



ORIGINAL
RESEARCH

Comparison between traditional and goal directed perfusion in cardiopulmonary by-pass. Adaptation of a differential cost analysis

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ABSTRACT

BACKGROUND: A previous patient-level discrete event simulation (DES) model was developed to perform an economic evaluation of GDP strategy with respect to TP in US. Aim of this supplement is provide results of the adaptations of the differential cost analysis to Belgium, Canada, France, Germany, Italy, and UK. **METHODS:** A Discrete Event Simulation model was developed to compare TP and GDP strategy in patients undergoing CPB. National perspective was adopted to calculate costs associated to each event while GDP strategy was exploited the introduction of Sorin Heartlink (HL) Card/GDP Card and Sorin Connect (electronic data management system). **RESULTS:** GDP reduces the total cost with respect to traditional perfusion; furthermore the cost of GDP strategy (Sorin GDPTM Monitor and Sorin ConnectTM) is completely offset by the saving in hospital stay. **CONCLUSION:** GDP seems to improve significantly the main outcomes related to CPB surgery, when compared to TP techniques. Additional costs due to perform GDP strategy have no impact on the total cost since completely offset by the savings in hospital cost.

Keywords

Cardiopulmonary bypass; Traditional perfusion; Goal directed perfusion

INTRODUCTION

A previous patient-level discrete event simulation (DES) model was developed incorporating baseline outcomes rates and comparative efficacy data from published literature, and US hospital cost data [1] to compare traditional perfusion (TP – targeted on BSA and CPB temperature) and goal-directed perfusion (GDP – specifically aimed at maintaining DO₂ over the critical threshold) in patients undergoing CPB. This supplement provides results of the adaptations of the differential cost analysis to Belgium, Canada, France, Germany, Italy, and UK.

METHODS

Model structure

The patient's pathway (Table I) is detailed below.

During CPB:

- Each patient is characterized by sampling a nadir haematocrit (HCT) value; this is independent of the perfusion strategy considered.
- According to the HCT level (> or < 26%), patients reach DO₂ target with a probability that depends on the perfusion strategy.
- According to transfusion protocol (depending on HCT level) patients can receive packed red cells (PRCs).
- Patients are at risk of renal adverse events:
 - AKI, with probabilities depending on DO₂ level (target reached or not).
 - Renal failure needing RT (only for patients experiencing AKI) with probabilities that also depend on DO₂ level (target reached or not).

Post CPB:

- During the post-operative period, patients can die with probability that depends on

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Disclosure

This supplement was funded by Sorin Group.

Event	Depending on
During CPB surgery	
Reaching DO2 target	HCT, P*
PRCs transfused	HCT
Renal disease (AKI)	DO2
AKI needing of RT	DO2
In ICU (post-CPB)	
LOS	DO2
PRCs transfused	HCT
Death	AKI
In ward	
LOS	DO2

Table I. Events evaluated during the simulation

*** perfusion strategy (traditional or GDP)**

AKI = acute kidney injury; HCT= nadir haematocrit; LOS = length of stay; PRCs = packed red cells

renal complications (AKI or not) and can receive PRCs.

- Post-operative length of stay (LOS) in ICU depends on DO2 level during CPB.
- LOS in ward (only for patients discharged alive from ICU) depends on DO2 level during CPB.

All clinical input parameter was described in [1].

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COST INPUT

The cost of GDP strategy was calculated considering the introduction of Sorin Heartlink (HL) Card/GDP card and Sorin Connect (electronic data management system); for every cost the worst case (i.e. higher possible price) was considered: cost of the card was € 80.00 and cost of Connect per patient, calculated dividing the total hospital cost for GDP monitors (assuming three system per hospital) by the number of cases per HL Card/GDP Card and the Connect lifetime (10 years), results in € 14.93.

Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about € 7,200 vs. € 9,000); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin Connect™)

Cost items	Unit cost	Source
Renal replacement therapy (€/day)	105.92	[2]
ICU (€/day)	705.79	[3]
Ward (€/day)	500.58	[3]
PRC unit transfused (€)	93.00	[4]

Table I. Unit cost used in the model, updated to 2014

	Resulted costs (€) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	8,830 (6,094-11,465)	6,907 (4,619-9,249)	1,922 (734-2,959)
• ICU stay	2,565 (1,502-3,667)	1,779 (1,000-2,674)	786 (193-1,301)
Renal complication	15 (0-37)	4 (-3-12)	10 (-4-32)
Transfusion	231 (139-321)	232 (139-322)	-1 (-2-0)
GDP (HL Card+connect)	NA	95 (60-131)	-95 (-131- -60)
Total cost	9,075 (6,341-11,715)	7,238 (4,943-9,586)	1,837 (644-2,883)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

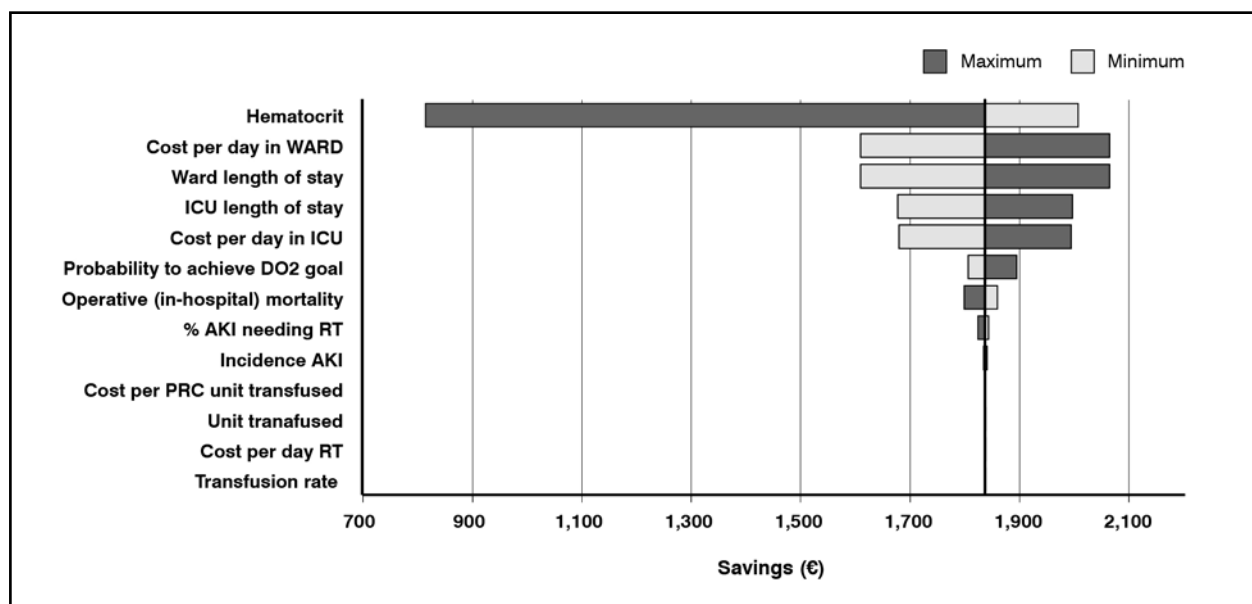


Figure 1. Deterministic sensitivity analysis – tornado diagram for saving

is completely offset by the saving in hospital stay (Table II). Total saving is mostly influenced by nadir haematocrit, hospital length of stay and hospital cost per day, both in ICU and ward (Figure 1).

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COST INPUT

The cost of GDP strategy was calculated considering the introduction of Sorin Heartlink (HL) Card/GDP card and Sorin Connect (electronic data management system); for every cost the worst case (i.e. higher possible price) was considered: cost of the card was \$CAN 80.00 and cost of Connect per patient, calculated dividing the total hospital cost for GDP monitors (assuming three system per hospital) by the number of cases per HL Card/GDP Card and the Connect lifetime (10 years), results in \$CAN 10.05.

Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about \$CAN 13,500 vs. \$CAN 17,200); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin

Cost items	Unit cost	Source
Renal replacement therapy (\$CAN/day)	500.07	[2]
ICU (\$CAN/day)	1,662.38	[3]
Ward (\$CAN/day)	816.02	[3]
PRC unit transfuse (\$CAN)	347.99	[4]

Table I. Unit cost used in the model, updated to 2014

	Resulted costs (\$CAN) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	16,254 (11,417-20,956)	12,550 (8,542-16,728)	3,704 (1,417-5,687)
• ICU stay	6,042 (3,537-8,637)	4,190 (2,355-6,299)	1,852 (456-3,065)
Renal complication	69 (1-174)	19 (-14-58)	49 (-20-150)
Transfusion	863 (519-1,200)	867 (521-1,205)	-3 (-8-1)
GDP (HL Card+connect)	NA	90 (57-125)	-90 (-125- -57)
Total cost	17,186 (12,353-21,914)	13,526 (9,490-17,731)	3,660 (1,361-5,685)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

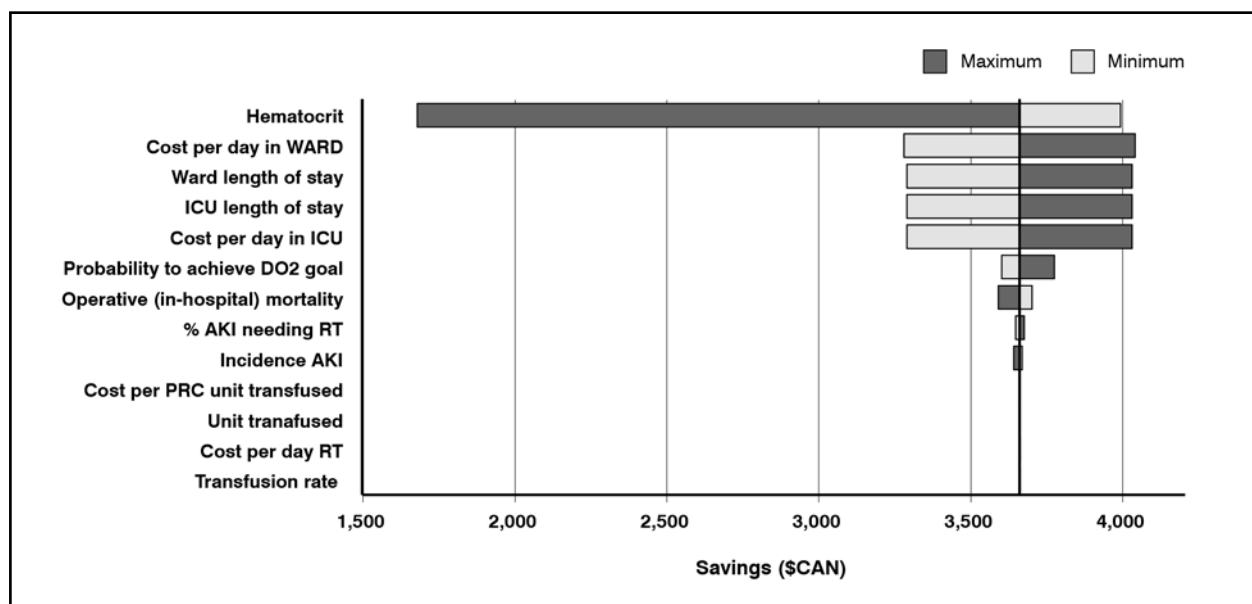


Figure 1. Deterministic sensitivity analysis – tornado diagram for saving

Connect™) is completely offset by the saving in hospital stay (Table II). Total saving is mostly influenced by nadir haematocrit, hospital length of stay and hospital cost per day, both in ICU and ward (Figure 1).

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COST INPUT

The cost of GDP strategy was calculated considering the introduction of Sorin Heartlink (HL) Card/GDP card and Sorin Connect (electronic data management system); for every cost the worst case (i.e. higher possible price) was considered: cost of the card was € 80.00 and cost of Connect per patient, calculated dividing the total hospital cost for GDP monitors (assuming three system per hospital) by the number of cases per HL Card/GDP Card and the Connect lifetime (10 years), results in € 9.71.

Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about € 8,500 vs. almost € 11,000); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin

Cost items	Unit cost	Source
Renal replacement therapy (€/day)	154.20	[2]
ICU (€/day)	1,336.62	[3]
Ward (€/day)	447.37	[4]
PRC unit transfused (€)	183.84	[5]

Table I. Unit cost used in the model, updated to 2014.

	Resulted costs (€) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	10,457 (7,402-13,460)	7,952 (5,464-10,603)	2,504 (937-3,858)
• ICU stay	4,858 (2,844-6,945)	3,369 (1,893-5,065)	1,489 (366-2,464)
Renal complication	21 (0-54)	6 (-4-18)	15 (-6-46)
Transfusion	456 (274-634)	458 (275-636)	-2 (-4-1)
GDP (HL Card+connect)	NA	90 (56-124)	-90 (-124- -56)
Total cost	10,934 (7,881-13,944)	8,506 (6,006-11,167)	2,428 (855-3,796)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

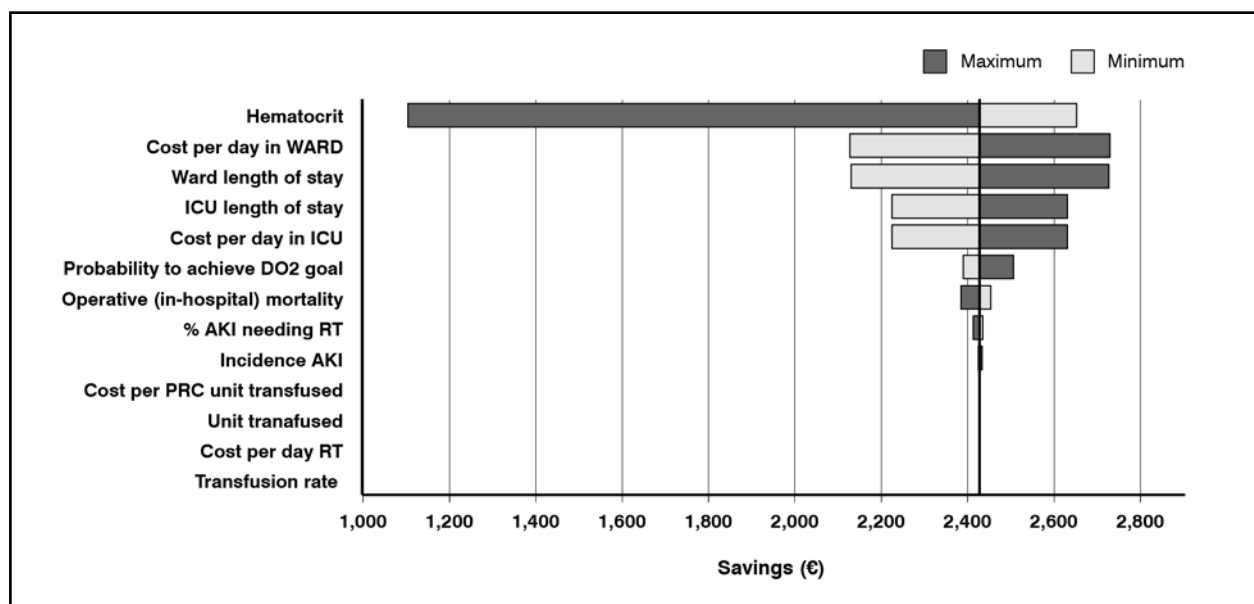


Figure 1. Deterministic sensitivity analysis – tornado diagram for saving

Connect™) is completely offset by the saving in hospital stay (Table II). Total saving is mostly influenced by nadir haematocrit, hospital length of stay and hospital cost per day, both in ICU and ward (Figure 1).

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COST INPUT

The cost of GDP strategy was calculated considering the introduction of Sorin Heartlink (HL) Card/GDP card and Sorin Connect (electronic data management system); for every cost the worst case (i.e. higher possible price) was considered: cost of the card was € 80.00 and cost of Connect per patient, calculated dividing the total hospital cost for GDP monitors (assuming three system per hospital) by the number of cases per HL Card/GDP Card and the Connect lifetime (10 years), results in € 9.26.

Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about € 7,800 vs. € 10,000); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin Con-

Cost items	Unit cost	Source
Renal replacement therapy (€/day)	72.78	[2]
ICU (€/day)	1,141.86	[3]
Ward (€/day)	448.44	[4]
PRC unit transfused (€)	105.53	[5]

Table I. Unit cost used in the model, updated to 2014

	Resulted costs (€) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	9,762 (6,899-12,564)	7,472 (5,121-9,954)	2,290 (867-3,520)
• ICU stay	4,150 (2,430-5,933)	2,878 (1,618-4,327)	1,272 (313-2,105)
Renal complication	10 (0-25)	3 (-2-8)	7 (-3-22)
Transfusion	262 (157-364)	263 (158-365)	-1 (-2-0)
GDP (HL Card+connect)	NA	89 (56-123)	-89 (-123--56)
Total cost	10,034 (7,172-12,837)	7,827 (5,471-10,314)	2,207 (780-3,445)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

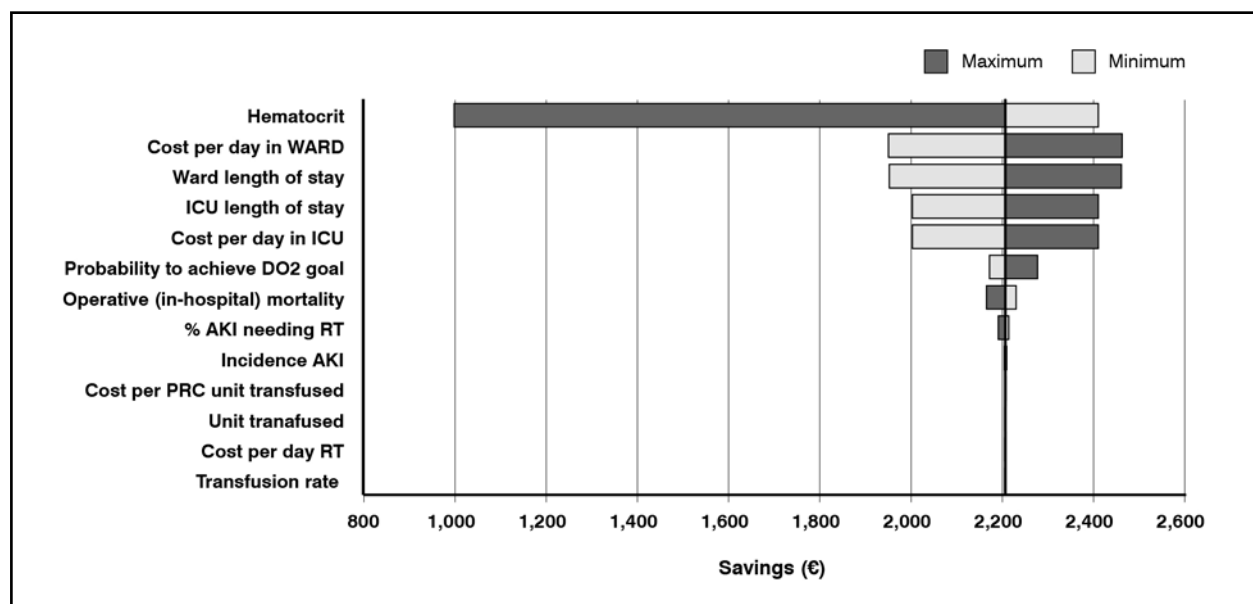


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nect™) is completely offset by the saving in hospital stay (Table II). Total saving is mostly influenced by nadir haematocrit, hospital length of stay and hospital cost per day, both in ICU and ward (Figure 1).

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COST INPUT

The cost of GDP strategy was calculated considering the introduction of Sorin Heartlink (HL) Card/GDP card and Sorin Connect (electronic data management system); for every cost the worst case (i.e. higher possible price) was considered: cost of the card was € 80.00 and cost of Connect per patient, calculated dividing the total hospital cost for GDP monitors (assuming three system per hospital) by the number of cases per HL Card/GDP Card and the Connect lifetime (10 years), results in € 12.12.

Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about € 7,500 vs. € 9,600); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin Connect™)

Cost items	Unit cost	Source
Renal replacement therapy (€/day)	340.20	[2]
ICU (€/ day)	1,018.44	[3]
Ward (€/day)	441.18	[4]
PRC unit transfused (€)	153.00	[5]

Table I. Unit cost used in the model, updated to 2014

	Resulted costs (€) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	9,223 (6,504-11,875)	7,087 (4,844-9,441)	2,136 (813-3,281)
• ICU stay	3,702 (2,167-5,292)	2,567 (1,443-3,859)	1,135 (279-1,878)
Renal complication	47 (0-118)	13 (-10-40)	34 (-13-102)
Transfusion	380 (228-528)	381 (229-530)	-1 (-3-1)
GDP (HL Card+connect)	NA	92 (58-127)	-92 (-127--58)
Total cost	9,649 (6,937-12,317)	7,573 (5,317-9,942)	2,076 (744-3,251)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

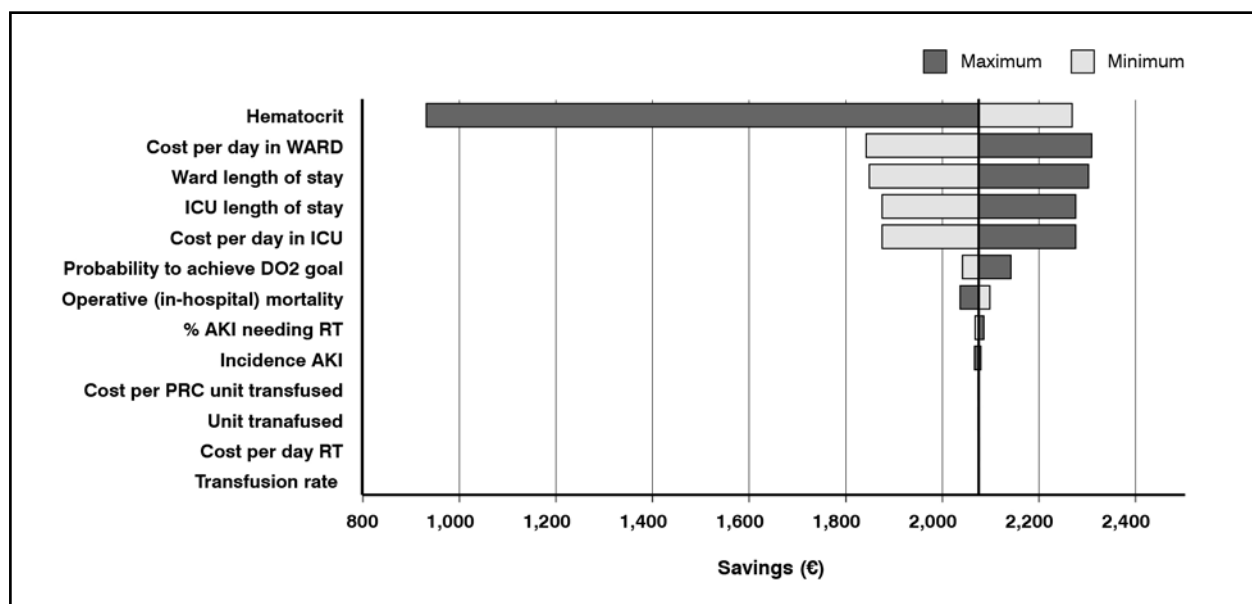


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is completely offset by the saving in hospital stay (Table II). Total saving is mostly influenced by nadir haematocrit, hospital length of stay and hospital cost per day, both in ICU and ward (Figure 1).

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United Kingdom



COST INPUT

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Unit costs, updated to 2014 using official inflation indices [1], are summarized in Table I.

RESULTS

GDP reduces the total cost with respect to traditional perfusion (about £ 9,300 vs. £ 12,200); furthermore the cost of GDP strategy (Sorin GDP™ Monitor and Sorin Con-

Cost items	Unit cost	Source
Renal replacement therapy (£/day)	159.65	[2]
ICU (£/day)	1,841.76	[3]
Ward (£/day)	402.67	[4]
PRC unit transfused (£)	167.55	[5]

Table I. Unit cost used in the model, updated to 2014

	Resulted costs (£) [Mean (95% CI)]		
	TP strategy	GDP strategy	Savings (GDP vs. TP)
Hospital stay	11,733 (8,245-15,211)	8,767 (5,998-11,789)	2,966 (1,056-4,613)
• ICU stay	6,694 (3,919-9,569)	4,642 (2,609-6,979)	2,052 (505-3,396)
Renal complication	22 (0-55)	6 (-5-19)	16 (-6-48)
Transfusion	416 (250-578)	417 (251-580)	-1 (-4-1)
GDP (HL Card+connect)	NA	93 (58-128)	-93 (-128--58)
Total cost	12,171 (8,687-15,652)	9,284 (6,507-12,312)	2,887 (971-4,549)

Table II. Resulted cost for traditional and goal directed perfusion: mean results from base case (10,000 simulated patients) while the 95% CI is calculated from PSA (1,000 x 1,000 simulation)

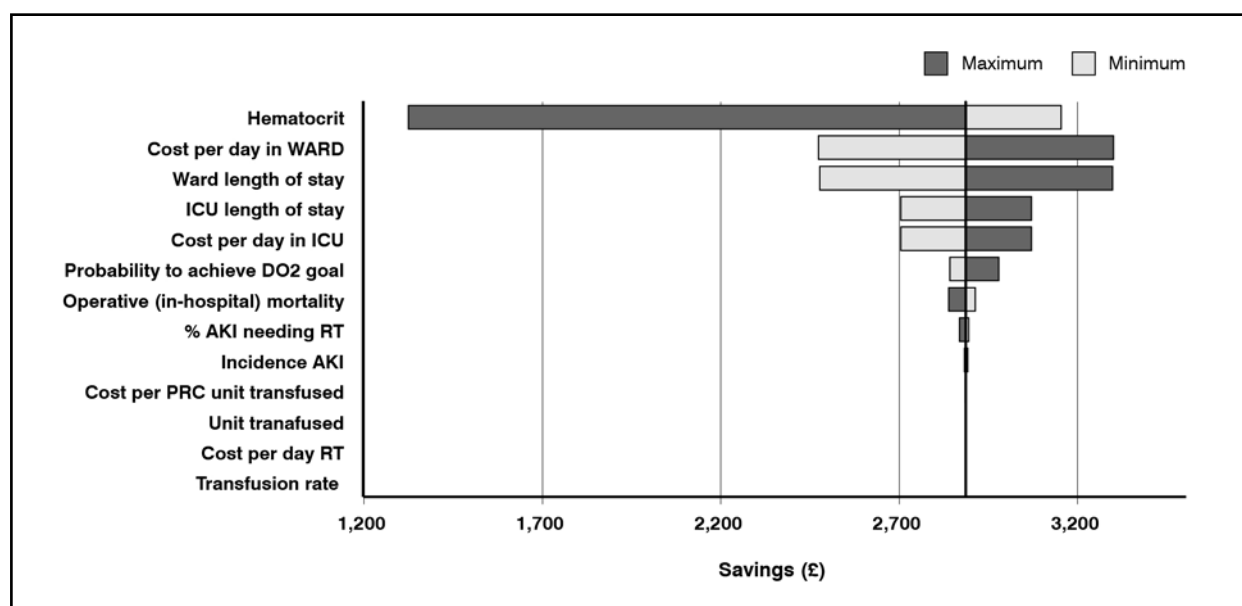


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