



Combining Operations
Research and Analytics

Data-driven evaluation of policy initiatives

Dr Michael O'Sullivan

Department of Engineering Science

Outline

- Who am I?
- Faster Cancer Treatment
- Non-Acute Rehabilitation & ACC
- Government Initiatives & IDI
- Final Thoughts





Who am I?

- Dr Michael O'Sullivan
- Senior Lecturer in the Department of Engineering Science

University of Auckland alumni

- BSc (1st Class Hons) in Maths & CS
- MPhil (Dist) in Operations Research (OR)

Stanford University alumni

- MS (Eng Eco Systems & OR)
- PhD (Man Sci and Eng)

- Research/consulting in Operations Research and Computational Analytics for Health, Cloud Computing, Water Resources Planning, Finance

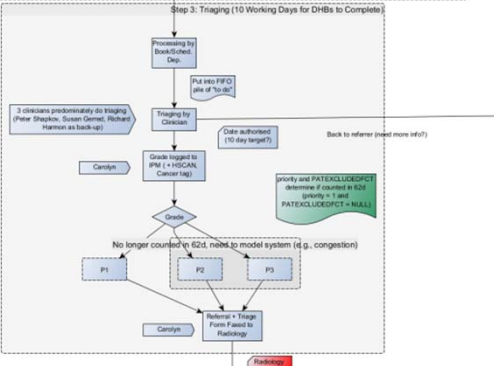
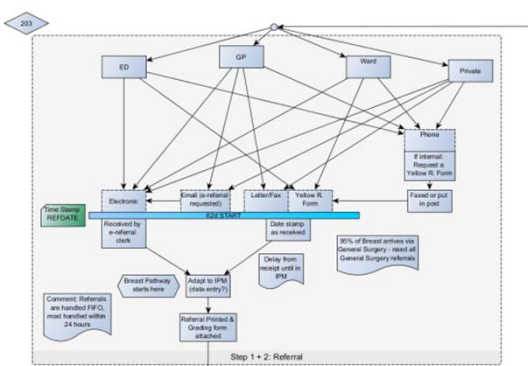


Faster Cancer Treatment

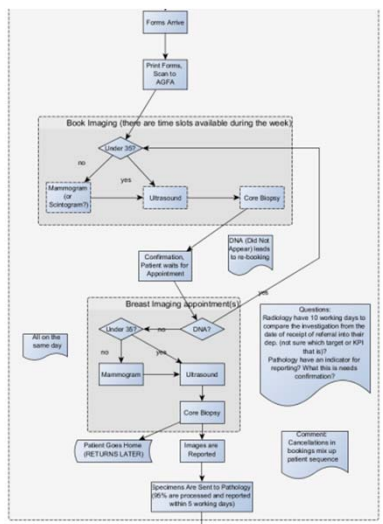
- Government target of 90% of priority 1 patients have less than 62 days from referral until first treatment
- Processes are complex
- No single person has overview of entire process
- How can we leverage data to evaluate policy changes?



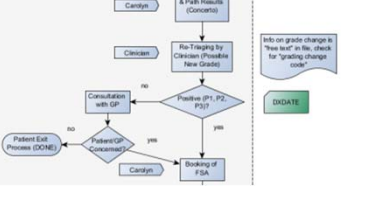
Process Map



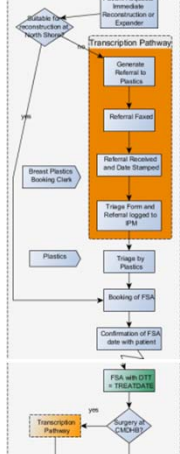
Step 4: Radiology Investigations (10 Working Days For DHBs to Complete)



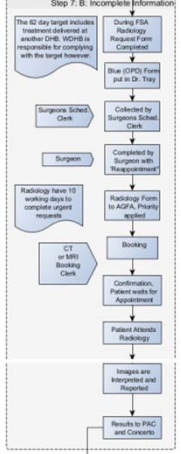
Step 5: Results



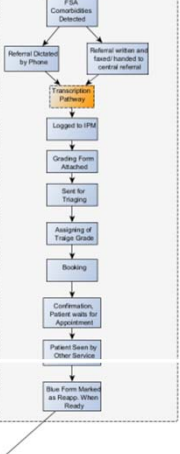
Step 7: B: Immediate Reconstruction



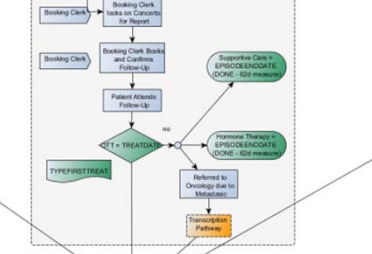
Step 7: B: Incomplete Information



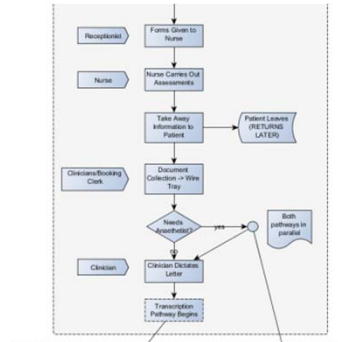
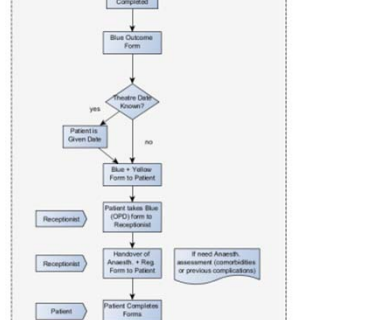
Step 7: B: Comorbidities



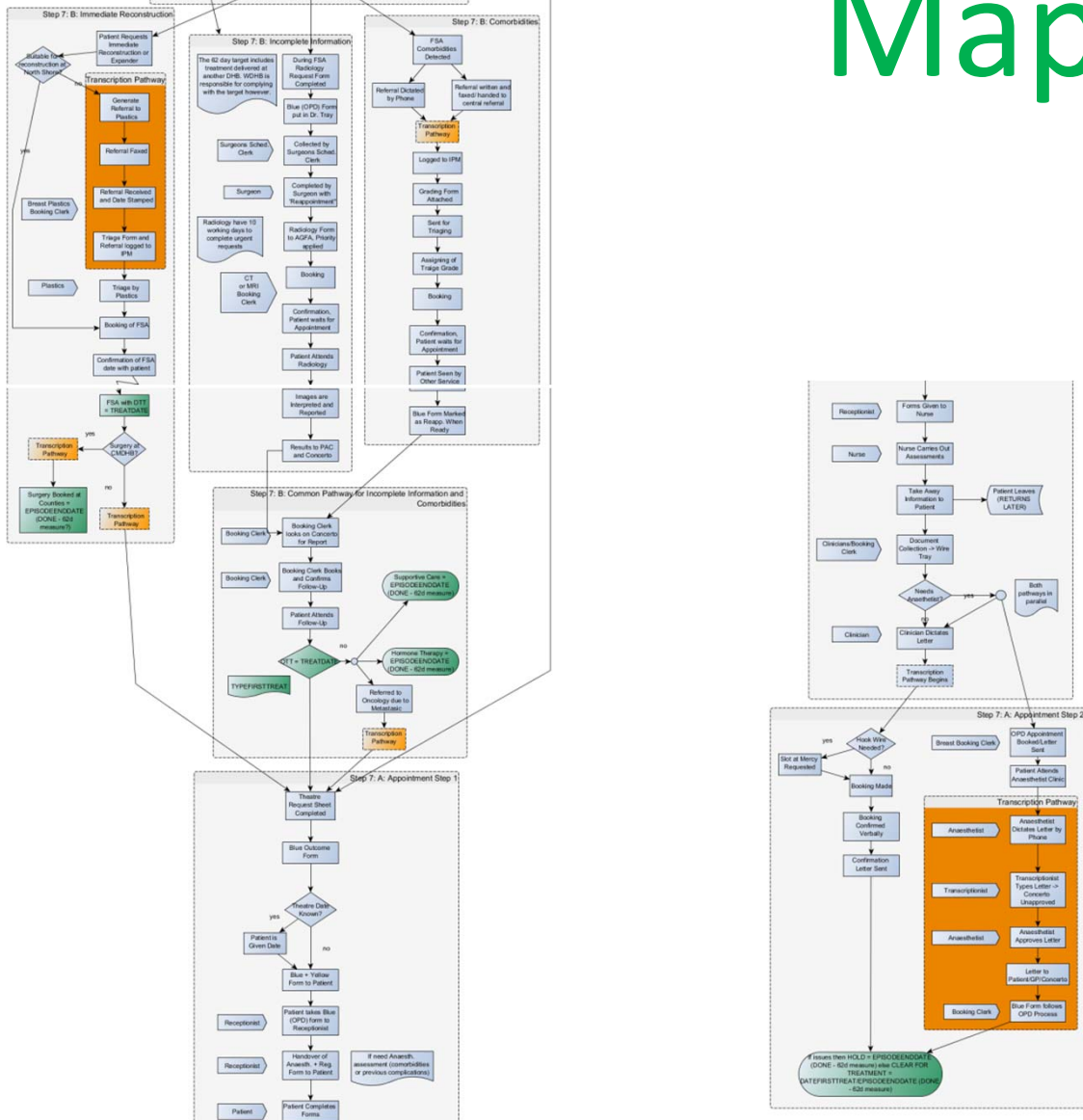
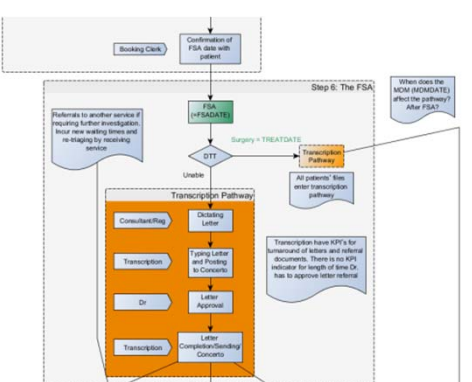
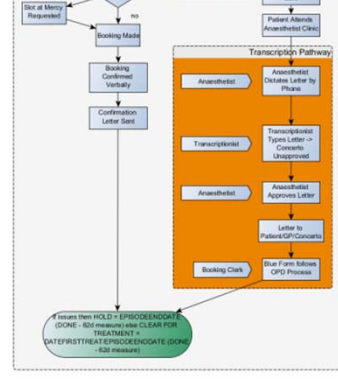
Step 7: B: Common Pathway for Incomplete Information and Comorbidities



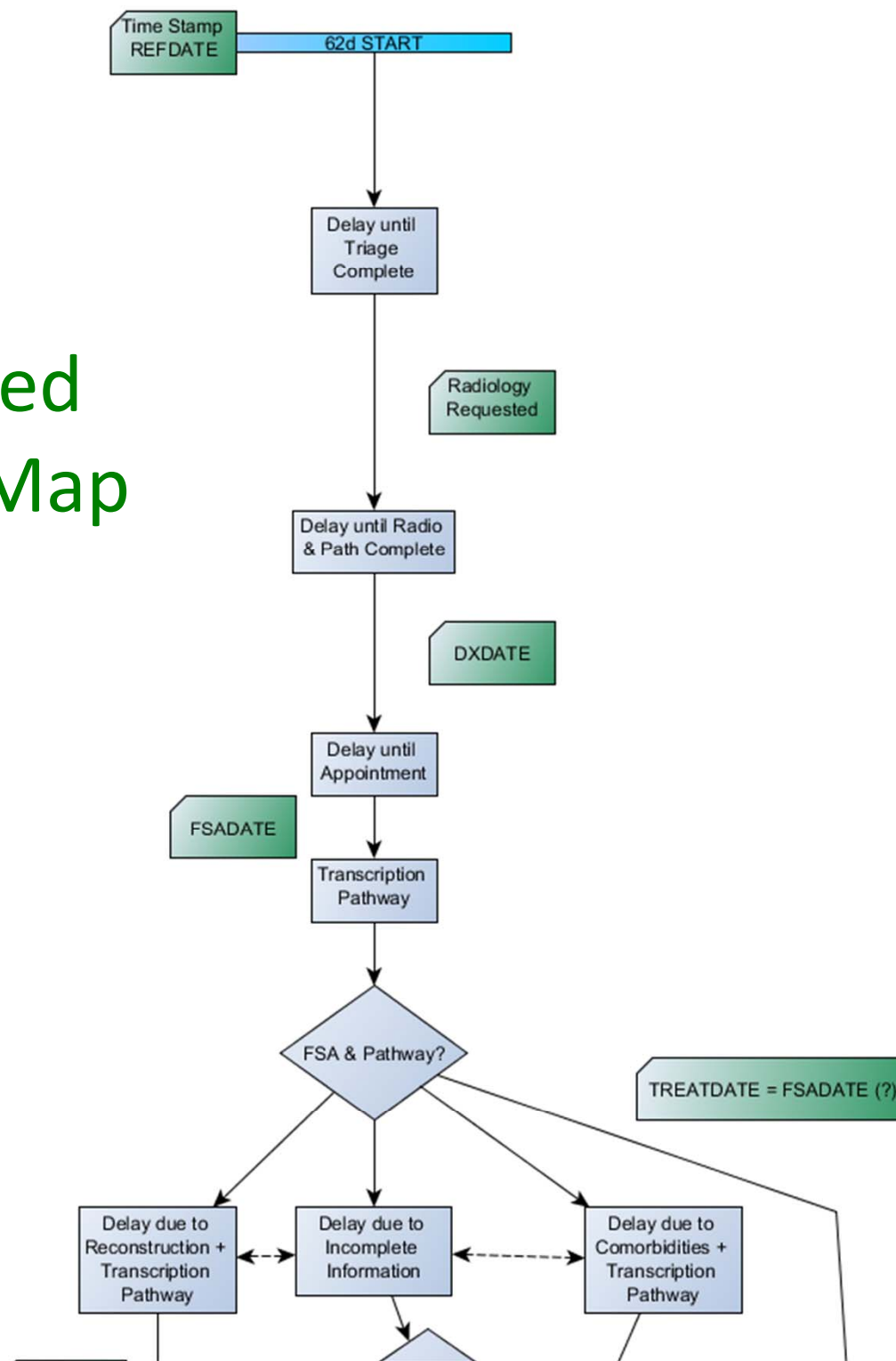
Step 7: A: Appointment Step 1

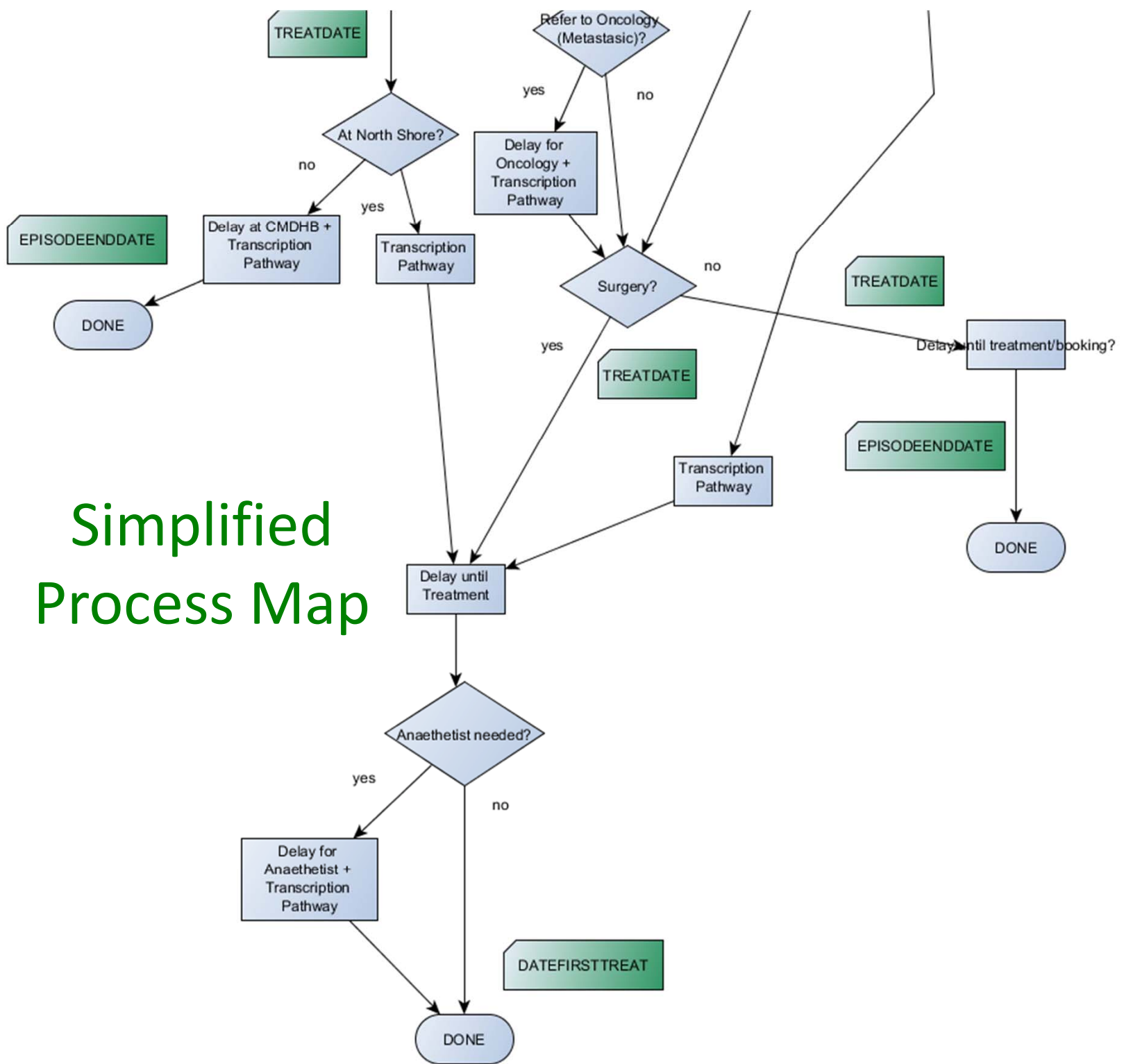


Step 7: A: Appointment Step 2



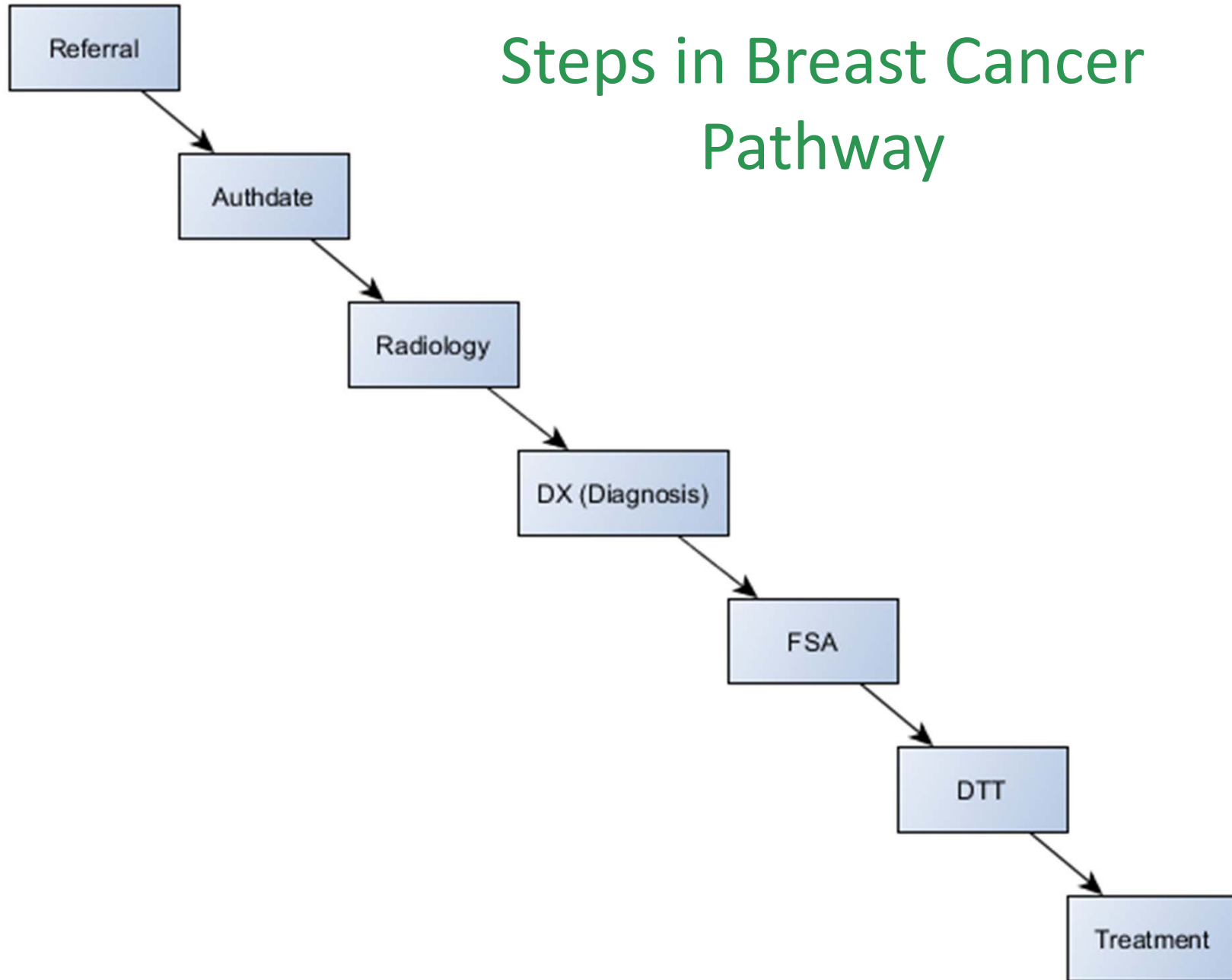
Simplified Process Map



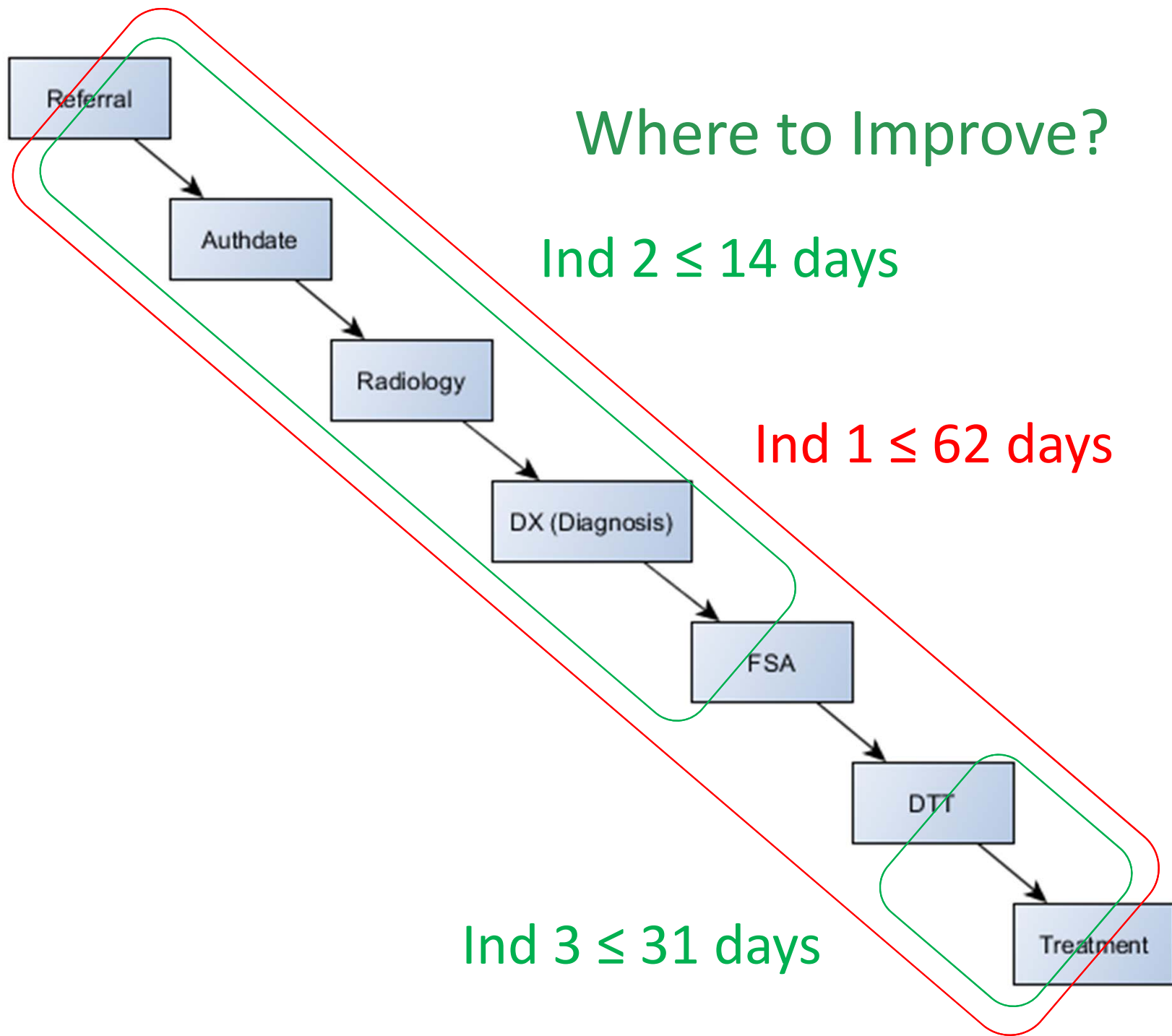


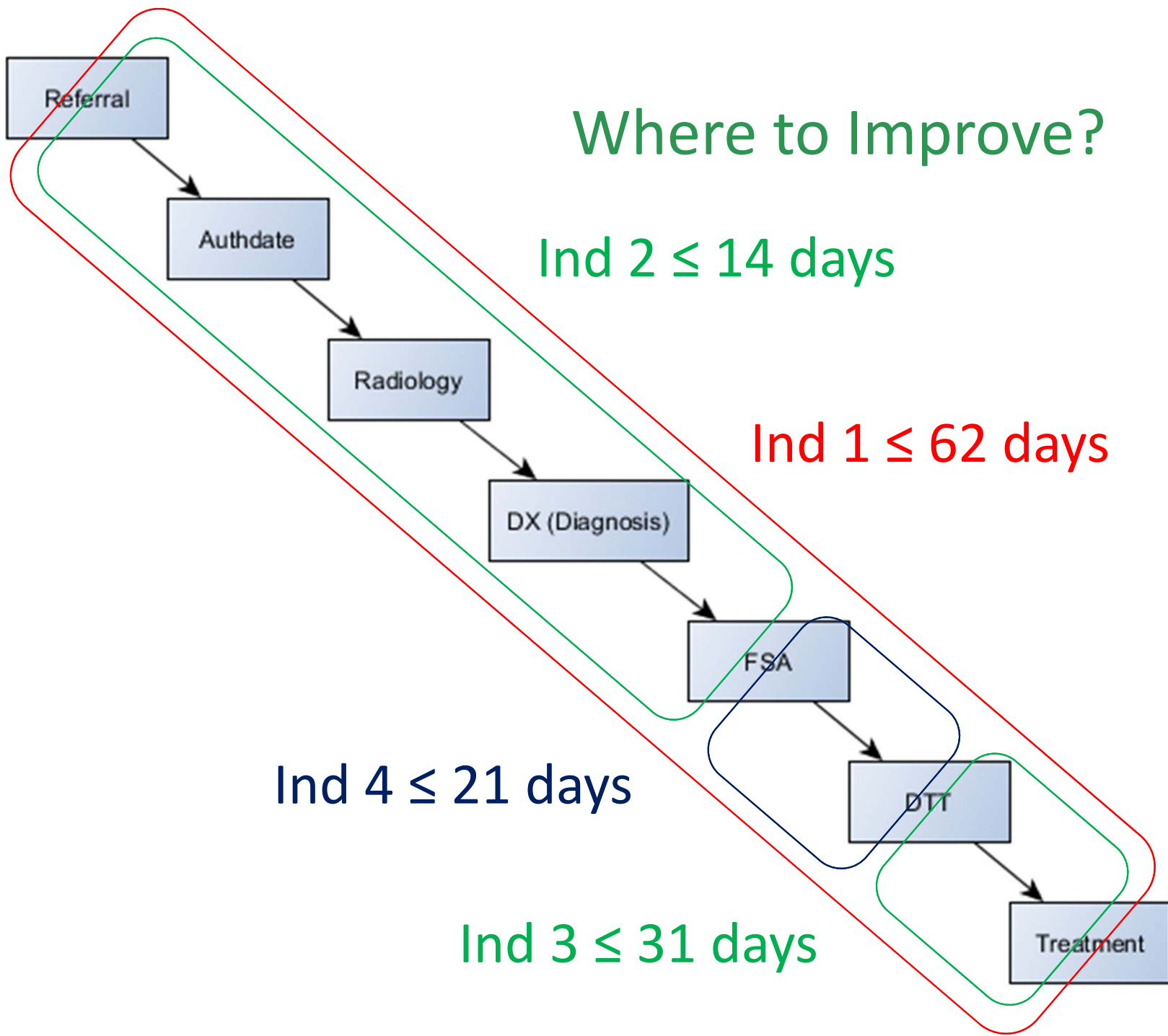
Simplified Process Map

Steps in Breast Cancer Pathway



Where to Improve?





Where to Improve?

Ind 2 \leq 14 days

Ind 1 \leq 62 days

Ind 4 \leq 21 days

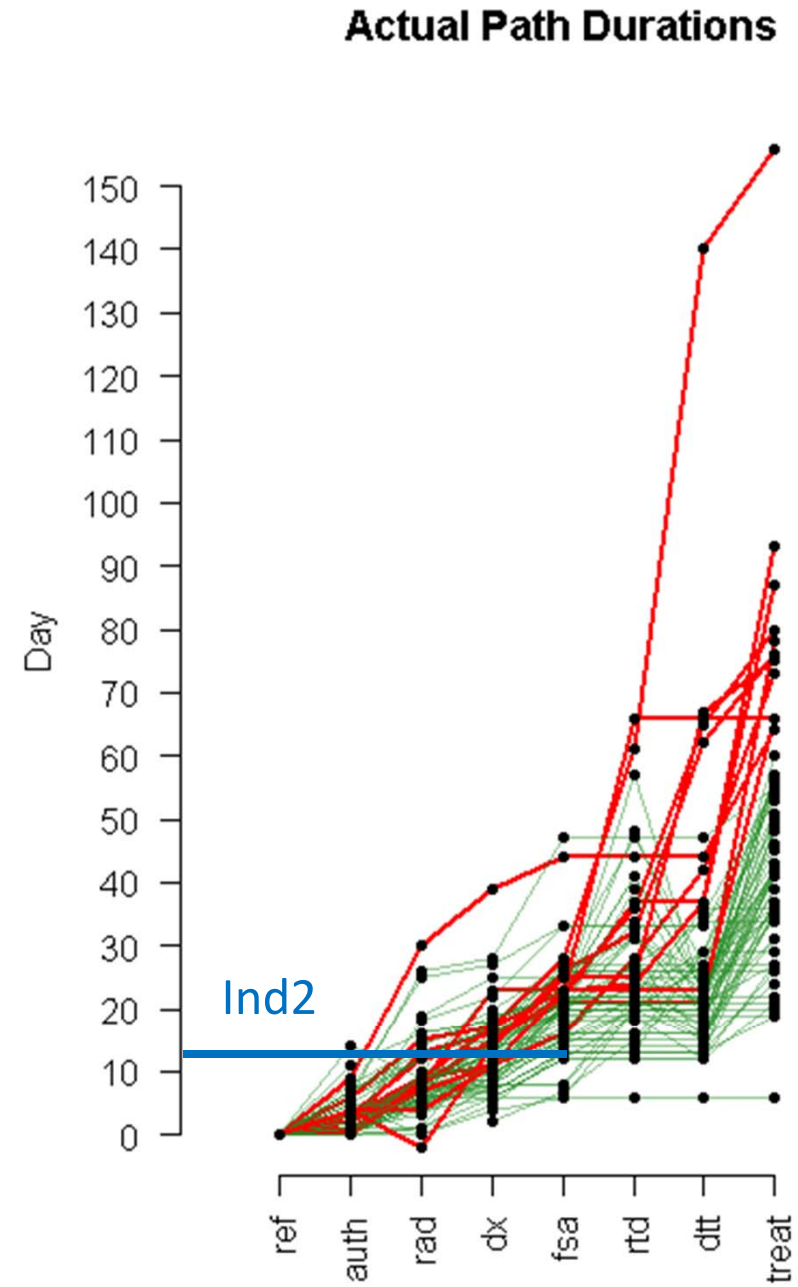
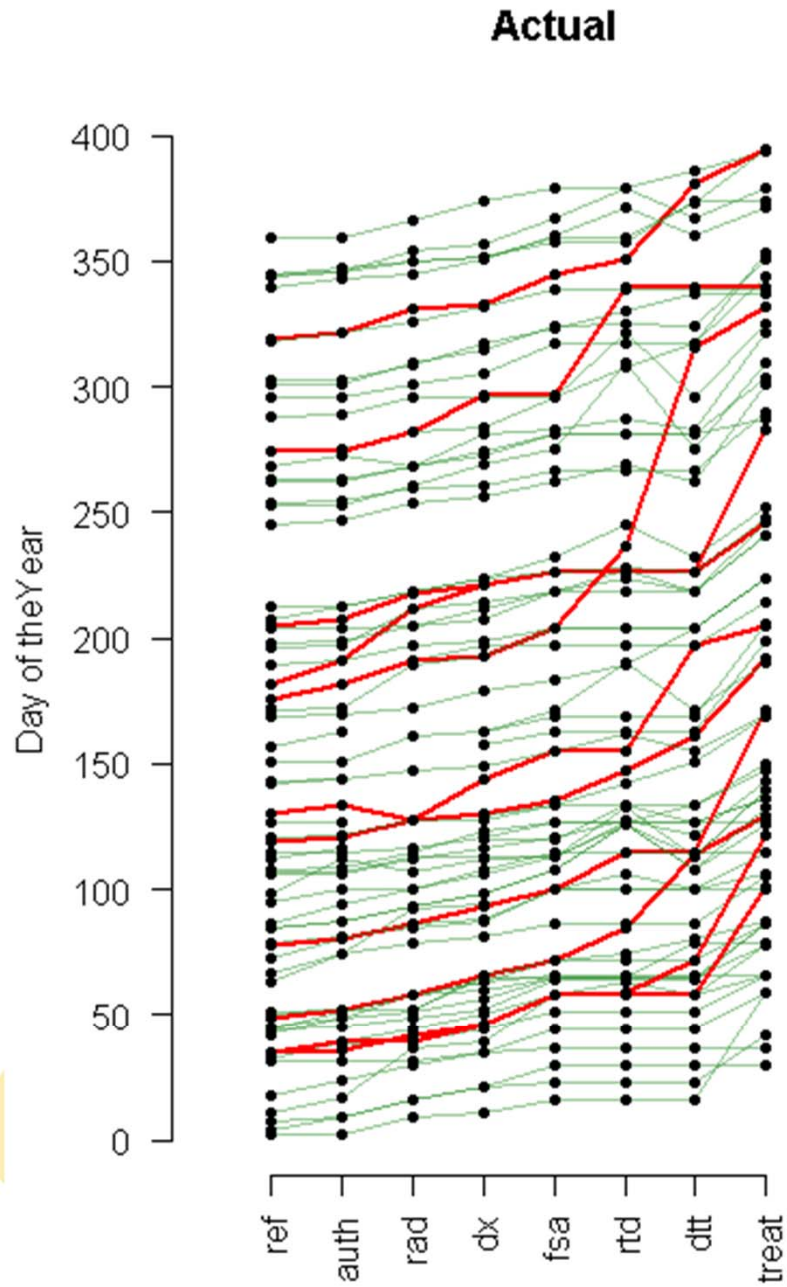
Ind 3 \leq 31 days

Where to Improve?

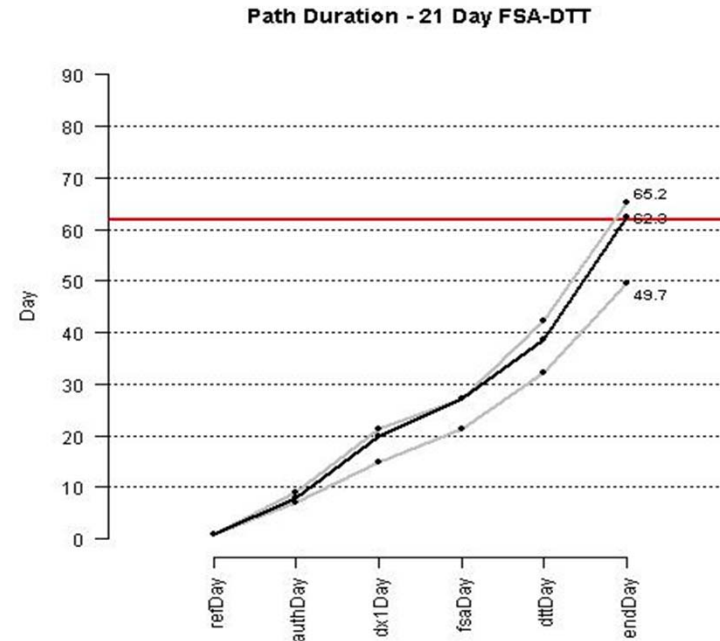
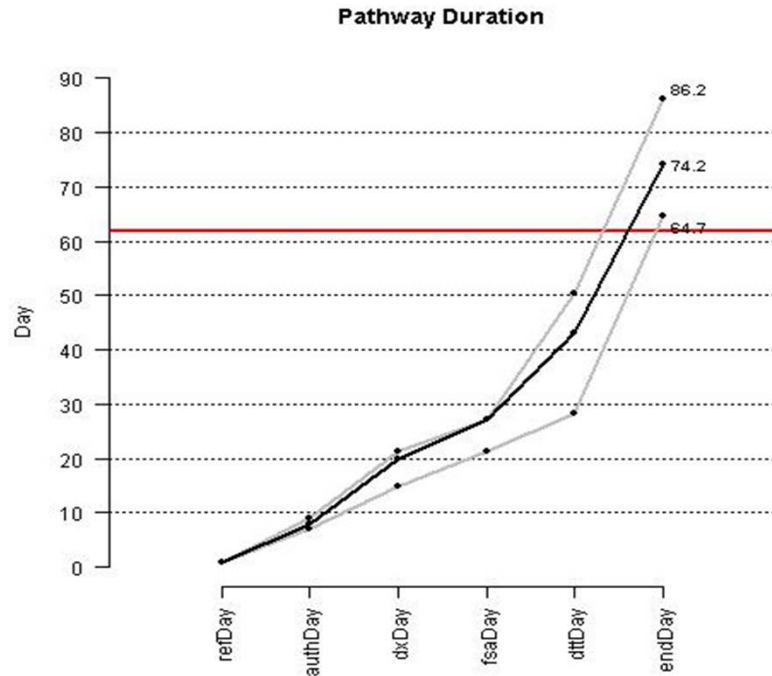
- Anecdotally, Ind2 is the problem
 - “If they get to their FSA on time, everything runs smoothly”
 - Often > 14 days, need more resourcing
 - Triage/Grading, Imaging, etc



Actual Pathways (Day 0 = 1 July 2013)



Simulation of Breast Stream

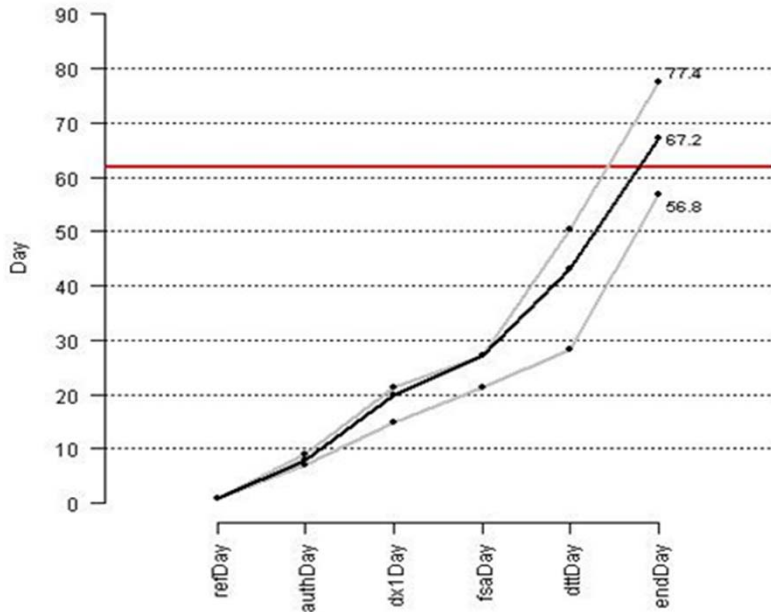


Simulation Model	Targets Enforced			Lower Bound		Point Estimate		Upper Bound	
	14 Day	31 Day	21 Day	Dur	Prop	Dur	Prop	Dur	Prop
1	No	No	No	64.66	0.77	74.2	0.85	86.17	0.92
2	Yes	No	No	56	0.8	65	0.88	76	0.95
3	No	No	Yes	49.67	0.77	62.3	0.85	65.23	0.93
4	No	Yes	No	56.8	0.8	67.2	0.87	77.4	0.94
5	No	Yes	Yes	47.47	0.84	57.3	0.91	59.2	0.96
6	Yes	No	Yes	45.4	0.86	56.1	0.92	60.44	0.98
7	Yes	Yes	No	48.06	0.86	58.2	0.93	70.23	0.98
8	Yes	Yes	Yes	43.47	0.93	51	0.97	56	1

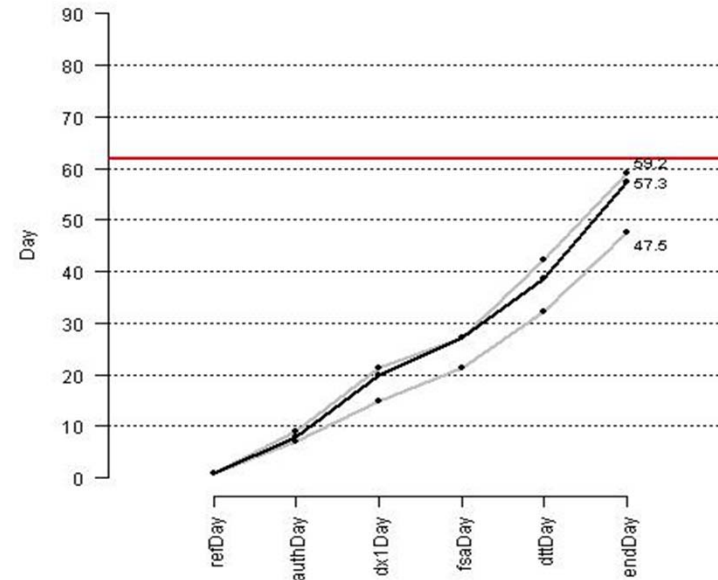
Ind2
"fixed"

Simulation of Breast Stream

Path Duration - 31 Day DTT-Treat



Path Duration - 21,31 Day FSA-DTT-Treat



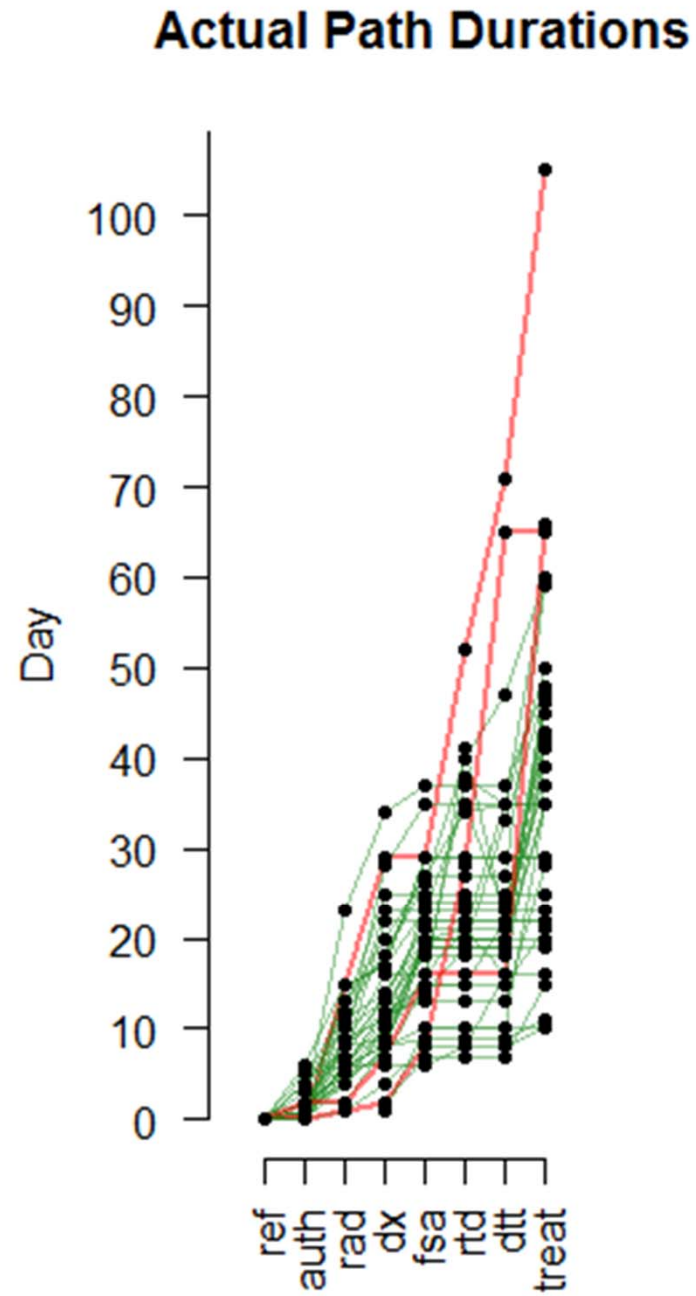
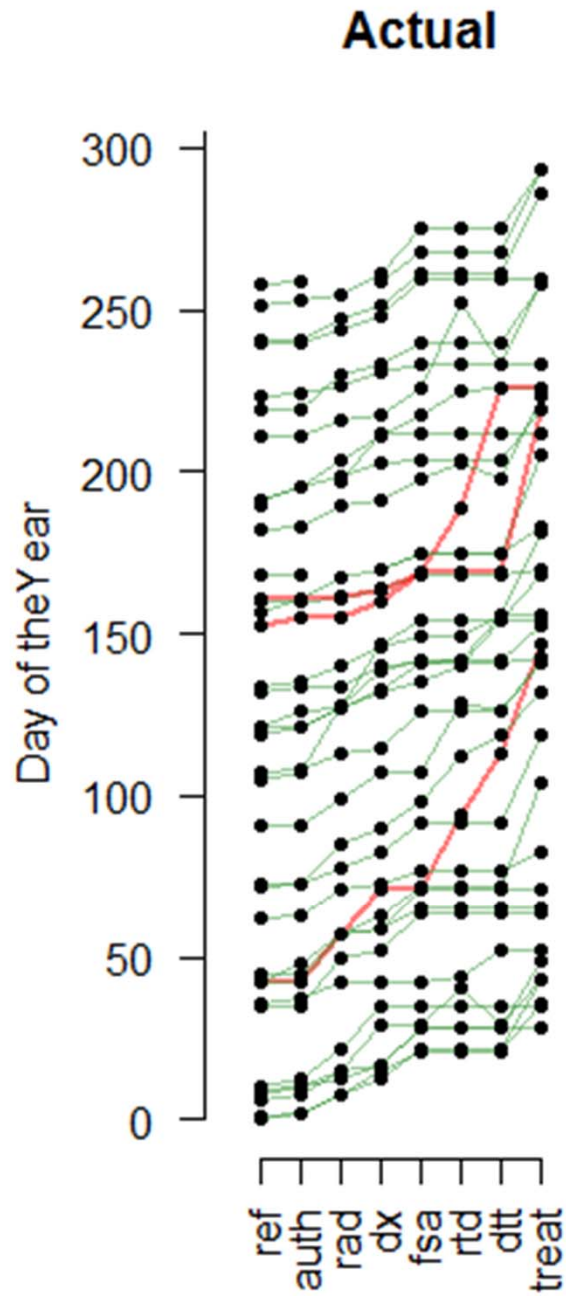
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Outcome of Evaluation

- Don't just focus on Ind2 (Referral to FSA)
- In parallel to this work, WDHB suggested 38 days Referral to DTT target
 - We suggested Ind2 (14 days Referral to FSA) & Ind4 (21 days FSA to DTT), i.e., 35 days Referral to DTT
- WDHB improved entire Breast Cancer Process pathway

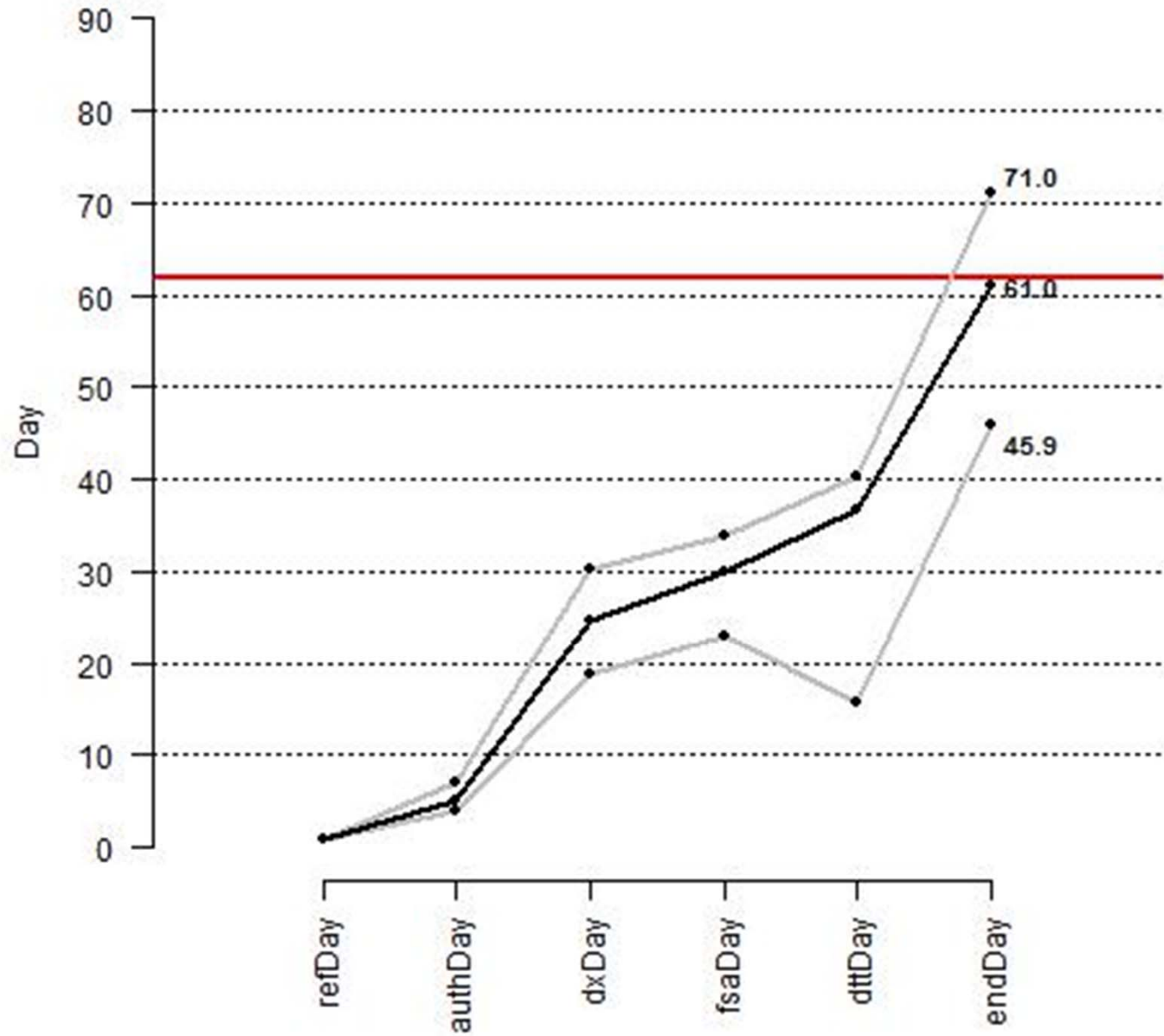


Actual Pathways (Day 0 = 1 July 2014)



Simulation of New Breast Stream

Pathway Duration

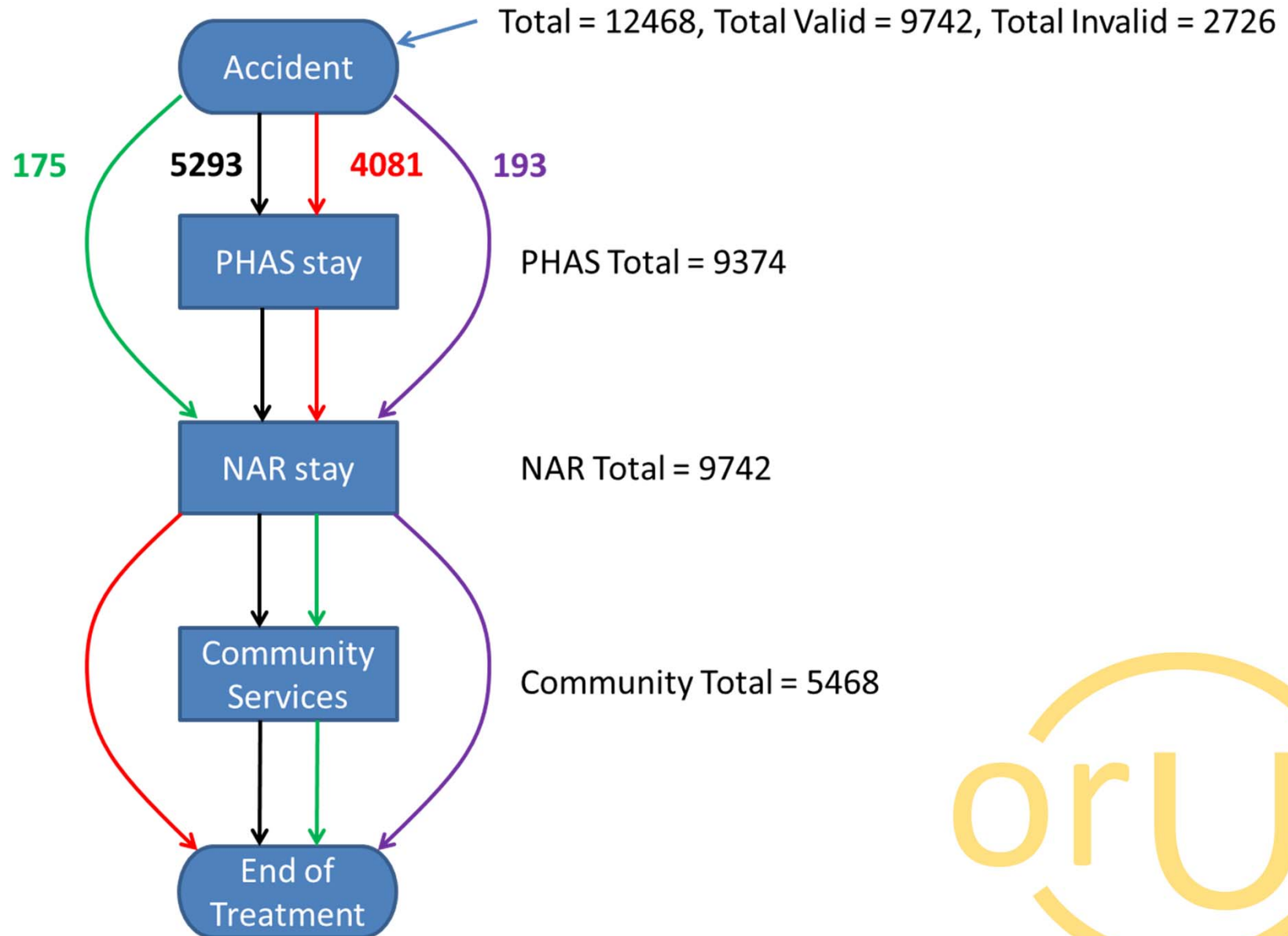


Non-Acute Rehabilitation & ACC

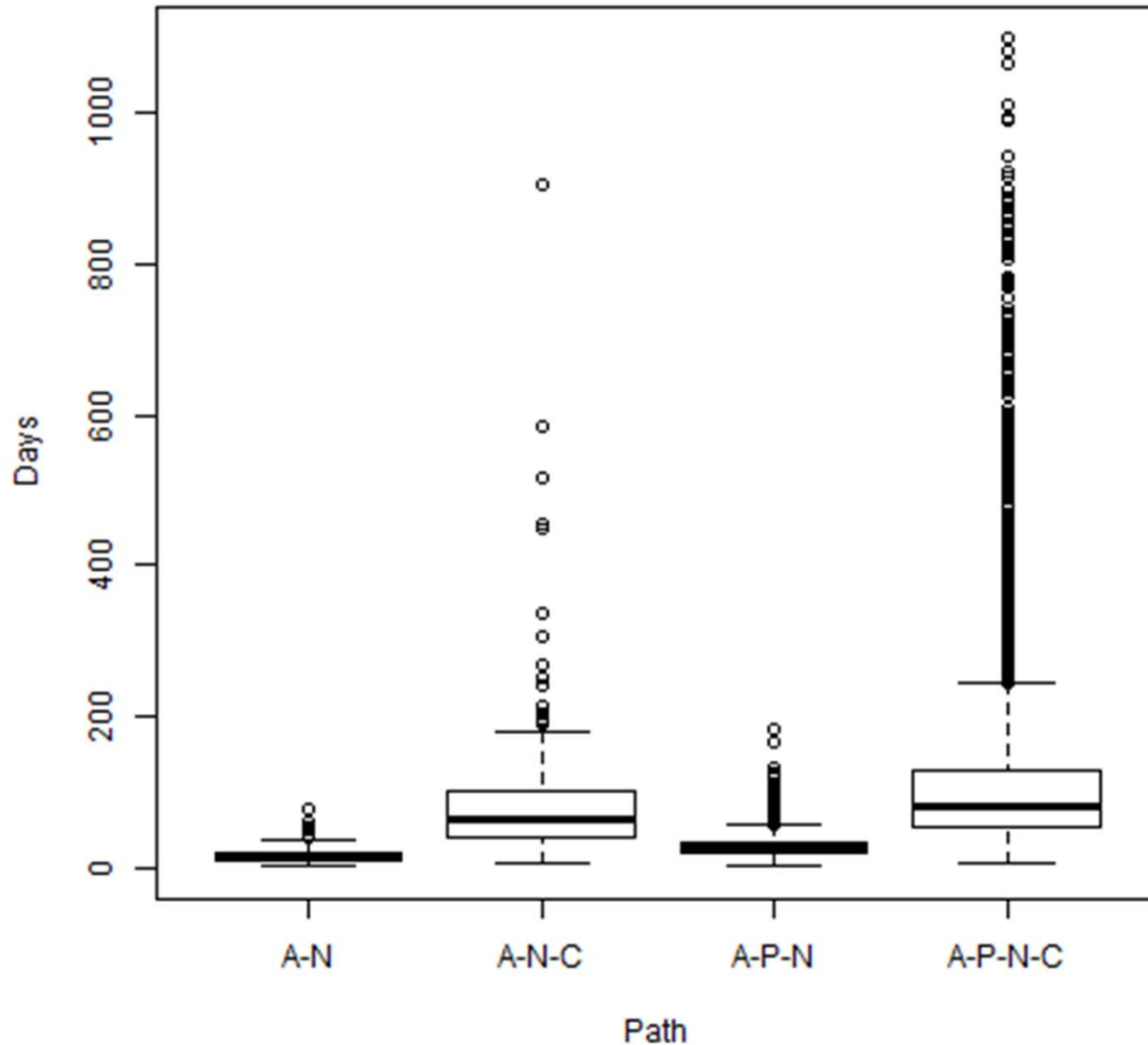
- ACC funds Public Health Acute Services (PHAS) and Non-Acute Rehabilitation (NAR) stays in hospital
- PHAS is bulk-funded, i.e., fixed amount per patient with extra funding on negotiation
- NAR is funded on a per diem basis



Patient Pathway



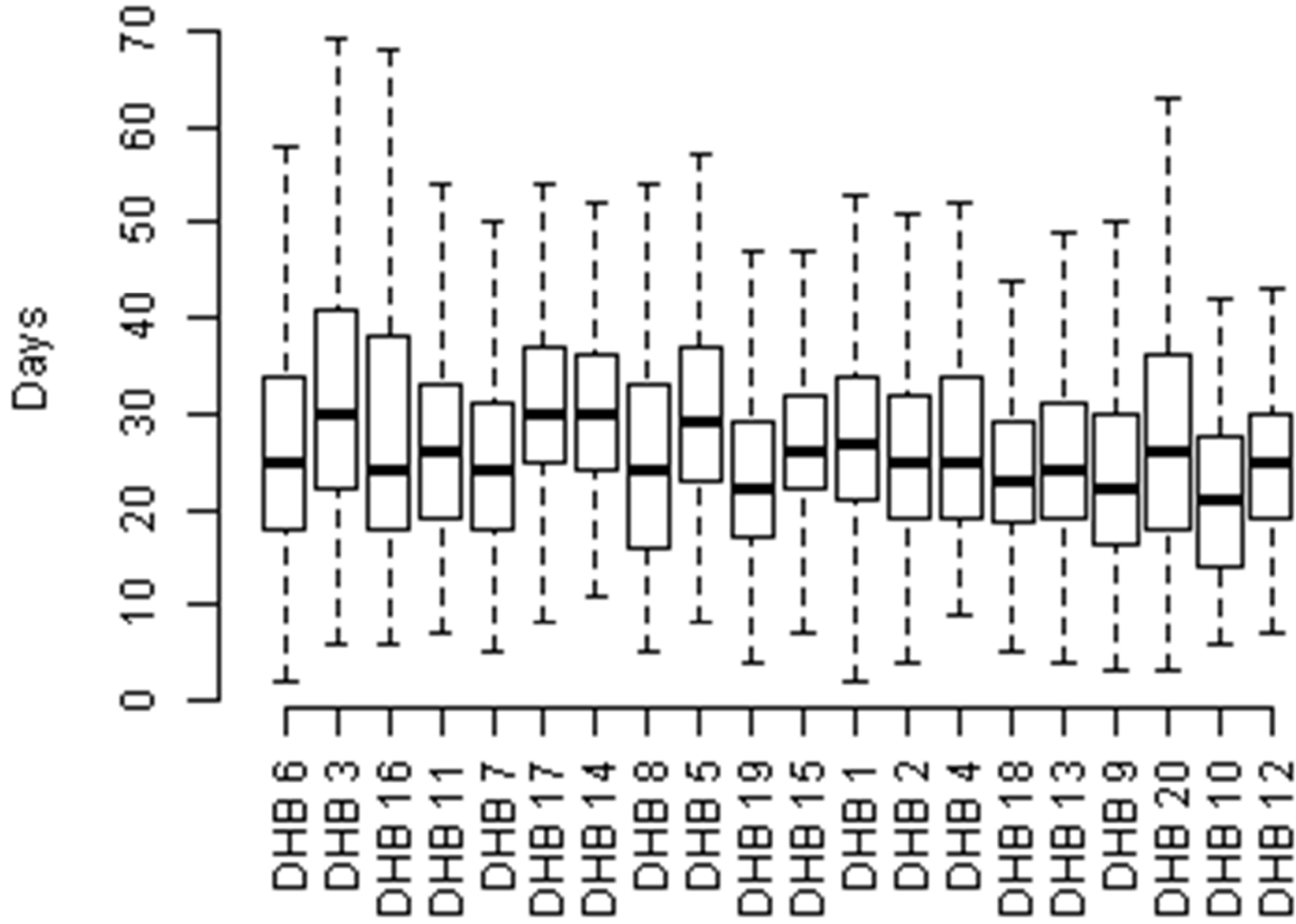
Length of Stay (LoS)



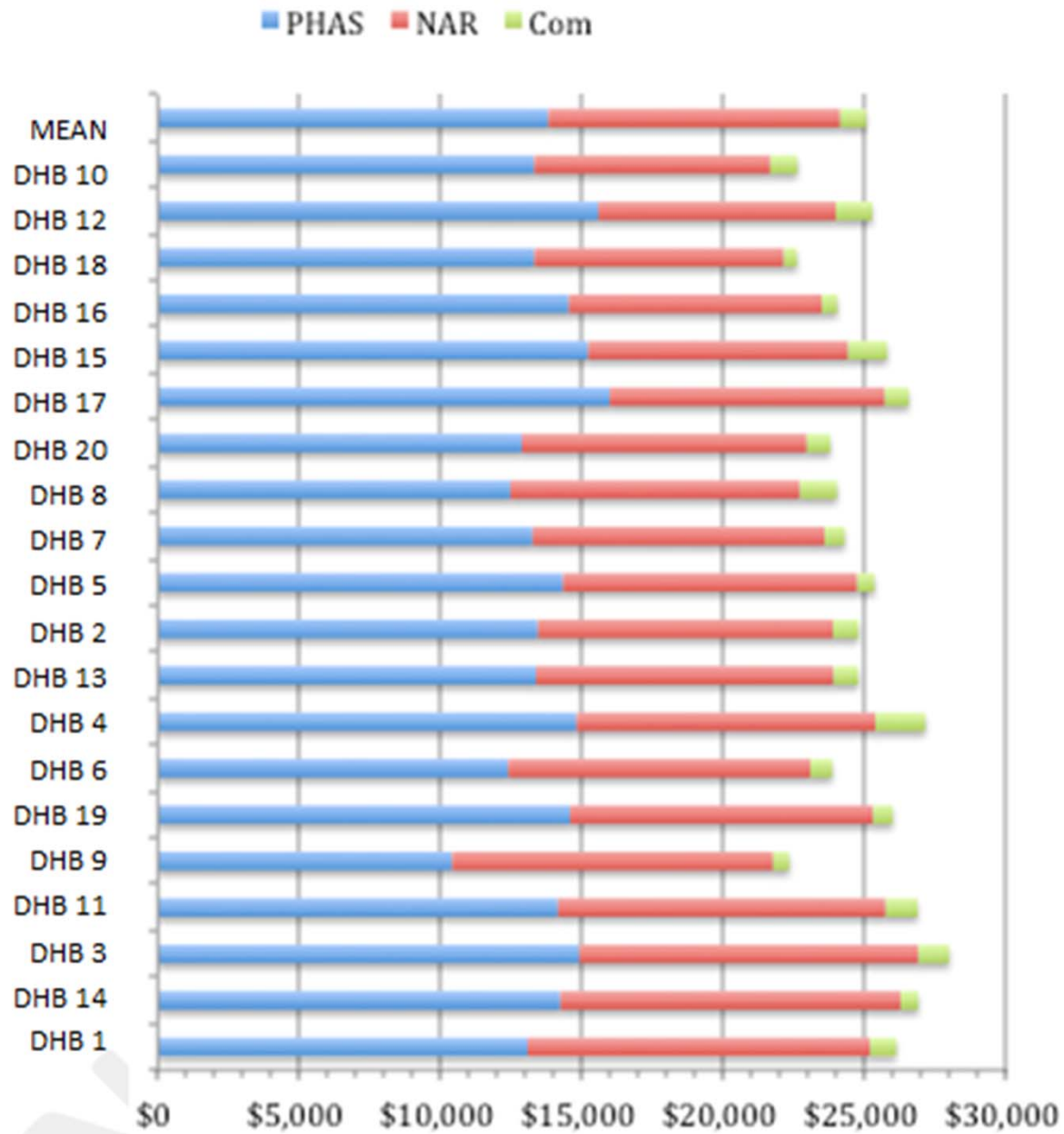
A = Accident
P = PHAS
N = NAR in-patient
C = NAR Community services



Hospital (APN) LoS by DHB



Cost of Pathway by DHB



InterRAI and AROC

Variable	Description	Source
aloneV1	Living alone	interRAI Contact - B3
carerStressV	Carer stress	interRAI Contact – D20a
bathV	Self Care Item - bathing	FIM
medV	Managing medication	interRAI Contact - D4c
mentImpV	Cognitive Function - problem solving or memory	FIM
resV*	Domicile	interRAI Contact
AdmToile	Self-care items Toileting	FIM
AdmBladd	Sphincter control bladder	FIM
AdmBowel	Sphincter control bowel	FIM
AdmXfrTo	Mobility items, transferring to toilet	FIM
AdmProb	Cognitive function, problem solving	FIM

Note. * Not significant, included for completeness



NAR Cost Adjustments

Coefficients:					
	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	16358.7	1683.2	9.719	< 2e-16	***
resV	-1069.1	1437.2	-0.744	0.457545	
mentImpV	-982.8	262.1	-3.75	0.000214	***
aloneV1	719.3	886.6	0.811	0.417838	
carerStressV	1119.9	1035.1	1.082	0.280222	
bathV	-3189.5	1750.5	-1.822	0.069489	.
medV	2190.1	953.7	2.297	0.022368	*
Multiple R-squared	0.1293		Adjusted R-squared	0.1111	



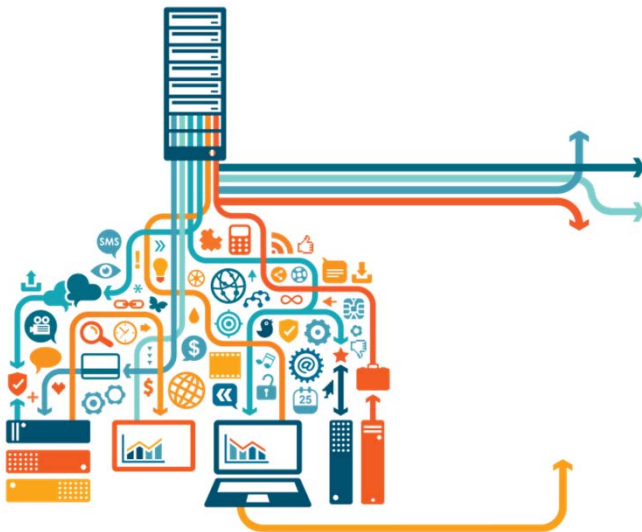
Outcome of Evaluation

- ACC can align funding and clinical pathways within NAR with a straightforward assessment
 - Ascertain any adjustors
 - Provide appropriate, individualised funding



Government Initiatives & IDI

- Government initiatives will have cross-sector benefits
 - e.g., being in work has recognised health benefits
- How can we leverage data to evaluate the impact of an initiative?



Context and Outcomes

- “Stitch” an individual’s contextual and outcome data together
 - E.g., age, employment status, days in contact with police
- Explore differences in outcomes that relate to different contextual data
 - E.g., people working < 15 hours per week have more days in hospital, but cost ACC less



Evaluate an Initiative



- Changes an individual's context
- E.g., training programme
 - Realises a 50% increase in employment hours
 - Transforms someone working 12 hrs per week into someone working 18 hrs per week
 - Consequent change in days in hospital and increase in ACC cost
- Results in changes to individual's outcomes = value of initiative



Understanding Value



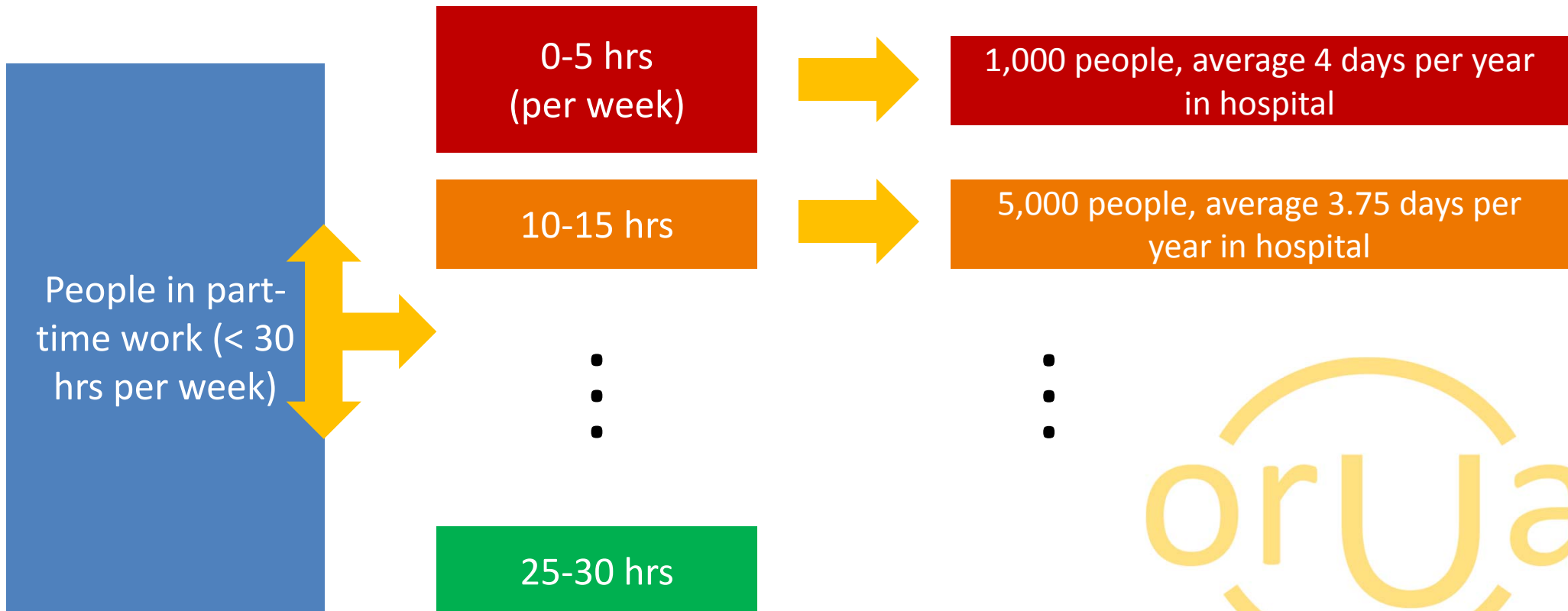
Gather target cohort



Partition by context



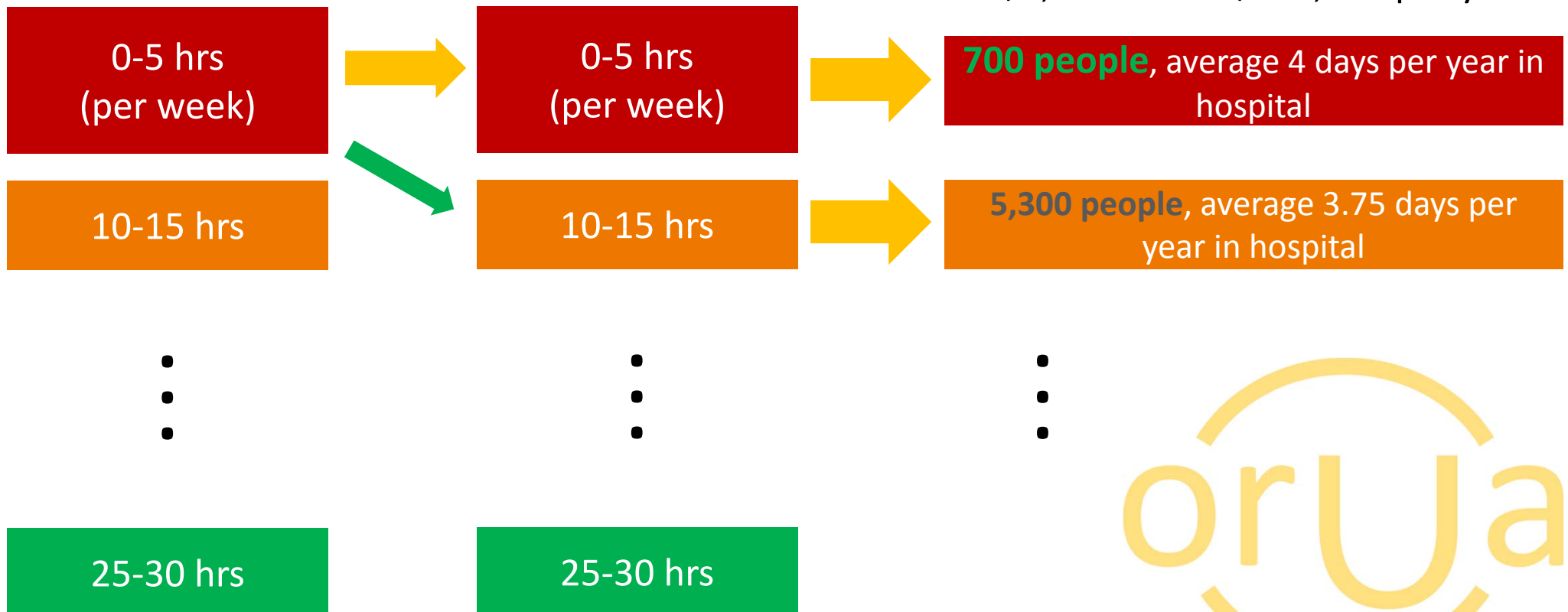
Measure counts and outcomes for each partition



Evaluating Initiative



Estimate changes due to initiative



Value of initiative is 300×0.25 days = 75 hospital days per year
 $\approx \$1,854 \times 75 = \$139,050$ per year



* Average across 2014 patient costing available from 11 DHBs, adjusted to 2016

Cross Sector Investment

- Initiative run by one sector,
 - E.g., Ministry of Social Development for training programme
- Benefits to other sectors
 - E.g., Ministry of Health, hospital bed days

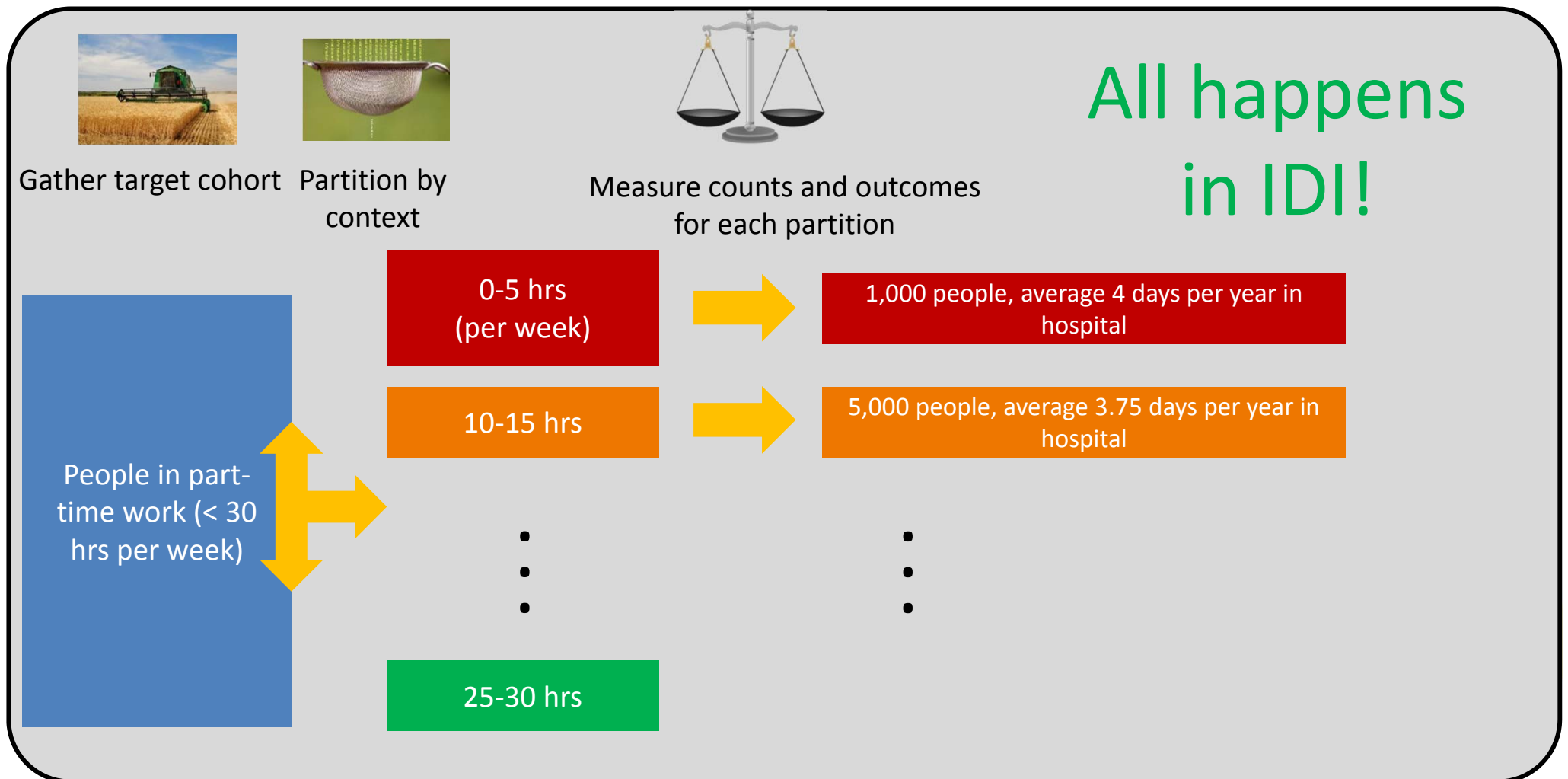


- Share the cost of the initiative = Data-Driven Cross-Sector Investment



Integrated Data Infrastructure

- IDI (Stats NZ) holds many linked datasets



IDI “Gotchas”



- Timeframe
 - 3 days to get data out for your research team
 - Random rounding (to base 3) for anonymisation
 - 10 days to get reports screened
- SQL vs SAS
 - SQL good to get data, not great for manipulation
 - SAS great for manipulation, beware of macros!
 - Validation! Unit testing?!
 - Read-only access, tricky to dynamically filter data “pulls”
 - Loop over list of SNZ IDs and pull from, e.g., NMDS, in “bunches”



Final Thoughts

- The data is there! = IDI, DHBs, ACC, etc
- We can (and should) use it to inform policy
- Tools of the trade



- R (Statistics)
- Python (Scripting, Programming)
- SQL (Scripting)
- SAS (Statistics, Scripting, approx. Programming)



Thanks!!!



michael.osullivan@auckland.ac.nz

