The Economic Evaluation of Implementation Strategies

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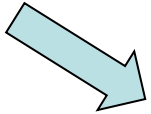
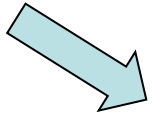
Road Map

- Need for Economic Evaluation in D&I Research
- EE Methods in Implementation Context
- An Example Illustration Throughout
- Mixed-methods

A Story Sounding All So Familiar…





Innovation effectiveness DOES NOT guarantee its uptake into routine usage

Gap!

- ~10-27% individuals receive scientifically validated care (IOM 2006)
- ~17-20 years for clinical innovations to get integrated into usual practice (Balas and Boren 2000)
- ~ 80% of medical research $ do not make a public health impact (Chalmers and Glasziou 2009)!

New Trend

- Evaluate interventions in environment where they will potentially be used
  - Practical clinical trials / Pragmatic clinical trials
  - Comparative effectiveness trial
  - Large simple trials

Why?: individual-level

Acceptability

Food Cost

Time Cost

Food Sufficiency

Blue Apron

WINE GIFTS MARKET LOG IN SIGN UP

ever-changing mix of meat, fish, and vegetarian
along with repeating customer favorites.

Week of August 12th | 2 | 3 | Recipes per week (each serves 2) | $9.99 per serving FREE shipping | ~~$47.95~~ $27.95 First Week Total | SELECT PLAN

Honey-Ginger Pork Chops
with Spicy Marinated Vegetables & Crispy Shallot

45 min

Seared Chicken & Vegetable Orzo
with Brown Sugar & Caper Pan Sauce

30 min

University of Virginia Health System

Why?: organization-level

- Audience: practitioners, provider organizations etc.
- Product of consideration:
  - Efficacious and effective interventions
  - Processes/strategies that help the intervention to be spread to / adopted by target providers →IS
- IS: complex endeavors and NOT FREE
  - No research funds
  - No existing personnel fit for the intervention executions
  - Current reimbursement do not cover all IS costs
  - Institution/Organization level contextual issues

A Specific Example

At the launch of the initiative, President Barack Obama signed a Presidential Memorandum creating the first-ever Task Force on Childhood Obesity to conduct a review of every single program and policy relating to child nutrition and physical activity and develop a national action plan to maximize federal resources and set concrete benchmarks toward the First Lady's national goal. The Task Force recommendations focus on the five pillars of the First Lady's *Let's Move!* initiative:

1. Creating a healthy start for children
2. Empowering parents and caregivers
3. Providing healthy food in schools
4. Improving access to healthy, affordable foods
5. Increasing physical activity

A Specific Example

Serving Healthier School Food

- $10 billion over 10 years to improve the quality of NSLP and SBP

Some schools push to roll back healthy lunch requirements

202

EMAIL

BY MARY CLARE JALONICK, ASSOCIATED PRESS *May 5, 2014 at 9:26 AM EDT*

Students at Doherty Middle School get their healthy lunch at the school cafeteria, on June 18, 2012 in Andover, Massachusetts. Some schools are concerned new guidelines only mean more healthy food will end up in the trash. Photo by Melanie Stetson Freeman/The Christian Science Monitor via Getty Images

Economic 101: Demand

Economic 101: Supply

Economic Evaluation Brief Intro

- Key concept: opportunity cost (OC)
  - The potential benefits might have been accrued through B are forgone due to support of A instead
- Central question:
  - Is the support of A the best possible use of available resources given its OC? [efficacy; effectiveness]
  - Is the A strategy making the most economic sense to deploy?
- Goal of EE:
  - Quantify costs and outcomes of both A and B
  - Then compare

EE Components in IS: Costs

- Costs by Implementation Components
  - IS execution
  - Program tailoring/adaptation: e.g., excess cost of service delivery as uptake or implementation changes
  - OC of practitioners' and participants' engagement
- Types of Costs
  - Direct costs: e.g., cost of purchasing new equipment to monitor fidelity
  - Indirect costs: e.g., time away from other duties
  - Overhead: e.g., utilities, administrative support

EE Components in IS: Outcomes

- Traditional EE focuses on efficacy outcomes only
- Outcome Measurements by Types of Trials:
  - Efficacy: extensive battery of health outcomes (comprehensive)
  - Effectiveness: focused battery of health outcomes
  - Implementation: process related outcomes (may also include health outcome measures similar to effectiveness studies)
    - Implementation ones: e.g., fidelity; reach
    - Service ones: e.g., equity; patient-centeredness
    - Clinical ones: e.g. functioning; symptoms

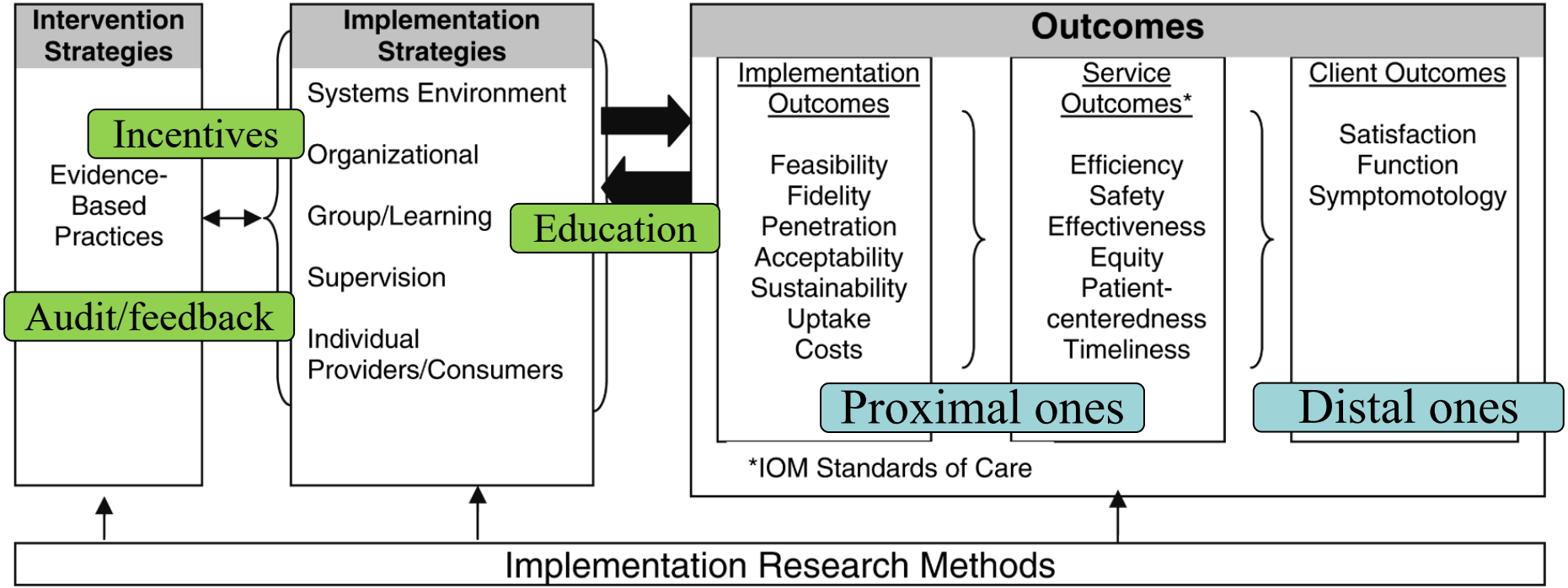


Fig. 1. Conceptual model of implementation research

All types of outcomes are intertwined!

Proctor et al. (2009). Implementation research in mental health services: an emerging science with conceptual, methodological, and training challenges. *Adm Policy Ment Health*.

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Standard EE Methods

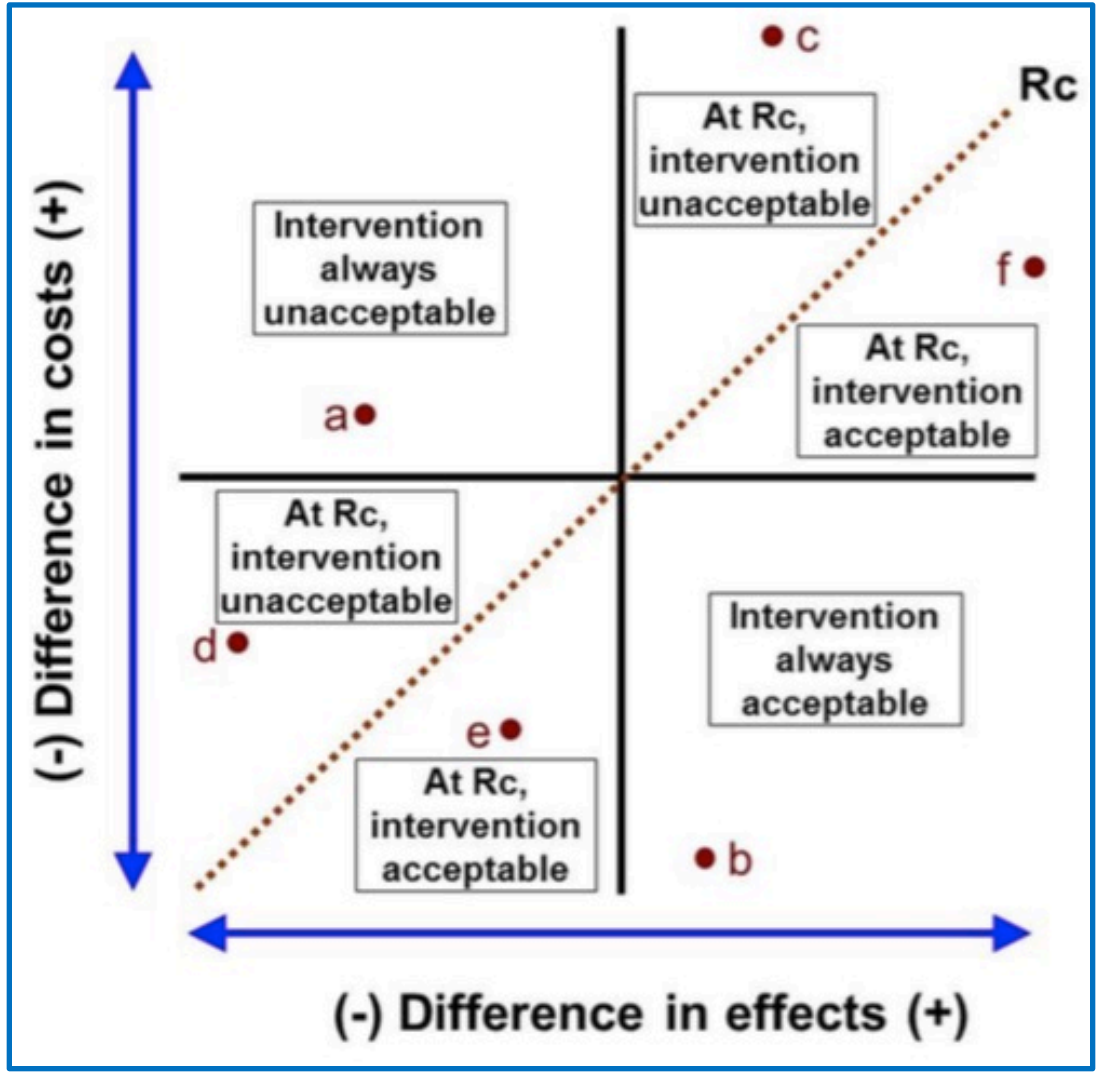
- Compare costs only: cost offsets; budget impact analysis
- Cost-Effectiveness Analysis [benefit: natural units]
  - Incremental Cost-Effectiveness Ratio: $ per unit outcome gained

$$ICER = \frac{Cost_A - Cost_B}{Outcome_A - Outcome_B} = \frac{\Delta C}{\Delta E} < R_T$$

- Cost-Utility Analysis [benefit: quality of life/preference]
- Cost-Benefit Analysis [all in $]
- Net Health Benefits:

$$NHB = \Delta E - \frac{\Delta C}{R_T} > 0$$

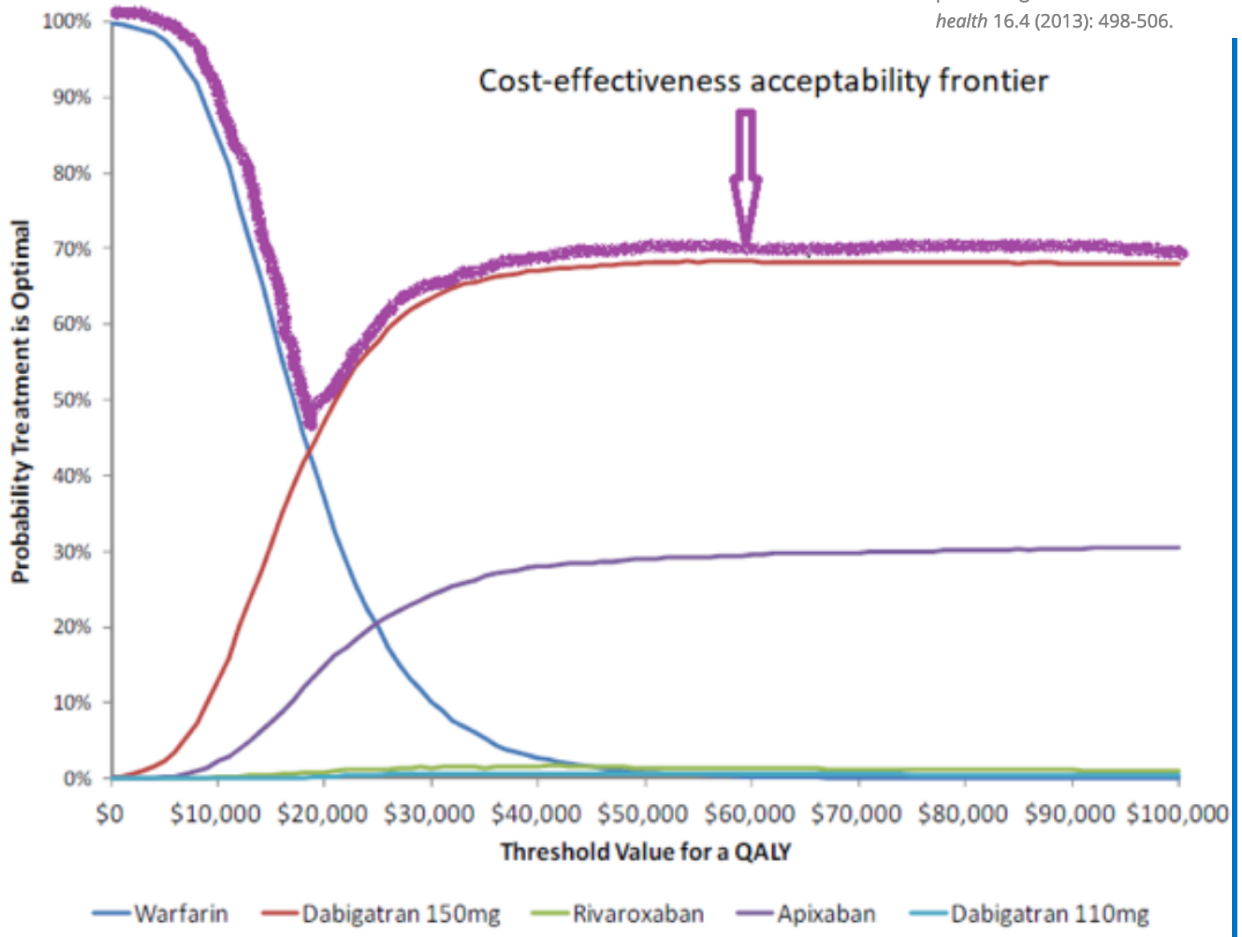
The CE Plane


c
Rc
At Rc, intervention unacceptable
Intervention always unacceptable
f
At Rc, intervention acceptable
a
At Rc, intervention unacceptable
d
Intervention always acceptable
e
At Rc, intervention acceptable
b
(-) Difference in costs (+)
(-) Difference in effects (+)

Standard EE Methods

- The CE Acceptability Curve (CEAC):
  - The probability that A is CE compared with B, given the observed data, for a range of maximum WTP values (thresholds) for a particular unit change in outcome.
  - Nonparametric bootstrapping of IC and IE jointly
- The CE Acceptability Frontier (CEAF)
- Modeling and simulation

Figure 1. The Cost-Effectiveness Acceptability Curve



Coyle, Doug, et al. "Cost-effectiveness of new oral anticoagulants compared with warfarin in preventing stroke and other cardiovascular events in patients with atrial fibrillation." *Value in health* 16.4 (2013): 498-506.

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EE Adaptation to Evaluate IS

- Explicitly account for resources used in developing and executing IS as a cost of ensuring appropriate delivery

Hoomans and Severens, "Economic Evaluation of Implementation Strategies in Health Care" Implementation Science 2014 9:168

Table 1 Overview of forms of economic evaluation

Form of evaluation	Use for decision making	Measurement of health effects	Economic summary measure
Cost-consequences analysis	Comparison of implementation strategies that have disparate outcomes	Any measure	Not applicable
Cost-effectiveness analysis	Comparison of implementation strategies that produce a common outcome	Process measures (e.g., professional guidance adherence, patient compliance to medication) or health effects (intermediate or final), measured in natural units	Cost-effectiveness ratio (e.g., cost per case averted, cost per life-year saved), at patient or population level
Cost-utility analysis	Comparison of implementation strategies that have morbidity and mortality outcomes	Final health outcomes, including health status, patient preferences, utilities	Cost per quality-adjusted life-year, at patient or population level
Cost-benefit analysis	Comparison of implementation strategies with different units of outcome (health and nonhealth)	Monetary units	Net health benefit or net monetary benefit, at patient or population level
Cost analysis	Comparison of net cost of implementation strategies with equivalent outcomes	Not applicable	Net cost or cost of illness, at patient or population level

Challenges in EE of IS

- Find better ways for the following:
  - The full economic costs and consequences of alternative IS
    - Economies of scale and scope when target larger groups and/or multiple behaviors and practices
    - Degree of data collection: focused vs. extensive
  - System/contextual factors: uncertainty; relevant perspectives
  - ROI Threshold for IS outcomes: i.e., fidelity; wait time
  - Ethical issues: e.g., equity; confidentiality

Issue 1: Relevant Perspective

- Perspective → what costs to capture

  Example: what is cost of a day of hospital care

  - Health plan perspective:

    $ paid to the hospital by the plan

  - Organizational perspective:

    total hospital expenditure on that patient that day (labor + medicines + overhead)

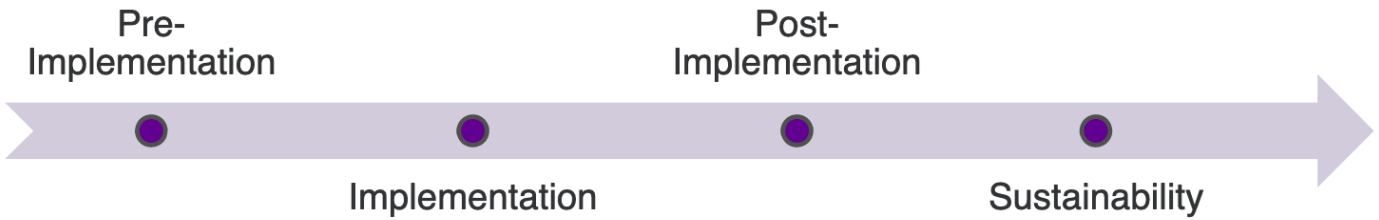
  - Patient perspective:

    out-of-pocket payments, OC of time

  - Societal perspective: all costs (irrespective of who incurs them), including OC of all resources and time used

Issue 2: Costs

- Consider costs across multiple domains and throughout the full implementation process
- Discounting's relevance varies with time horizon



Damschroder, L. (2009). Implementation Science. Stetler, CB. (2006) J Gen Intern Med.

Issue 2: Costs (cont.)

- Across Domains: Comprehensive cost measurement

  Example: IS → group education for clinician

  - Direct costs: costs of IS directly relevant resources

    e.g., training materials; trainer labor costs; equipment

  - Indirect costs: costs of indirectly related ones

    e.g., OC for participants: foregone clinical revenues due to the loss of those billable hours

  - Overhead: cannot be directly assigned to a particular clinician

    e.g., administration; facility and utilities

Issue 2: Costs (cont.)

- Types of costs:
  - One-time fixed costs

    e.g., costs of initial training; equipment purchase
  - Regular scheduled fixed costs

    e.g., costs of ongoing supervision/auditing
  - Variable costs increasing with services provided

    e.g., administration; fidelity assessment
- IS: activity-based costing strategy

Issue 3: Outcomes

- IS outcomes encompass intervention outcomes

  Example: Dopp et al. 2017 → CE of Learning Collaboratives

  - Implementation outcome: Clinician Competence →not favorable
  - Clinical outcome: youth mental symptoms → favorable

  EE on implementation outcomes in isolation can be misleading

- Practice nature of IS limit the 'rigor' of measurement
  - Less controlled methods: e.g. Pre-post design
  - Pragmatic self-report measures

Eisman et al. "Economic Evaluation in Implementation Science: Making the Business Case for Implementation Strategies" Psychiatry Research (2019 in press)

Table 1

Characteristics of economic evaluations for interventions versus implementation.

Characteristic	Economic evaluation of interventions	Economic evaluation of implementation
Relevant costs	Discrete costs of intervention	Expansive costs of intervention (i.e., costs for replication) + implementation strategy
Relevant benefits	Clinical outcomes	Implementation, service, and clinical outcomes
Time horizon	Variable, but can be brief (< 1 year)	Often multi-year, can include short-term implementation and long-term sustainment
Perspective	Variable, but full societal perspective often encouraged	Health care system perspective is often most relevant
Study design	Research methods are chosen to maximize internal validity, rigor, comprehensiveness	"Minimum acceptable" research methods; must be pragmatic, feasible for practice settings
Impact of context	Minimized; often standardized interventions delivered in ideal settings	Variable; often multi-site studies with variability in intervention, implementation across settings
Relevant decision-makers	Health care payers (invest in clinical care)	Health system payers (invest in infrastructure)

Example

Gillespie *et al. Trials* 2014, **15**:227
http://www.trialsjournal.com/content/15/1/227

TRIALS

RESEARCH Open Access

Cost effectiveness of group follow-up after structured education for type 1 diabetes: a cluster randomised controlled trial

Paddy Gillespie[1*], Eamon O'Shea[1], Mary Clare O'Hara[2], Sean F Dinneen[2] for the Irish DAFNE Study Group

Example: Intervention

- The Dose Adjustment for Normal Eating (DAFNE)
  - Group-based structured education program for type I diabetes
  - It is cost effective as compared to conventional program

The DAFNE course is delivered over 5 consecutive days to groups of up to 8 individuals who are using a basal/bolus insulin regimen to manage their diabetes. It involves 38 hours of structured education covering all aspects of diabetes self-management with an emphasis on carbohydrate estimation and matching of quick-acting insulin to food.

The course is delivered by a DAFNE-trained diabetes nurse, dietitian and doctor, who are regularly peer reviewed to ensure that the education is consistently delivered according to the curriculum.

All groups are invited back to a 3 hour review session at 6 weeks post-DAFNE to consolidate skills learned and to review targets and goals.

Example: Implementation Trial

- Remaining question → follow-up care for maintenance
- Cluster RCT: post-DAFNE
  - Individual follow-up (usual care) vs. Group follow-up
  - 6 hospital clinics with 437 patients w/ type I diabetes
  - Individual follow-up (usual care) arm: 3 clinics, 221 patients
    - Outpatient one-to-one visit
    - 6 and 12 months post-DAFNE
  - Group follow-up arm: 3 clinics, 216 patients
    - "booster" education sessions in original DAFNE group
    - Structured curriculum

Example: Implementation Trial

- Group follow-up details:

Intervention arm participants met at 6 and 12 months post-DAFNE in the original group to which they were assigned. Group follow-up sessions lasted approximately 3 hours.

Sessions were facilitated by trained educators using a structured curriculum, which included topics such as principles of insulin dose adjustment, carbohydrate estimation and managing hypoglycaemia. Groups identified their own priorities for discussion while the educator used the curriculum to guide the session.

Participants were encouraged to reflect on progress and difficulties with their original self-management goals and to produce an updated action plan.

Example: EE overall plan

- Time horizon: 18 m (12-m trial + 6 m trial follow-up)
- Discounting: no discounting was considered due to short length of trail follow-up
- Perspective: healthcare provider
- Effectiveness outcome: HbA1c change
- Health outcome: QALYs
- Threshold value: over a range that healthy system may be willing to pay per additional QALYs
- Multivariate multilevel model (cluster, correlation)

Example: EE – Costs

P: Prospectively recorded by research team;
S: structured surveys done by patients at each time point

- Expressed in 2009 Euros
- Direct costs: sessions costs
  - Educator's and administrator's time; education materials, consumables, packaging, telephone and travel expenses [P]
- Indirect costs: capture cost savings
  - Primary and secondary healthcare services and medications used [S] (unit cost estimates were based on national data)
- Overhead: Administrator's time
- What else are missing?
  - e.g., retention protocol and costs?

Example: EE – Costs (cont.)

- Missing resource costs at individual respondent level
  - Multiple imputation controlling for age, gender, illness length, treatment arm, clinic cluster
- Incremental total healthcare costs estimation
  - Linear mixed effects regression on each MI data set then generate to overall coefficients of interest
  - Control for baseline cost, age, gender, illness length, treatment arm, clinic cluster, HbA1c, BMI, heart disease status, high blood pressure status, chest/lung disease status, smoking status, insurance, marital status, education, employment

Example: EE – Effectiveness

- QALYs: EuroQol EQ5D 3L
- Use a UK population based algorithm to transform it into a single health index range from 0 to 1
- Similar MI procedure for missing values as costs

- Find: no statistically significant differences in effectiveness between two arms

Variable/time point	Baseline: 12 months		Follow-up 1: 0 to 6 months		Follow-up 2: 6 to 12 months		Follow-up 3: 12 to 18 months	
	Individual follow-up	Group follow-up	Individual follow-up	Group follow-up	Individual follow-up	Group follow-up	Individual follow-up	Group follow-up
Healthcare resources								
GP visits: diabetes	25 (68)	19 (46)	12 (38)	9 (30)	14 (36)	7 (23)	13 (42)	14 (45)
GP visits: other	68 (98)	58 (86)	73 (122)	56 (72)	62 (81)	56 (69)	59 (103)	58 (71)
Diabetes nurse visits	29 (28)	24 (28)	20 (33)	16 (21)	16 (30)	12 (20)	12 (19)	12 (22)
Diabetes nurse calls	21 (48)	17 (48)	20 (38)	15 (29)	14 (34)	13 (29)	15 (33)	12 (37)
Dietitian visits	9 (14)	8 (18)	7 (15)	7 (13)	7 (16)	5 (11)	4 (9)	3 (8)
Dietitian calls	1 (5)	1 (5)	7 (26)	2 (8)	3 (11)	2 (12)	1 (6)	2 (13)
Outpatient visits: diabetes	143 (128)	139 (110)	85 (99)	60 (98)	85 (101)	50 (89)	83 (103)	69 (104)
Outpatient visits: other	49 (122)	66 (262)	76 (282)	55 (149)	83 (218)	54 (134)	72 (158)	83 (198)
Inpatient days: diabetes	228 (1199)	139 (716)	131 (792)	19 (160)	33 (251)	21 (129)	50 (362)	90 (533)
Inpatient days: other	195 (860)	324 (1913)	242 (1230)	80 (350)	383 (1799)	184 (853)	161 (882)	124 (593)
A & E visits: diabetes	23 (104)	17 (74)	10 (53)	6 (56)	2 (23)	12 (58)	8 (47)	8 (47)
A & E visits: other	20 (79)	30 (105)	20 (80)	41 (138)	26 (96)	31 (122)	17 (69)	29 (100)
Chiropodist visits	7 (13)	6 (15)	8 (15)	5 (10)	8 (15)	6 (13)	8 (17)	6 (14)
Diabetes centre visits	229 (187)	211 (194)	172 (225)	136 (156)	156 (203)	118 (153)	133 (180)	122 (156)
Quick-acting insulin	111 (55)	102 (53)	93 (50)	88 (50)	98 (47)	88 (55)	94 (48)	94 (50)
Background insulin	94 (42)	89 (52)	77 (33)	69 (36)	78 (36)	70 (35)	80 (39)	74 (42)
Blood glucose tests	270 (169)	265 (141)	317 (136)	290 (102)	323 (139)	311 (137)	327 (145)	301 (145)
Lipid lowering therapy	76 (113)	79 (114)	78 (114)	87 (117)	82 (115)	89 (117)	80 (115)	89 (117)
Antiplatelet therapy	26 (44)	34 (48)	31 (47)	36 (49)	30 (47)	36 (49)	28 (47)	33 (48)
Antihypertensive therapy	36 (60)	49 (65)	26 (54)	49 (65)	30 (56)	47 (64)	28 (55)	49 (65)

Total cost								
Total healthcare cost	1,597 (1,549)	1,643 (2,416)	1,413 (1,347)	1,189 (840)	1,343 (1588)	1,246 (1021)	1,274 (1181)	1,283 (1105)
Health outcome								
QALYs gained	0.44 (0.09)	0.43 (0.09)	0.45 (0.08)	0.44 (0.07)	0.46 (0.05)	0.43 (0.07)	0.46 (0.06)	0.44 (0.08)

Table 6 Incremental cost effectiveness analysis results

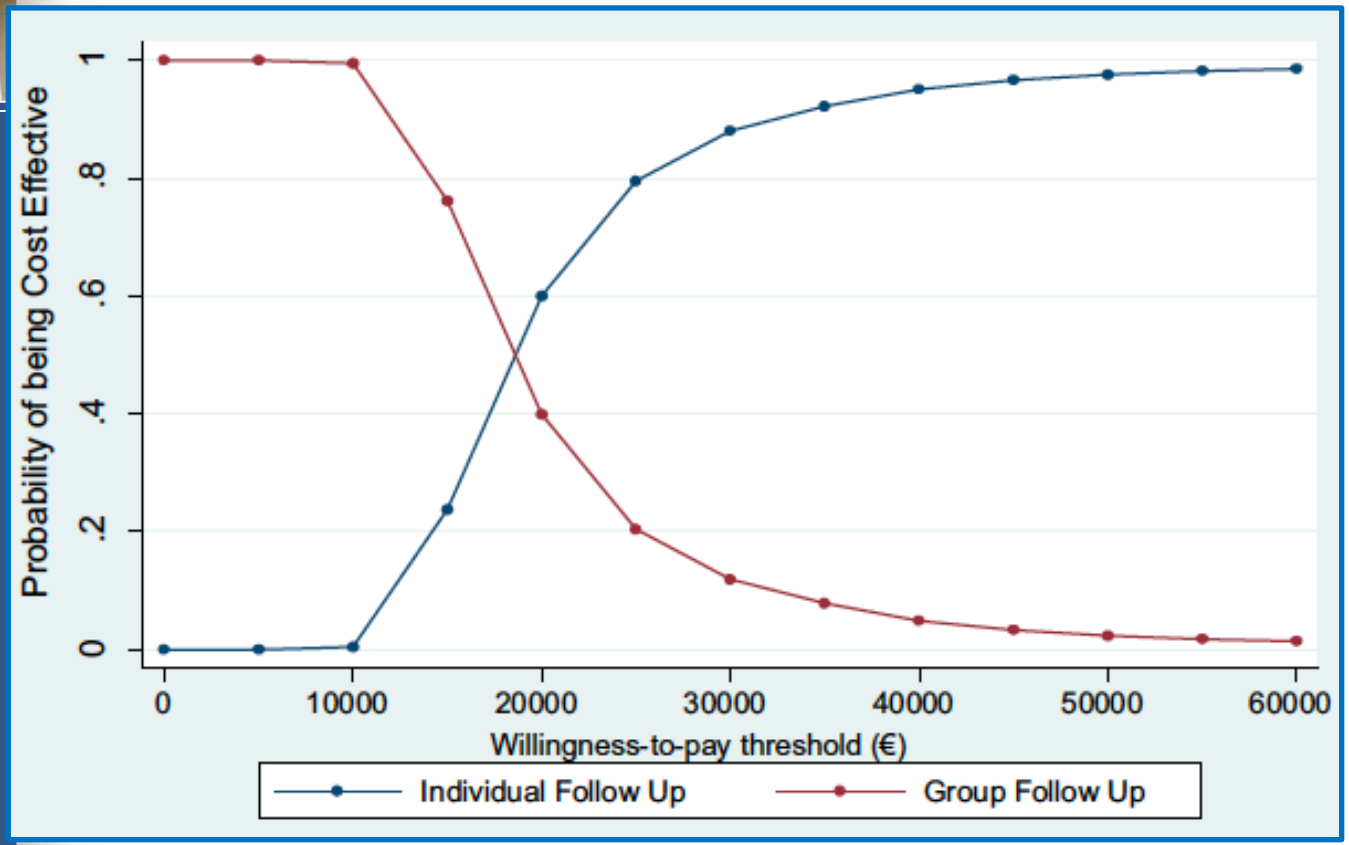
Analysis	Intervention Group follow-up N = 216	Control Individual follow-up N = 221	ICC
Cost analysis			
Total healthcare cost (€)			
Mean (SD)	3,551 (566)	4,337 (551)	0.016
Incremental analysis (difference in means; intervention versus control)	−772 (95% CI, −1,415 to −128; $P = 0.020$)		
Effectiveness analysis			
QALYs gained			
Mean (SD)	1.31 (0.12)	1.35 (0.12)	0.033
Incremental analysis (difference in means; intervention versus control)	−0.04 (95% CI, −0.08 to 0.01; $P = 0.052$)		

Example: EE – CE

Threshold value (λ)	Cost effectiveness analysis (probability that treatment is cost effective at λ	
λ = €0	1.000	0.000
λ = €5,000	1.000	0.000
λ = €10,000	0.996	0.004
λ = €15,000	0.762	0.238
λ = €20,000	0.400	0.600
λ = €25,000	0.204	0.796
λ = €30,000	0.119	0.881
λ = €35,000	0.078	0.922
λ = €40,000	0.049	0.951
λ = €45,000	0.033	0.967

λ or threshold value of the maximum that the health system would be willing to pay per QALY gained. ICC, intra-class coefficient; QALY, quality-adjusted life year.

Example: EE – CE



Mixed-Method Approach

- Integrate two types of data & analyses (quant & qual) in parallel/sequential phases to address specific questions
- Why is it useful in IS?
  - IS: activity-based with the goal of integrating an efficacious innovation into normal practice in local settings
  - The IS uptake and sustainability are human decisions
  - Local decision makers and individual program participants are institutionally and socially embedded
  - Qual help to bring the perspectives, experiences and understanding of research subjects into assessment

Mixed-Method Approach

- Quant vs. Qual:
  - closed-end vs. open-end ways to gather data
  - Quant: representativeness, statistical power, concise
  - Qual: depth, complexity, contextually relevant
- MM helps IS in:
  - Inform equity impact of IS
  - Inform choice of WTP threshold and perspective
  - Interpret and triangulate CEA findings

Mixed-Method Approach

- Example: sequential Quant-Qual-Quant
  - First: quantify relative costs of group follow-up vs. individual follow-up and relative quantifiable intermediate outcomes
  - Second: qualitatively assess fidelity outcome and patient satisfaction outcome
  - Third: examine if those qualitative outcome improvement lead to improvements in distal outcomes such as QUALYs etc.
- Example: Qual-Quant
  - First: interview to assess follow-up barriers from patients to identify distinct subgroups
  - Second: quantify CE by subgroups

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THANK YOU!

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