No More Canaries in Coal Mines:
A Systematic Review of Environmental Health Monitoring

The 3Rs Collaborative
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FELESA 2025

Core Terminology & Types

- Soiled Bedding Sentinels (SBS) = traditional rodent health monitoring that involves transferring soiled bedding to a cage with live rodents which are periodically sampled/euthanized to determine colony health status. (Sometimes referred to as “sentinels")
- Environmental Health Monitoring (EHM) = any type of health monitoring that does not require use of live animal sentinels

Traditionally, soiled bedding sentinel rodents are used to ensure colony health status.

However there is not good data to support using soiled bedding sentinels.

A 2016 systematic review concluded there was only sufficient data that soiled bedding sentinels was effective for 5 pathogens: MHV, MPV, TMEV, *Helicobacter* spp., Fur Mites*

RESEARCH ARTICLE

Efficacy of Soiled Bedding Transfer for Transmission of Mouse and Rat Infections to Sentinels: A Systematic Review

W. C. C. de Bruin[1]*, E. M. E. van de Ven[1], C. R. Hooijmans[2]


With the advent of PCR technology, we now can replace sentinels with EHM.

There are two major types of EHM:

- Exhaust Dust Testing (EDT) = use of swabs or a media to collect dust and nucleic acid that accumulates in **primary housing equipment** such as an individually ventilated cage (IVC) exhaust system
  - This is vendor-independent terminology, but you may have heard this called, Exhaust Air Dust (EAD®), Environmental Diagnostics (Edx), EnviroRax, Sentinel™ EAD® or Sentinel2™, or Intercepter EAD®.
- Sentinel-Free Soiled Bedding (SFSB) = serial pooling of soiled bedding from rodent colony cages which is then sampled by either swabs and/or media for particulates and nucleic acid
  - This is vendor-independent terminology, but you may have heard this called, Shake & Bake, PathogenBinder™ , REPLACE, or Sentinel Swab.

Supplemental EHM can include:

- Direct Colony Sampling (DCS) = collection of feces, fur swabs, oral swabs, or blood to non-invasively (or minimally invasive) sample specific animals or their cage microenvironment
  - Typically used for quarantine testing of new arrival rodents or secondary/tertiary testing after positive test by different EHM method
- Room & Equipment Monitoring (REM) = use of swabs or media to sample husbandry or facility support equipment where dust and nucleic acid accumulate
  - This is uncommon as a main strategy

Our goal was to establish the evidence base behind environmental health monitoring.

Our review has high rigor & objectivity, avoiding bias and cherry-picking.

PRISMA Guidelines

Preferred **R**eporting **I**tems for **S**ystematic Reviews and **M**eta-**A**nalyses

SYRCLE Guidelines

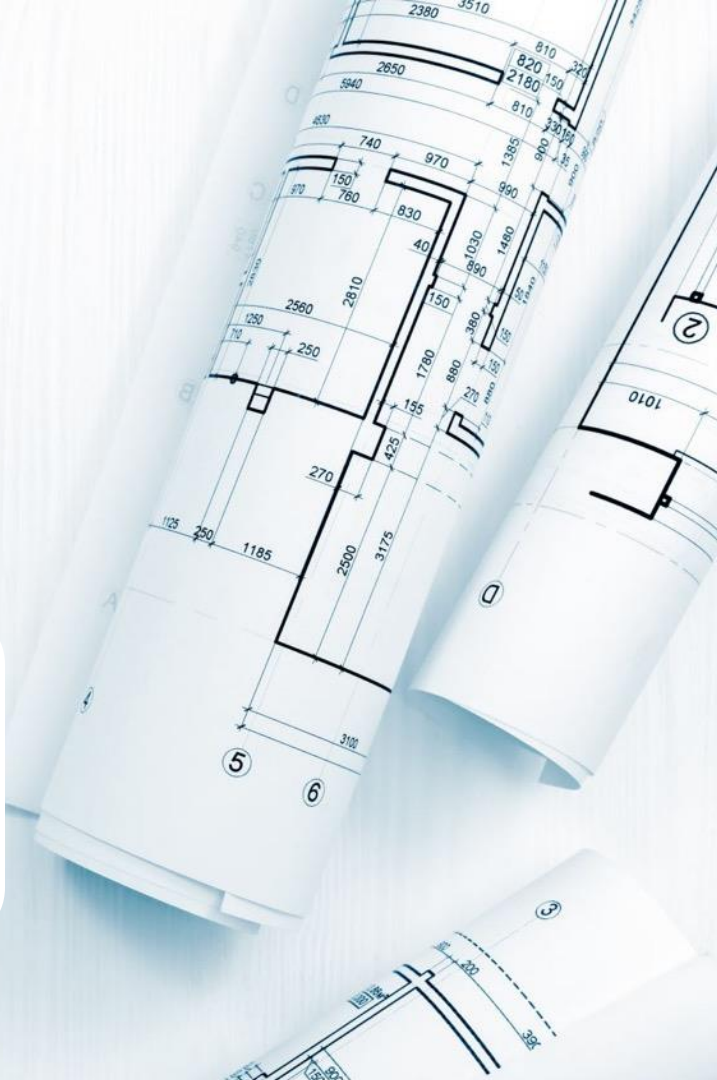
Systematic **R**eview **C**enter for **L**aboratory Animal **E**xperimentation

Liberati 2009; Moher 2009; Hooijmans 2014

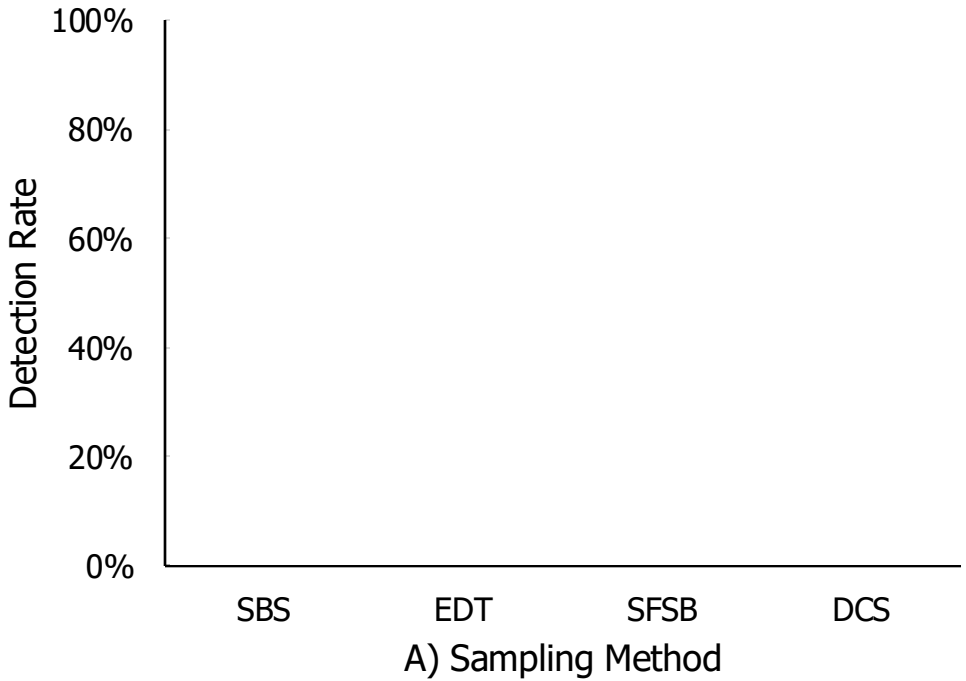
RESULTS

A total of 42 papers were included.

(>2x as many as SBS in 2016)



Results: Environmental health monitoring detects pathogens more often than soiled bedding sentinels, regardless of sampling method or pathogen type or importance.



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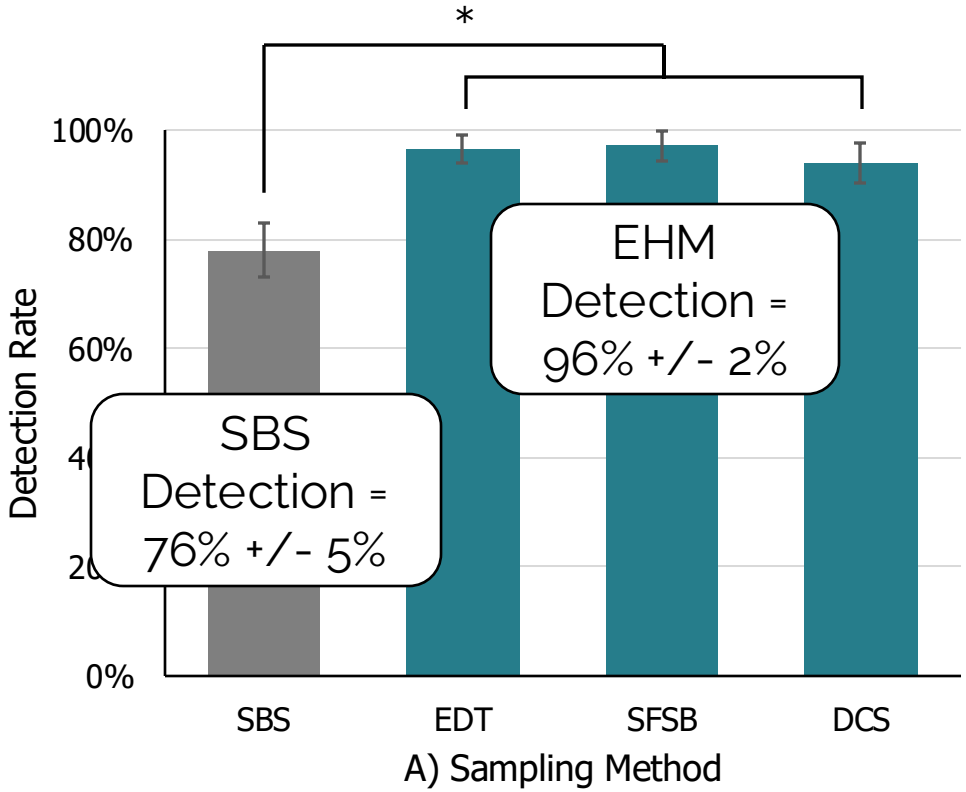

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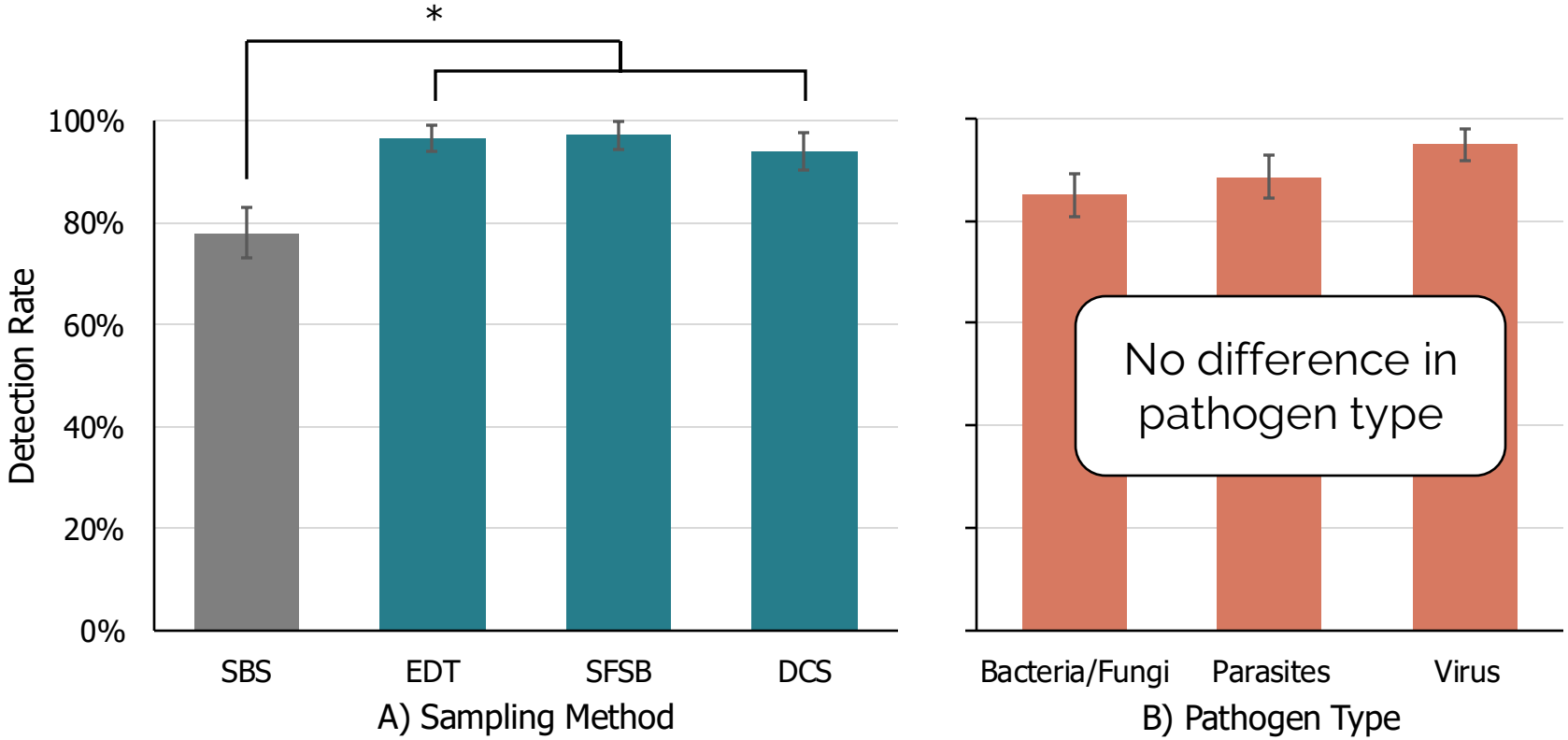


EHM is superior to SBS based on descriptive statistics

In head-to-head studies, where environmental health monitoring detected a pathogen, soiled bedding sentinels failed in 25% of cases.

		SBS		SBS Relative Sensitivity
		No	Yes	
EHM	No	1	2	
	Yes	20	60	20/80 (25%)
EHM Relative Sensitivity			2/62 (3%)	

Pathogen Name	Detection by SBS/EHM
Pneumocystis spp.	0/2
Sendai Virus	0/1
Pseudomonas aeruginosa	1/0
Proteus mirabilis	2/5
Ectoparasites	3/7
Streptococcus spp.	2/1
Rodentibacter spp.	5/8
Spironucleus spp.	2/3
Tritrichomonas spp.	3/4
Entamoeba spp.	4/5
Pinworms	4/5
Helicobacter spp.	8/10
Staphylococcus spp.	6/7

Environmental Health Monitoring helps replace rodents & save costs

- Across articles, 6876 rodents from 4 institutions are being replaced annually with environmental health monitoring.
- 9 Articles mentioned that cost-savings were identified from switching to environmental health monitoring

Strong evidence-base supporting superiority of EHM makes it a scientific and ethical priority to replace SBS with EHM.

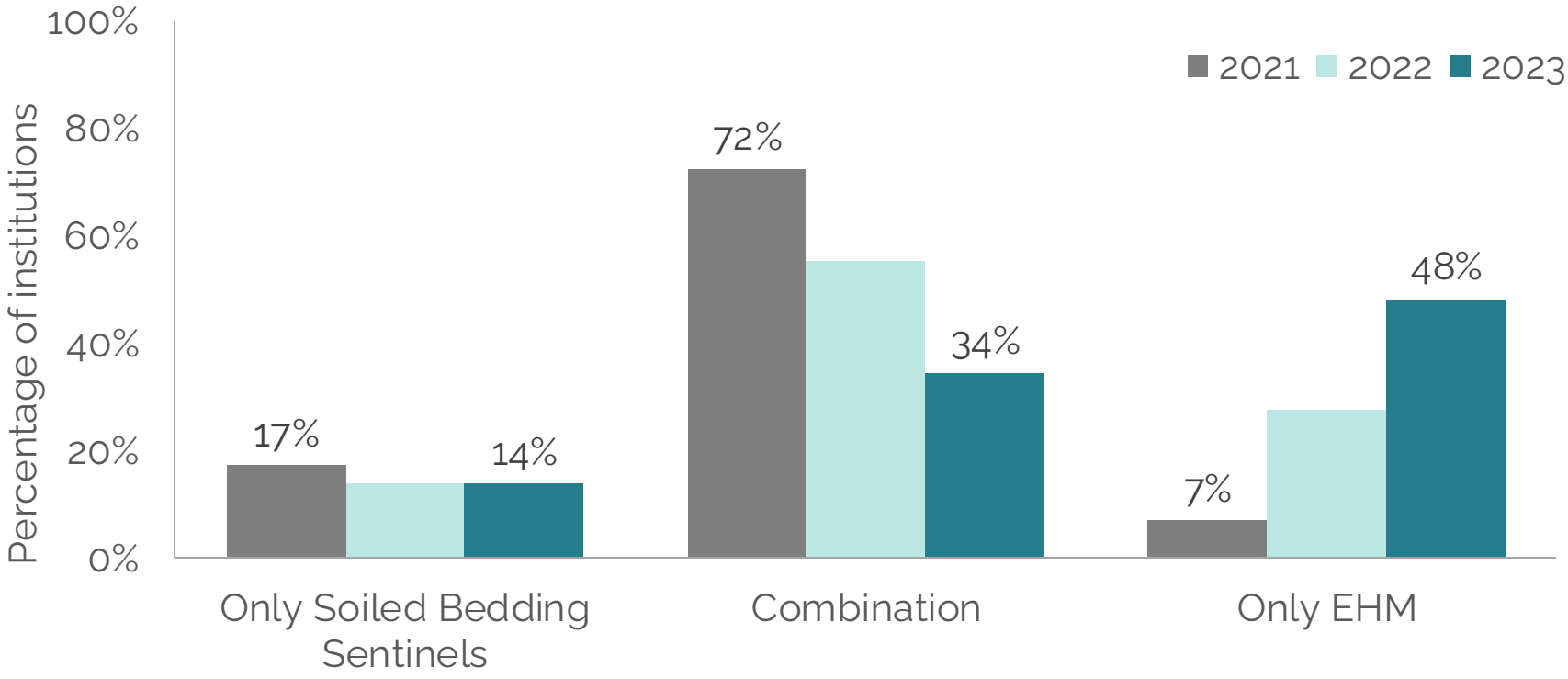
3Rs
Replaces Sentinel Rodents

Operations
Reduces labor & cost

Veterinary
Increases health monitoring sensitivity & accuracy

People
Reduces emotional / compassion fatigue

Side note: Environmental health monitoring is increasing over time.



(n = 29)

Use the 3Rs Collaborative's resources to switch to Environmental Health Monitoring

Overview Presentations Publications Editable Slide Deck SOPs Cost Analysis Sanitation

How to Switch Mentorship Program Call for Research Projects FAQs

Many institutions have replaced their sentinels.

Many institutions, from both Canada and the United States, have replaced their soiled bedding sentinel health monitoring programs with EHM programs.

US institutions that have shared their replacement of sentinels with us include: University of Washington, Pfizer Comparative Medicine sites (Kendall Square, La Jolla, Pearl River, Groton), University of Florida, University of Colorado Anschutz Medical Campus, Emory University, University of Chicago, University of Texas at Austin, University of Southern California, Emory National Primate Research Center, Medical College of Wisconsin, Northwestern University, Benaroya Research Institute, UT Southwestern Medical Center, University of Alabama at Birmingham, University of Arizona, Seagen, GSK, and Chapman University.

Example Cost Analysis for Exhaust Dust Testing

University of Chicago conducted and published a detailed cost analysis when making the switch to exhaust dust testing (Luchins 2020). This institution found that EHM was **26% less expensive** than SBS. Cost savings came from:

- Animal order
- Animal shipping
- Animal maintenance

New: Mentorship Program
New: Systematic Review is Published

Acknowledgments

- Aurore Dodelet-Devillers, McGill U.
- Aleeza Stephens, 3RsC Intern
- Barbara Stone, ParaTechs Corporations
- Beth Bennett, Pfizer
- Brian Bilecki, Allentown
- Bob Livingston, IDEXX
- Caroline Winn, Vertex
- Caroline Starla Clement, Stanford
- Chris Manuel, U. of Colorado Anschutz
- Christina Pettan-Brewer, U. of Washington
- Cris Torres, UCLA
- Joseph Garner, Stanford University
- John Hansenau, Tecniplast Consultant
- Kate Gates, Stanford University
- Ken Henderson, Charles River Laboratories
- Kerith Luchins, U. of Chicago
- Lise Phaneuf, Centre for Phenogenomics
- Massimo Foa, IDEXX
- Megan LaFollette, 3RsC
- Norman Peterson, Seagen
- Ovidiu Jumanca, ICRM
- Patricia Foley, Georgetown U.
- Robert (Bob) Livingston, IDEXX
- Theresa Faughnan, Long Island U.
- Wai Hanson, Emory U.

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