Using Configurational Comparative Methods (CCMs) in Implementation Science

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Overview

1. Why use CCMs such as coincidence analysis (CNA)
2. How CNA is different from other approaches
3. Application of CNA in real studies

Potential Advantages

Traditional Quantitative Methods

- Require large sample sizes
- Focus primarily on quantitative data

Configurational Comparative Methods (such as CNA)

- Small to large sample sizes
- Quantitative or **qualitative** data (or both)

Many methods can be used to make causal inferences (with caution)

“Causal” Factors

Old faulty electrical outlet
<u>AND</u> nearby couch

Outcome

Distinct Analytic Approaches

Traditional Quantitative Methods (Inferential Statistics)

- Independent ***variable(s)*** **change the probability** that the outcome will occur

Configurational Comparative Methods (such as CNA)

- Presence or absence of one or more ***factors*** **make a difference** in whether the outcome occurs

CNA Finds Difference Makers

Oxygen is necessary but <u>not</u> a difference maker because it is always present

CNA can only identify factors that make a difference among <u>observed cases</u>

Other Distinctions Between Approaches

Traditional Quantitative Methods (Inferential Statistics)

- **Strength of relationships** between variables using ***correlations***

Configurational Comparative Methods (including CNA)

- **Consistent patterns** of factor and outcome values using ***Boolean algebra***

Other Distinctions

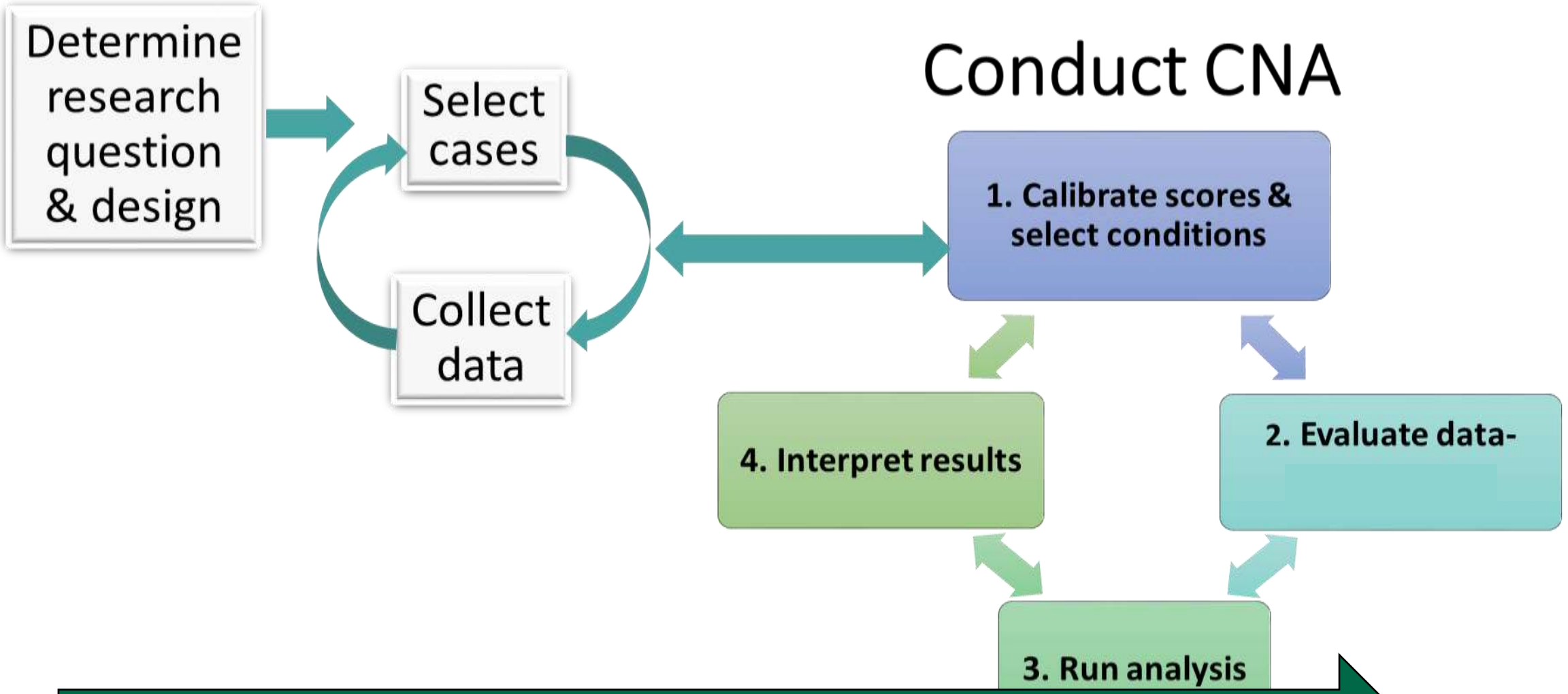
Traditional Quantitative Methods (Inferential Statistics)

- **Random sampling** (gold standard)
- Pre-planned analyses

Configurational Comparative Methods (including CNA)

- **Purposive sampling**
- Iterative approach

Iterative Approach



Apply theory and empirical knowledge of cases

Distinct Types of Causal Assumptions

Inferential Statistics

- A change in each independent variable may ⬆ or ⬇ the **chance** the outcome occurs

CNA

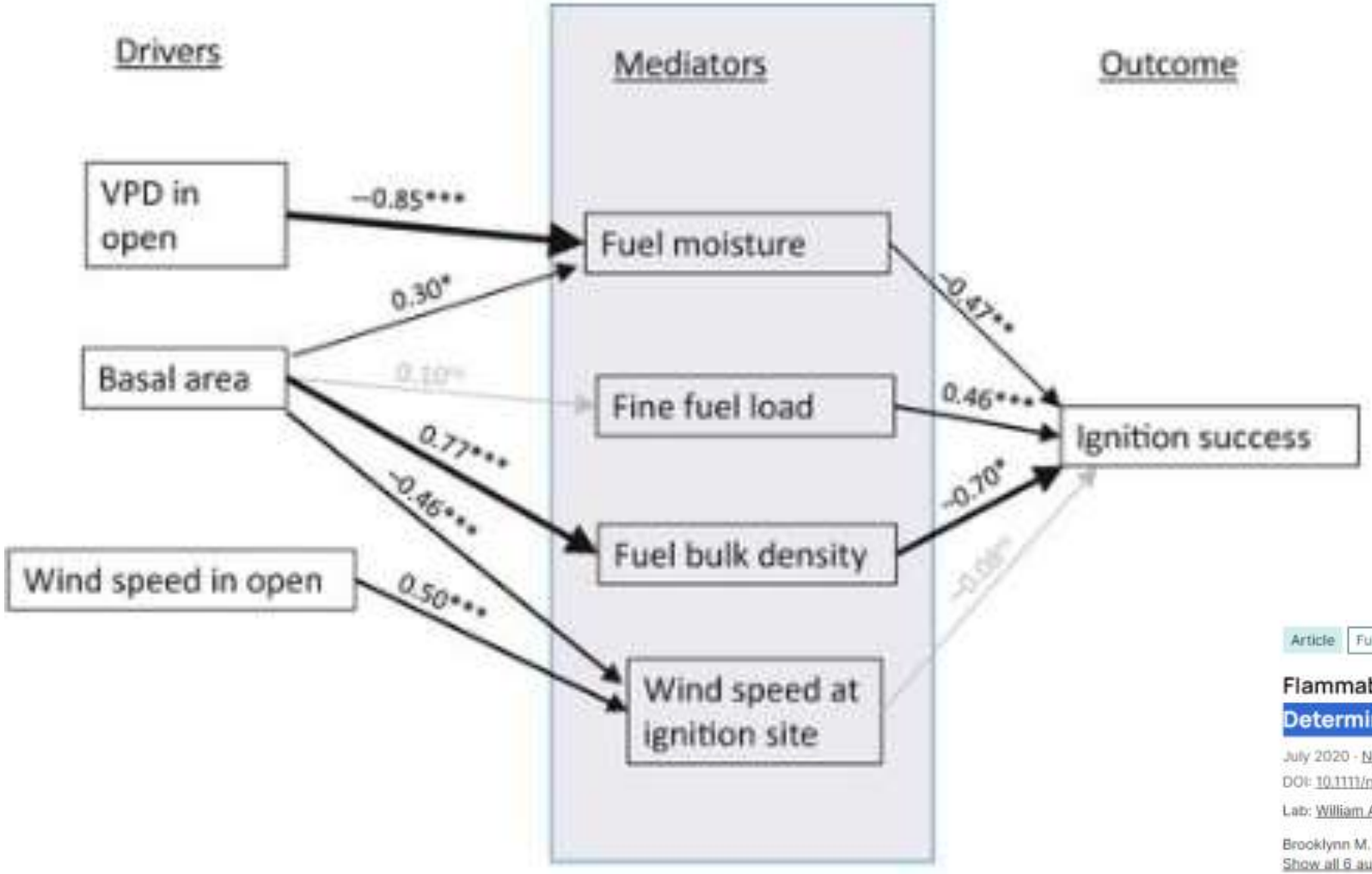
- Multiple factors may work together or in a sequence for the outcome to occur
- More than one path may lead to the same outcome

Multiple independent (unique) paths to the same outcome

#1

#2

Structural Equation Model (SEM)



Article · Full-text available

Flammability thresholds or flammability gradients? Determinants of fire across savanna-forest transitions

July 2020 · New Phytologist 228(3)

DOI: 10.1111/nph.16742

Lab: William Arthur Hoffmann's Lab

Brooklynn M. Newberry · Collin R. Power · Rodolfo Cesar Real de Abreu · Show all 6 authors · William Arthur Hoffmann

Some Similarities

SEM

- Intermediate outcomes "mediation"
- Measures of model fit (e.g., RMSEA, CFI)

CNA

- Intermediate outcomes "causal chains"
- Measures of model fit (e.g., consistency & coverage)

First Study Example

Demonstrate how CNA can identify patterns that are unclear based solely on a traditional qualitative approach

Background:
Goals of Precision Public Health

Ensure all people access care that is appropriate for their level of cancer risk

High-value care

Reduce care that is NOT risk appropriate

(i.e., unhelpful or even harmful)

Low-value care

Breast Cancer Research and Treatment (2020) 182:421–428
https://doi.org/10.1007/s10549-020-05699-y

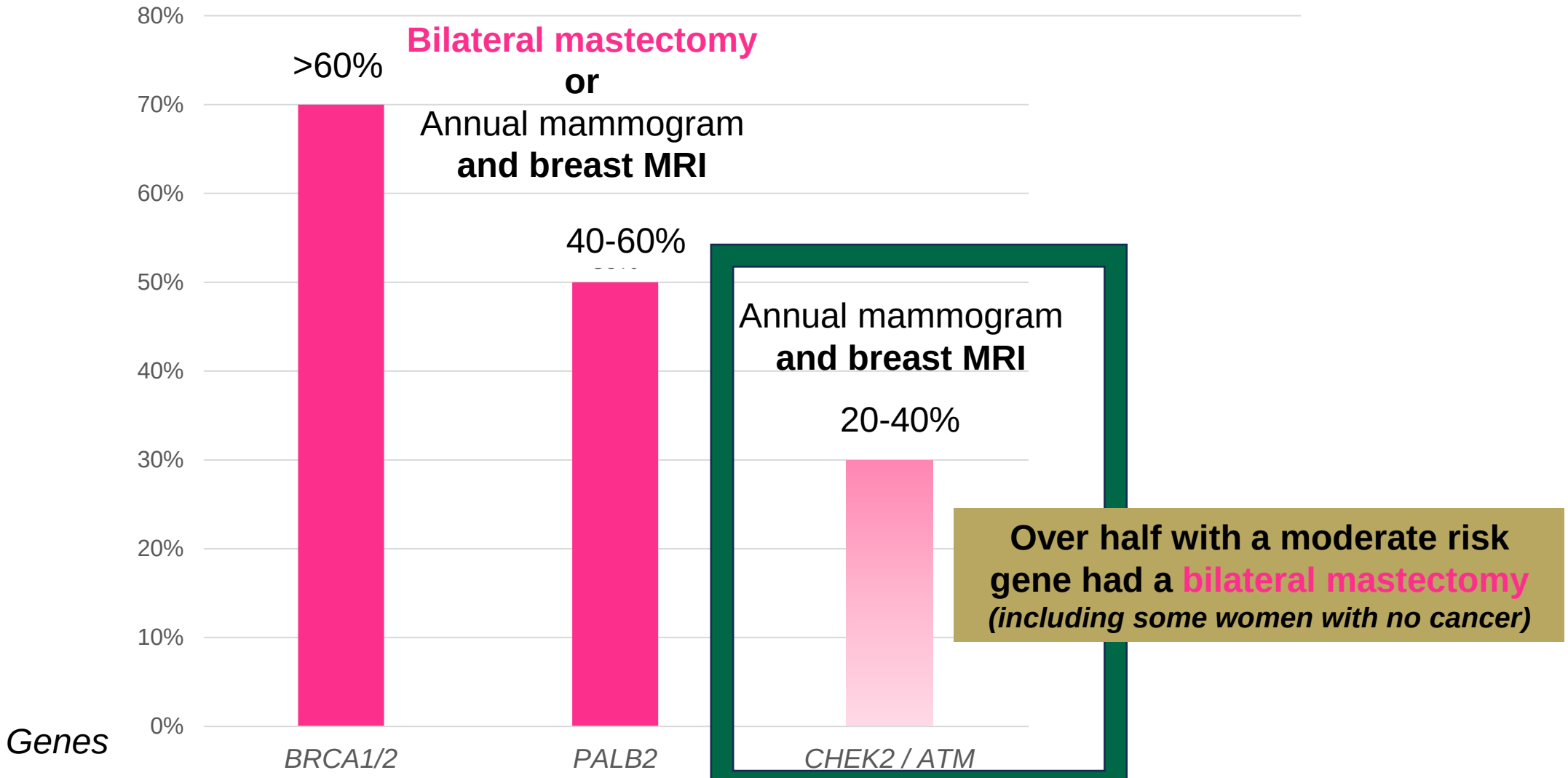
EPIDEMIOLOGY

Cancer risk management among female *BRCA1/2*, *PALB2*, *CHEK2*, and *ATM* carriers

Deborah Cragun[1] · Anne Weidner[2] · Ann Tezak[2] · Kate Clouse[3] · Tuya Pal[2,4]

Received: 8 April 2020 / Accepted: 18 May 2020 / Published online: 22 May 2020

Breast Cancer Risks Vary by Gene



Over half with a moderate risk gene had a bilateral mastectomy ***(including some women with no cancer)***

NCCN. Genetic/Familial High-risk Assessment: Breast, Ovarian, and Pancreatic.. https://www.nccn.org/professionals/physician_gls/pdf/genetics_bop.pdf

Ovarian Cancer Risk Management Guidelines

BRCA1/2 (20-40%)	*PALB2*	*ATM*	*CHEK2*
Risk reducing salpingo-oophorectomy (RRSO)	Potential increase in risk: **insufficient evidence** to recommend RRSO (manage based on family history)		No increased risk

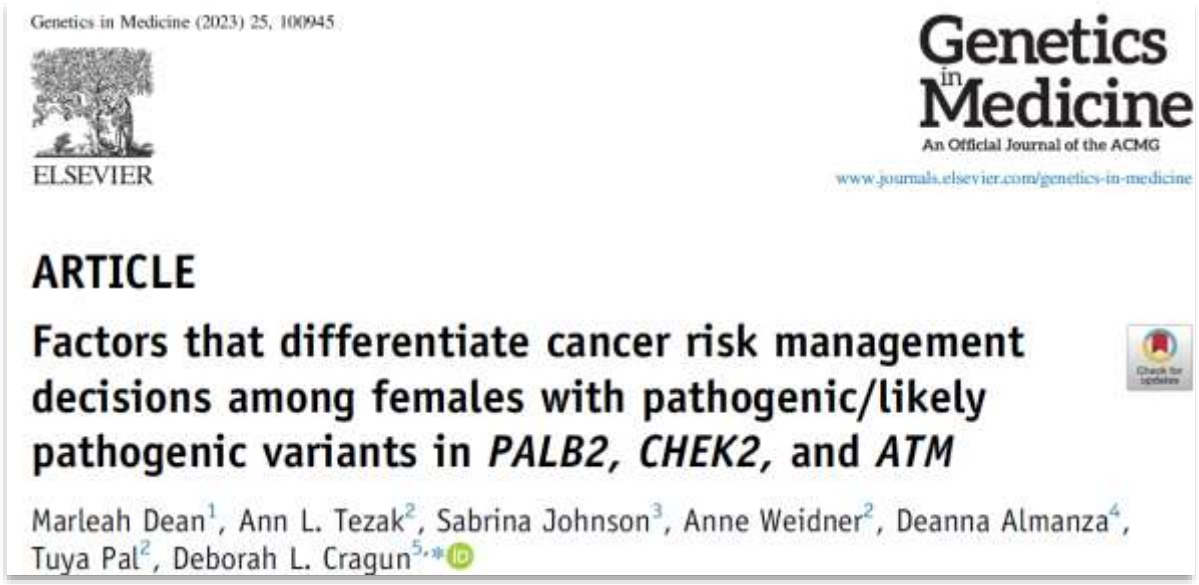
Over 70% had their ovaries removed

NCCN. Genetic/Familial High-risk Assessment: Breast, Ovarian, and Pancreatic..
https://www.nccn.org/professionals/physician_gls/pdf/genetics_bop.pdf

https://www.commonwealthfund.org/publications/2019/mar/choosing-wisely-international-movement-toward-appropriate-medical-care

Study Purpose

To identify **factors** that result in **following** or **not following** NCCN guidelines



Genetics in Medicine (2023) 25, 100945

ELSEVIER

Genetics in Medicine
An Official Journal of the ACMG
www.journals.elsevier.com/genetics-in-medicine

ARTICLE

Factors that differentiate cancer risk management decisions among females with pathogenic/likely pathogenic variants in *PALB2, CHEK2,* and *ATM*

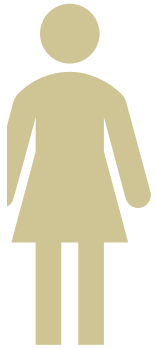
Marleah Dean[1], Ann L. Tezak[2], Sabrina Johnson[3], Anne Weidner[2], Deanna Almanza[4], Tuya Pal[2], Deborah L. Cragun[5,*]

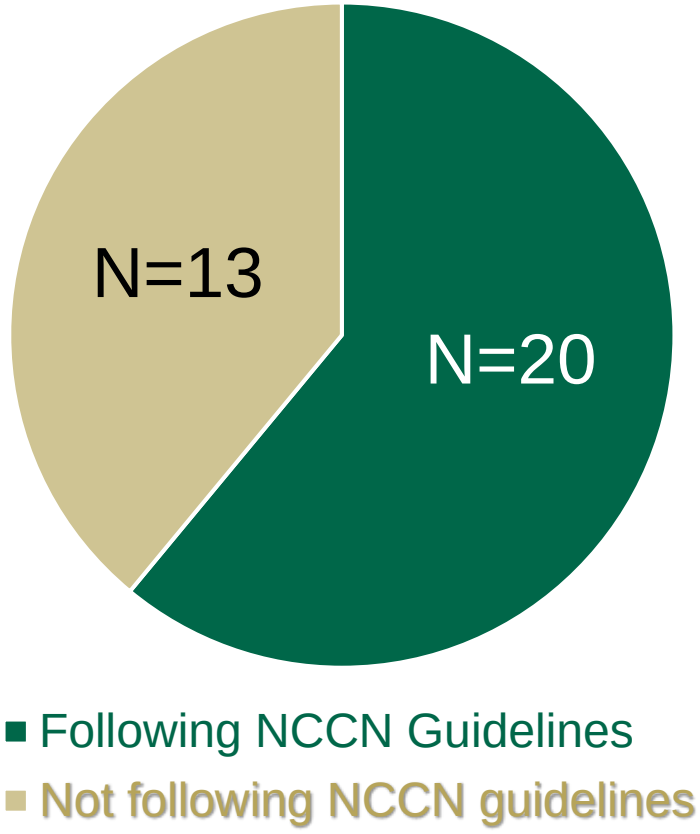
supported by research grants from the University of South Florida and Vanderbilt Cancer Center's Breast Spore **(5P50CA098131-19)**

SAMPLE

Telephone interviews with 33 Females with pathogenic variants:

- 12 *CHEK2*
- 4 *ATM*
- 17 *PALB2*





DATA ANALYSIS

3-Stage Iterative Qualitative Approach:

(1) inductive coding
(2) deductive coding
(3) extended analysis and verification

Coincidence Analysis:

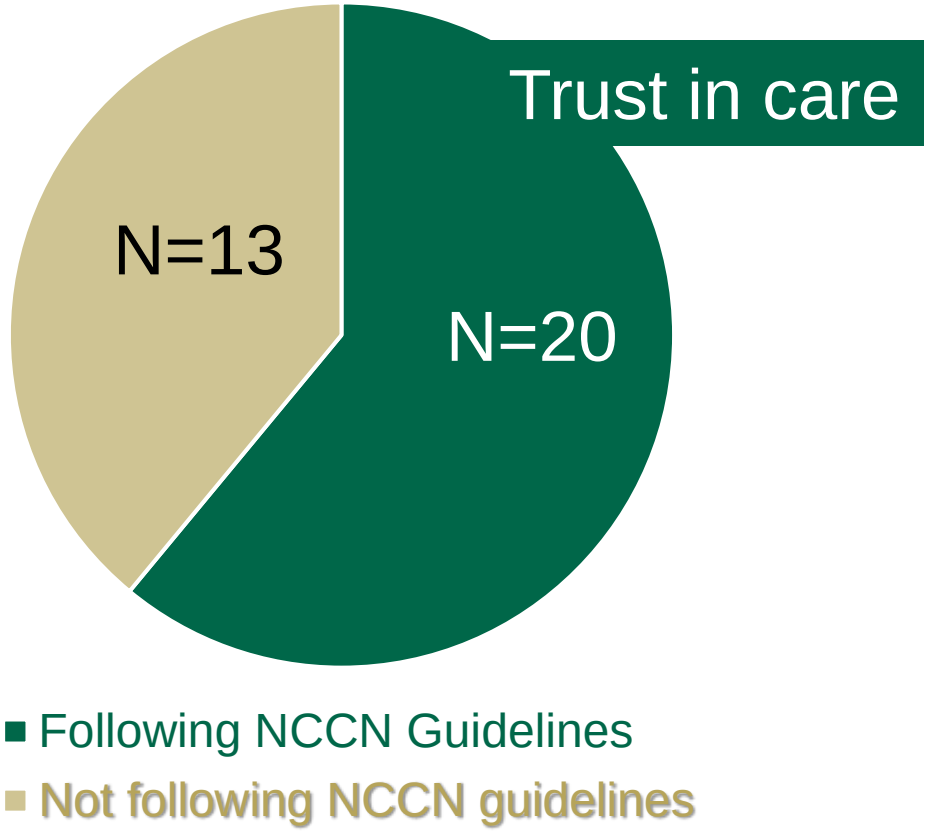
- Discover factors consistently differentiate between females who follow NCCN and those who do not

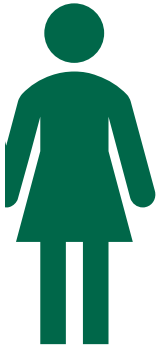
Trust in Care

“I do believe that they know what they’re doing, and I have to trust that they do.”

[Patricia, *ATM*, age 67]

Different reasons for their cancer risk management (CRM) decisions



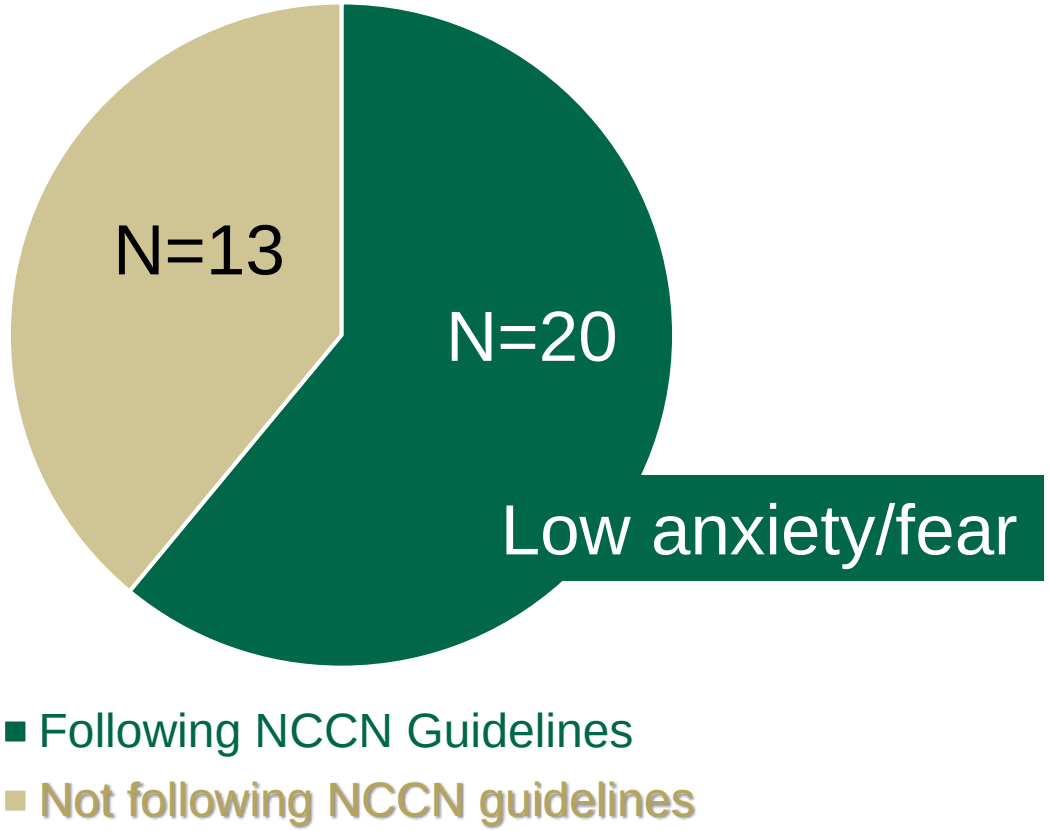


Low Anxiety and Fear

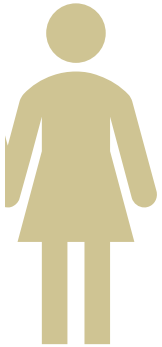
"I was not anxious…I didn't pursue any kind of surgical option."

[Melinda, *ATM, PALB2*, age 61]

Different reasons for their cancer risk management (CRM) decisions



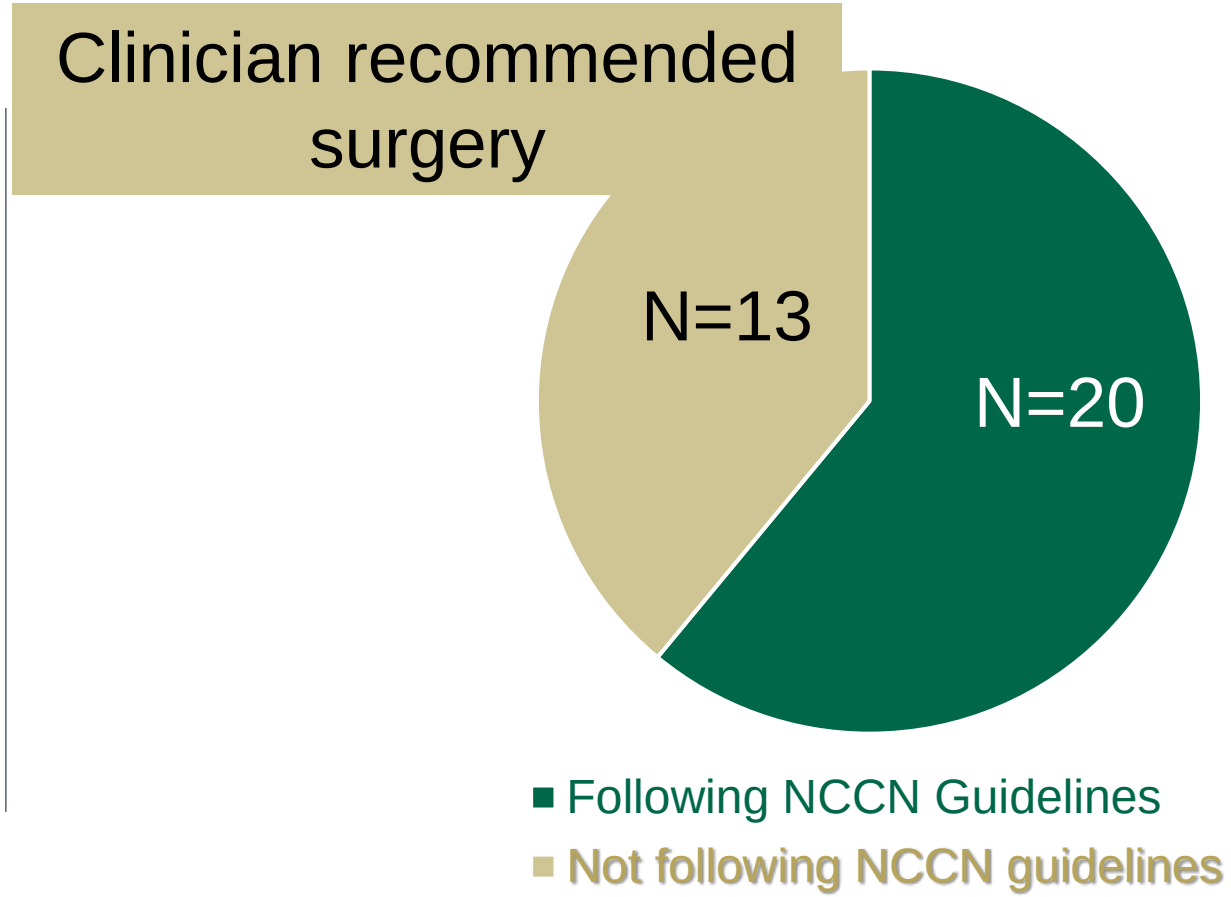
Different reasons for their cancer risk management (CRM) decisions



Recommendation

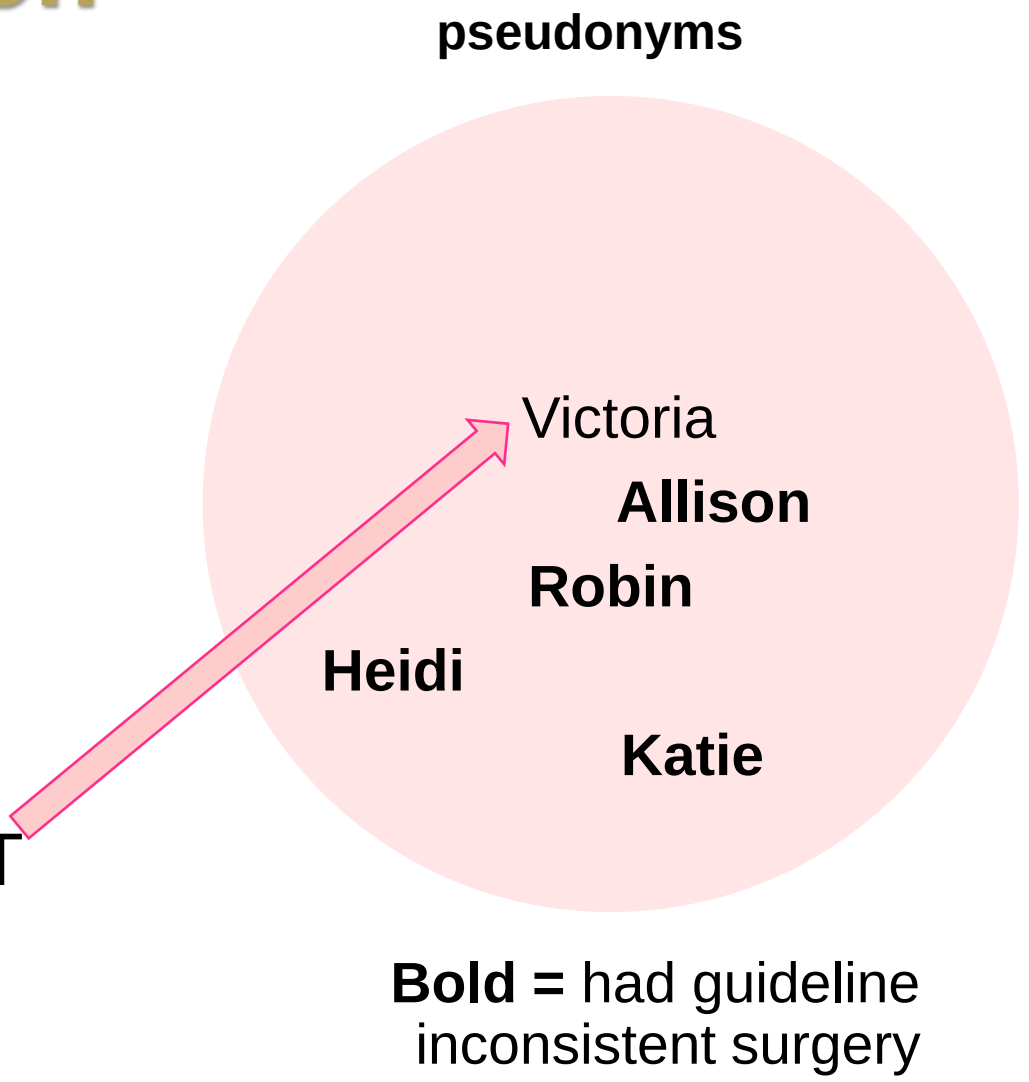
"…all my providers were like, 'Yes, you're doing the right thing keep going."

[Katie, *ATM, PMS2*, age 49
When referring to her mastectomy decision]

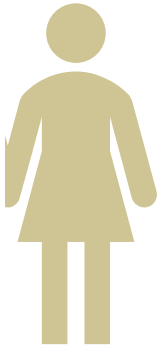


Clinician Recommendation

- Five reported their clinician recommended surgery that was inconsistent with the guidelines
- **Four** of the five followed their clinician's recommendation
- One chose to seek a second opinion from a different clinician who did NOT recommend surgery



Bold = had guideline inconsistent surgery

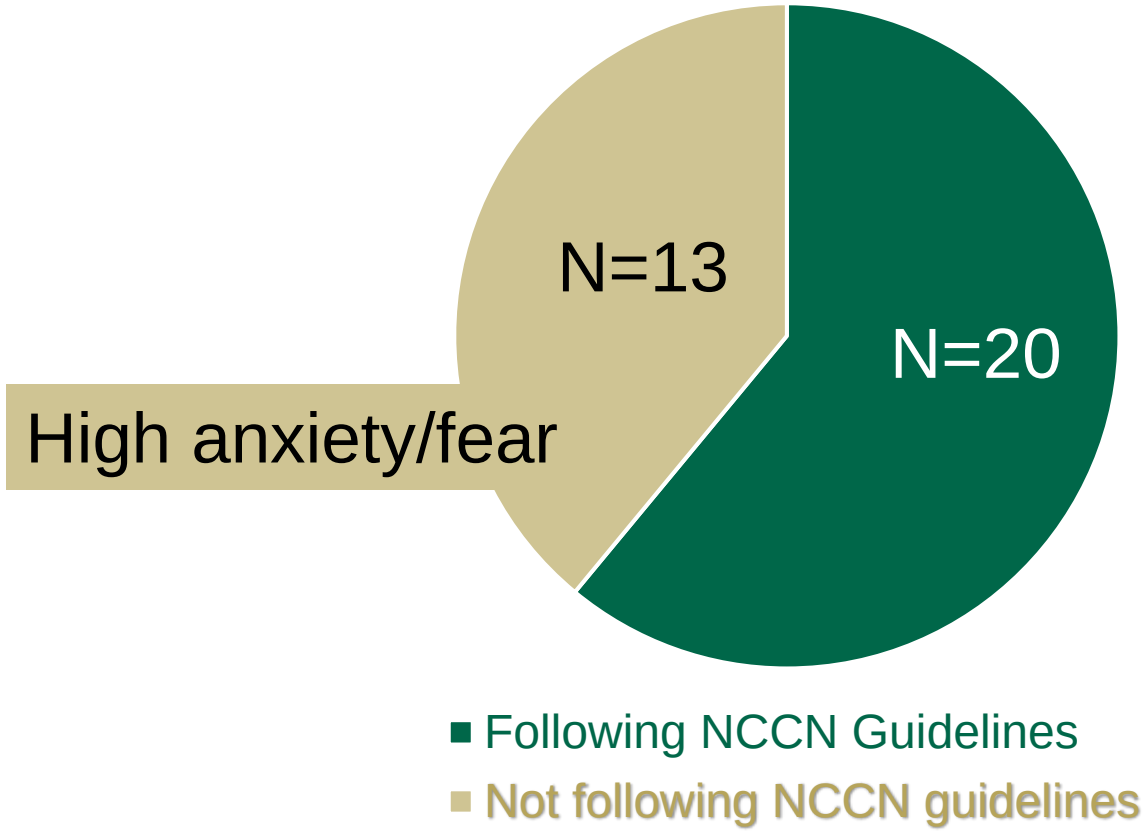


Reduce Worry and Fear

"I no longer have anything to worry about with the breasts because I had a bilateral mastectomy."

[Allison, *CHEK2*, age 50]

Different reasons for their cancer risk management (CRM) decisions



Role of Fear & Anxiety

- 12 described high cancer anxiety/fear
- **ONLY 6 had surgery** inconsistent with guidelines
- How can I argue that anxiety/fear is truly playing a role in the decision?

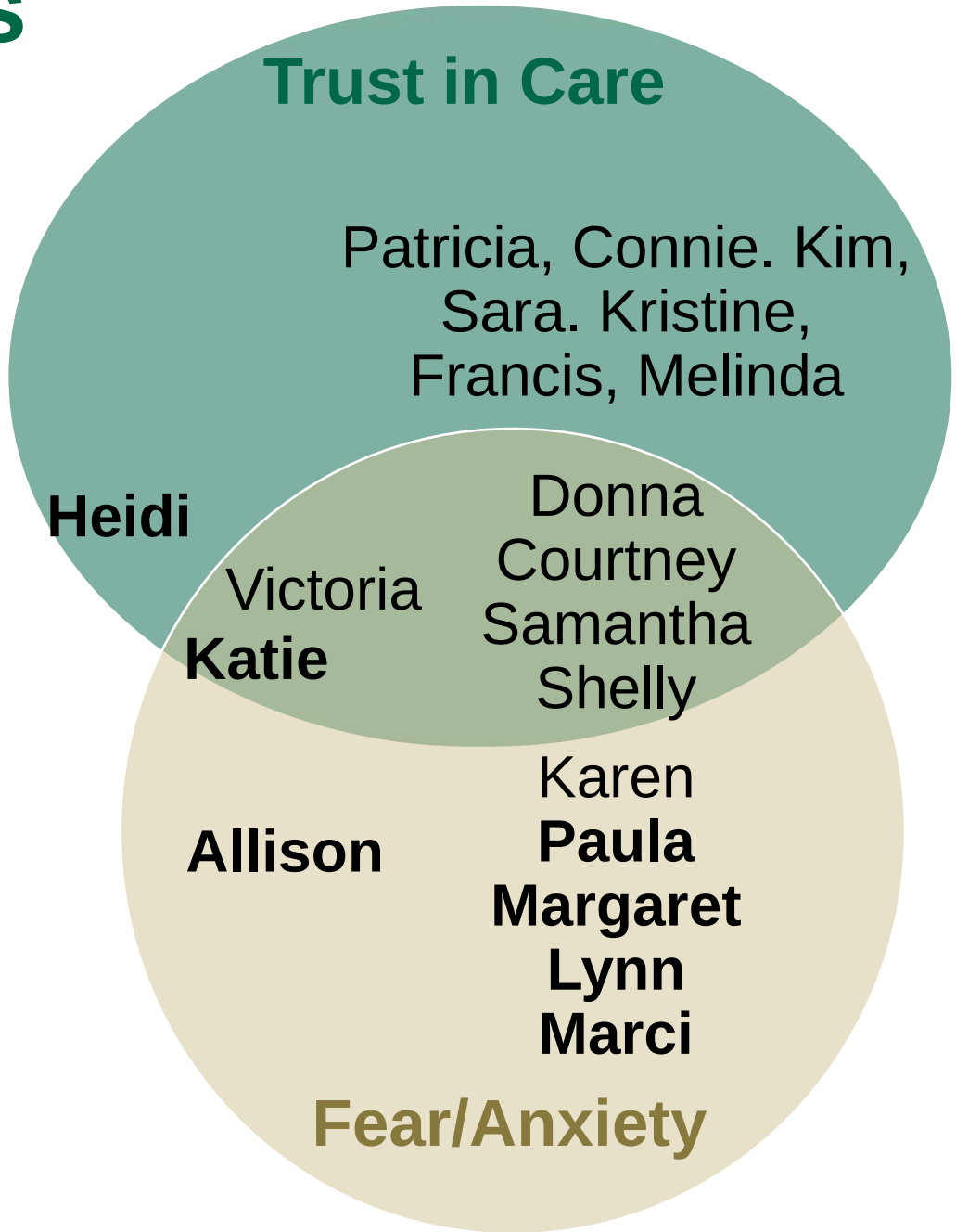
Bold = had guideline inconsistent surgery

CRM Decisions

Bold = had guideline inconsistent surgery

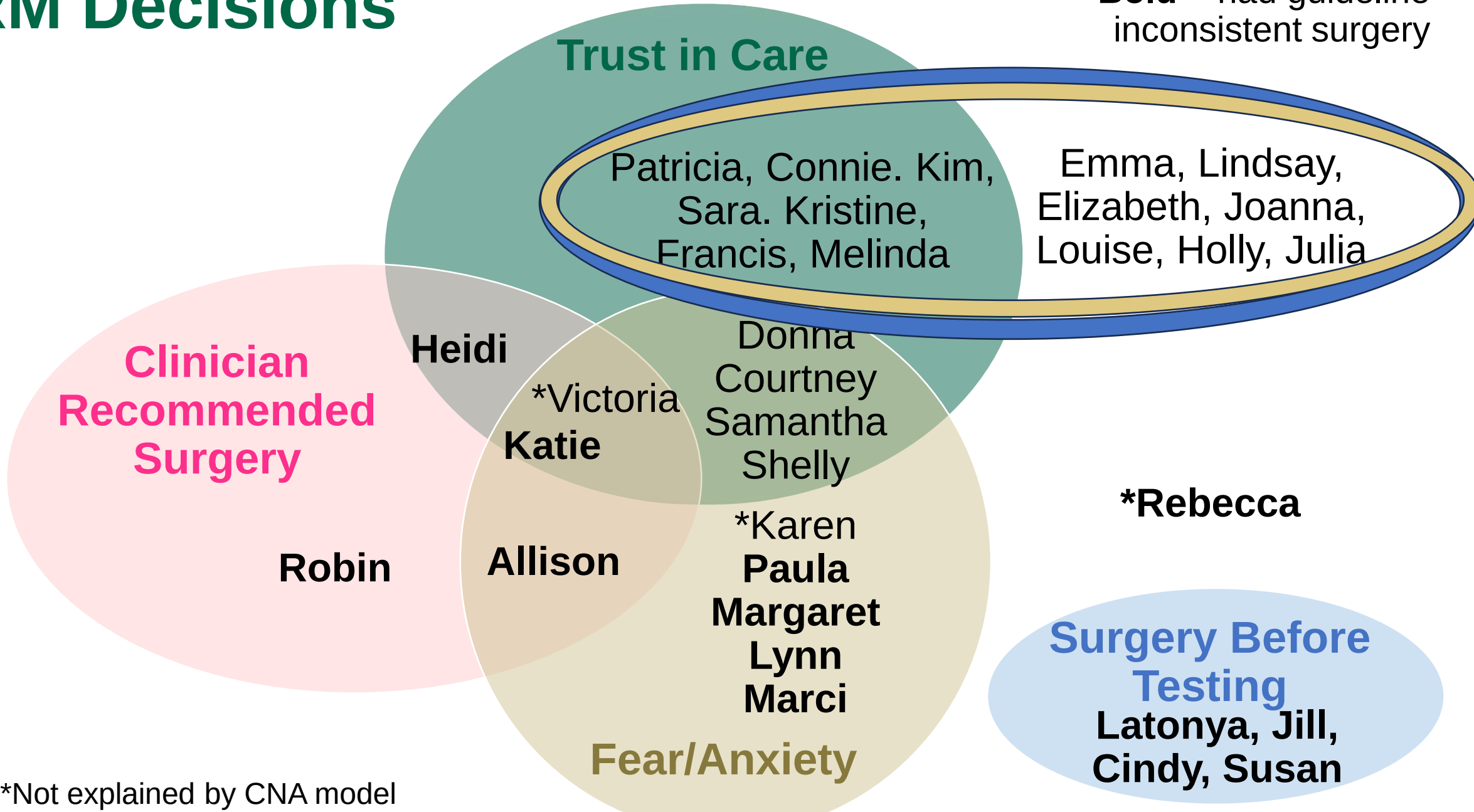
coincidence analysis (CNA)

uncovers difference makers



CRM Decisions

Bold = had guideline inconsistent surgery



*Not explained by CNA model

Implications

CNA helped make sense of qualitative themes

Improving **trust** in providers may **prevent** unnecessary surgery among women who are **anxious** about cancer **as long as providers don't recommend** such surgeries

A quantitative approach might miss the importance of anxiety

Since only half of those with **anxiety** had **unnecessary surgery finding a correlation is unlikely** even with a larger sample

Second Study Example

Demonstrate the use of data matrix heat mapping and CNA to understand what contributes to implementation success

Genetics in Medicine (2024) 26, 101201

ELSEVIER

Genetics in Medicine
An Official Journal of the ACMG
www.journals.elsevier.com/genetics-in-medicine

ARTICLE

Identifying factors and causal chains associated with optimal implementation of Lynch syndrome tumor screening: An application of coincidence analysis

Deborah Cragun[1], Zachary M. Salvati[2], Jennifer L. Schneider[3], Andrea N. Burnett-Hartman[4], Mara M. Epstein[5], Jessica Ezzell Hunter[6], Su-Ying Liang[7], Jan Lowery[8], Christine Y. Lu[9], Pamala A. Pawloski[10], Victoria Schlieder[2], Ravi N. Sharaf[11], Marc S. Williams[2], Alanna Kulchak Rahm[2,*]

Principal Investigator - Alanna Kulchak Rahm, PhD, MS
Funded by the National Cancer Institute
1R01CA211723-01A1

IMPULSS
Implementing Universal Lynch Syndrome Screening

Universal Tumor Screening (UTS) Programs

19 cases (organizational units)

within 9 healthcare systems

Table 2 UTS optimization by case identifier and health care system

Health Care System ID	Case ID	Optimization Score	UTS Implementation and Optimization Category
1	1A	2	Nonoptimized program
	1B	1	Nonoptimized program
	1C	3.5	Nonoptimized program
	1D	3	Nonoptimized program
2	2	0	No Program
3	3	2.5	Nonoptimized program
4	4A	5	Optimized Program
	4B	0	No Program
	4C	2	Nonoptimized program
	4D	0	No Program
	4E	5	Optimized Program
	4F	2	Nonoptimized program
5	5	3.5	Nonoptimized program
6	6A	Excluded	Excluded
	6B	3	Nonoptimized program
	6C	5	Optimized Program
7	7	0	No Program
8	8	5	Optimized Program
9	9	2.5	Nonoptimized program
9	19		Totals

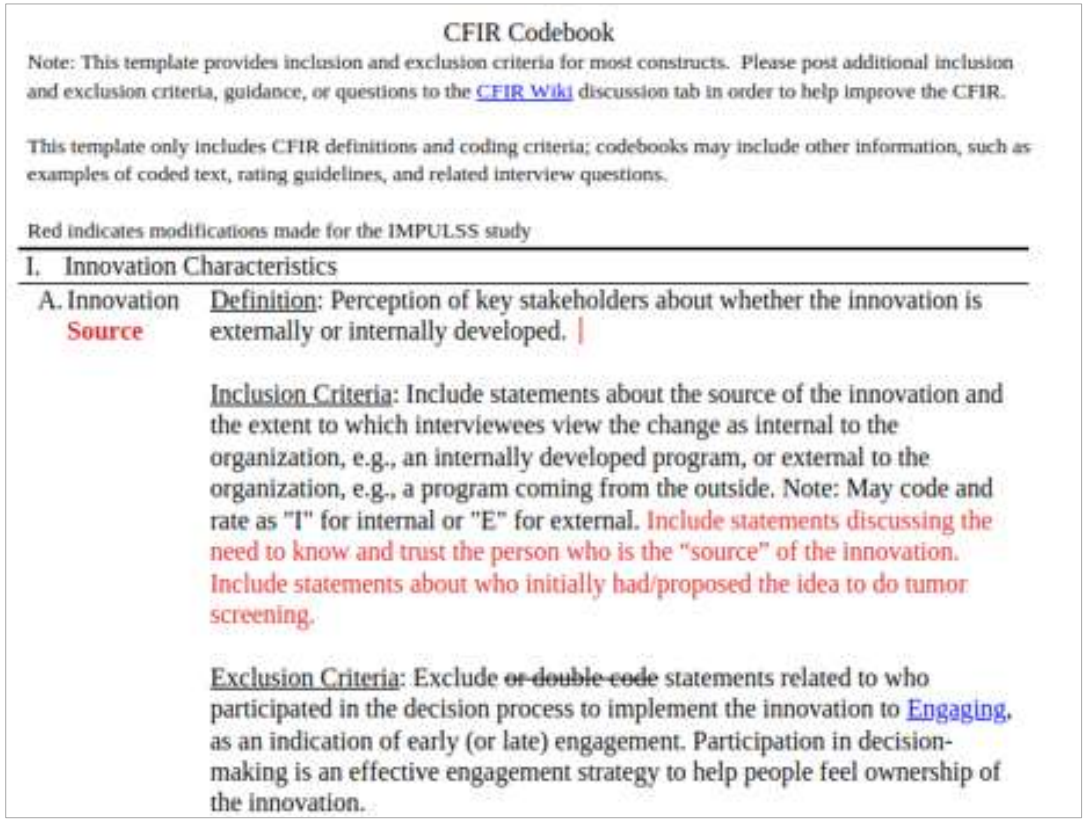
Optimized programs n=4

Nonoptimized programs n=10

No program n=4

Qualitative Coding

Using Consolidated Framework for Implementation Research (CFIR 1.0)



CFIR Codebook

Note: This template provides inclusion and exclusion criteria for most constructs. Please post additional inclusion and exclusion criteria, guidance, or questions to the CFIR Wiki discussion tab in order to help improve the CFIR.

This template only includes CFIR definitions and coding criteria; codebooks may include other information, such as examples of coded text, rating guidelines, and related interview questions.

Red indicates modifications made for the IMPULSS study

I. Innovation Characteristics	
A. Innovation Source	Definition: Perception of key stakeholders about whether the innovation is externally or internally developed. |
	Inclusion Criteria: Include statements about the source of the innovation and the extent to which interviewees view the change as internal to the organization, e.g., an internally developed program, or external to the organization, e.g., a program coming from the outside. Note: May code and rate as "I" for internal or "E" for external. Include statements discussing the need to know and trust the person who is the "source" of the innovation. Include statements about who initially had/proposed the idea to do tumor screening.
	Exclusion Criteria: Exclude ~~or double code~~ statements related to who participated in the decision process to implement the innovation to Engaging, as an indication of early (or late) engagement. Participation in decision-making is an effective engagement strategy to help people feel ownership of the innovation.

Data Matrix Heat Mapping

Matrix example showing all 4 stakeholder interviews that comprise **case 7**

Summarized Coded Data (creating a matrix for each case)

Stakeholders' roles from organizational unit 7 (Case 7)	CFIR domain: Intervention characteristics (Factors)			
	Evidence Strength & Quality	Relative Advantage	Cost	Complexity
Medical oncologist	Rationale is there but need quality literature	Benefit patient care, improve outcomes, reduce medical cost		
Primary care doctor	Have to be able to "show downstream benefit for having it done"		UTS decision comes down to cost effectiveness *(NOTE: unaware of available cost data so neutral)*	
Vice President over population health	Desires more information, need clinical outcome data	Challenge to get providers to	Unknown, but possible	
Nurse Practitioner		Additional screening could identify more patients	Familiar only with insurance and billing of germline test not UTS	

Qualitative codes in columns

Summarized stakeholder interview data in each row

Color Coded and Combined Data from Stakeholders

Stakeholders' roles from organizational unit 7 (Case 7)	CFIR domain: Intervention characteristics (Factors)			
	Evidence Strength & Quality	Relative Advantage	Cost	Complexity
Medical oncologist	Rationale is there, but need quality literature	Benefit patient care, improve outcomes, reduce total medical care	UTS can help save money in the long run	
Primary care doctor	Have to be able to "show downstream benefit for having it done"		UTS decision comes down to cost effectiveness *(NOTE: unaware of available cost data so neutral)*	
Vice president over population health	Desires more information; need clinical outcomes data	Challenge to get pr… see value in imple… affordability, how to…		
Nurse Practitioner		Additional screen… identify more p…		
Combined Valences for Case 7				

Rules for combining codes
Blue + blue = blue (all positive)
Red + red = red (all negative)
Red + blue = purple (becomes mixed)
Purple + any color = purple (stays mixed)
Gray + gray = gray (not salient)
Gray + any other color = the other color

Final summary row for **case 7**

Process repeated for each case

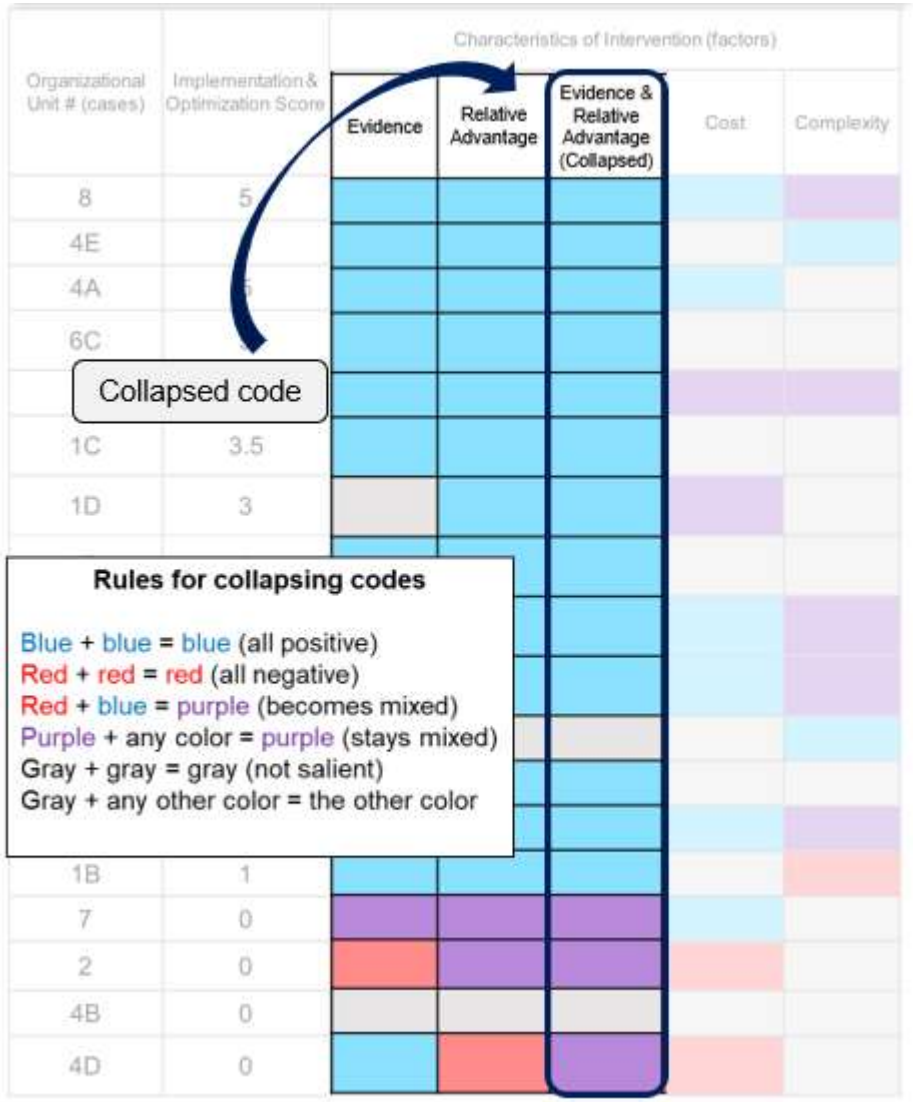
Compiled Summary Rows for Each Case into New File and Organized Cases by Outcome

Organizational Unit # (cases)	Implementation & Optimization Score	Characteristics of Intervention (factors)			
		Evidence	Relative Advantage	Cost	Complexity
8	**5**				
4E	**5**				
4A	**5**				
6C	**5**				
5	**3.5**				
1C	**3.5**				
1D	**3**				
6B	**3**				
9	**2.5**				
3	**2.5**				
4F	**2**				
4C	**2**				
1A	**2**				
1B	**1**				
7	**0**				
2	**0**				
4B	**0**				
4D	**0**				

Outcome of interest (optimization score)

Final summary row for **case 7**

Collapsed some Codes



Final Calibrated Data Matrix Heat Map

	CFIR Factors combined						Implementation Outcomes		
Cases	Cosmopolitanism or Peer Pressure	Imple-mentation Champion	Maintenance Champion	Cost Concerns	Evidence, advantage, knowledge, attitudes	Inner Setting (except structural)	Initial and Ongoing Planning & Engaging of Stakeholders	Implementation & Optimization (Calibrated)	Uncalibrated Optimization Score
8	4	4	4	0	4	4	4	2	5
4E	4	4	4	0	4	4	4	2	5
4A	4	4	4	0	4	4	4	2	5
6C	0	0	4	0	4	4	4	2	5
5	4	4	0	1	4	2	2	1	3.5
1C	4	4	4	0	4	2	4	1	3.5
1D	0	0	0	1	2	2	2	1	3
6B	0	4	0	0	4	4	2	1	3
9	0	4	4	0	2	2	2	1	2.5
3	0	4	4	0	2	2	2	1	2.5
4F	0	4	4	0	4	2	4	1	2
4C	0	4	0	0	4	2	2	1	2
1A	4	0	0	0	2	2	2	1	2
1B	0	0	0	0	2	2	2	1	1
7	0	0	0	0	1	2	1	0	0
2	0	0	0	1	1	2	1	0	0
4B	0	0	0	0	1	2[a]	1	0	0
4D	0	0	0	1	1	2	1	0	0

[a]Inner Setting was calibrated negatively for this case but was combined with "mixed/limited" cases to reduce data fragmentation.

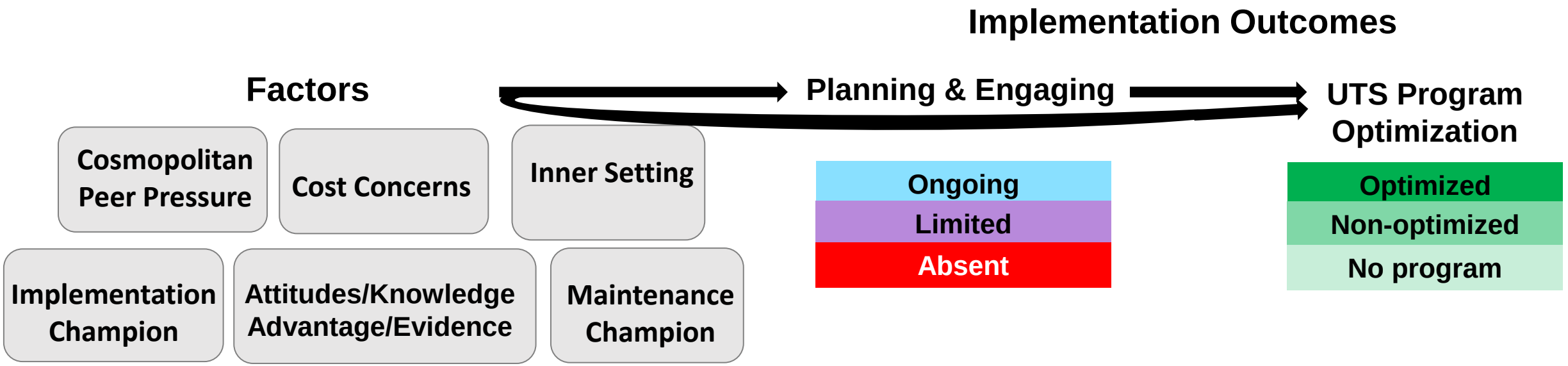
Data Calibration of Factors/Outcomes

- 4=Clearly present & positive
- 1=Clearly present & negative
- 0=Not clearly present

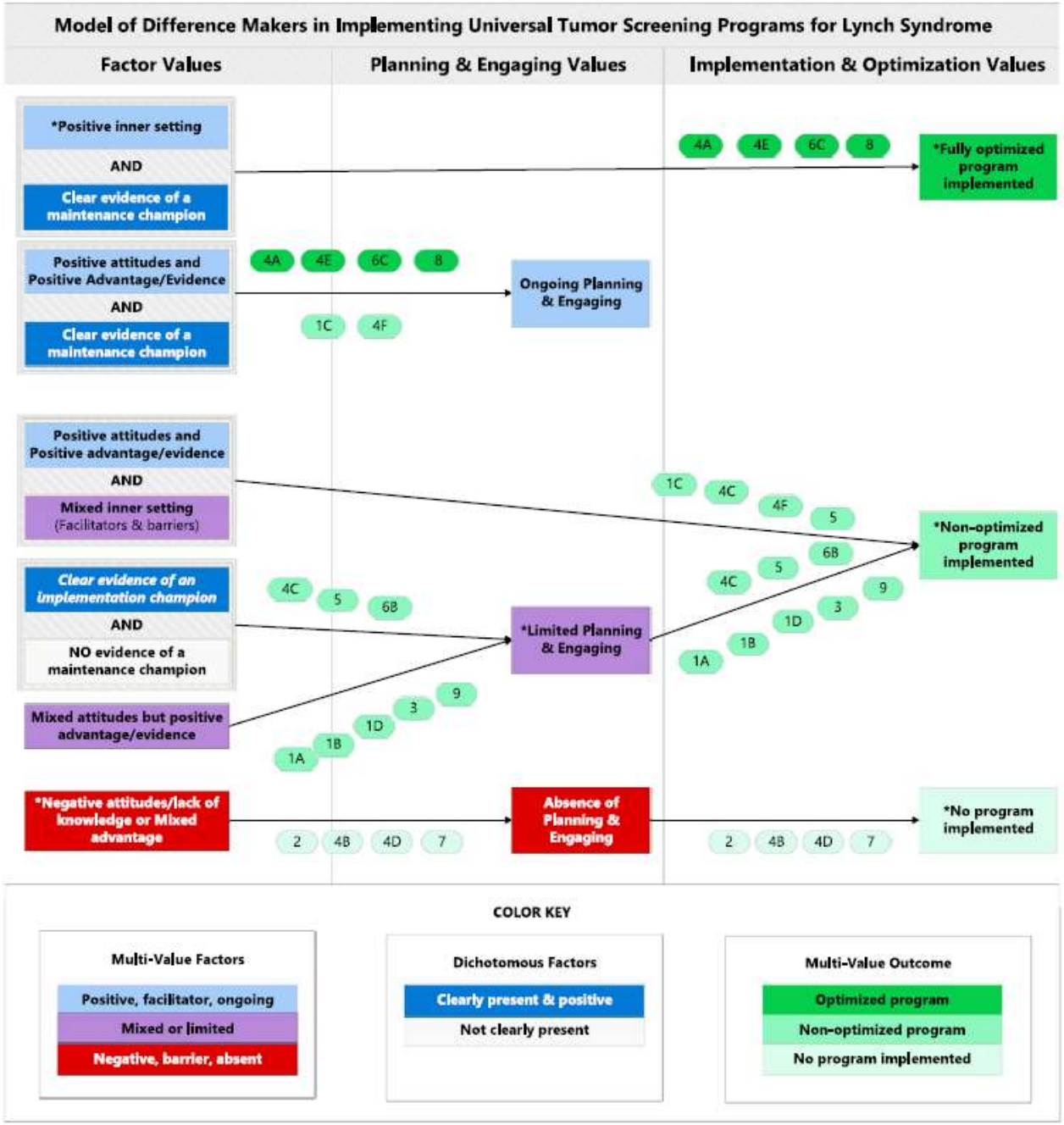
- 4=positive, facilitator, ongoing
- 2=mixed or limited
- 1=negative, barrier, absent

- 2=Optimized program
- 1=Non-optimized program
- 0=No program

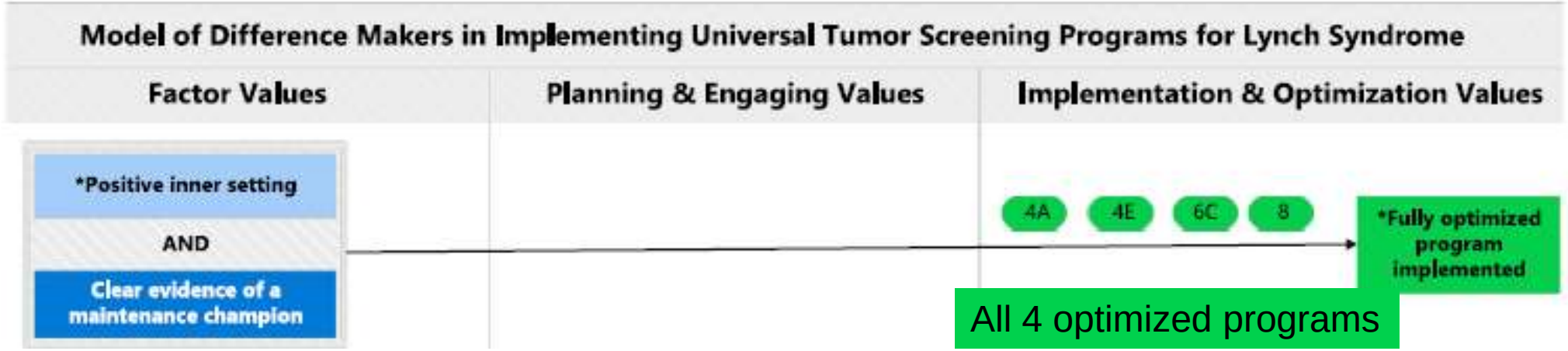
CNA Modeling



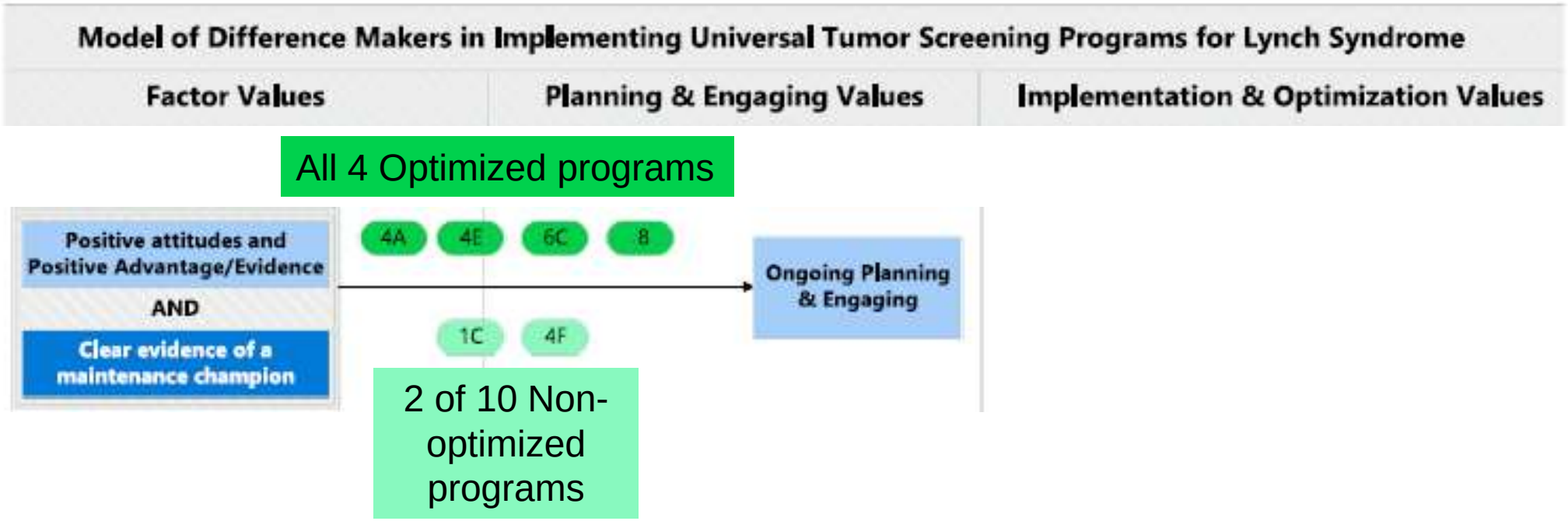
Final CNA Solution



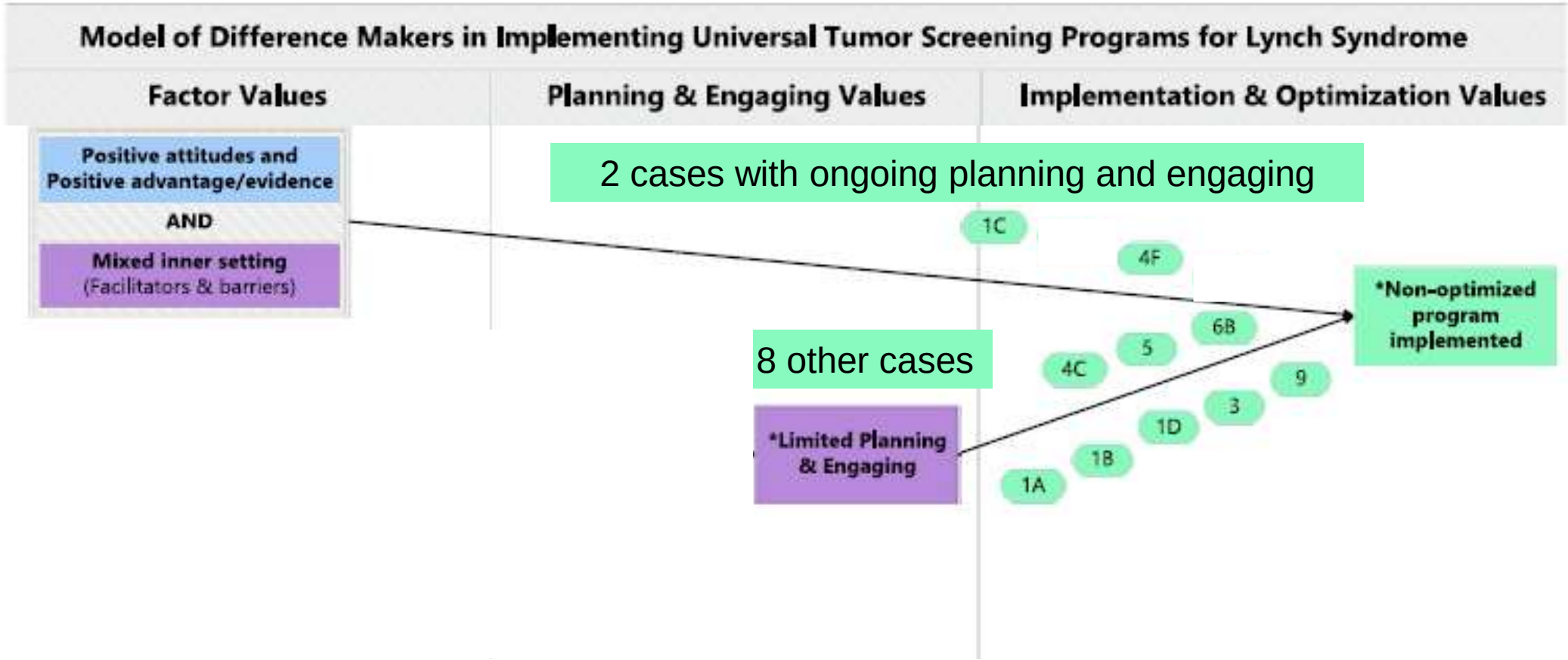
Path to Fully Optimized Program



Ongoing Planning and Engaging



Paths to Non-optimized Programs



Path Preventing Implementation

All 4 cases with no program

In Conclusion CNA…

1. Provides a unique approach to analyzing relatively small sample sizes

2. Identifies patterns that may be missed using only traditional statistics or qualitative analysis

3. Uncovers complexities in implementation science