WORKSHOP

W15: OPTIMAL ALLOCATION OF RESOURCES IN MANAGING MEDICAL DEVICE PORTFOLIOS

May 23, 2017

ISPOR OPTIMIZATION METHODS EMERGING GOOD PRACTICES TASK FORCE

Optimization Methods in Health Care Delivery Task Force

Co-Chairs:

William Crown, PhD, Chief Scientific Officer, OptumLabs, Boston, MA, USA

Kal Pasupathy, PhD, Associate Professor, Health Systems Engineering, Mayo College of Medicine and
Scientific Director, Clinical Engineering Learning Lab, Mayo Clinic, Rochester, MN, USA

Task Force Members (1)

- **Nasuh Buyukkaramikli, PhD,** Scientific Researcher, institute of Medical Technology Assessment(iMTA), Erasmus University Rotterdam, the Netherlands
- **Maarten J. IJzerman, PhD**, Professor of Clinical Epidemiology & Health Technology Assessment (HTA); Head, Department of Health Technology & Services Research, University of Twente, Enschede, The Netherlands
- **Deborah A. Marshall, PhD,** Professor, Health Services Research and Health Economics, University of Calgary, Alberta, Canada
- **Alec Morton, PhD**, Professor of Management Science, University of Strathclyde, Glasgow, Scotland, UK

Task Force Members (2)

- **William V. Padula, PhD, MS**, Assistant Professor, Department of Health Policy & Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA
- **Mustafa Sir, PhD**, Assistant Professor, Mayo College of Medicine, Rochester, MN, USA
- **Praveen Thokala, MASc, PhD,** Research Fellow, University of Sheffield, Sheffield, UK
- **Jonathan C. Tosh, PhD,** Senior Health Economist, DRG Abacus, Manchester, UK
- **Peter Wong, PhD, MS, MBA, RPh**, Principal, Compass Clinical Consulting, Cincinnati, OH, USA

Optimization Task Force Report 1 – Introduction

VALUE IN HEALTH 20 (2017) 310–319

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Constrained Optimization Methods in Health Services Research—An Introduction: Report 1 of the ISPOR Optimization Methods Emerging Good Practices Task Force

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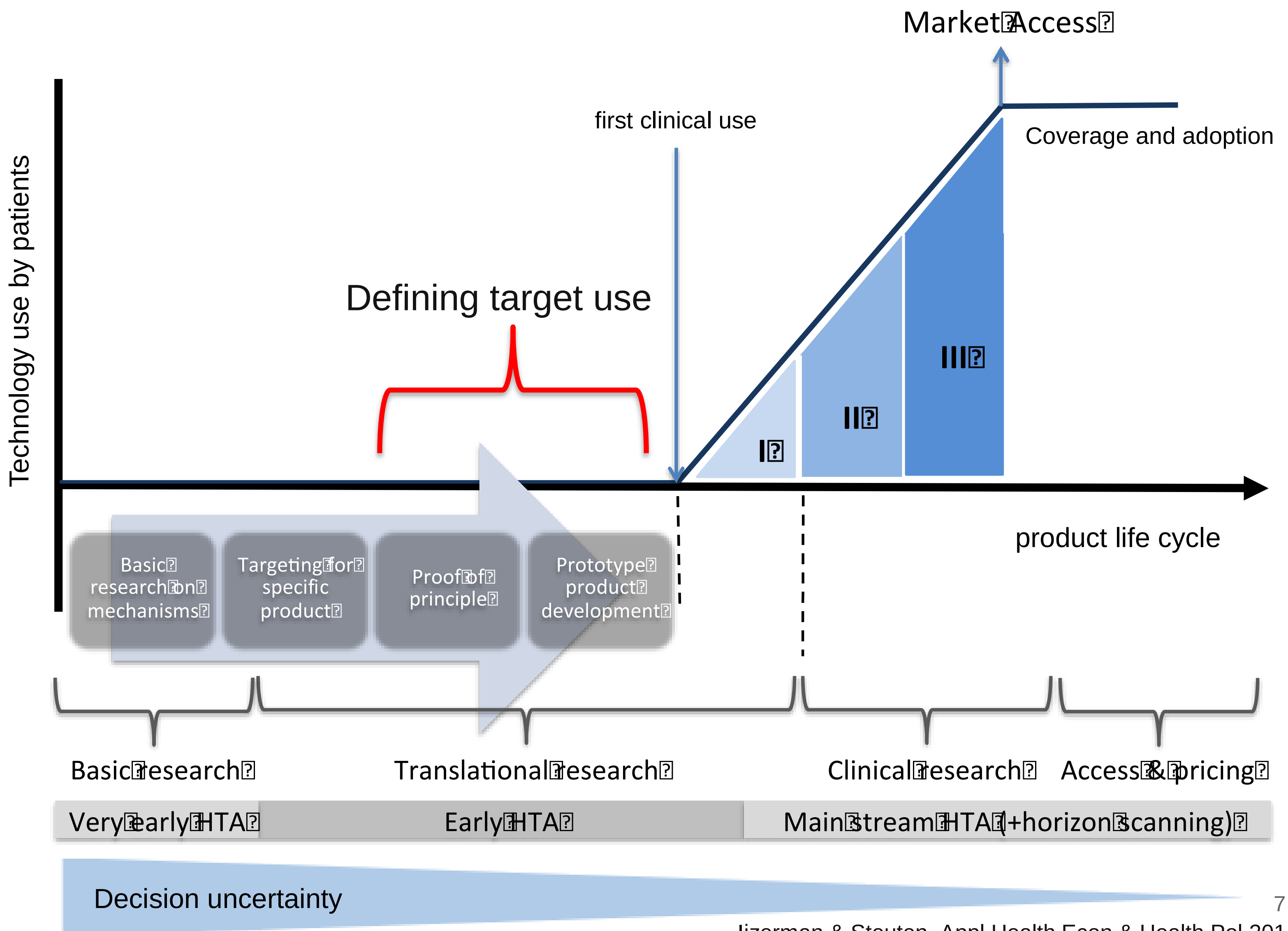
William Crown, PhD[1,*], Nasuh Buyukkaramikli, PhD[2], Praveen Thokala, PhD[3], Alec Morton, PhD[4], Mustafa Y. Sir, PhD[5], Deborah A. Marshall, PhD[6,7], Jon Tosh, PhD[8], William V. Padula, PhD, MS[9], Maarten J. Ijzerman, PhD[10], Peter K. Wong, PhD, MS, MBA, RPh[11], Kalyan S. Pasupathy, PhD[12,*]

[1]OptumLabs, Boston, MA, USA; [2]Scientific Researcher, Institute of Medical Technology Assessment, Erasmus University Rotterdam, Rotterdam, The Netherlands; [3]Research Fellow, University of Sheffield, Sheffield, UK; [4]Professor of Management Science, Department of Management Science, Strathclyde Business School, University of Strathclyde, Glasgow, Scotland, UK; [5]Assistant Professor, Health Care Policy & Research, Information and Decision Engineering, Mayo Clinic Kern Center for the Science of Health Care Delivery, Rochester, MN, USA; [6]Canada Research Chair, Health Services & Systems Research; Arthur J.E. Child Chair in Rheumatology Research; Director, HTA, Alberta Bone & Joint Health Institute; [7]Associate Professor, Department Community Health Sciences, Faculty of Sciences, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada; [8]Senior Health Economist, DRG Abacus, Manchester, UK; [9]Assistant Professor, Department of Health Policy & Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA; [10]Professor of Clinical Epidemiology & Health Technology Assessment (HTA); Head, Department of Health Technology & Services Research, University of Twente, Enschede, The Netherlands; [11]Vice President and Chief Performance Improvement Officer, Illinois Divisions and HSHS Medical Group, Hospital Sisters Health System (HSHS), Belleville, IL. USA; [12]Associate Professor - Healthcare Policy & Research, Lead, Information and Decision Engineering, Mayo Clinic Kern Center for the Science of Health Care Delivery, Rochester, MN, USA

Workshop Objectives

- Illustrate the challenges of investment decisions in medical device portfolios
- Introduce and discuss constrained optimization methods as a methodology for medical device investment decisions
- Introduce and discuss Multi-Criteria Portfolio Selection (MCPS) modeling as a methodology for prioritizing medical device portfolios
- Audience participation via an online survey in real-time.



Ijzerman & Steuten, Appl.Health Econ & Health Pol.2011

Early Modeling for R&D Decisions

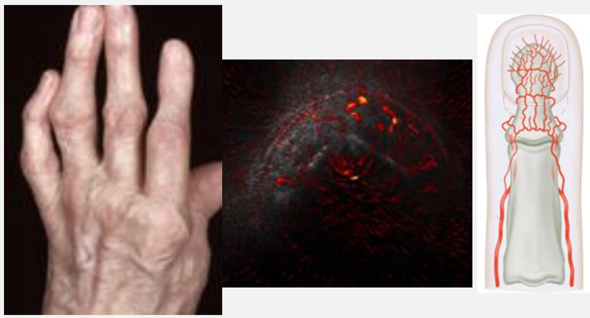
Table 1. Similarities and Differences between Classical HTA and Early HTA

	Classical HTA	Early HTA
Aim	Assess safety, effectiveness, and cost-effectiveness profiles of a new technology	Assess (likely) safety, effectiveness, and cost-effectiveness profiles of a new technology
Decision support	Decision support for **regulators, payers, and patients** about *market clearance, payment, and usage of a technology*	Decision-support for **manufacturers and investors** about *design and management of a technology, as well as regulatory and reimbursement strategy*
Available evidence	Usually evidence from clinical studies performed with the new technology	Evidence from early bench and animal testing, early clinical experience, and from previous generations of the technology
Influence on technology performance	Limited or no influence on clinical performance of a new technology	Potentially significant influence on (future) clinical performance of a new technology

INTL. J. OF TECHNOLOGY ASSESSMENT IN HEALTH CARE 24:1, 2008 **37**

Pietzsch & Paté-Cornell, Int. J. Techn. Assessm. Healthcare, 2008

Three real-life examples…



A CT photoacoustic device for monitoring inflammation in RA

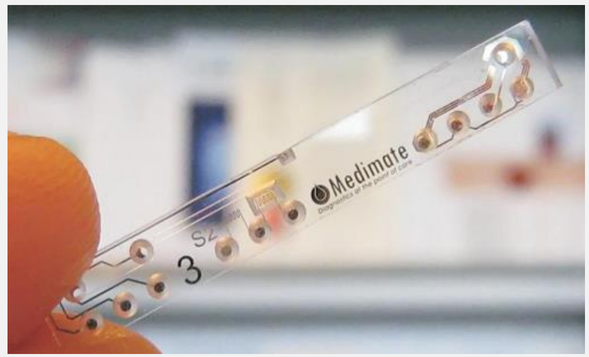
Rheumatoid Arthritis

Hospitals or specialized centers

Prevalence of disease: 1%
Incidence of disease: 0.03%

Standard of care: X-ray, blood analysis

Expected benefits: Early diagnosis severe RA, reduced cost due targeted treatment



A lab-on-a-chip technology for sodium (urine) and potassium (blood) for self-management of patients with stage 3 chronic kidney disease

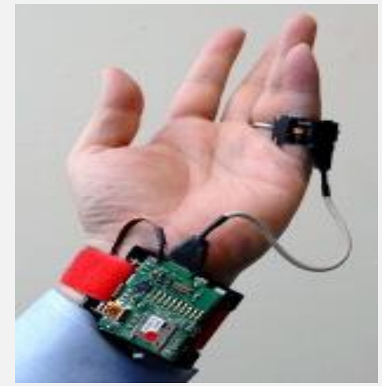
Chronic Kidney Disease stage III

Self-management

Prevalence of disease: 0.53 %
Incidence of disease: 0.12 %

Standard of care: Blood/urine analysis

Expected benefits: Delay progression with less GP and hospital visits



A device for accurate (24 hrs) blood pressure monitoring and other clinical data for patients on haemodialysis

Chronic Kidney Disease IV/V / dialysis

Expert supervised homecare

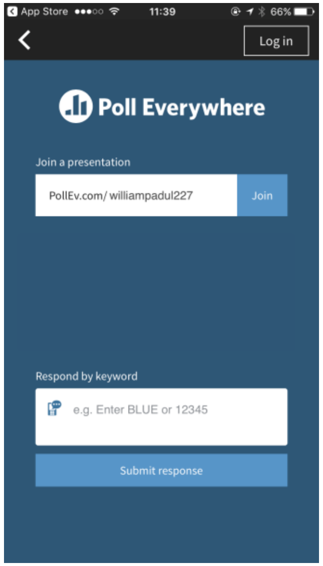
Prevalence of disease: 0.01 %
Incidence of disease: 0.03 %

Standard of care: Standard blood pressure

Expected benefits: Less risk of hypotensive crisis, better dosing anti-hypertensive treatment, less hospitalizations

Interactive Polling

- To participate in the following polling questions:
  - By Phone:
    - Text “WILLIAMPADUL227” to 37607
    - Then enter A, B, C or D to respond to questions
  - By Internet Browser: pollev.com/williampadul227



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Now...If you had $10 million (USD) to invest, which one would you prefer?

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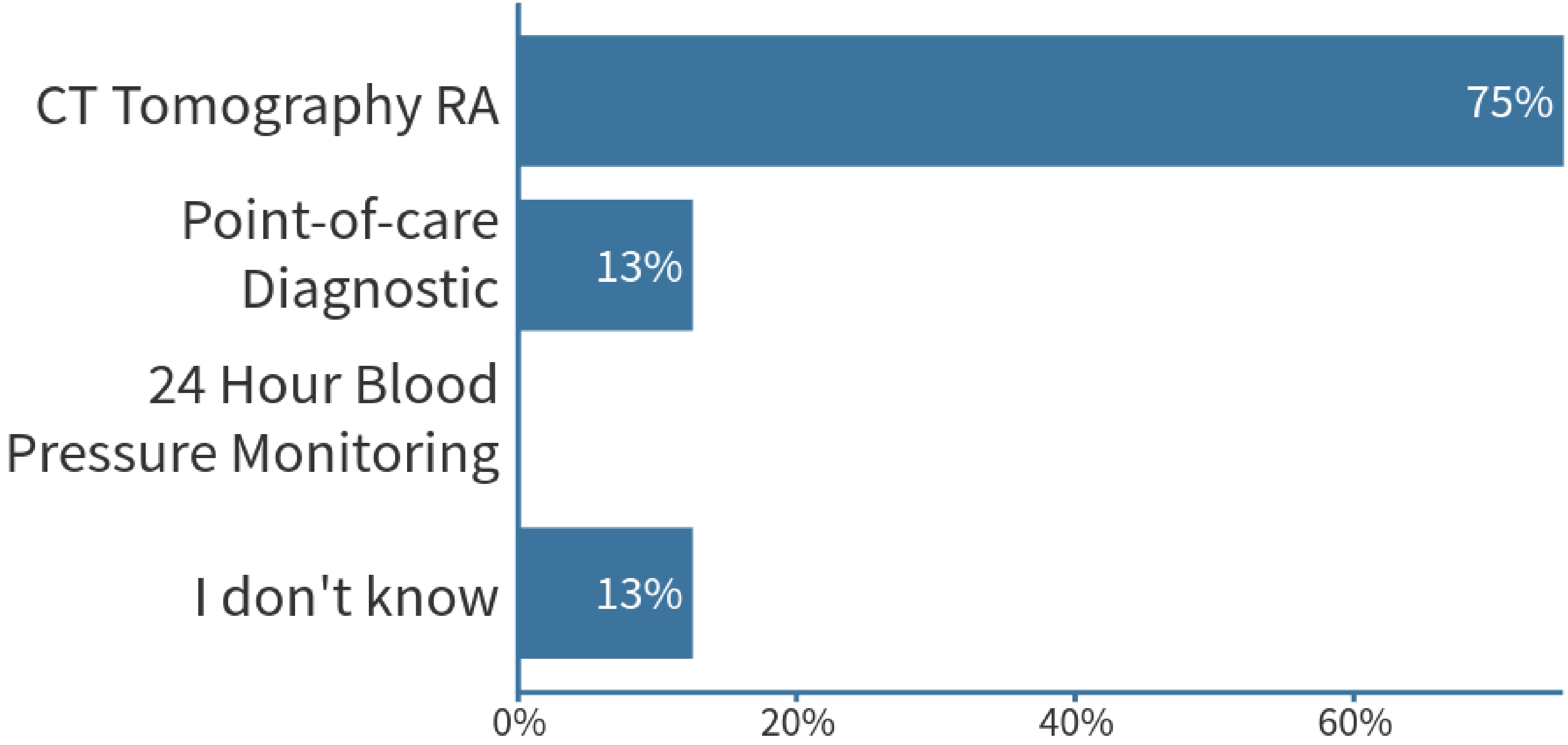

Headroom Analysis

The Headroom is the most the manufacturer could charge while securing funding from the care provider—the maximum reimbursable price (MRP) —and sets a ceiling on the unit cost of the new device, including production and development costs (Girling et al, 2015)

Device	QoL *new device*	QoL *standard*	δ_{QoL}	δ_{QALY}	Cost saving due device	Headroom per device
CT imaging RA	0,84	0,58	0,26	2,6	€4256	€1,645,000
POCT sodium and potassium	0,77	0,53	0,24	1,2	€250	€36,250
24 hour BP monitoring	0,53	0,40	0,13	0,65	€3561	€750,000

Max. headroom assuming WTP of 30,000/QALY

Markiewicz K *et al* Commercial viability of medical devices using Headroom and return on investment calculation. Technological Forecasting and Social Change. 2016 Oct 23;112(November):338–46.

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Conclusions

- Portfolio Selection is useful to narrowing down from a range of alternatives, but has limited value for only 2 comparators
- Constrained Optimization is an important consideration when health system budgets and resources limit an ability to expand/deliver services liberally
- These methods can work in tandem (or alone) with existing economic evaluation methods to provide useful insight into the feasibility of health care delivery system value

Issues with Headroom

These are three <u>different</u> devices

- in how they are used
  - Patient vs. physician use
  - Disposables vs. equipment
- regarding their uncertainty to reach the market
  - developmental uncertainty
- budget constraints are neglected
  - relevant for allocating resources in portfolios

PharmacoEconomics
DOI 10.1007/s40273-017-0509-1

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REVIEW ARTICLE

Emerging Use of Early Health Technology Assessment in Medical Product Development: A Scoping Review of the Literature

Maarten J. IJzerman[1,2] · Hendrik Koffijberg[1] · Elisabeth Fenwick[3] · Murray Krahn[4]

Abstract Early health technology assessment is increasingly being used to support health economic evidence development during early stages of clinical research. Such early models can be used to inform research and development about the design and management of new medical technologies to mitigate the risks, perceived by industry and the public sector, associated with market access and reimbursement. Over the past 25 years it has been suggested that health economic evaluation in the early stages may benefit the development and diffusion of medical products. Early health technology assessment has been suggested in the context of iterative economic evaluation alongside phase I and II clinical research to inform clinical trial design, market access, and pricing. In addition, performing early health

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required, in particular, by combining systems engineering and health economics to manage uncertainty in medical product portfolios.

Key Points for Decision Makers

The use of pharmacoeconomics in the early stages of clinical evidence development has been proposed since the mid-1990s. Since then, early health technology assessment has emerged and frequently applied to support medical product development and

Future developments should focus on the integration of early health economic models with systems engineering approaches, such as multi-criteria decision analysis and optimization methods, to actually support decisions in medical product development.

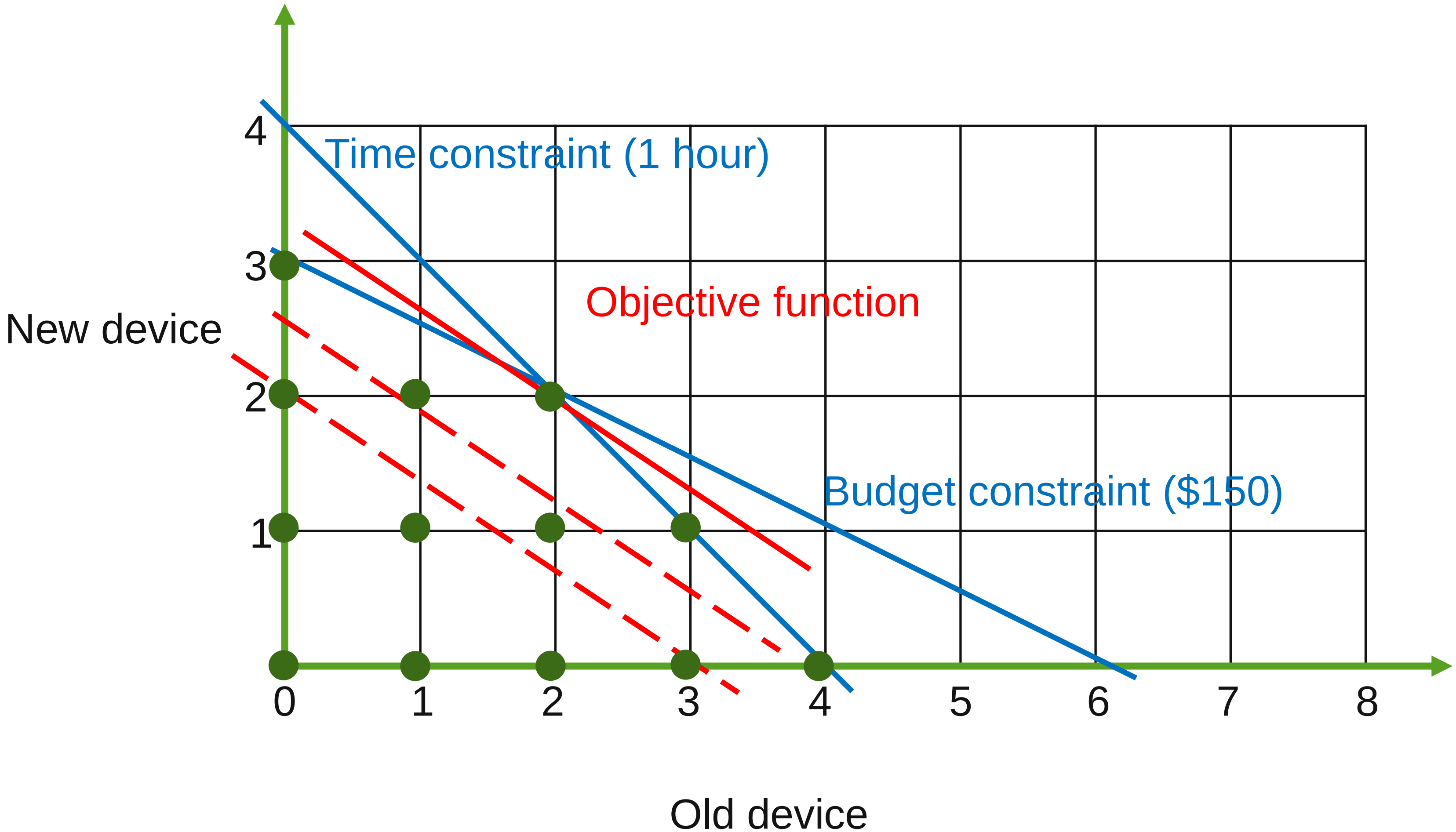
Optimization

- A set of methods to find the best from a set of potential solutions
  - Respect constraints (budget, resources)
  - Many possible potential solutions
  - Methods are designed to be systematic and efficient
- Used in a range of fields (logistics, manufacturing, military)
  - A range of established and emergent uses in health systems
- Framing your problem as an ‘optimization problem’ is crucial, to enable an optimization method to solve it

Surgery Problem

- Setting: Manager of a surgical center
- Surgery types: Procedure using old or new device
- Some info:
  – Procedure with old device will provide 2 QALYs. Procedure with new device will provide 3 QALYs
  – Old device costs $25, new device costs $50
  – Each surgical procedure requires 15 minutes
  – You have 1 hour of total time available
  – Total budget of $150
- Question: What is the greatest health benefit this center can achieve given these inputs and constraints?

Graphical Representation



Optimization model

Parameters:

- c_N, c_O = cost of new and old device, respectively
- B = total budget available
- t_N, t_O = time to treat with new and old device, respectively
- T = total time available
- f_N, f_O = number of QALYs the new and old devices will provide, respectively

Decision variables:

- x_N, x_O = number of procedures with the new and old device, respectively

Optimization model

Optimization Model

max $f_N x_N + f_O x_O$ (objective function)

subject to $c_N x_N + c_O x_O \le B$ (budget constraint)

$t_N x_N + t_O x_O \le T$ (time constraint)

$x_N, x_O \ge 0$ and integer

Model Data:

- $f_O = 2$ QALYs, $f_N = 3$ QALYs
  - $c_O = \$25$, $c_N = \$50$, $B = \$150$
- $t_O = 0.25$ hours, $t_N = 0.25$ hours, $T = 1$ hour

Healthcare Optimization

	Surgical problem	Health Care	Terminology
Options available	Old or new device	pharma, bundled episodic payment models, ortho, hip/knee, etc	Decision variables
Constraints	Total cost < $150	Budget constraint	Constraints
Aim	Maximize number of QALYs	Maximize health care benefits	Objective function
Evidence base	Cost of each device, how many QALYs are generated and procedure time	Costs of each intervention, health benefits, and any other relevant data	Model (to determine the objective function and Constraints)
Complexity	One-off, deterministic, static problem	Repeated, stochastic, dynamic problem	Optimization method

Complexity

Complexity	Surgery problem	Health Care
Static vs Dynamic	Static (i.e. one-off) problem. If the health center problem was solved for multiple time periods, then it will become dynamic problem	Dynamic problem. Health care is constantly evolving – changing budgets, new policies, new interventions, etc
Deterministic vs stochastic	All the information is assumed to be certain (e.g. costs of the procedure, QALYs, procedure time	Know that the information is uncertain (i.e. uncertainty in the costs and benefits of the interventions)
Linear vs Non-linear	Linear (i.e. each procedure costs the same and achieves the same amount of QALYs)	Non-linear (e.g. Quality/outcomes maybe non-linear, also interactions between the interventions, etc)

Portfolio Optimization

- Research organization wishes to maximize profit/health
- How to choose which allocation of R&D decisions to make
  - Stop/go with new portfolio technology
  - Stop/go with continuing portfolio technology R&D
  - Increasing/decreasing resources for each technology in portfolio
- Respecting constraints
  - Budget constraint
  - Time constraint
  - Constrained resources

Multi-Criteria Portfolio Selection (MCPS):
Portfolio Selection Problem

- Case study: choosing between R&D projects for developing robotic systems to support minimally invasive surgery
- Decision problem
  - Choice between 9 robotic R&D projects (A-I)
  - Budget 9 million euros
  - Synergy between projects A and G
- Projects A and G have synergies, which mean if both of them are chosen, their costs will go down

Hummel et al 2017. Supporting the Project Portfolio Selection Decision of Research and Development Investments by Means of Multi-Criteria Resource Allocation Modelling. Book chapter Multi-Criteria Decision Analysis to Support Healthcare Decisions pp 89-103

Need for Prioritisation

- Total cost of all the projects more than the budget
- Need to prioritise
- Value for money approach
- Optimization approach

	Cost (in 1000 euros)
Robot A*	2000
Robot B	1700
Robot C	3000
Robot D	15000
Robot E	2500
Robot F	1500
Robot G*	2000
Robot H	1500
Robot I	2500

Hummel et al 2017. Supporting the Project Portfolio Selection Decision of Research and Development Investments by Means of Multi-Criteria Resource Allocation Modelling. Book chapter Multi-Criteria Decision Analysis to Support Healthcare Decisions pp 89-103

Value for Money (VfM) methodology

- Develop a measure of ‘value’ to compare the different R&D projects
  - This is the ‘multi-criteria’ part of MCPS (multi criteria portfolio selection)
- Identify the value of the different R&D projects
- Identify the VfM (value/money) of each project
  - Higher VfM => Greater priority
- Allocate until budget is finished

Hummel et al 2017. Supporting the Project Portfolio Selection Decision of Research and Development Investments by Means of Multi-Criteria Resource Allocation Modelling. Book chapter Multi-Criteria Decision Analysis to Support Healthcare Decisions pp 89-103

Defining ‘Value’

- Six ‘criteria’ were chosen to represent value, mixture of quantitative and qualitative criterion

Evaluation criterion	Type of criterion	Type of descriptor	Descriptor of performance
QALY gain patient	Benefit	Quantitative	Quality of life years gained
Economic advantage healthcare	Benefit	Quantitative	Amount in euros
Fit with healthcare setting	Risk	Qualitative	5 qualitative performance levels
Fit with expertise and resources company	Risk	Qualitative	5 qualitative performance levels
Market size	Benefit	Quantitative	Number of patients
Market competitiveness	Risk	Qualitative	5 qualitative performance levels

Hummel et al 2017. Supporting the Project Portfolio Selection Decision of Research and Development Investments by Means of Multi-Criteria Resource Allocation Modelling. Book chapter Multi-Criteria Decision Analysis to Support Healthcare Decisions pp 89-103

Measuring ‘Value’

- Use MCDA weighting and scoring techniques to identify overall value for each project

	QALY gain	Economic benefit	Fit healthcare setting	Fit expertise & resources	Market size	Competitiveness	Overall value
Weight	0.26	0.13	0.14	0.26	0.15	0.06	
Scoring							
Robot A	102	-115	60	0	5	100	**27**
Robot B	27	116	120	-80	112	60	**39**
Robot C	-3	-102	0	0	11	60	**-9**
Robot D	-8	13	0	0	-6	60	**2**
Robot E	27	61	100	120	-7	-80	**54**
Robot F	14	19	100	100	-6	60	**49**
Robot G	102	-115	60	0	5	0	**21**
Robot H	6	-116	100	60	5	60	**20**
Robot I	39	47	-80	0	-6	120	**11**

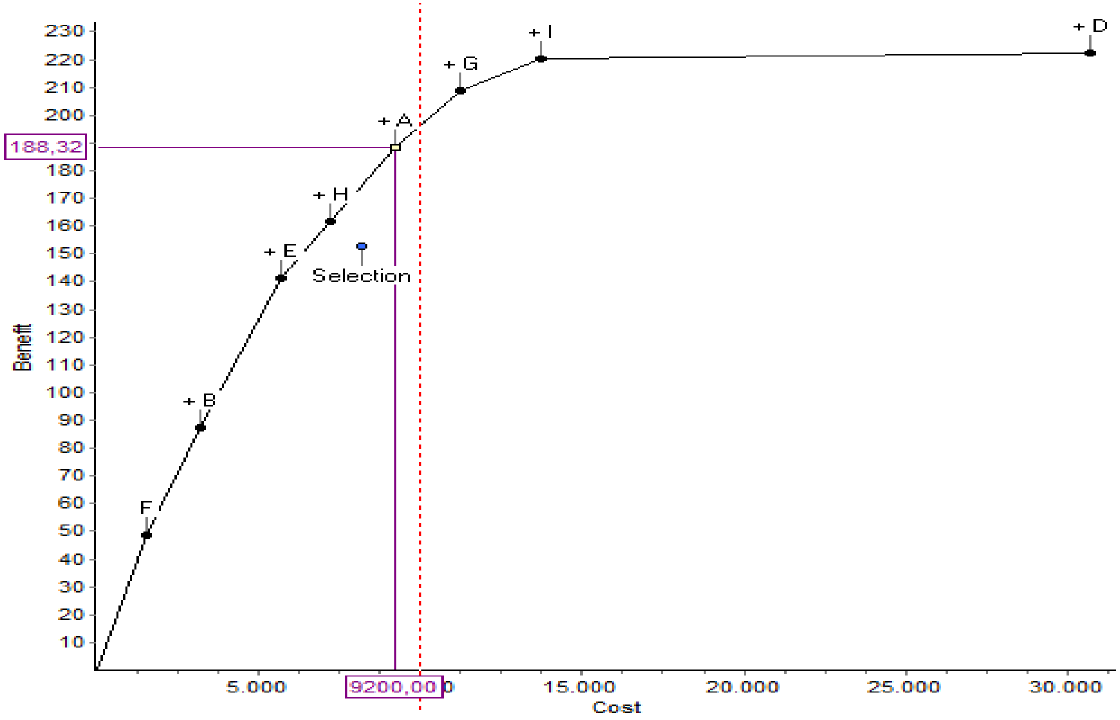
Prioritising Using ‘Value for Money’

- Identify the VfM (value/money) of each project, higher VfM => Greater priority
- Add projects until the budget is allocated

	Value	Cost	Value/cost ratio
Robot A*	**27**	**2000**	**1.33**
Robot B	**39**	**1700**	**2.28**
Robot E	**54**	**2500**	**2.17**
Robot F	**49**	**1500**	**3.24**
Robot G*	21	2000	1.03
Robot H	**20**	**1500**	**1.35**
Robot I	11	2500	0.45

'Value for Money' Efficiency Frontier

- Cumulative cost vs value graph, all the projects to the left of the budget line are included



- VfM cannot (or difficult to) include synergies between projects, such as if projects A and G are chosen, their costs will go down

Optimization approach

- Use mathematical programming to identify the optimal portfolio
  - Objective function: Maximize total ‘value’
  - Constraint: Budget constraint
  - Decision variables: whether a given project is chosen, xa = 1 (if project a is chosen) or 0 (if not)
  - Parameters: Costs, values for each project
- The mathematical formulation can also incorporate the synergies between projects

Prioritising Using 'Optimization'

- Taking into account synergies in the development costs of robots A and G, robot G is now included and robot H is excluded from the optimal portfolio, even though robot H has a higher VfM ratio than robot G

Optimization	Value	Cost	Value/cost ratio
Robot A	27	2000	1.33
Robot B	**39**	**1700**	**2.28**
Robot E	**54**	**2500**	**2.17**
Robot F	**49**	**1500**	**3.24**
Robot G	21	2000	1.03
Robot H	20	1500	1.35
Robot I	11	2500	0.45
Robot A' (synergy)	**27**	**1700**	**1.58**
Robot G' (synergy)	**21**	**1700**	**1.23**

Key Points

- Using optimization methods to select the project portfolio reduced the total costs (from 9.2 to 9.1 million euros), while increasing the value of the portfolio (from 188 to 189 overall value units)
- Even a simple interaction (two synergistic projects) make it difficult to use VfM approach. Almost impossible with multiple interactions
- Difficult to identify the optimal portfolio by trial and error, need to use mathematical optimization techniques (which can go through the different choices available in an efficient manner)

Interactive Polling

- We would like to ask you some questions about your comprehension of this topic and presentation
- We also want to gauge ISPOR community's general interest in optimization moving forward
- To participate in the following polling questions:
  - By Phone:
    - Text "WILLIAMPADUL227" to 37607
    - Then enter A, B, C or D to respond to questions
  - By Internet Browser: pollev.com/williampadul227
  - Twitter: @DrWmPadula

Based on this workshop, do you see value in optimization approaches alongside economic evaluation methods?

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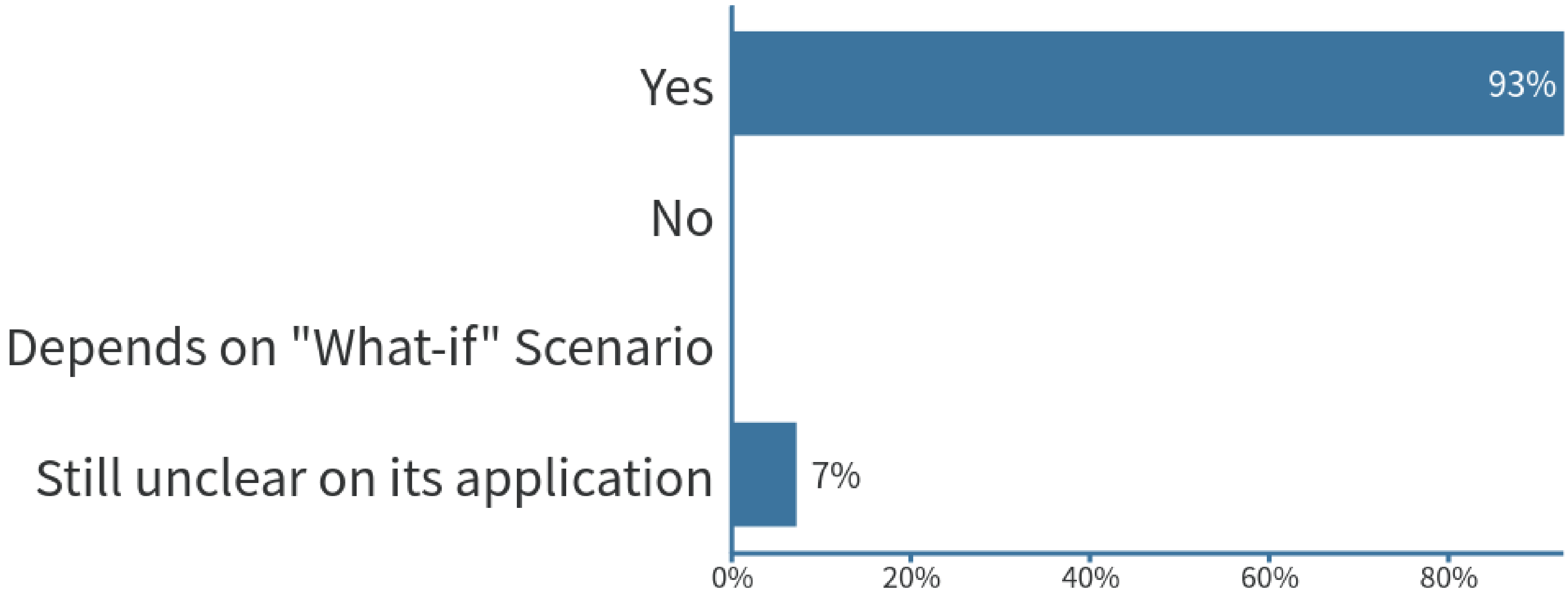

Do you see opportunities to apply optimization methods in your own work?

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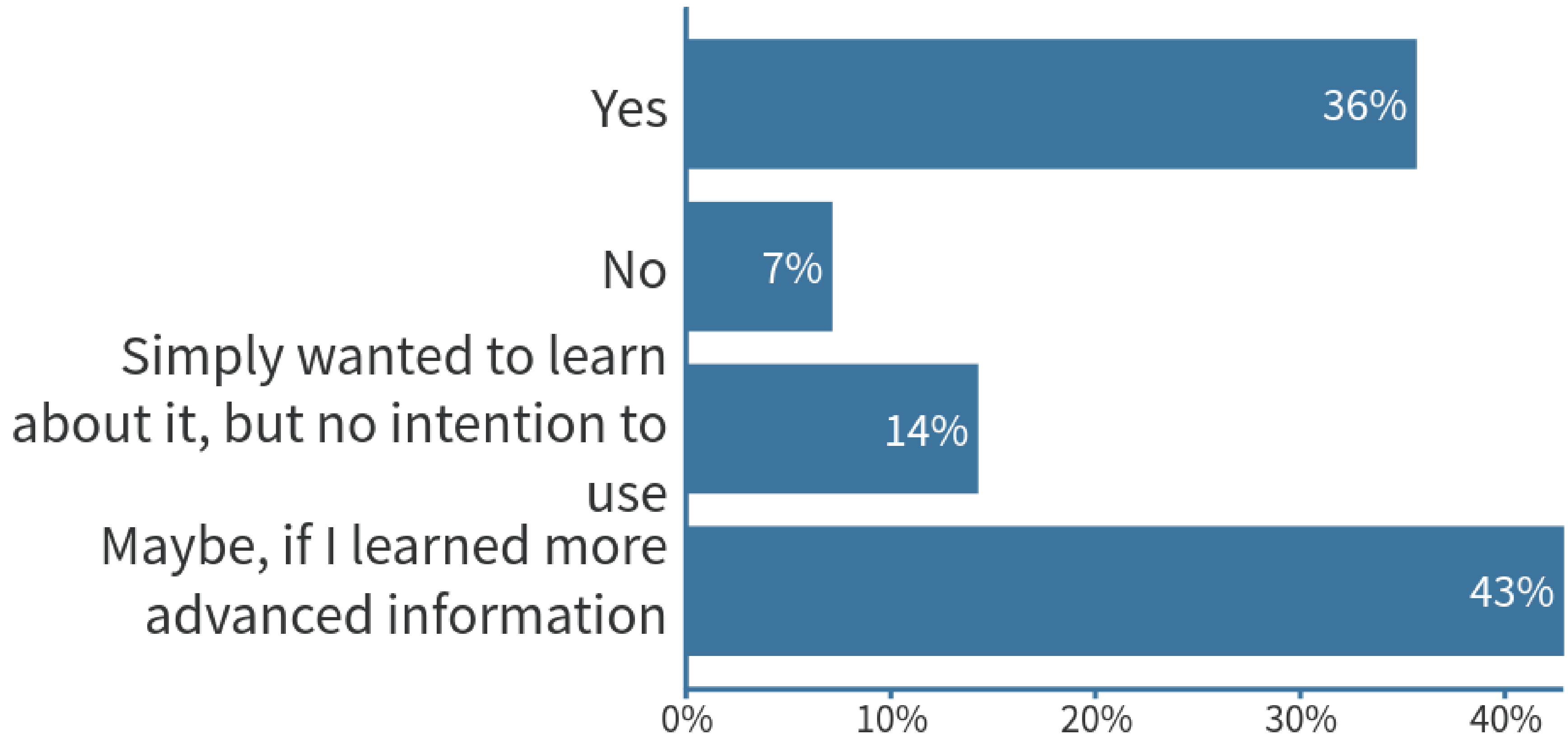

Do you understand the difference between "Portfolio Selection" and "Constrained Optimization"?

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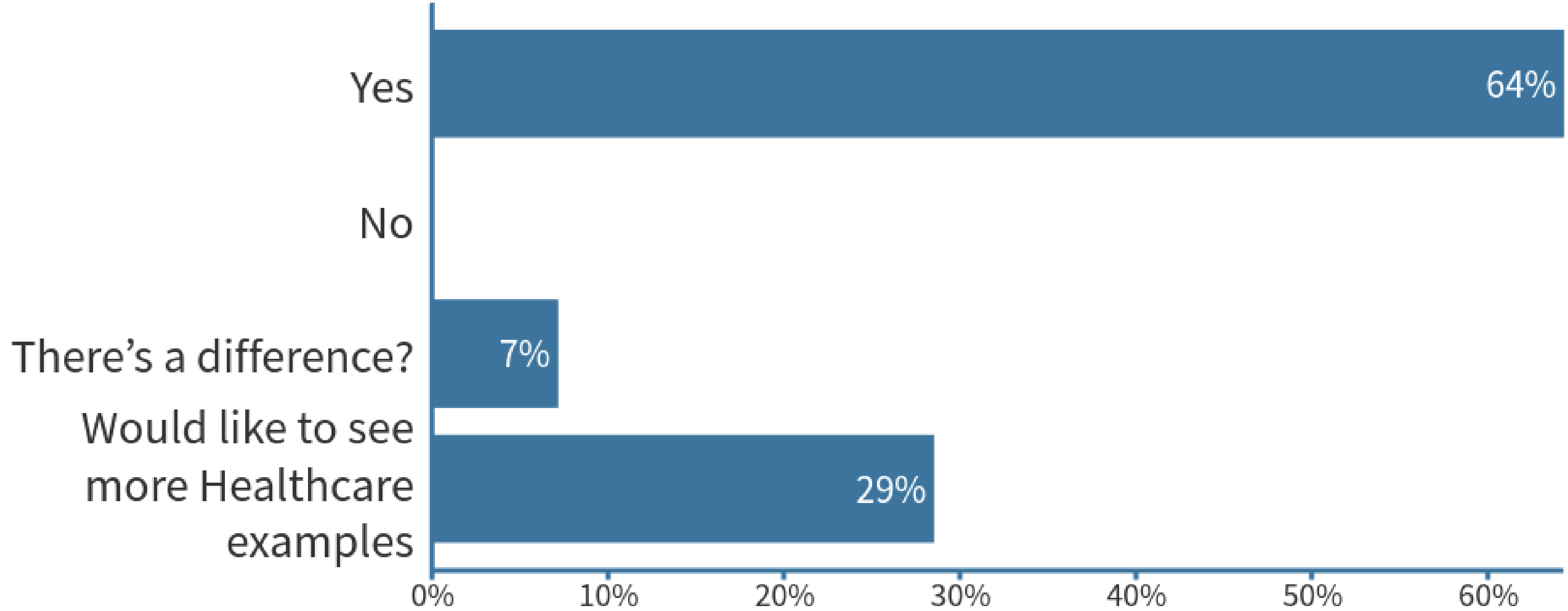

Do you find either approach to Optimization more useful in economic evaluation?

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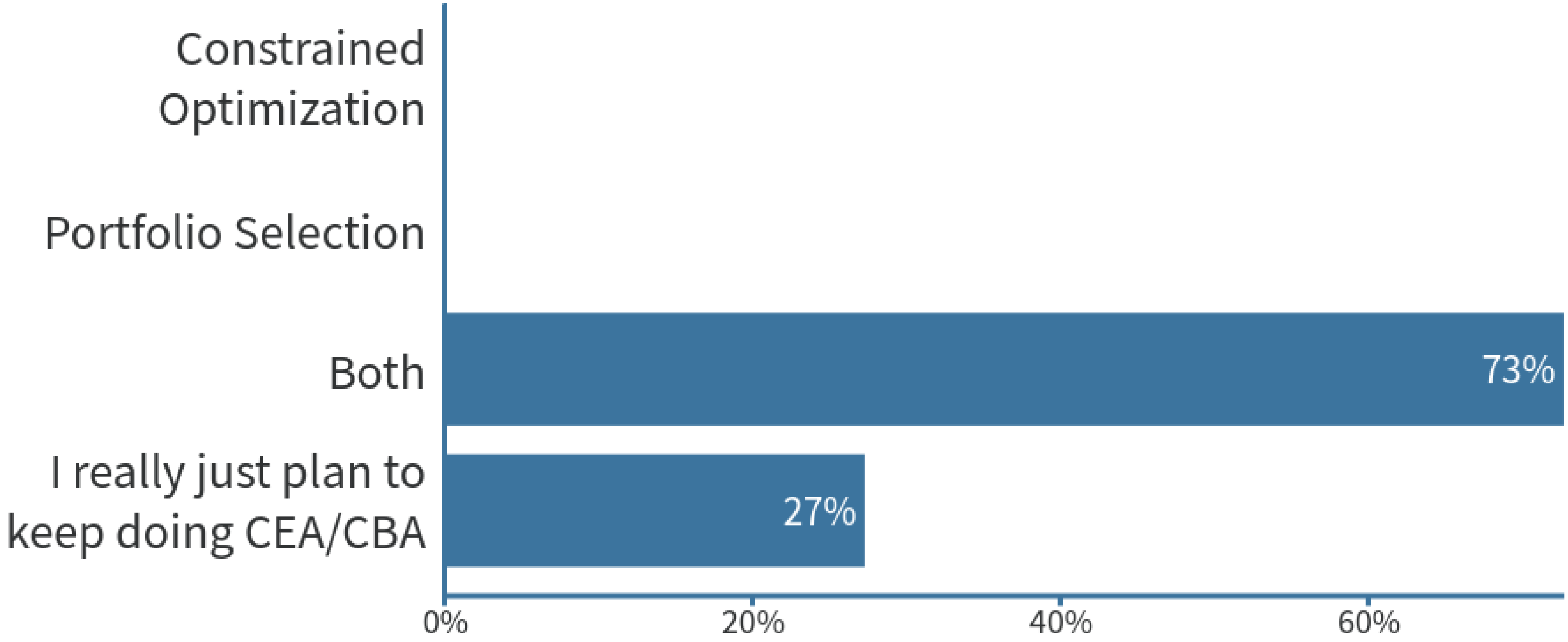

Should Optimization be a standard fcomponent of CEA, as Probabilistic Sensitivity Analysis (PSA) and Value of Information (VOI) are part of CHEERS/IMPACT Guidelines?

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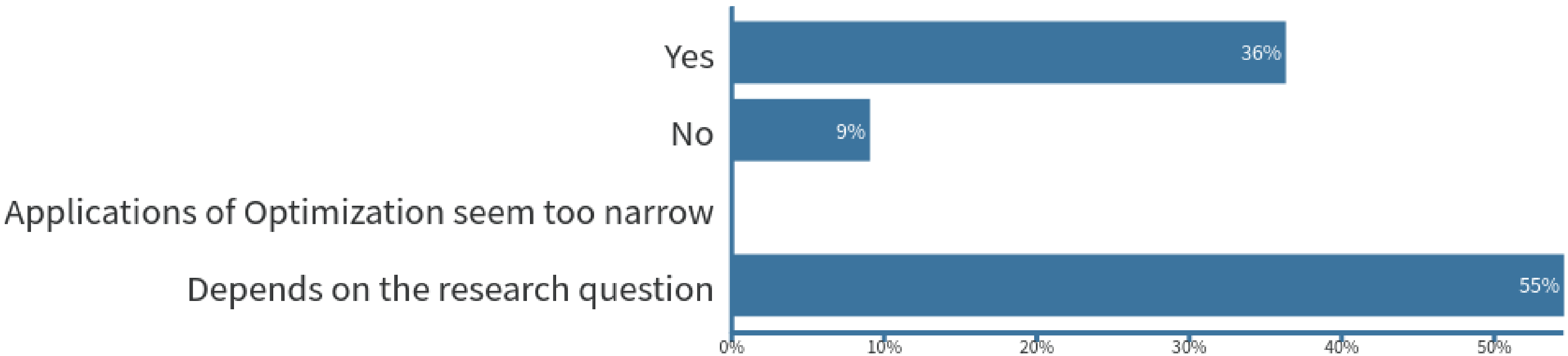

Would you like to see a separate ISPOR checklist to guide research conduct on use of optimization methods such as these?

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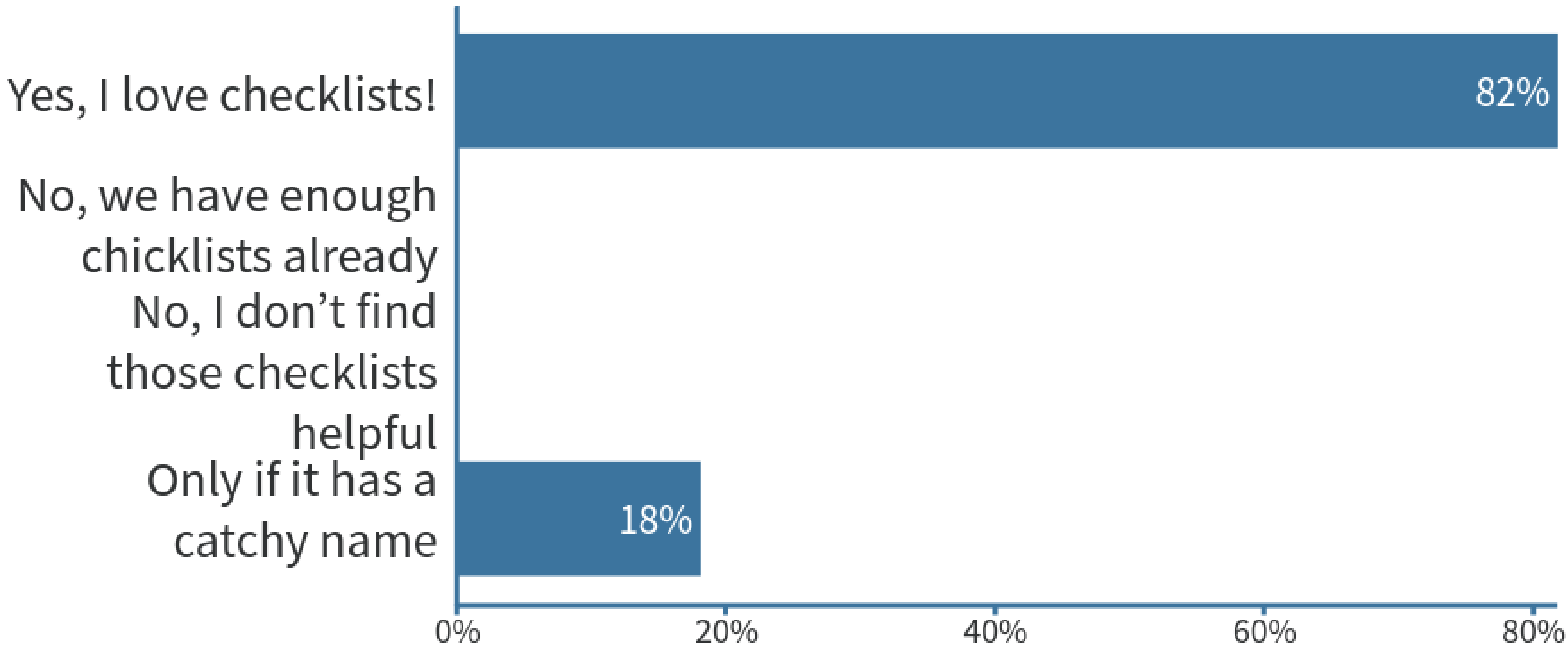

QUESTIONS?

SLIDES ARE AVAILABLE VIA:

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3) our task force webpage!