The community blood supply model and its potential role in planning for pandemic flu

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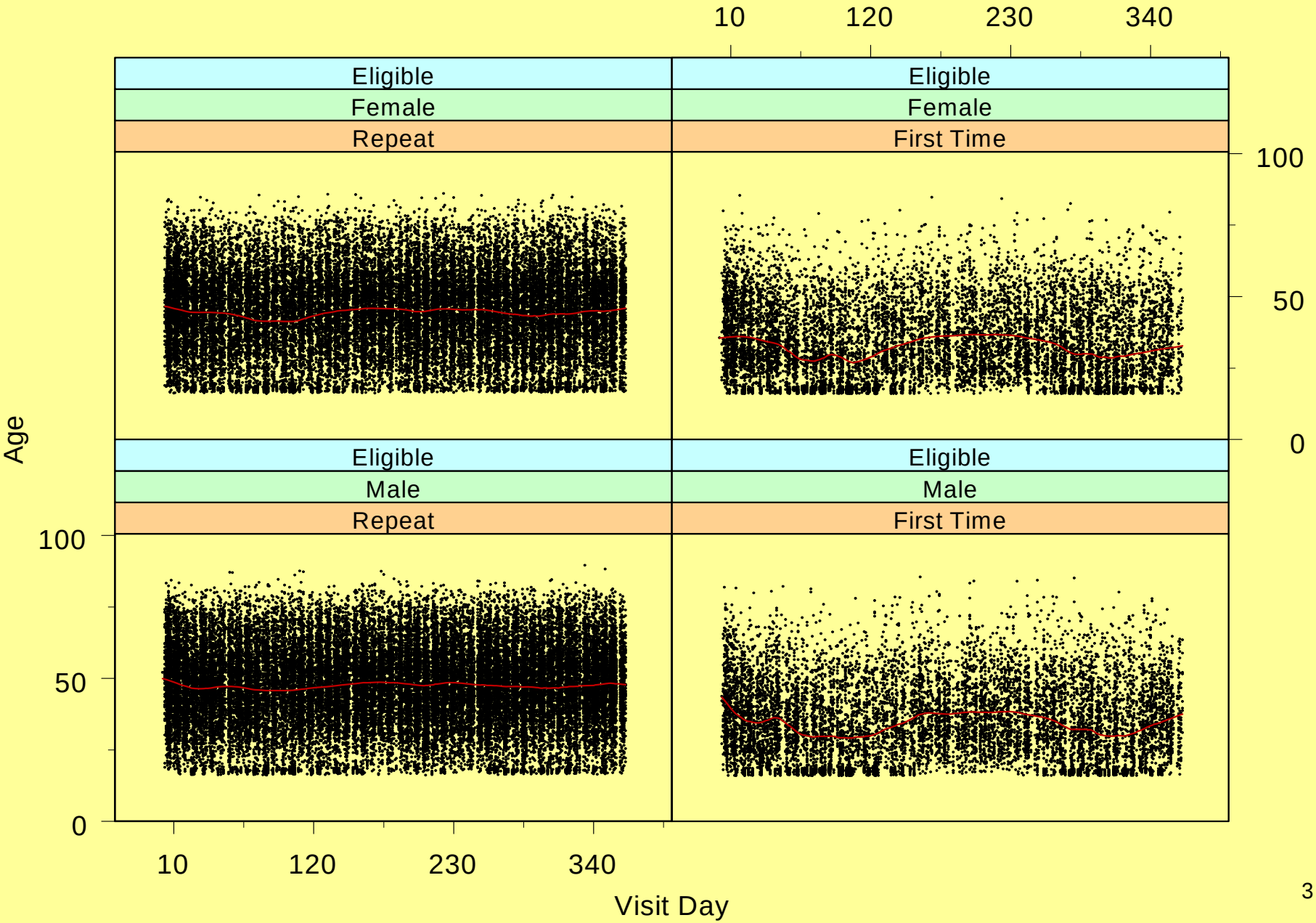
Specific aims

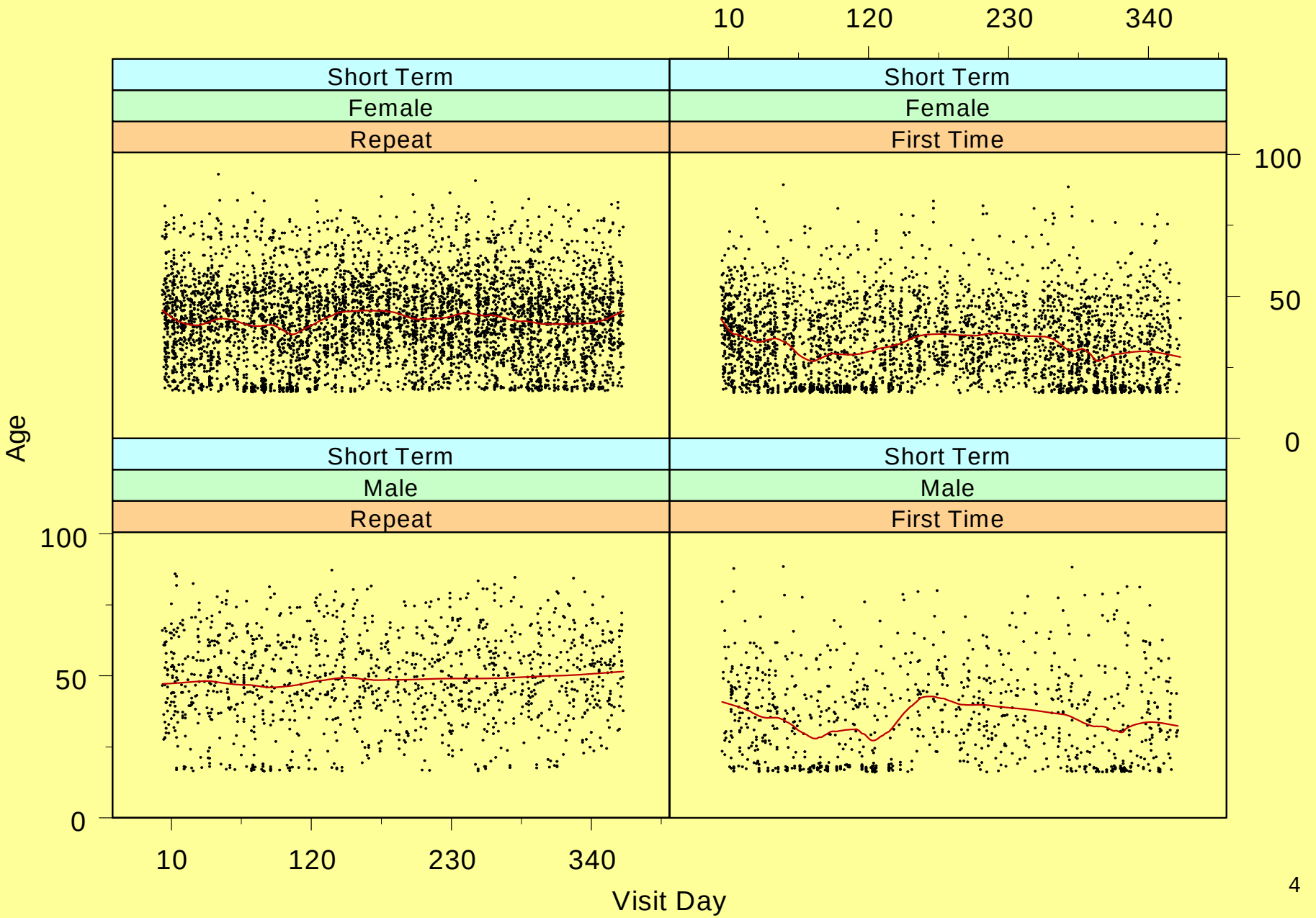
→ Develop a community blood supply model that can be used to assess trade-offs between safety and sufficiency of the supply, and cost implications of blood policies or threats to the supply

→ Use the community blood supply model to estimate the impact of threats to the supply

Eligible donors



Short term deferrals



Community blood supply model

Model design:

→ All parameters estimated using year 2000 Blood Centers of the Pacific (BCP) data

→ Cohort simulation (with probabilistic sensitivity analysis using Monte Carlo simulation)

The model is not a microsimulation of individual blood donor experiences

→ Results determined for both the societal and blood bank perspectives

→ Focus is whole blood donation from allogeneic donors

→ Time horizon – 1 year

Community blood supply model

Model design:

→ Critical time component – 56 day post-donation deferral

Model consists of 6 two-month periods over the course of a year

→ The model was purposely designed with the ability to define separate event probabilities for each 2-month period

Model capable of addressing acute events

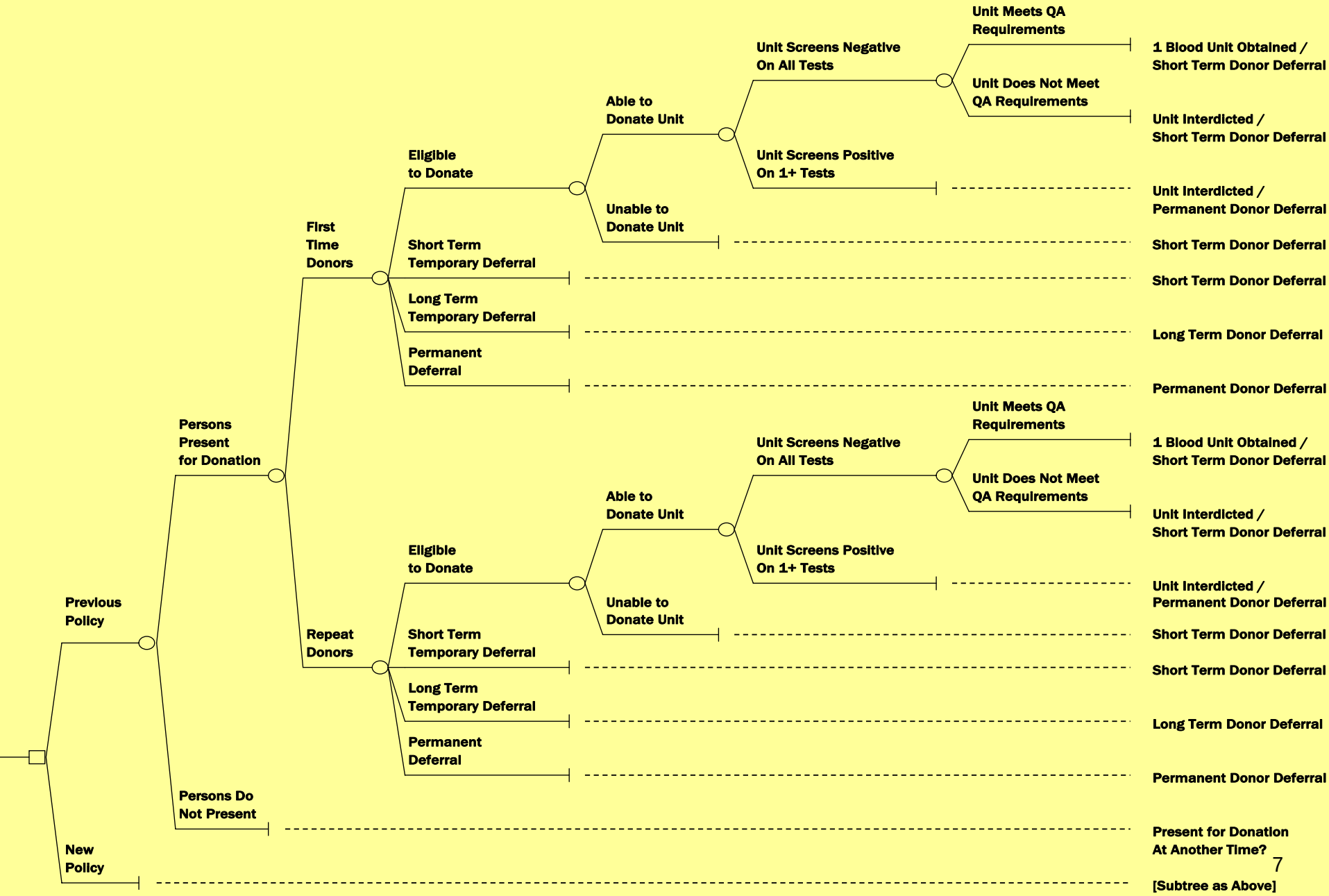
→ Model is scalable

The initial cohort size can be set to any number

→ 95% results distributions through probabilistic sensitivity analysis

→ Through "what if?" analyses a wide-range of parameter values and assumptions can be incorporated into the model

Structure


Previous Policy
Persons Present for Donation
First Time Donors
Eligible to Donate
Able to Donate Unit
Unit Screens Negative On All Tests
Unit Meets QA Requirements
1 Blood Unit Obtained / Short Term Donor Deferral
Unit Does Not Meet QA Requirements
Unit Interdicted / Short Term Donor Deferral
Unit Screens Positive On 1+ Tests
Unit Interdicted / Permanent Donor Deferral
Unable to Donate Unit
Short Term Donor Deferral
Short Term Temporary Deferral
Short Term Donor Deferral
Long Term Temporary Deferral
Long Term Donor Deferral
Permanent Deferral
Permanent Donor Deferral
Repeat Donors
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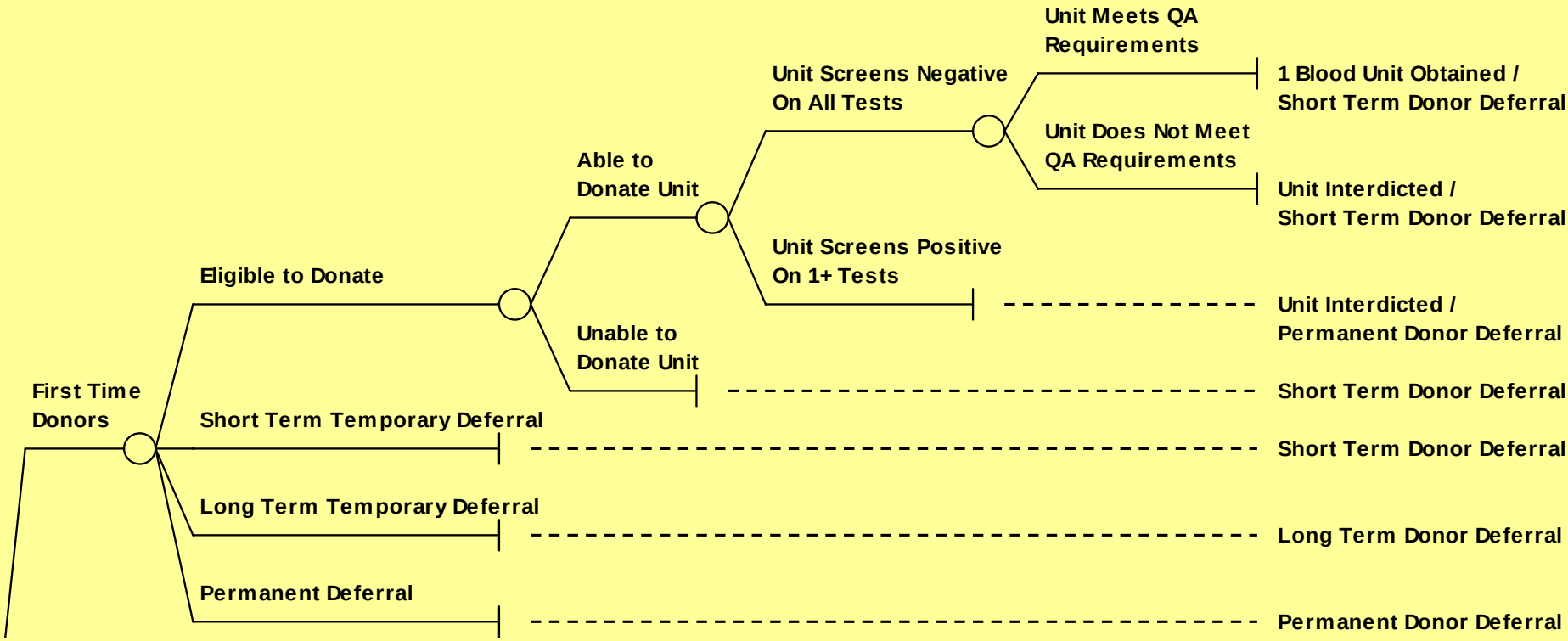
Short Term Donor Deferral
Long Term Temporary Deferral
Long Term Donor Deferral
Permanent Deferral
Permanent Donor Deferral
Persons Do Not Present
Present for Donation At Another Time?
New Policy
[Subtree as Above]

Structure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Outcome parameters

→ 8 demographic groups based on 15-year age intervals and gender due to observed epidemiological differences

→ 9 outcome parameters estimated for each demographic group within each two-month period for the modeled year

→ 6 cycles over the course of the modeled year

→ Model probabilities for each cycle reflect the frequency of events observed in two-month intervals of BCP data

→ Baseline model has 432 event probabilities

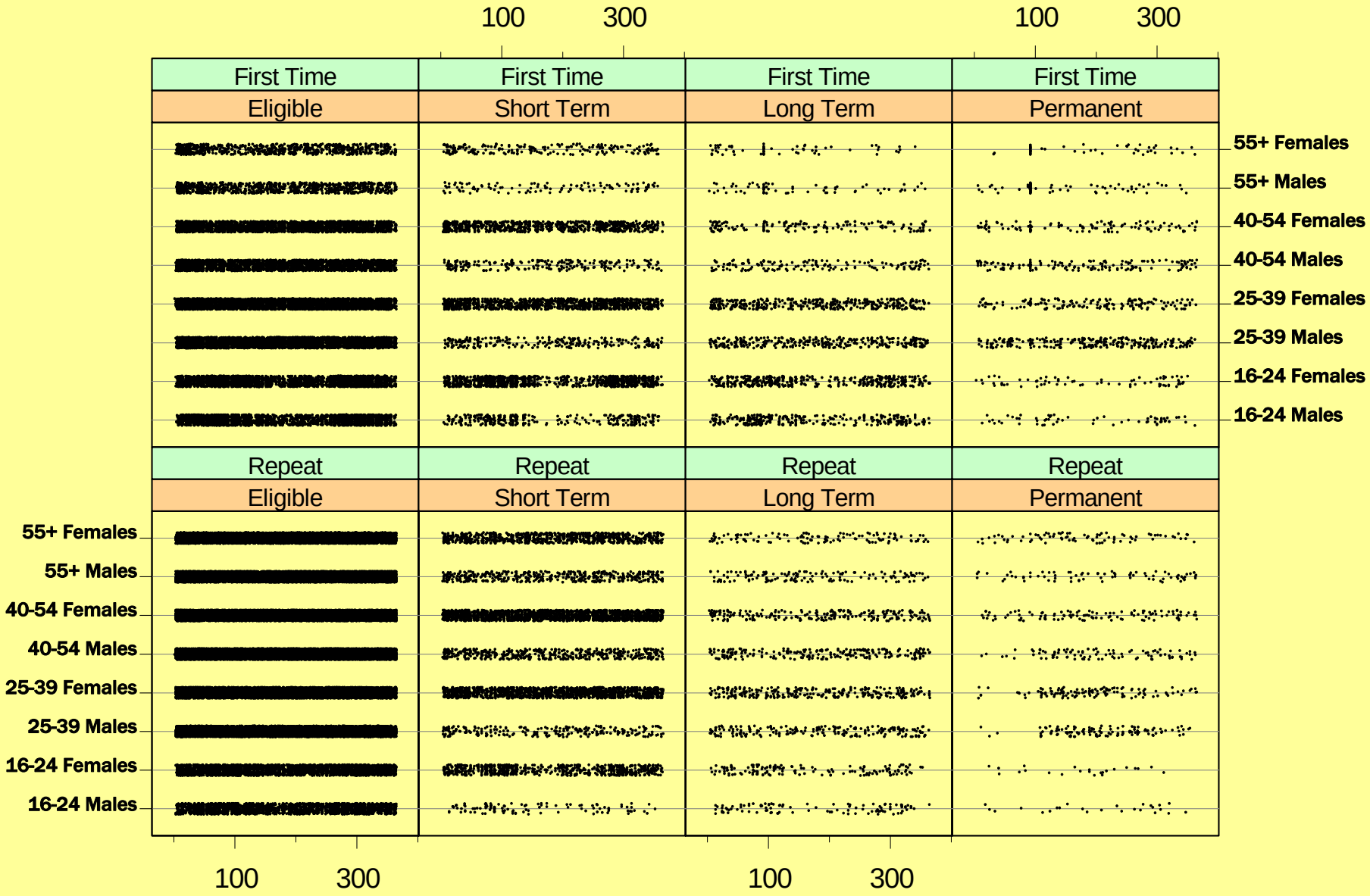
Community blood supply model

Model design:

→ Results can be reported by 2-month intervals or multiples thereof for the entire year in terms of:

- Transfusable units obtained
- Deferrals categorized by duration
- Miscollections (underweight/overweight units)
- Disease marker positive units
- Total and per unit costs for blood bank perspective and estimated cost from the societal perspective

Pre-donation classification



Pre-donation deferral risk by demographic group

Demographic Group	Short Term Deferral		Long Term Deferral		Permanent Deferral	
	First Time Donors	Repeat Donors	First Time Donors	Repeat Donors	First Time Donors	Repeat Donors
Females 16-24	2.66	2.72	2.41	1.94	1.46	0.86
Males 16-24	1.74	1.10	2.75	2.24	1.70	1.30
Females 25-39	2.63	1.86	2.37	1.49	2.14	1.36
Males 25-39	1.33	0.80	2.46	1.38	2.71	1.40
Females 40-54	3.36	1.58	2.50	1.12	2.60	1.08
Males 40-54	1.67	0.89	2.32	1.06	3.20	0.95
Females 55+	4.81	1.72	3.90	1.13	5.36	1.27
Males 55+	2.43	Referent	3.86	Referent	7.64	Referent

Example model output

Demographic Group	Presenting Donors	Short Term Deferrals	Long Term Deferrals	Permanent Deferrals	Successful Donation Attempts	Disease Marker Positive Units	Under Collected Units	Total Units Cleared for Release	Blood Bank Unit Cost ($)	Societal Unit Cost ($)
Males 16-24	7,858	443	432	100	6,872	93	374	6,406	205.30	238.20
Females 16-24	11,390	2,011	603	111	8,598	104	769	7,724	216.05	253.50
Males 25-39	15,187	492	563	389	13,740	183	347	13,210	198.60	229.80
Females 25-39	16,968	2,666	689	299	13,250	184	628	12,437	206.10	241.10
Males 40-54	21,227	680	403	288	19,849	223	409	19,216	196.70	227.10
Females 40-54	19,514	2,796	394	243	16,063	185	637	15,240	202.80	236.30
Males 55+	14,046	832	212	144	13,157	77	303	12,777	196.10	226.30
Females 55+	9,977	1,062	183	121	8,599	57	331	8,212	200.80	233.10
Total	116,167	10,702	3,479	1,695	100,127	1,107	3,797	95,222	201.60	234.10

Toward validation

Outcome	Number Observed in Data	Number Predicted by Model	Difference	Percent Difference
Presenting blood donors	116,165	116,167	+2	+0.001
Able to donate	158	164	+6	+3.8
Short term deferrals	10,696	10,702	+6	+0.06
Long term deferrals	3,476	3,479	+3	+0.09
Permanent deferrals	1,692	1,695	+3	+0.2
First-time donor collections screened	24,782	25,567	+85	+3.2
First-time donor miscollections	1,626	1,588	-38	-2.3
Repeat donor collections screened	74,473	74,559	+86	+0.1
Repeat donor miscollections	2,228	2,210	18	-0.8

Limitations

→ *Mean cost not incremental or marginal cost; the most interesting question is what is the incremental cost of replacing deferred donors, but this is very difficult to answer without a specific study to collect these costs*

→ **Supply model does not address demand or utilization issues**

→ **Model does not fully track the experience of the most dedicated donors (people who return between 56 and 61 days)**

→ **Would benefit from a more user friendly interface**

Limitations

→ Does not include components or outdates

→ Parameters specific to BCP – generalizability to other community blood supplies not established

→ Cost parameters may overestimate cost of obtaining whole blood units

→ Societal cost underestimated (doesn't include other indirect costs such as vehicle cost)

Community blood supply model: How pandemic flu assumptions could be incorporated into model

→ In an affected community outbreak will last

6 to 8 weeks

→ Multiple waves could occur with each wave lasting

2 to 3 months

→ Overall attack rate 30%:

In 16-24 year olds attack rate 40%

In working adults 20% of working adults become ill during a 2-month period

Preliminary Results

2-month Interval	Donations without pandemic (95% Range)	Donations with pandemic (95% Range)	Percent loss (95% Range)
Jan-Feb	17,113 (17,059 – 17,166)	13,271 (12,757 – 13,781)	22.4 (19.5 – 25.5)
Mar-Apr	15,597		
May-Jun	14,982		
Jul-Aug	15,488		
Oct-Sept	16,153		
Nov-Dec	15,928		
Totals	95,221 (94,909 – 95,522)	91,380 (90,168 – 92,037)	4.0 (3.5 – 4.6)

Current work on model

Next version of the model nearly completed:

→ Uses Blood Systems data from 14 blood centers

Enhanced generalizability

→ Includes double-red cell collections

Demographic groups still define the model, after eligibility assessment donors either move to double-red cell apheresis or standard unit collection

Community blood supply model: Publications

Medical Decision Making. 2005 Sep-Oct;25(5):571-82.

Custer B, Johnson ES, Sullivan SD, Hazlet TK, Ramsey SD, Murphy EL, Busch MP. Community blood supply model: development of a new model to assess the safety, sufficiency, and cost of the blood supply.

Transfusion. 2004 Oct;44(10):1417-26.

Custer B, Johnson ES, Sullivan SD, Hazlet TK, Ramsey SD, Hirschler NV, Murphy EL, Busch MP. Quantifying losses to the donated blood supply due to donor deferral and miscollection.

Acknowledgements

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Calculation of cost parameters

Blood Bank Cost:
Year 2000 expenditure data provided by BCP accounting/finance

Cost parameters represent average cost per unit

Process costing used to estimate:

1. Donor recruitment and selection
2. Donation collection
3. Donation processing and screening
4. Unit distribution

Allocated general and administration (overhead) expenditures to each of the other categories based on the proportion of total blood bank costs incurred in each of those categories (stand alone allocation)

Calculation of cost parameters

Societal Cost:

Human capital method

Cost = mean wage rate for Bay Area
multiplied by the time spent in each part of donation process

Two categories:

1 Donor recruitment and selection including travel time to and from clinic

2 Donation collection and recovery

vCJD deferral policy assessment

Additions to community blood supply model to assess expanded deferral impact

1. Proportion of first time and repeat donors deferred

   - Estimated using deferral survey

2. Repeat donors

   a. Two types of repeat donors – those who last donated before implementation of the new policy and those who have donated after policy implementation

   b. Different return patterns by demographic group

   - Both a. & b. estimated using donor return matrices for each two-month cycle over the modeled year using linked donation records

vCJD assessment: estimated national impact

→ Loss of 378,000 units (from an approximately 13 million unit supply)

→ Blood bank cost to replace - Additional cost US$7 million

→ Societal cost to replace - Additional cost US$16 million

→ Doesn't account for increased donor recruitment costs or increased morbidity and mortality resulting from a reduced supply

Data sources

- 3 Separate databases combined to form master data set

1 Retroviral Epidemiology Donor Study (REDS) data set containing donation data, screening results, and demographics for all persons who donated blood to BCP between 1991-2000 (approximately 1 million records)

2 BCP donor deferral file for the year 2000 which captures all deferrals including the reason for the deferral and associated demographics (approximately 130,000 records)

3 BCP quality assurance data set for the year 2000 which contains data on whether donations met donation volume requirements as assessed by the weight of the donation (approximately 100,000 records)

Records linked by the unique donor identification number and date of visit to a donation location thereby fully describing all donor encounters

All year 2000 records form the denominator for the analysis; this combined data set captures what happened to every presenting blood donor and every unit of blood that was obtained from a donor