

ECOLOGICAL MOMENTARY ASSESSMENT

- EMA via text messaging to measure cigarette and e-cigarette use patterns

Morgan T; Stevens ER; Nicholson A; El-Shahawy O; Sherman SE

Contact: elizabeth.stevens@nyulangone.org
The authors have no conflicts of interest to declare.

PRESENTATION OUTLINE



01

SWITCHING TO E-CIGARETTES

Our harm-reduction research in patients with COPD who smoke.



02

WHAT IS EMA?

Ecological momentary assessment and how it was used.



03

EMA FINDINGS

Observed patterns in EMA engagement and e-cigarette switching.



04

PERFORMANCE & FUTURE USE

How EMA compares to other measures and its potential utility.

SWITCHING TO E-CIGARETTES

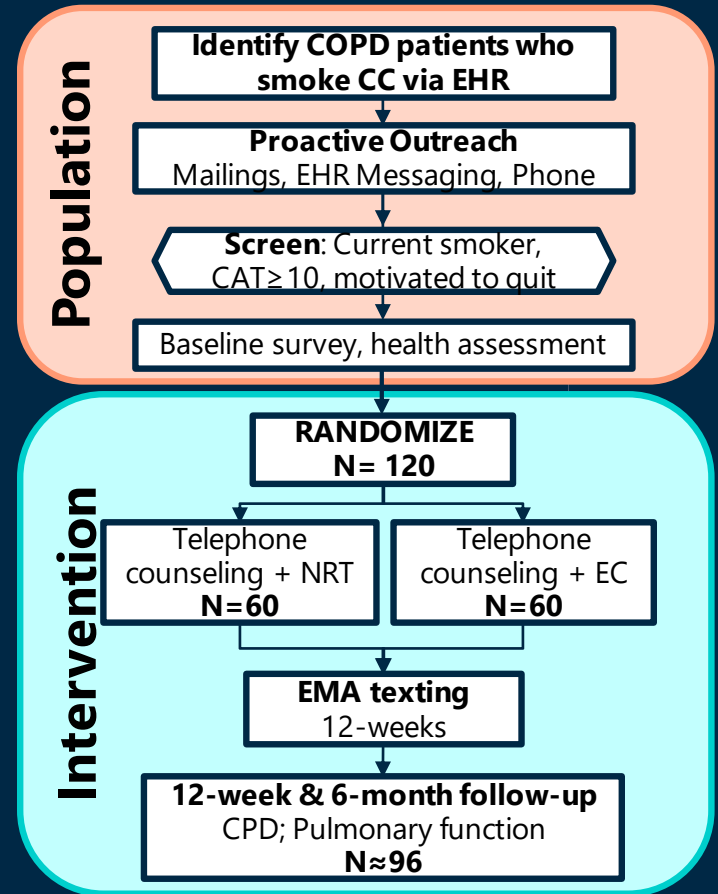
EMA context:

A harm-reduction trial among
patients with COPD who smoke

01

Pilot Harm-Reduction RCT

Testing the impact of switching to e-cigarettes on pulmonary function and smoking reduction



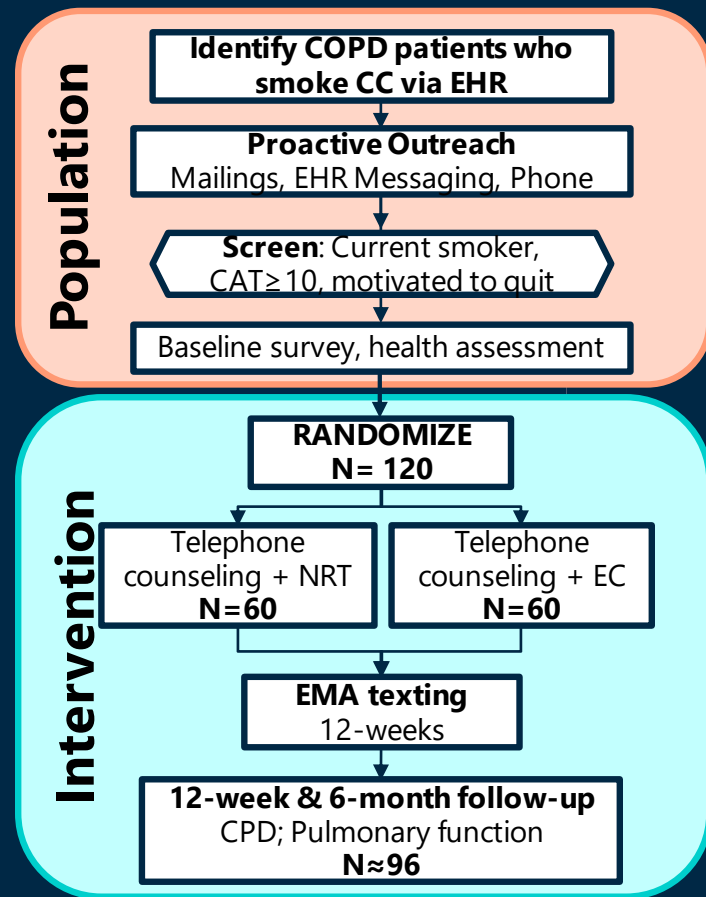
SWITCHING STUDY

POPULATION

- ❖ Chronic obstructive pulmonary disease (COPD) diagnosis
- ❖ Smoke ≥ 5 cigarettes per day (CDP)
- ❖ COPD Assessment Test (CAT) score ≥ 10
- ❖ Motivated to quit smoking (≥ 5 on 10-point Contemplation Ladder)

INTERVENTION

- ❖ 1:1 randomization
- ❖ Behavioral counselling with nicotine replacement therapy (NRT) or e-cigarettes



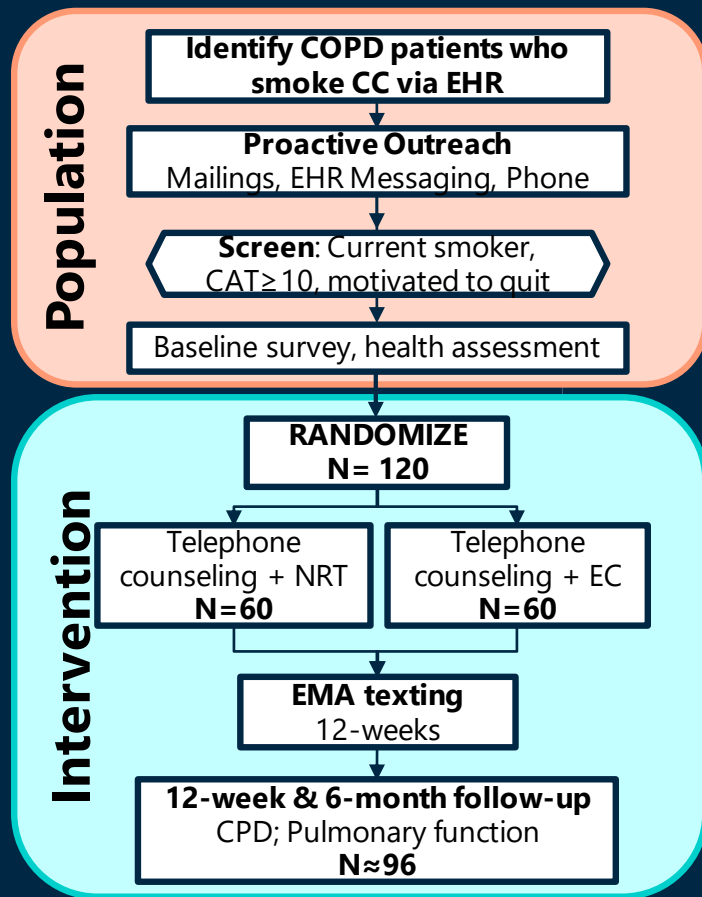
SWITCHING STUDY

PRIMARY OUTCOME MEASURES

- ❖ Pulmonary function
 - ❖ mMRC (Modified Medical Research Council) Dyspnea Scale
 - ❖ Clinical COPD Questionnaire (CCQ)
 - ❖ COPD Assessment Test (CAT)
- ❖ Cigarettes per day (CDP)
- ❖ E-cigarette uses per day

SECONDARY MEASURES

- ❖ Craving and satisfaction
- ❖ Acceptability
- ❖ Counselling adherence



SWITCHING STUDY

PRIMARY OUTCOME MEASURES


- ❖ Pulmonary function
 - ❖ mMRC (Modified Medical Research Council) Dyspnea Scale
 - ❖ Clinical COPD Questionnaire (CCQ)
 - ❖ COPD Assessment Test (CAT)

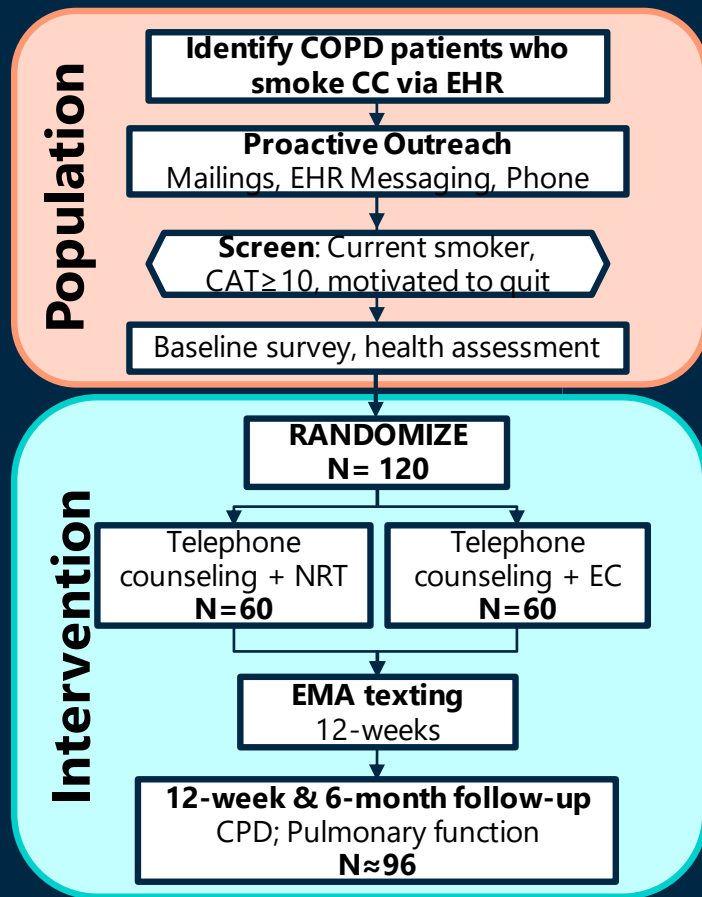
❖ Cigarettes per day (CDP) 

❖ E-cigarette uses per day 

Measured
via EMA

SECONDARY MEASURES

- ❖ Craving and satisfaction 
- ❖ Acceptability
- ❖ Counselling adherence



ECOLOGICAL MOMENTARY ASSESSMENT

What is EMA?
And how did we use it?

02

WHAT IS EMA?

Ecological momentary assessment (EMA) is the study of people's behavior in their daily lives by repeatedly collecting data in an individual's normal environment, at or close to the time they carry out that behavior.

Definition from UK.gov



Strengths of EMA

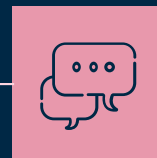
- ❖ Provides data collection “in the real world”
- ❖ Reduced recall bias
- ❖ Measure changes over time
- ❖ Efficient data collection, once set up



EMA EXAMPLES

Diaries

Recording events, behaviors, or feelings

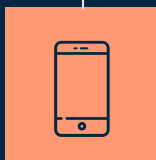


Text Messaging

Recurring short questionnaires

Smartphone Apps

Solicit response, take measurements

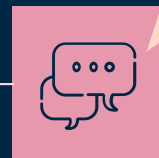


Geospatial Monitoring

Solicit response within particular locations

EMA EXAMPLES

Diaries
Recording events,
behaviors, or feelings

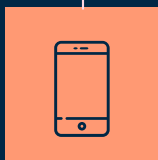


Text Messaging

Recurring short
questionnaires

**Smartphone
Apps**

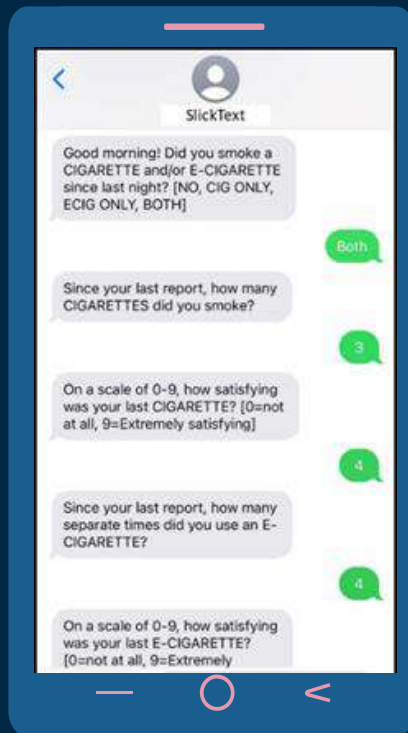
Solicit response,
take measurements



**Geospatial
Monitoring**

Solicit response within
particular locations

EMA SETUP FOR PILOT



- ❖ Simple SMS
- ❖ Four check-ins per day: 9h, 13h, 17h, 21h
- ❖ Measures: E-cig and cig use, satisfaction, and craving
- ❖ Started one week before product received (baseline)

Since the last check-in, did you smoke a CIGARETTE and/or E-CIGARETTE?
[NO, CIG ONLY, ECIG ONLY, BOTH]

NO

On a scale of 0-9 how much do you want to smoke a cigarette right now?

CIG ONLY

Since your last report, how many cigarettes did you smoke?

On a scale of 0-9 how much do you want to smoke a cigarette right now?

ECIG ONLY

Since your last report, how many separate times did you use an e-cig?

On a scale of 0-9, how satisfying was your last e-cig?

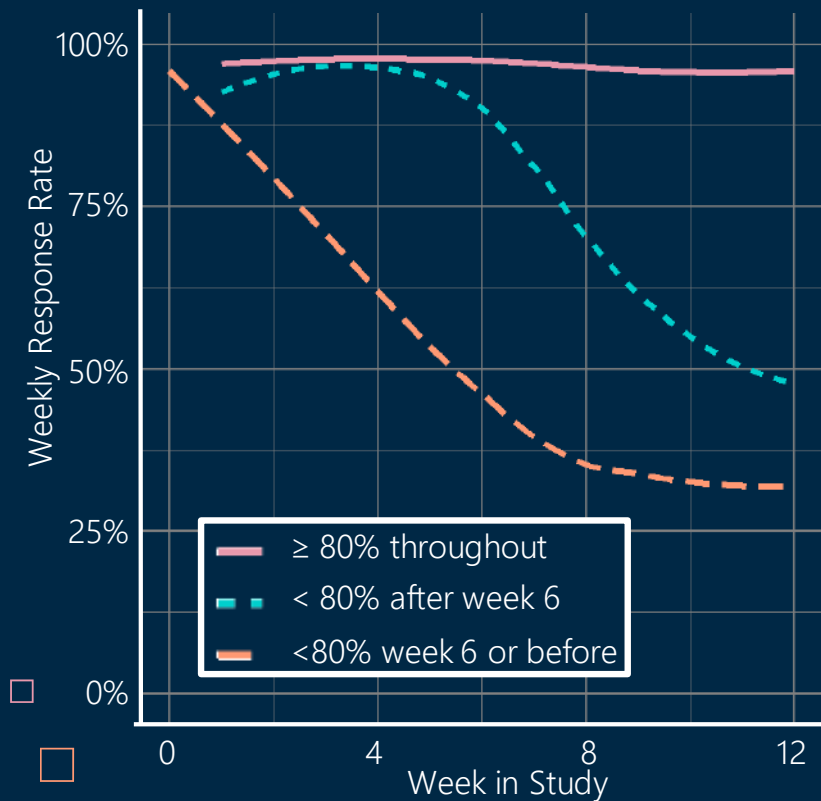
On a scale of 0-9 how much do you want to smoke a cigarette right now?

EMA FINDINGS

What patterns were found in
EMA responses?

03

EMA RESPONSE RATE



- ❖ Three response patterns
- ❖ High response rate throughout
- ❖ Rapid drop-off in response rate
- ❖ Drop in response rate midway

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	60 (21)	75 (91)

NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	60 (21)	75 (91)

NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	60 (21)	75 (91)

NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	60 (21)	75 (91)

NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	60 (21)	75 (91)

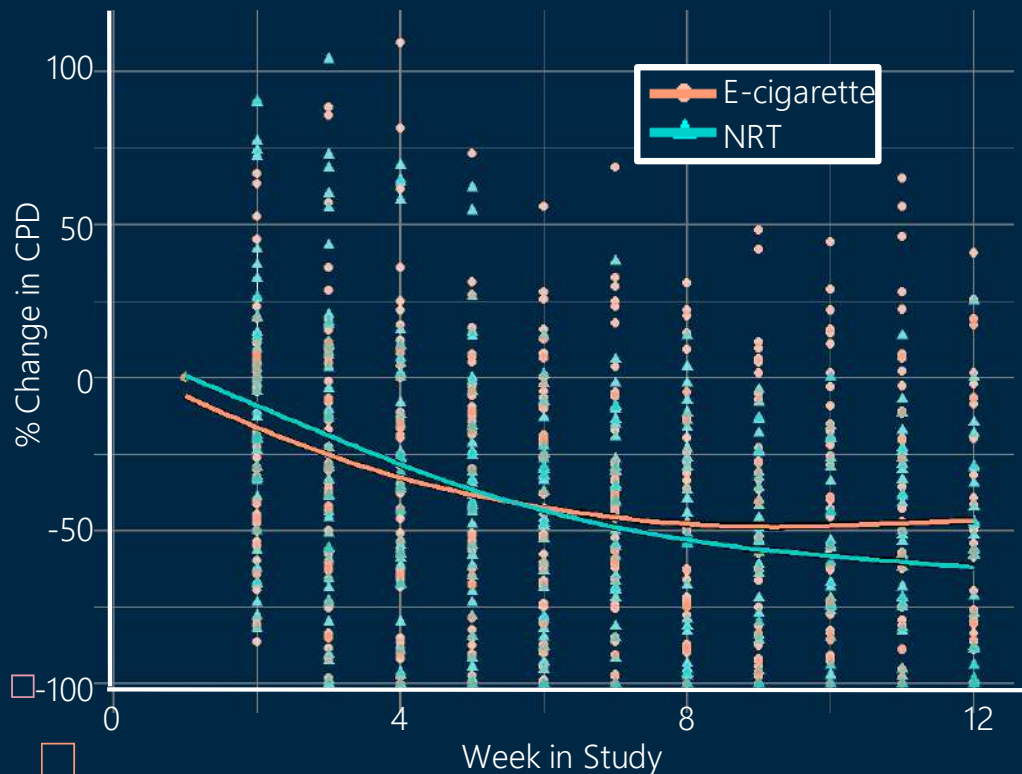
NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

RESPONDERS

Characteristic	≥80% throughout, N = 53 %(N)	<80% after wk 6, N = 21 %(N)	<80% wk 6 or before, N = 35 %(N)	Overall, N = 121 %(N)
Randomization Arm				
E-cig	49 (26)	76 (16)	46 (16)	52 (63)
NRT	51 (27)	24 (5)	54 (19)	48 (58)
Age (Mean [SD])	58.9 [9.3]	58.1 [11.3]	57.9 [11.9]	58.3 [10.5]
Female	57(30)	43 (9)	57 (20)	54 (65)
Educational history				
High School or less	36 (19)	33 (7)	26 (9)	33 (40)
Some College or more	64 (34)	66 (14)	74 (26)	67 (81)
Confidence to quit (1-10)	6.5 [2.2]	6.8 [2.6]	6.11 [1.94]	6 [2.28]
CAT Score^a (Mean [SD])	19.8 [6.8]	22.2 [7.3]	20.1 [6.0]	20 [6.7]
Average CPD^b (Mean [SD])	16.5 [9.4]	18.3 [9.2]	17.6 [10.7]	18 [9.6]
Work status				
Full-time (>40hrs/wk.)	19 (10)	24 (5)	40 (14)	25 (30)
Other	81 (43)	76 (16)	80 (27)	75 (91)

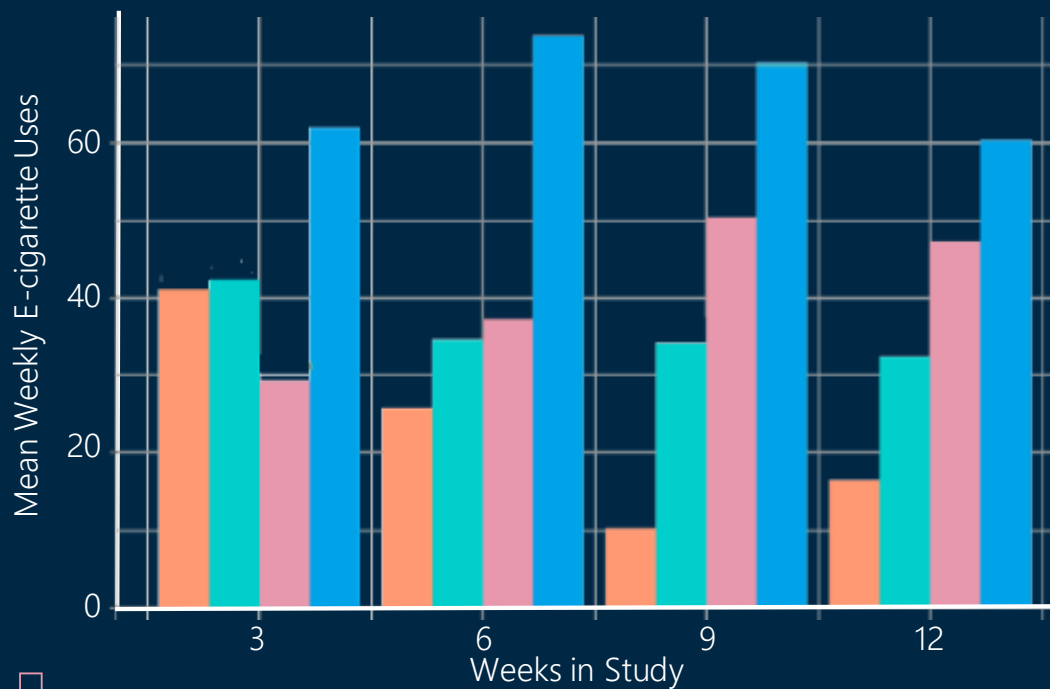
NOTE: Those with no EMA data are included in the Overall N; ^a N missing=39; ^b CPD based on interview

CPD CHANGE OVER TIME



- ❖ CPD change over 12-weeks by study arm
- ❖ E-cig average -48.1% reduction
 - ❖ 12.7 CPD to 5.7 CPD
- ❖ NRT average -62.5% reduction
 - ❖ 10.2 CPD to 3.6 CPD

DISPLACEMENT



- ❖ More frequent e-cigarette use associated with greater CPD reduction
- ❖ In some cases e-cigarette use may supplement rather than displace CPD

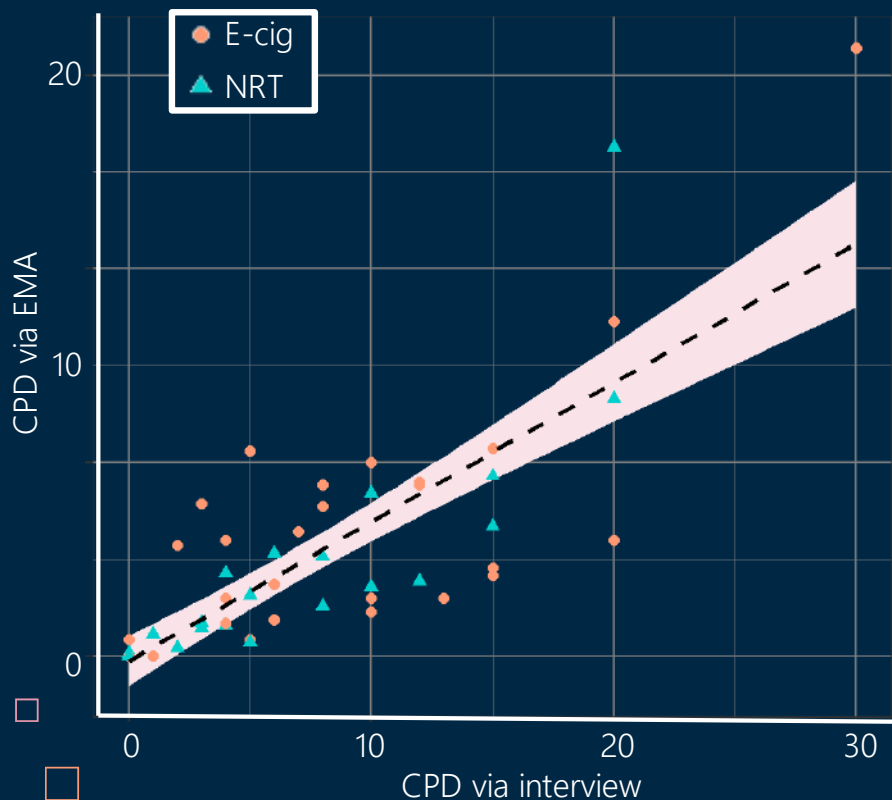
Legend: Increase in CPD (orange), 0-50% Reduction (teal), 51-75% Reduction (pink), 76-100% Reduction (blue)

PERFORMANCE & FUTURE USE

How does EMA compare?
What is the potential role of EMA
in e-cigarette research?

04

CORRELATION IN CPD



- ❖ Correlation of CPD collected via EMA vs. 12-week interview

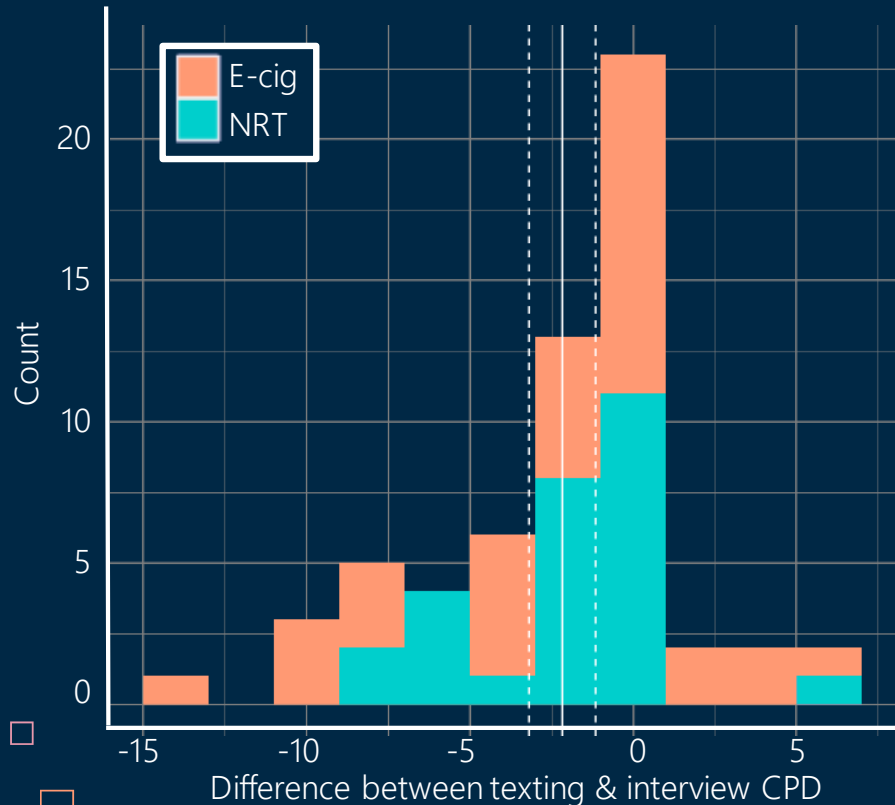
- ❖ EMA less than interview

- ❖ Correlation coefficient = 0.81 (95%CI: 0.70 to 0.88)

- ❖ Note: One outlier was removed where reported EMA CPD was <10 but CPD in the interview = 50.

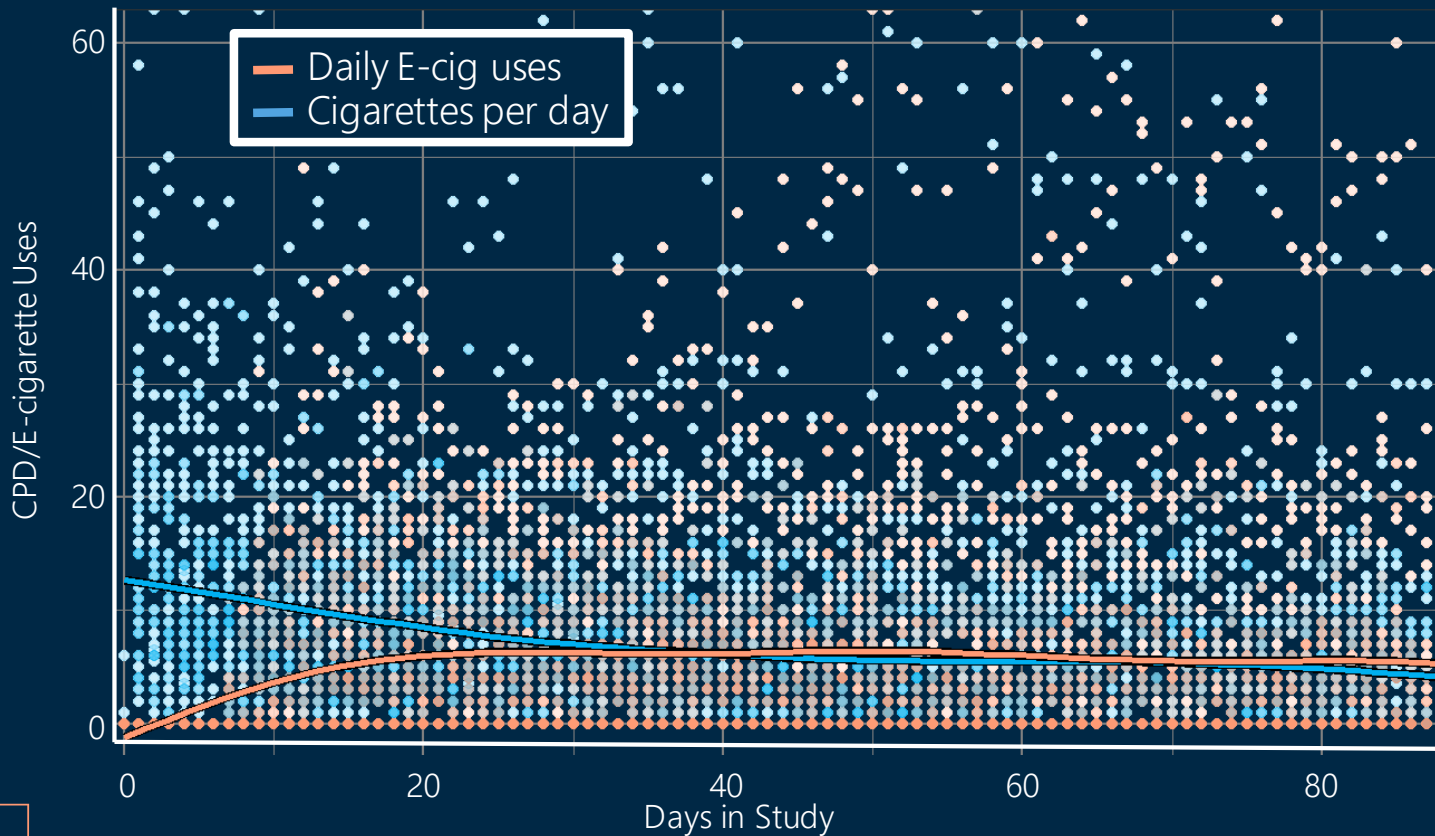
- ❖ With outlier, correlation coefficient = 0.63 (95%CI: 0.46 to 0.77)

DISTRIBUTION OF DIFFERENCES

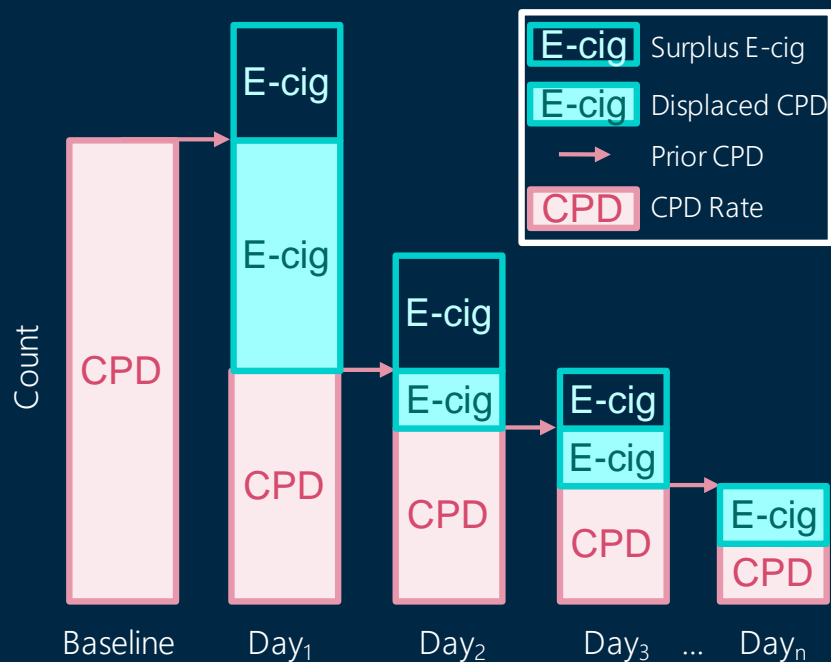


- ❖ Paired differences of CPD collected via EMA vs. 12-week interview
- ❖ EMA average less than interview
- ❖ Paired difference = -2.16 (95%CI: -3.18 to -1.15)
 - ❖ Note: One outlier was removed where reported EMA CPD was <10 but CPD in the interview = 50.
 - ❖ With outlier, paired difference = -2.84 (95%CI: -4.53 to -1.16)

MAPPING DISPLACEMENT



DISPLACEMENT PROCESS



- ❖ Measure additive vs. displacement e-cigarette use
- ❖ Evaluate switching patterns to identify points for intervention
- ❖ More accurately estimate dual-use

EMA LIMITATIONS

- ❖ Still susceptible to self-report biases
- ❖ Response fatigue
- ❖ EMA messaging may impact behavior
- ❖ Potential for significant missing data
- ❖ Complex data processing and analysis

CONCLUSIONS

- ❖ EMA may be more reliable than survey estimates
- ❖ Texting is a feasible method for collecting CPD data
- ❖ Potential to reveal patterns of EC and cigarette use not observable with standard survey collection
- ❖ Further exploration needed to:
 - ❖ Understand factors contributing to lower response rates
 - ❖ Evaluate the validity of EMA as a measure of CPD
 - ❖ Examine how/if EMA impacts smoking behavior

Do you have any questions?

elizabeth.stevens@nyulangone.org
Twitter: @ERS_PhD

THANK YOU



Tucker Morgan



Andrew Nicholson, MSPH



Omar El-Shahawy, MD, PhD, MPH



Scott E Sherman, MD, MPH

