COST AND OPERATIONAL EFFICIENCY COMPARISON OF AN INTEGRATED VS. A MULTI-STEP SYSTEM FOR EXTRACORPOREAL PHOTOPHERESIS IN GERMANY

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BACKGROUND

- Extracorporeal photopheresis (ECP) is a treatment in which the mononuclear cells of a patient are *ex vivo* exposed to 8-Methoxypsoralen (8-MOP), irradiated with ultraviolet A, and then reinfused into the patient.[1,2]
- Two approaches exist for delivering ECP: 1) integrated ECP systems, where all procedure steps are fully integrated and the patient remains connected to the system and 2) multi-step systems, where separate devices are used for cell separation and photoactivation.[3]

OBJECTIVE

- Aim of this model was to compare the budget impact of delivering photopheresis with an integrated and a multi-step system.

METHODS

- A decision analytic model was developed in Excel to compare the two ECP approaches in different scenarios.
- Scenarios were adjustable by procedure steps times, cost parameters, average German Diagnosis Related Groups (G-DRG) lump sum, weekly available time, occupation of personnel and time horizon.
- The procedure steps for each treatment were the set-up time, apheresis time, illumination time and reinfusion time which in sum resulted in the total treatment duration in minutes and in the total bed retention time by adding an additional bed retention time to the treatment duration.
- Other time parameters were the occupation of a physician and operator per treatment cycle in minutes.
- These time parameters determined how many treatments could be achieved in the set time period which was set to one year with five workdays per treatment week and nine hours per workday available for ECP treatment in this analysis.
- The default values for the time parameters were obtained by averaging the data of four different hospitals applying ECP.
- Cost parameters included wage for physicians and operators, bed retention costs per hour, pharmaceutical costs of 8-MOP, costs for different procedure kits of both systems and costs for potential laboratory tests.
- The hourly wages were comprised by the average personnel costs for physicians and nursing for each full-time equivalent (FTE) stated in the cost data of hospitals by the German federal office of statistics (DESTATIS) for 2014.
- Bed retention costs per hour were based on the total costs and number of hospital beds in Germany stated by DESTATIS for 2014.[4,5]
- The pharmaceutical costs were obtained from the Lauer-Taxe under the assumption of using one vial per treatment.
- The prices for physical procedure kit costs were determined by information of the vendor.
- Capital costs and service costs were excluded for this analysis due to high variations among hospitals but can be implemented in the cost comparison of the calculator for specific considerations.
- A weighted average lump-sum of all G-DRG presenting with codes for ECP in 2016 was calculated with information from the G-DRG-Report-Browser of the Institut für das Entgeltsystem im Krankenhaus (InEK GmbH).[6]
- Sensitivity analyses were conducted to assess the consistency and robustness of results by varying all time and cost parameters.
- The default values of the input parameters for the base case scenario are stated in Table 1.

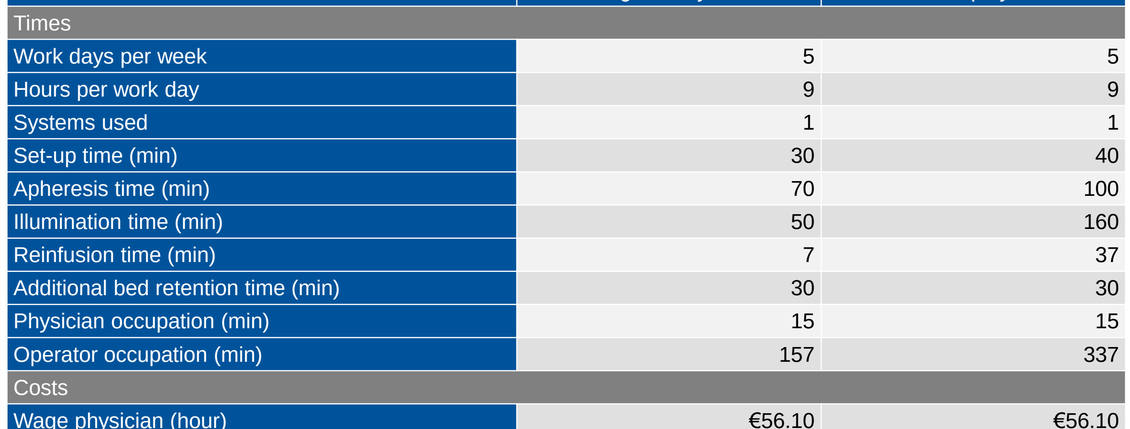
Table 1. Default Parameter Values

Parameter	Integrated system	Multi-step system
Times		
Work days per week	5	5
Hours per work day	9	9
Systems used	1	1
Set-up time (min)	30	40
Apheresis time (min)	70	100
Illumination time (min)	50	160
Reinfusion time (min)	7	37
Additional bed retention time (min)	30	30
Physician occupation (min)	15	15
Operator occupation (min)	157	337
Costs		
Wage physician (hour)	€56.10	€56.10
Wage operator (hour)	€25.80	€25.80
Bed retention costs (hour)	€87.94	€87.94
8-MOP costs (per treatment)	€89.25	€89.25
Procedure kit I (per treatment)	€983.33	€297.50
Procedure kit II (per treatment)	-	€238.00
Laboratory analysis (per treatment)	€50.00	€50.00
Income		
Average DRG lump-sum (per treatment)	€3,492.00	€3,492.00

RESULTS

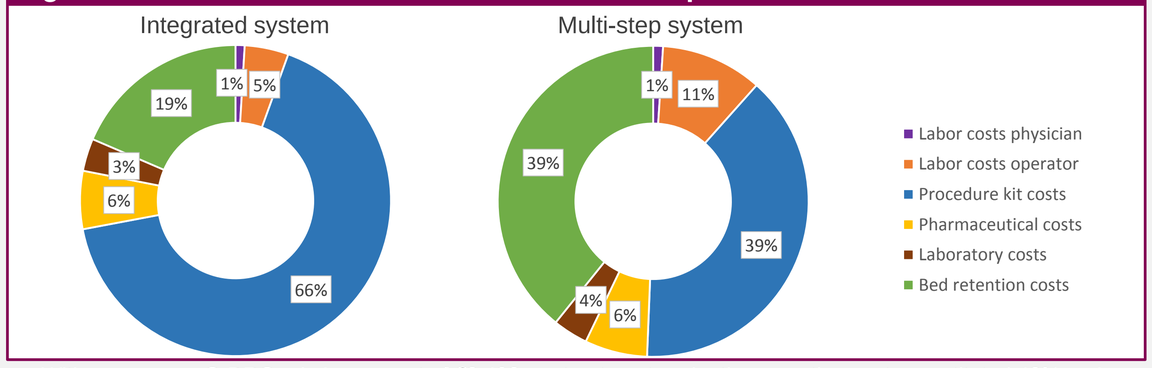
- The integrated system achieved three times more treatments due to shorter procedure step times, which lead to a system utilization of 87% compared to 62% of the multi-step system (Figure 1).
- By assuming a 45 hour working week, the integrated system needed 0.09 physician FTEs and 0.98 operator FTEs for all applications whereas the multi-step system required 0.03 and 0.70 FTEs respectively.

Figure 1. Daily Treatment Sequence and System Utilization



- Over a one year time period, the application of each system resulted in 780 treatment cycles for the integrated approach vs. 260 treatment cycles for the multi-step approach with cost of €1,478 and €1,372 per cycle respectively.
- Due to the three times higher treatment volume for the integrated system the annual costs amounted to €1,152,992 vs. €356,612 for the multi-step system.
- A large proportion of the total costs was induced by the physical procedure kits with 66.5% of costs for the integrated and 39.0% for the multi-step system respectively. However, the breakdown of hospitals overheads on bed retention times constituted a slightly greater part on the costs for the multi-step system with a proportion of 39.2%. The labor costs for physicians were the smallest part in the cost composition for both systems (Figure 2).

Figure 2. Distribution of Total Costs on Cost Components



- With an average G-DRG reimbursement of €3,492 per treatment cycle, the operating costs constituted 42% and 39% of the G-DRG compensation, which implies a slightly greater marginal profit of the multi-step system.
- Applying the integrated system resulted in annual net earnings of +€1,570,770.05 compared to +€551,308.62 for the multi-step system.
- The net earnings result in a budget impact of €1,019,461 for one year in favor for the integrated system when comparing both approaches (Figure 3).

Figure 3. Annual Costs, Income and Net Earnings of ECP Systems

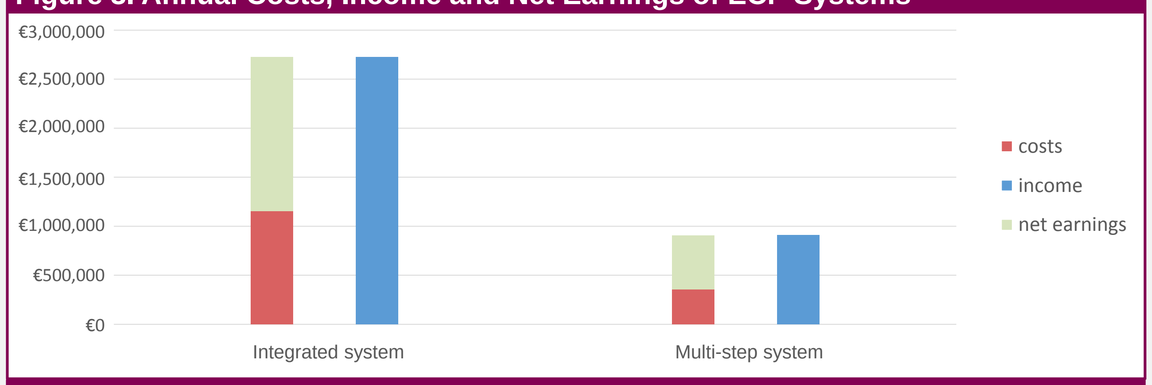
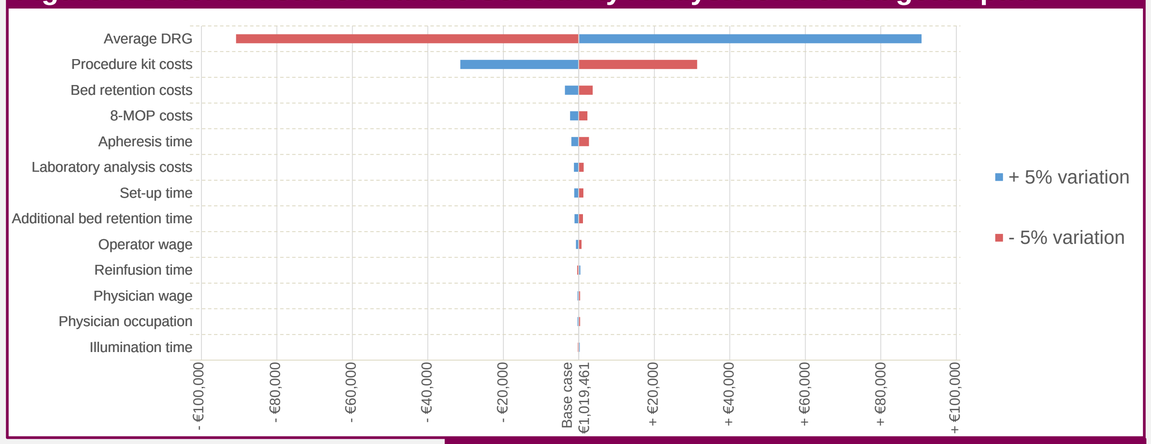
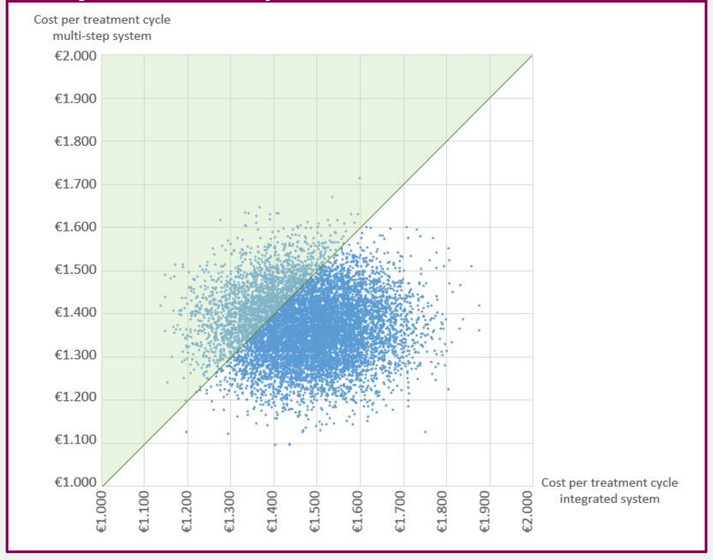


Figure 4. Deterministic Univariate Sensitivity Analysis of the Budget Impact



- A deterministic univariate sensitivity analysis for all cost and time parameters showed that the variation of average G-DRG lump-sums had the greatest impact on the budget impact with ±€90,790.
- The procedure kit costs ranked second with a 3% change in budget impact whereas the effects of all other parameter variations were smaller than 1% (Figure 4).
- A multivariate probabilistic sensitivity analysis was conducted to assess the variation of the costs per treatment with respect to parameter uncertainty. The integrated system showed lower costs per treatment cycle in 21% of 10,000 performed calculations (Figure 5).
- The maximum/minimum costs per treatment cycle were €1,876/€1,137 and €1,715/€1,097 for the integrated and multi-step approach respectively.

Figure 5. Probabilistic Multivariate Sensitivity Analysis of Costs per Treatment



CONCLUSIONS

- Due to a better system utilization, integrated ECP systems can achieve a higher number of treatments than the multi-step approach in the same timeframe.
- Higher annual costs are compensated by a higher G-DRG revenue which makes the integrated approach financially advantageous with €1,019,461 greater net earnings in the considered base case scenario.
- The sensitivity analyses showed consistency for the beneficial budget impact of the integrated approach.
- Even when varying the cost parameters and procedure step times by +20% (integrated) and - 20% (multi-step), the budget impact of the integrated system remained beneficial compared to the multi-step system with +€197,439 in annual net earnings.
- Therefore, results show a substantial potential for hospitals to increase clinical efficiency and profitability in the healthcare delivery for the relevant patient groups by applying integrated ECP approaches.

Limitations

- This analysis is subject to the general limitations of health economic modeling. Due to necessary assumptions and parameter uncertainty the calculator provides an approximation for specific hospital realities and results need to be interpreted carefully.

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