

Cost–effectiveness of pathogen reduction technology for plasma and platelets in Quebec: a focus on potential emerging pathogens

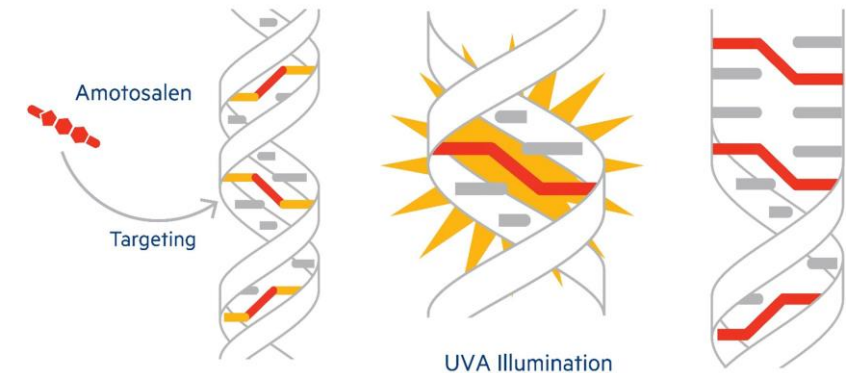
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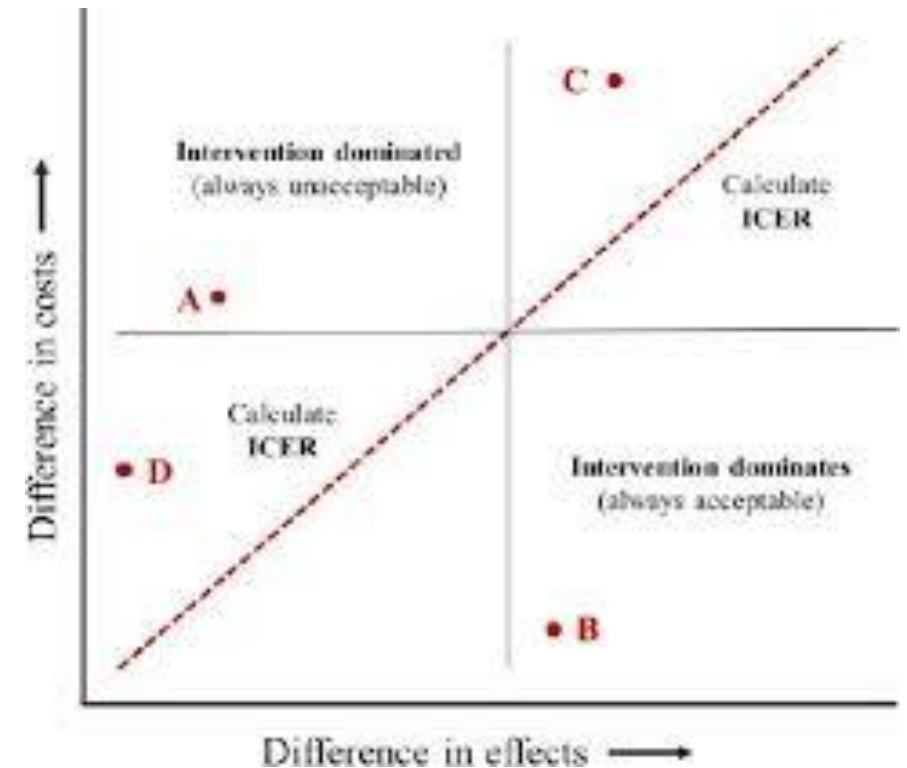
Context (1/4)

- Pathogen reduction technologies (PRT) can reduce 'known' risks associated with transfusion:
 - **Residual risks for known pathogens** ('window period' risk; HIV, HCV, HBV,...);
 - Bacterial contamination of platelets (as an alternative to culture methods);
- Other non-infectious risks (e.g. febrile non-hemolytic reactions);
- Perhaps more importantly, PRT can also protect against **unknown, emerging pathogens**



Context (2/4)

- Pathogen reduction technologies are fairly expensive, and 'known' risks associated with transfusion are quite low;
- Funding for healthcare is limited and ideally should prioritize the most 'cost-efficient' interventions;
- As with other healthcare interventions, PRT can be subjected to pharmacoeconomic evaluations



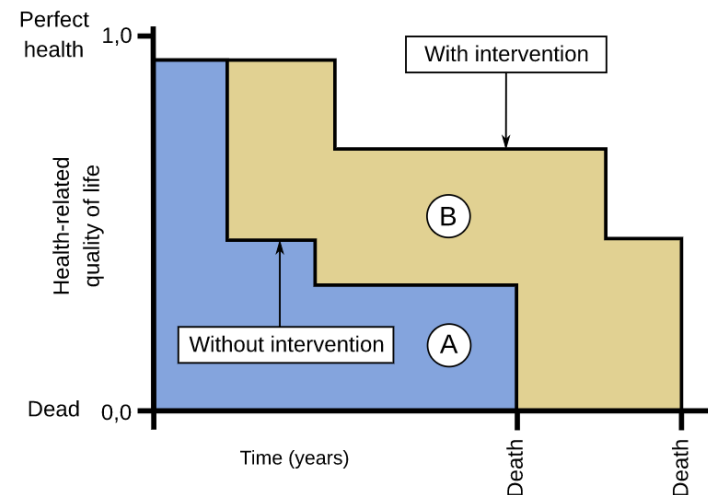
Context (3/4)

- What is cost-effectiveness?

(Costs with technology – costs without technology)

(Health benefit with technology - Health benefit without technology)

- Measurement unit for health benefit: *Quality-Adjusted Life-Years (QALY)*



- Measurement unit for cost-effectiveness: *Incremental Cost-Effectiveness Ratio (ICER) : \$/QALY*

Context (4/4)

- In 2007, ICER for PRT in Canada was estimated at **1,423,000\$ / QALY¹**

[1] Custer, B., Agapova, M. & Martinez, R. H. *Transfusion (Paris)* **50**, 2461–2473 (2010).

- In 2020, this estimate was thought to be **outdated** because of :
 - Costs of implementing PRT had changed
 - Efficacy and costs of new treatments for some infections (e.g. hepatitis C)
 - Residual risks for some infections had changed
 - Emergence of new pathogens (ZIKA, BORNA, Babesia,...)
- More importantly, the previous cost-effectiveness assessment did not take into account the impact of **possible emerging pathogens that could pose a risk to transfusion safety**, a scenario that is all the more likely given the recent events (COVID-19, monkeypox, etc.)
- **Study objective : Evaluate ICER for PRT (*INTERCEPT Blood System*, Cerus Corporation) for plasma and platelets in Quebec, in 2020, also looking at scenarios for potential, emerging pathogens**

- The methodological approach is similar to the 2007 analysis (Markov models)
- PRT was modeled as **an addition to existing safety measures** (including screening tests) and not as a replacement
 - **Exception : Bacterial cultures of platelets**
- The analysis took into account :
 - **Benefits of PRT for reducing risks of infection**
 - **Benefits of PRT for non-infectious complications**
 - **Loss of productivity associated with infections**
 - **Costs of PRT, current screening tests, treatments for infections and non-infectious complications**

Methods (2/3)

Inputs related to the risk of pathogen transmission and various complications

Proportion of transfusions stratified by blood component combinations and PRT risk adjustment factor used for each combination

Transfused component(s)	Proportion of recipients (%) ¹	PRT adjustment factor ²
Plasma-containing transfusions	21.2	
Plasma only	12.9	100% of PRT AF
Plasma and RBCs	8.3	50% of PRT AF
Platelet-containing transfusions	78.8	
Platelets only	45.4	100% of PRT AF
Platelets and RBCs	23.4	50% of PRT AF
Platelets and plasma	1.9	100% of PRT AF
Platelets, RBCs, and plasma	8.0	50% of PRT AF

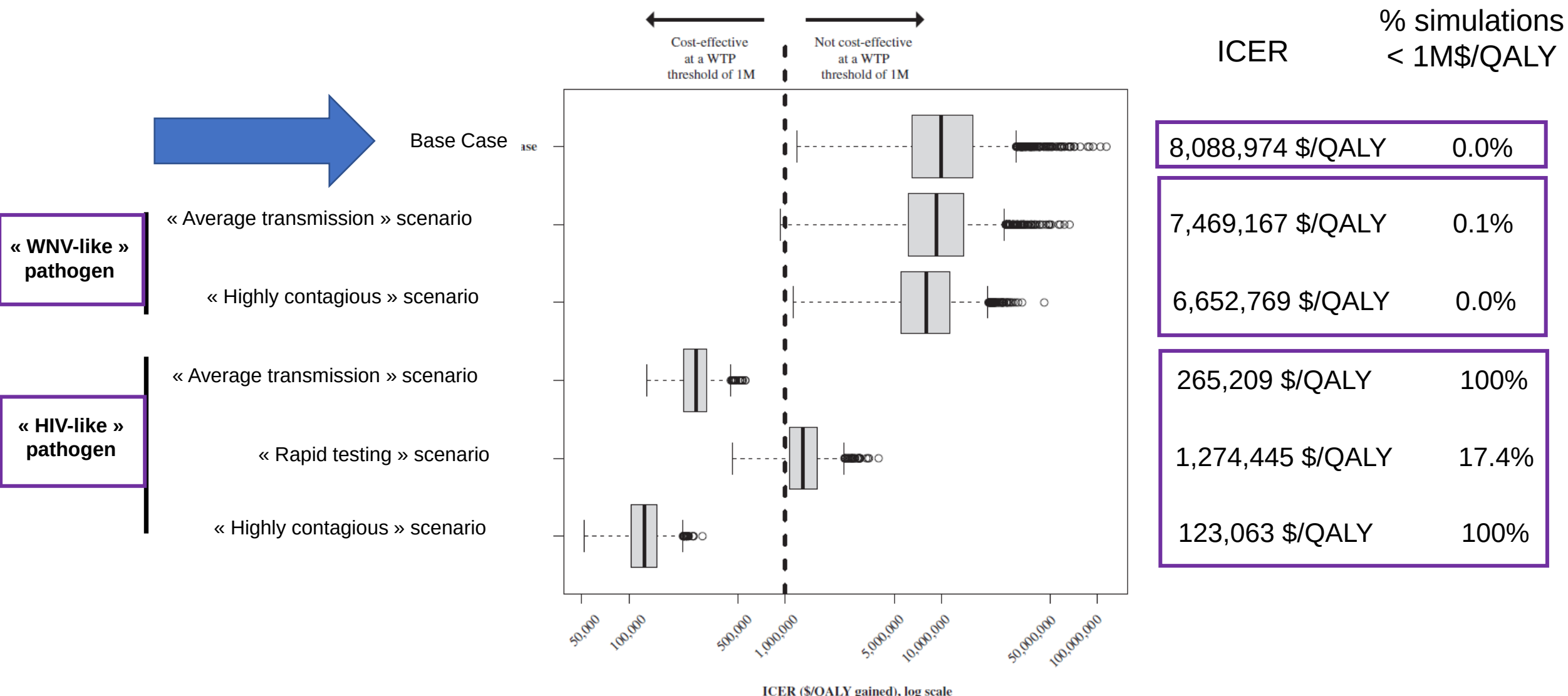
Pathogen or condition	Prevalence or yield of testing	Residual risk	Source for prevalence or residual risk estimates	Clinical risk reduction factor ^{1,2}	Estimated risk post-PRT
Base case					
Sepsis due to bacterial contamination of platelets	N/A	1/1,000,000	McDonald et al. 2017, ³⁵ Hong et al. 2016, ³⁶ Benjamin et al. 2008 ³⁷	50 (10-90)	1/50,000,000
Sepsis due to bacterial contamination of plasma	N/A	0	Assumption	50 (10-90)	0
CHIKV	N/A	1/10,000,000	Assumption	1.5 (1.01-1.99)	1/15,000,000
CMV	N/A	1/80,000	Custer et al., 2010 ¹¹	2 (1.25-2.75)	1/160,000
FNHTR	N/A	1/610	Cohn et al., 2014 ³⁸	2 (1.01-2.99)	1/1,200
HBV	1/21,824	1/1,961,690	Internal data from Héma-Québec ²¹	10 (5-15)	1/19,616,900
HCV	1/29,954	1/45,414,765	Internal data from Héma-Québec ²¹	10 (5-15)	1/454,147,650
HIV	1/763,823	1/31,824,560	Internal data from Héma-Québec ²¹	10 (5-15)	1/318,245,600
HTLV(I/II)	1/166,614	1/11,458,513	Internal data from Héma-Québec ²¹	10 (5-15)	1/114,585,130
Syphilis	1/21,824	1/2,000,000	Internal data from Héma-Québec ²¹ , assumption for residual risk	10 (5-15)	1/20,000,000
Trypanosoma cruzi	N/A	1/4,000,000	Canadian surveillance data	20 (10-30)	1/80,000,000
TA-GVHD	N/A	1/2,400,000	Custer et al., 2010 ¹¹	2 (1.25-2.75)	1/4,800,000
TRIM	N/A	1/150,000	Custer et al., 2010 ¹¹	1.5 (1.01-1.99)	1/225,000
WNV	1/115,600	1/1,000,000	Assumption	10 (5-15)	1/10,000,000

Methods (3/3)

- Changes compared to previous analysis :
 - Update of model parameters (when possible and justified)
 - Inclusion of possible scenarios regarding the occurrence of emerging pathogens that would pose a risk to transfusion safety (« **hypothetical** » **emerging pathogens**)
 - A pathogen that would have characteristics similar to those of HIV (epidemiology, transmissibility, incubation phase, clinical outcome, etc.
 - A pathogen that would have characteristics similar to those of West Nile virus (WNV)

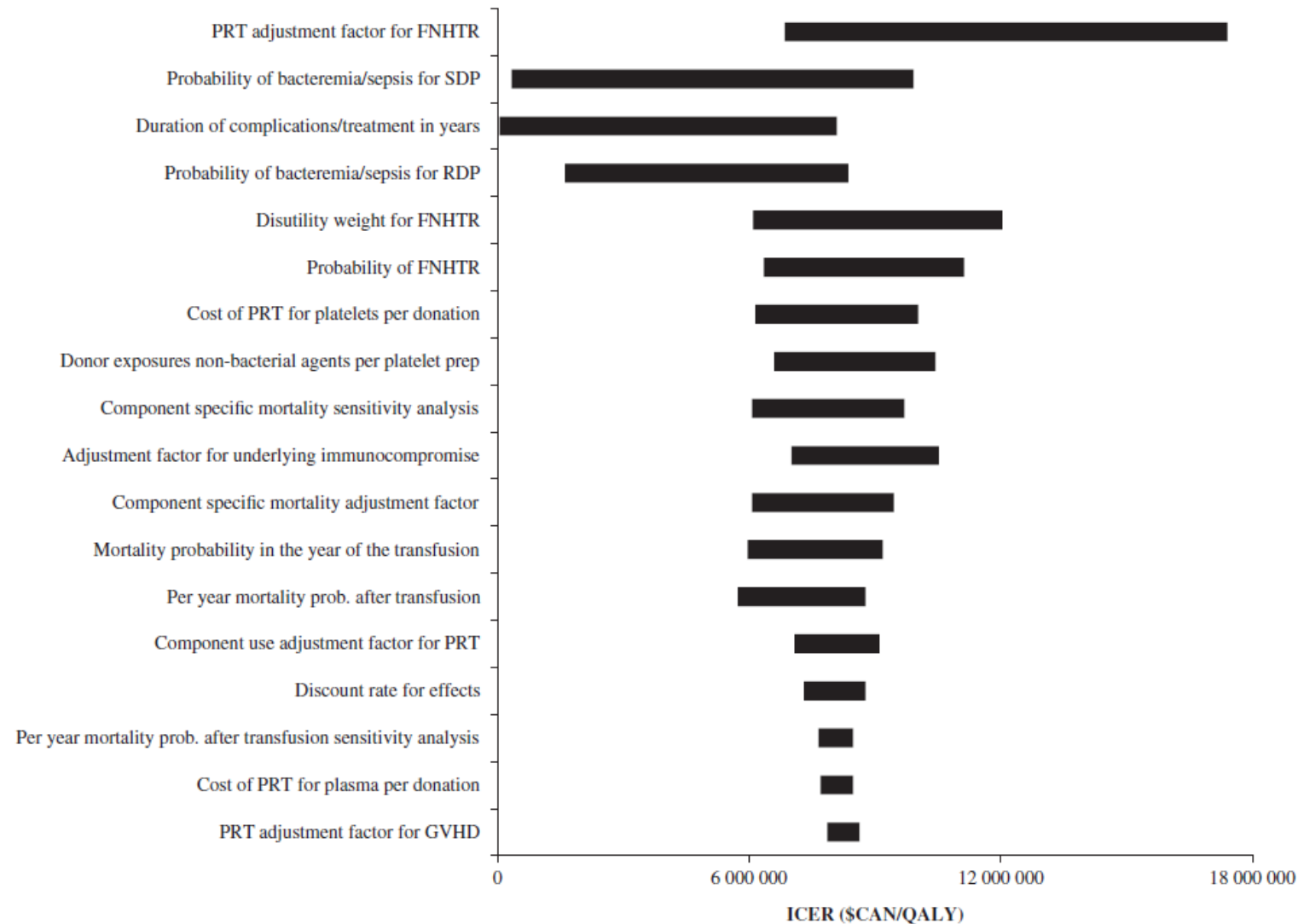
« Fictional » Emerging Pathogen	Scenario	Risk (No PRT)	Risk (with PRT)	Clinical Risk Reduction Factor	Transfusion transmission data
« WNV-like »	« Average transmission » scenario	1/115,607	1/1,156,070	10 (5-15)	2003-2016
	« Highly contagious » scenario	1/44,444	1/444,440	10 (5-15)	2012-2014
« HIV-like »	« Average transmission » scenario	1/10,548	1/105,480	10 (5-15)	1978-1985
	« Rapid testing » scenario	1/51,020	1/510,200	10 (5-15)	1978-1981
	« Highly contagious » scenario	1/5,720	1/56,720	10 (5-15)	1984

Results



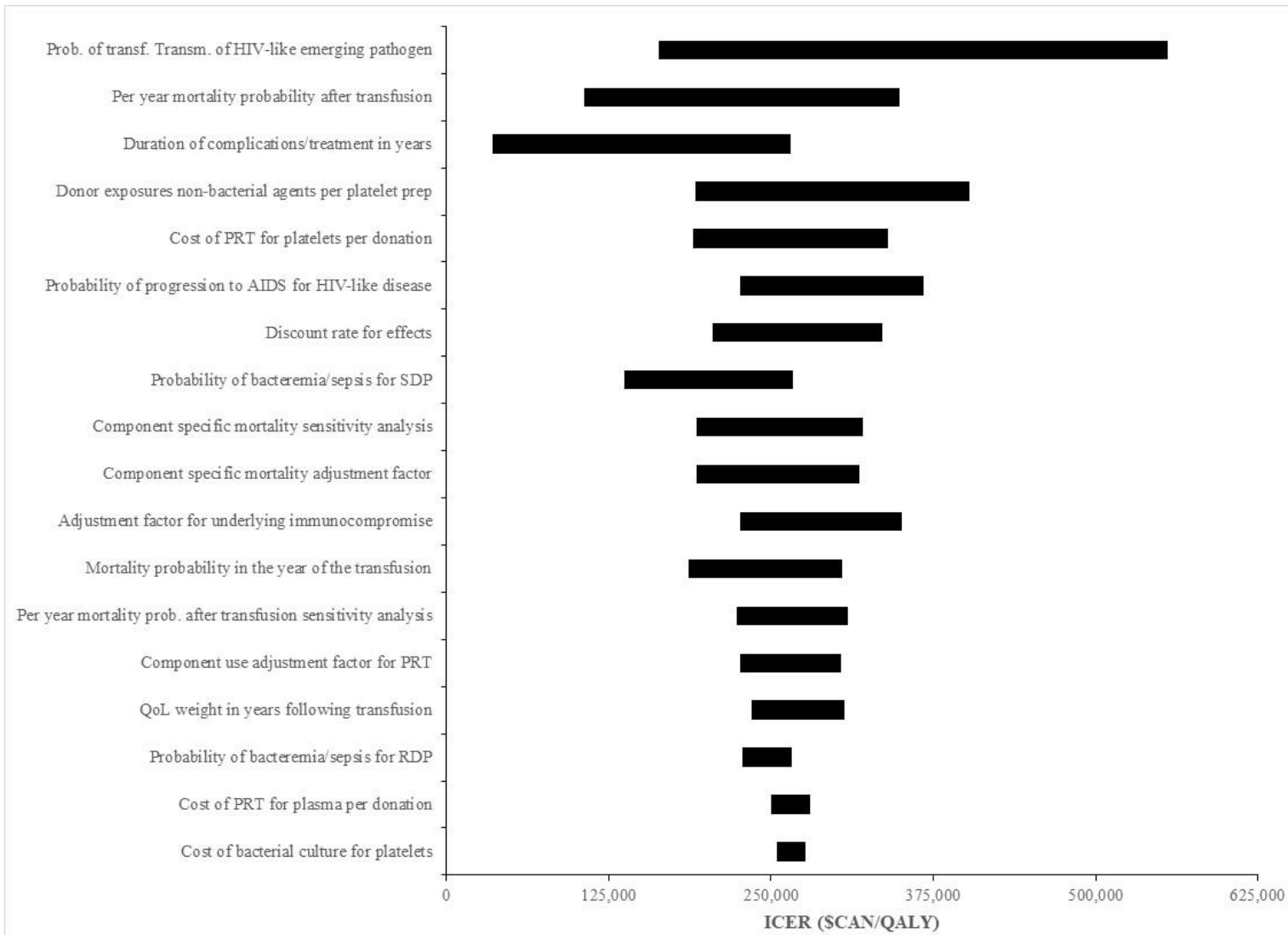
Results

Tornado diagram depicting the results of the sensitivity analyses for the base case scenario



Results

Tornado diagram depicting the results of the sensitivity analyses for the for the “average” scenario that assumed the emergence of an HIV-like pathogen



Discussion

- Calculated ICER (even for base case) is of the same order of magnitude as other safety precautions in transfusion

Measure	ICER	References
NAT (in <i>pool</i>) for HBV, HCV and HIV (vs. serological testing)	1.5 – 1.6 M\$/QALY	Marshall et al. 2004. Vox Sang. 86(1): 28-40 Custer et al. 2017. Vox Sang. 112(6): 526-534
Individual NAT for Zika virus (vs. no measure)	341 M\$/QALY	Russel et al. 2019. Ann Intern Med. 170(3): 164-174

- ICER for base case is higher than in 2007 (8,088,974\$/QALY vs. 1,423,000\$/QALY), mainly because :
 - Risks for some infectious complications are lower: e.g. hepatitis B, hepatitis C, and HIV
 - Better therapies (e.g. HCV)
 - Reduced risks of non-infectious complications, such as febrile non-hemolytic reactions
- Costs of PRT have remained almost the same from 2007 to 2020 (~100\$/product)
- **ICER for PRT is much more favorable when assuming the appearance of an emerging pathogen with characteristics similar to HIV**

- Study limitations:
 - The analysis assumes that leucoreduction would still be done along with PRT. If abandoned, ICER would be lower
 - The analysis relied on transfusion recipients characteristics dating from 2013 (more recent data unavailable because of confidentiality issues)
 - Results cannot be generalised to technologies other than the INTERCEPT Blood System (Cerus Corporation)
 - Cost-effectiveness in the context of an emerging pathogen would likely be temporary (i.e. until the introduction of a new screening test)

Conclusions

- ICER for PRT is 8,088,974\$/QALY in the base case scenario
- ICER for PRT is much more favorable when assuming the appearance of an emerging pathogen with characteristics similar to HIV
- The decision to implement PRT should take into consideration the inevitable appearance of emerging pathogens that could pose a threat to the safety of the blood supply
- The full benefits of PRT will happen only when the technology is applicable to all blood products, not just platelets and plasma
- The benefits of PRT as an ‘insurance policy’ could go beyond just those that were calculated in this study
 - The cost-effectiveness calculations do not take into consideration the potential cost savings that would result from not implementing screening tests or other mitigation measures (e.g. deferrals) for non-significant emerging pathogens (e.g. Zika, monkeypox, etc.)

Questions?