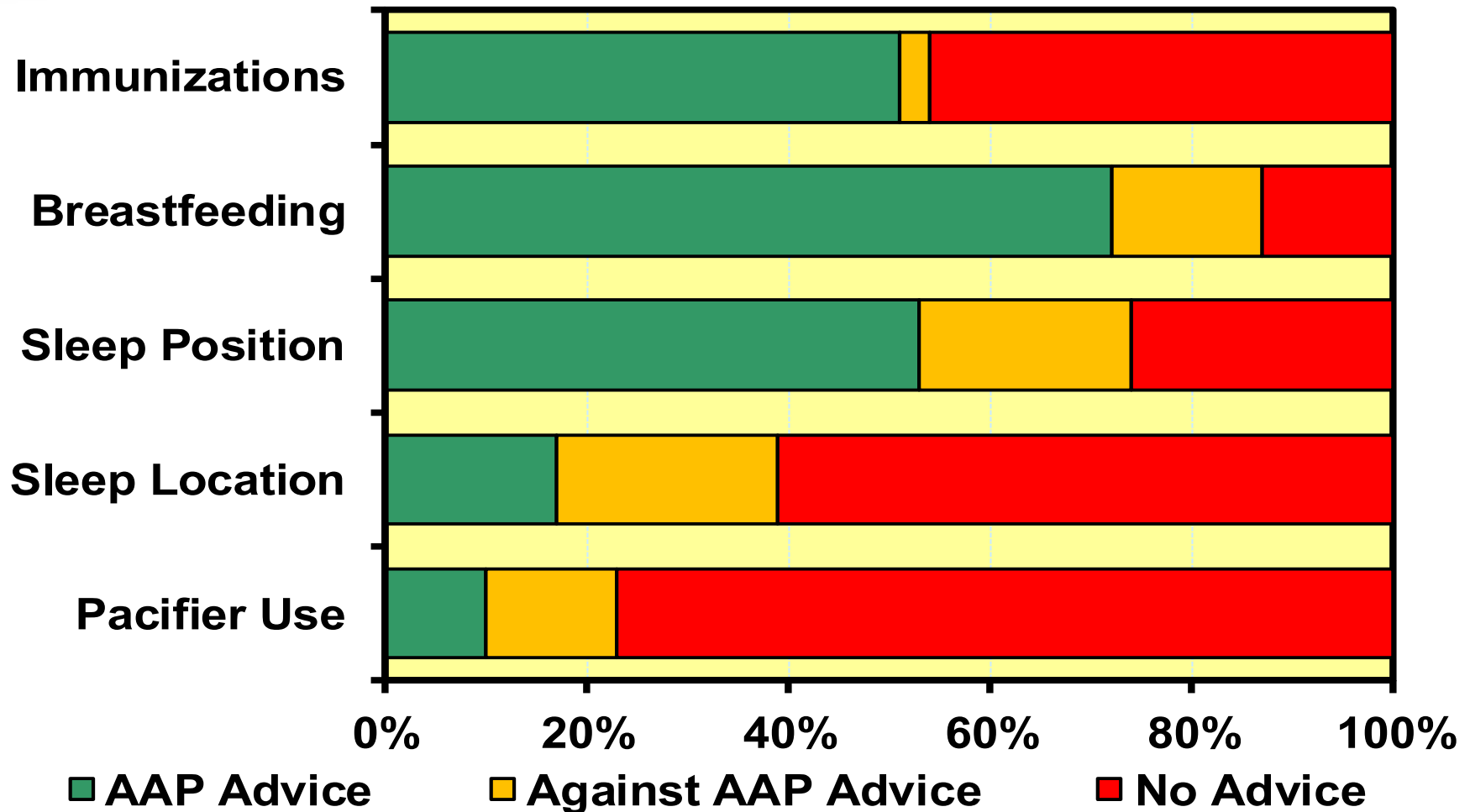




Mothers Commonly Receive No Advice on Infant Care Practices



Advice from Nurses



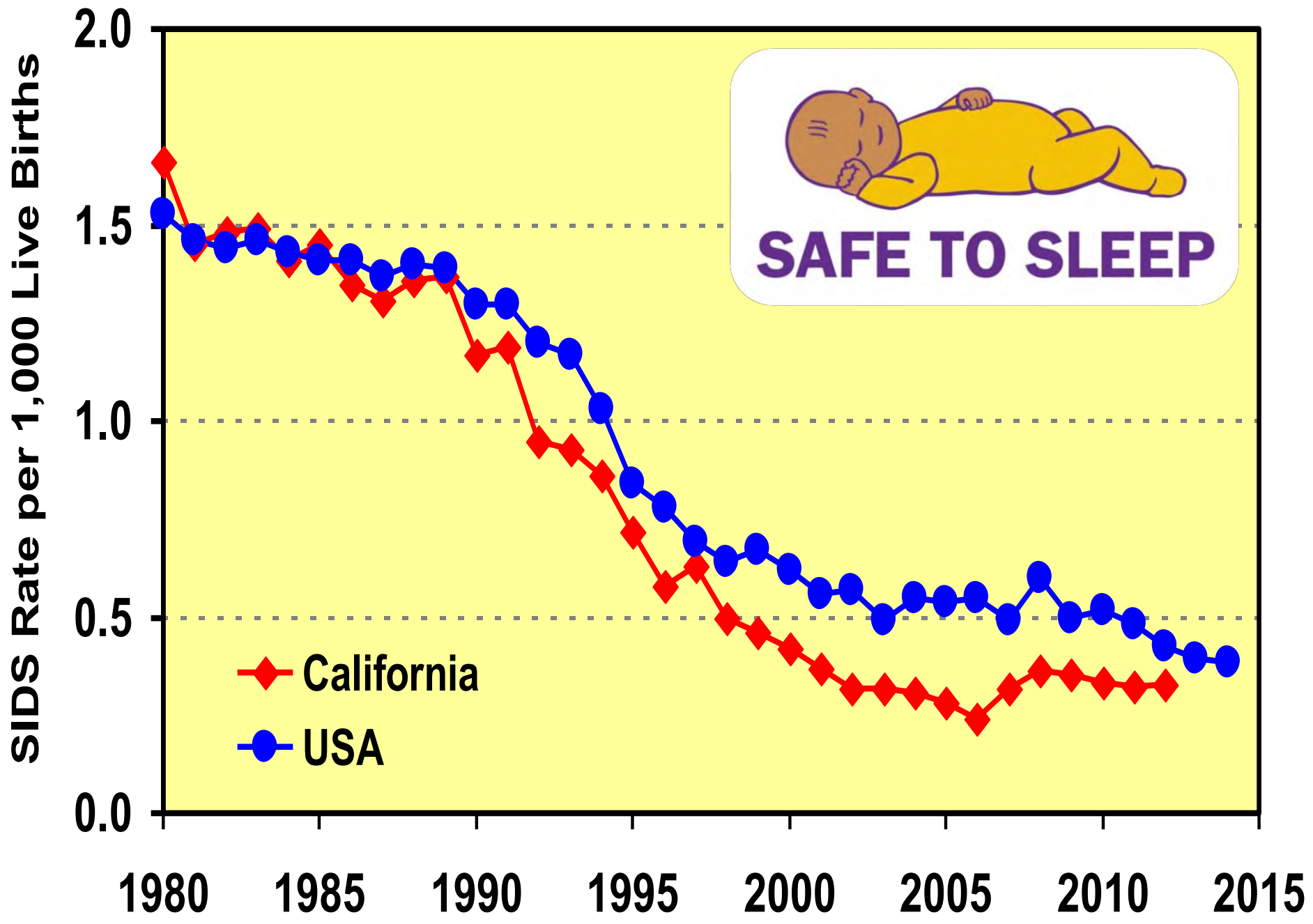


Supine

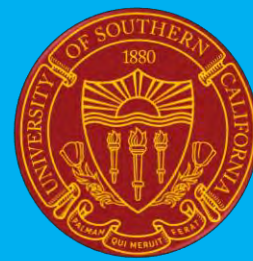
Alone

Firm mattress

Empy crib



Are We Reducing SIDS or Suffocation?



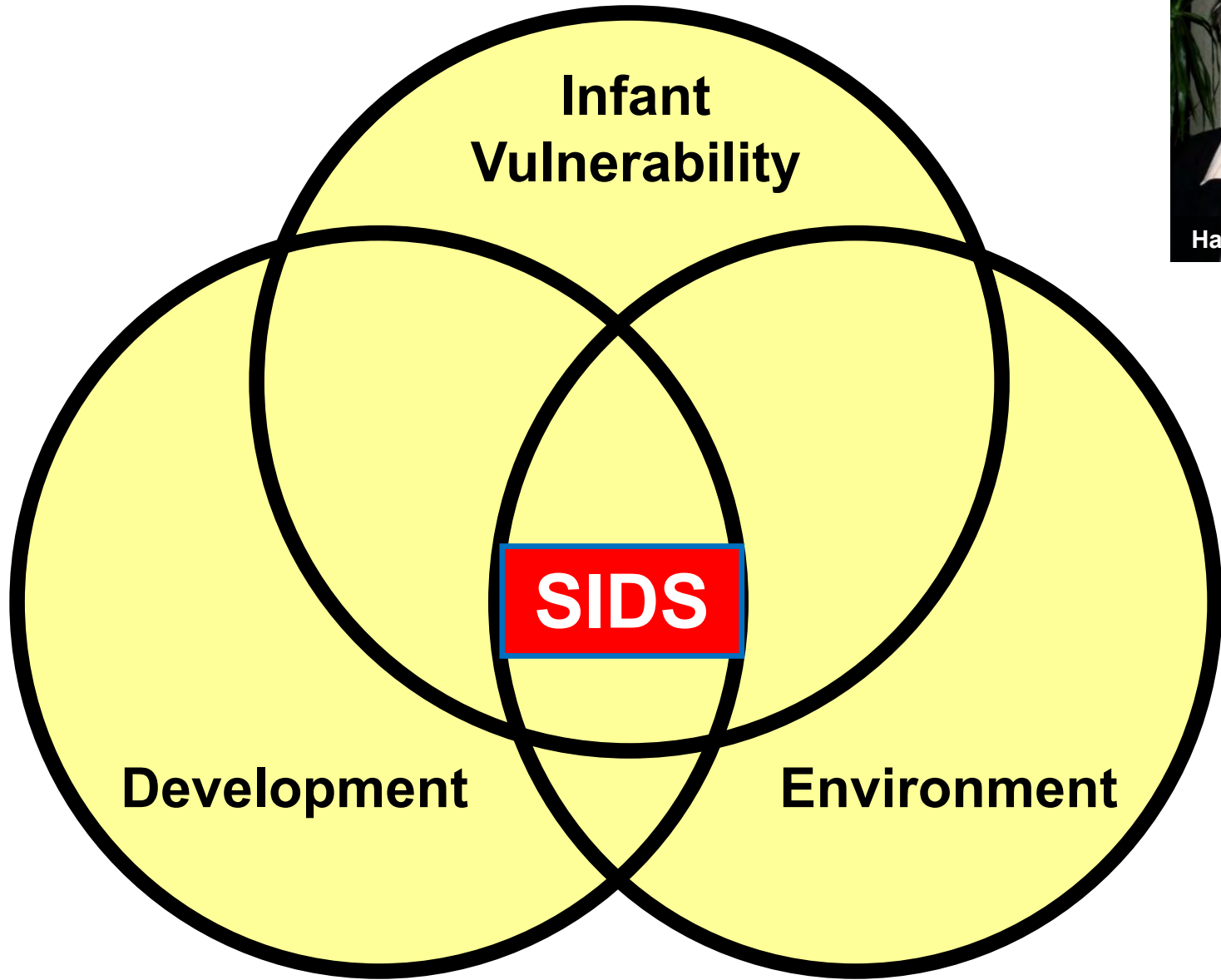
- **Safe infant sleep recommendations create a safer infant sleep environment.**
- **Should reduce accidental infant deaths during sleep.**
- **Triple Risk Hypothesis suggests SIDS is an interaction between age, intrinsic vulnerability, and environment.**
- **The only thing we can affect is the environmental stress.**

WARNING

The cause of SIDS is not yet known.

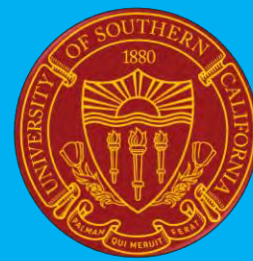
This information has not been proved to be the cause of SIDS.

However, I have attempted to give you some idea about some current directions of SIDS research.



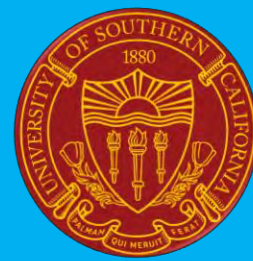
Filiano, J.J., and H.C. Kinney. *Biol. Neonate*, 65: 194-197, 1994.

Sudden Infant Death Syndrome



- **Most common cause of sudden infant death between the ages of 1-month and 1-year.**
- **Cause remains unknown.**
- **Can not be predicted in infants prior to death.**
- **Reduction in SIDS in populations through public health intervention.**
- **SIDS has not been eliminated.**

Sudden Infant Death Syndrome



**Explaining the Triple Risk Model to SIDS
parents is a powerful way to reduce guilt.**

