

- 36 Viviano M, Catarino R, Jeannot E, et al. Self-sampling to improve cervical cancer screening coverage in Switzerland: a randomised controlled trial. *Br J Cancer* 2017; 116:1382–8.
- 37 Tavasoli SM, Pefoyo AJK, Hader J, et al. Impact of invitation and reminder letters on cervical cancer screening participation rates in an organized screening program. *Prev Med* 2016; 88:230–6.
- 38 Sultana F, English DR, Simpson JA, et al. Home-based HPV self-sampling improves participation by never-screened and under-screened women: results from a large randomized trial (iPap) in Australia. *Int J Cancer* 2016; 139:281–90.
- 39 Virtanen A, Nieminen P, Luostarinen T, Anttila A. Self-sample HPV tests as an intervention for nonattendees of cervical cancer screening in Finland: a randomized trial. *Epidemiol Biomarkers Prev* 2011; 20:1960–9.
- 40 McBride E, Marlow L, Forster AS, et al. Psychological Impact of Primary Screening (PIPS) for HPV: a protocol for a cross-sectional evaluation within the NHS cervical screening programme. *BMJ Open* 2016; 6:e014356.
- 41 Acera A, Manresa JM, Rodriguez D, et al. Increasing cervical cancer screening coverage: a randomised, community-based clinical trial. *PLoS one* 2017; 12:e0170371.

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The European Journal of Public Health, Vol. 28, No. 3, 415–420

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doi:10.1093/eurpub/cky035 Advance Access published on 23 March 2018
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Organ recovery cost assessment in the French healthcare system from 2007 to 2014

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Background: Organ recovery costs should be assessed to allow efficient and sustainable integration of these costs into national healthcare budgets and policies. These costs are of considerable interest to health economists, hospitals, financial managers and policy makers in most developed countries. This study assessed organ recovery costs from 2007 to 2014 in the French healthcare system based on the national hospital discharge database and a national cost study. The secondary objective was to describe the variability in the population of deceased organ donors during this period. **Methods:** All stays for organ recovery in French hospitals between January 2007 and December 2014 were quantified from discharge abstracts and valued using a national cost study. Five cost evaluations were conducted to explore all aspects of organ recovery activities. A sensitivity analysis was conducted to test the methodological choice. Trends regarding organ recovery practices were assessed by monitoring indicators. **Results:** The analysis included 12 629 brain death donors, with 28 482 organs recovered. The mean cost of a hospital stay was €7469 (SD = €10, 894). The mean costs of separate kidney, liver, pancreas, intestine, heart, lung and heart–lung block recovery regardless of the organs recovered were €1432 (SD = €1342), €502 (SD = €782), €354 (SD = €475), €362 (SD = €1559), €542 (SD = €955), €977 (SD = €1196) and €737 (SD = €637), respectively. Despite a marginal increase in donors, the number of organs recovered increased primarily due to improved practices. **Conclusion:** Although cost management is the main challenge for successful organ recovery, other aspects such as organization modalities should be considered to improve organ availability.

Introduction

Organ retrieval associated with organ transplantation is a validated procedure for treating patients with end-stage organ failure.¹ Organ transplantation improves life expectancy and simultaneously reduces the use of medical resources for managing organ failure.² In 2014, 118 646 patients around the world, including 40 201 in Europe, received an organ transplant.³ This therapy avoids the occurrence of repeated hospitalizations and reduces patient morbidity.⁴ In the last 10 years, the number of patients awaiting transplants has gradually increased, exceeding 63 000 in the 28 EU Member States. Despite the development of multiple international organ procurement networks and 11 492 European deceased donors, in 2014, the number of available grafts to meet the needs of the European population remained insufficient.³ That same year, 4100 people across the continent died while waiting for a transplant.

With more than 12 713 patients awaiting transplantation in 2014, France is also engaged in the race for organ procurement.⁵ From year to year, needs have progressed with the expansion of medical indications for transplantation and the ageing population. During the last decade, French legislation has evolved to stimulate the development of transplantation. The health ministry developed successive graft plans to meet the graft needs and better adapt to changes in the donor population.⁶ The implementation of hospital coordination throughout the country and the allocation of human and financial resources resulted in 1635 brain death donors in 2014 and 5370 transplant recipients.³

Transplantation is a very expensive treatment, but in kidney transplantation, for example, treating chronic terminal kidney failure with a graft is less costly for the community than dialysis treatment. In 2007, the cost of dialysis was assessed at approximately €89 000

per year, whereas the cost of transplantation is only approximately €20 000 per year per person for the lifetime of the graft.⁷ Moreover, transplantation significantly improves a patient's duration and quality of life.⁷ Ultimately, transplantation is the most cost-effective supportive treatment, providing the best quality of life for patients with chronic end-stage renal disease. Although organ recovery activities effectively addresses vital needs, in the context of health budgets, a monetary assessment is required for organ recovery to be efficiently and sustainably integrated into national health policies. An analysis of recent cost data would also inform financial management by hospitals and would provide researchers and health economists with real-world data for future economic evaluations. Despite the importance of these data, available medico-economic studies on organ recovery activities in France and Europe are either scarce or outdated.^{8,9} Other studies have used old data or have calculated the cost of organ acquisition but not organ recovery.^{10,11} In the Australian public health system, the costs of kidney and liver acquisition were assessed in 1996 and were found to be \$1860 and \$5049, respectively.¹⁰ A publication has found that pancreas procurement in the French system costs €1086.⁸ A possible explanation for the lack of data may be the difficulty in assessing the cost of an activity carried out during a multi-step emergency procedure, which compromises the real-time acquisition of cost data.

The development of hospital discharge databases in each French hospital and the implementation since 2006 of a national cost study provide an opportunity to solve this problem. Medico-economic and medico-administrative databases could be used to assess organ recovery costs, as has been done for other procedures.¹² Moreover, these databases may allow us to observe changes in donor populations, which is relevant for adjusting future graft plans to enhance organ recovery activity.

The main objective of this study was to assess organ recovery costs from 2007 to 2014 in the French healthcare system based on the national hospital discharge database and a national cost study. The secondary objective was to describe the variability in the population of deceased organ donors during this same period.

Methods

Study design

This study was based on discharge data for public and private French hospitals performing organ recovery from January 2007 to December 2014. Direct medical costs were estimated from the hospital's perspective. Direct non-medical costs and indirect costs were not considered in this study. The timeframe considered was from the beginning of the hospital stay during which organ recovery was performed until the end of the hospital stay. Costs related to liquid preservation, family management, machine perfusion and organ shipment were not included.

Databases

The national hospital discharge database and the French national cost study were used for this analysis.^{13,14} Their use as a medico-administrative database and an economic database, respectively, has allowed researchers to conduct previous medico-economic analyses.¹⁵ For each deceased donor identified during the eight consecutive years, a discharge abstract combining personnel and stay data was extracted from the national hospital discharge database.

All resources consumed during hospital stays for organ recovery were identified and quantified using the discharge abstract and were valued using the national cost study. The national cost study is annually updated with cost accounting data from representative hospitals.¹⁶

Patients and organ collection

All brain death donors who underwent kidney, liver, pancreas, intestine, heart, lung or heart–lung block recovery in one of the

181 public or private French hospitals between 2007 and 2014 were eligible. Kidney recovery in this paper systematically refers to the removal of both kidneys. Donors were excluded if hospital stay data were not correctly provided and/or if cost data were unavailable. To enhance representativeness, the French national cost study does not assess the costs of diagnosis in related groups with sparse numbers of patients providing data. Donors were identified in a medical database and selected using the Common Classification of Medical Procedures codes corresponding to organ recovery from donors after brain death (Supplementary Appendix S1). Living donors and donors after circulatory death were excluded.

Identification and quantification of cost components

Because cost information in the French healthcare system was not available at the individual level, the resources consumed during the organ recovery stay and organ recovery procedure were identified, quantified and valued retrospectively at the diagnosis-related group (DRG) level from the national cost study. Eight items were identified (Supplementary Appendix S2). Surgery, anaesthesia, reanimation, intensive care, ongoing monitoring, biology and imaging were sub-divided into five sub-items: medical staff, non-medical staff, nursing staff, maintenance, depreciation and cost of structure occupation. Medical logistics items were regrouped into sterilization, biomedical engineering, hygiene, vigilance and pharmacy groups.

Valuation of cost components

All cost components were valued in 2014 Euros. Items identified and quantified were valued using the corresponding annual national cost study. As organ recovery is not a classifying procedure, hospital stays for organ recovery may correspond to either a medical DRG or a surgical DRG, according to the main reason for hospital admission. The valuation process requires a specific methodology for each case.

For a surgical DRG, each surgical act related to (or not) an organ recovery procedure is characterized by the relative cost indexes (RCIs). An RCI is used to assess the cost of a procedure carried out in ideal conditions.¹⁷ These indexes are commonly used to break down the overall cost of surgery activities according to the number of RCIs specific to each procedure.¹⁸ For each donor, we assessed a ratio corresponding to the portion of RCIs related to organ recovery out of the total number of RCIs related to surgical activities. Thus, surgery, anaesthesia, biology, imaging and medical logistics were valued from national cost data weighted by the ratio determined to relate exclusively to organ recovery. Regarding reanimation, intensive care and ongoing monitoring, discussions with hospital co-ordinators of organ procurement allowed us to elaborate the working hypothesis that expenditures related to organ recovery are exclusively focused on the last day of the stay. For each donor, we added the costs of re-animation, intensive care and ongoing monitoring and divided this sum by the corresponding length of stay.

For a medical DRG, the valuation of surgery and anaesthesia items with national cost study data entails the risk of greatly underestimating these items. Thus, surgical and anaesthesia items resulting from a medical DRG were valued using mean costs of surgery and anaesthesia during a surgical DRG. This approach was tested using a sensitivity analysis. All other items, including re-animation, intensive care, ongoing monitoring, biology, imaging and medical logistics, were valued using national economic data weighted by the length of stay corresponding to each donor.

Outcomes

Organ recovery cost assessment from 2007 to 2014

Five cost evaluations were conducted. Each explored a specific characteristic of organ recovery procedures. All costs are presented according to their mean, minimum, maximum and standard deviation (SD).

- (1) The cost of hospital stays during which an organ recovery procedure was performed to obtain an overview of hospital costs related to organ recovery activity.
- (2) The cost of hospital stays corresponding to the French classification for organ recovery procedures based on OP (organ procurement) classes:
 - OP1: Kidneys and/or liver.
 - OP2: Kidneys, liver, heart, pancreas, lung(s) and/or the intestine or at least seven organs.
 - OP3: Other organ recovery.
- (3) The cost of organ recovery procedures, according to OP classification, to assess the portion of hospital stay costs related exclusively to organ recovery activities.
- (4) The cost of separate kidney, liver, pancreas, intestine, heart, lung or heart–lung block recovery regardless of the organs recovered to obtain the cost for each organ recovered to inform future medico-economic studies.
- (5) The cost of all organ recovery combinations to better reflect the realities of organ recovery.

Sensitivity analysis

For objective 3, a sensitivity analysis was conducted to test the choice to value surgical and anaesthesia items during a medical DRG using the mean costs of surgery and anaesthesia during a surgical DRG. The results of the sensitivity analysis are presented using the real surgical and anaesthesia item costs from a medical DRG.

Changing population of deceased organ donors between 2007–2014

General trends regarding organ recovery activity in France were assessed according to several parameters from 2007 to 2014:

- Number of deceased organ donors, age and sex of donors.
- Number of organ recovery procedures, including one, two, three or more organs recovered and the mean number of organs recovered by the procedure.
- Number of organ recovery procedures based on OP class (OP1, OP2 or OP3).
- Number of most common combinations of organ recovery procedures.

Results

From 2007 to 2014, a total of 12 629 brain death donors were included in the analysis, corresponding to a total of 11 920 pairs of kidneys, 8788 livers, 1450 pancreases, 1796 lungs, 3971 hearts, 324 heart–lung blocks and 233 intestines.

Organ recovery cost assessment from 2007 to 2014

The mean cost of hospital stays during which an organ recovery procedure was performed was assessed at €7469 (SD = €10 894) but differed strongly between medical DRGs €4153 (SD = €4264) and surgical DRGs €18 202 (SD = €17 126) (table 1).

According to the French OP classification, the costs of hospital stays during which an organ recovery corresponding to an OP1, OP2 or OP3 procedure was performed were assessed at €6483 (SD = €9045), €6033 (SD = €6669) and €9044 (SD = €13 239), respectively (table 1).

According to the French OP classification, the costs of OP1, OP2 and OP3 procedures were assessed at €1881 (SD = €1577), €2, 188 (SD = €1835) and €2368 (SD = €2343), respectively (table 1). These results were influenced by our methodological choices. Using the real surgical and anaesthesia costs of a medical DRG changed the cost assessments; OP1, OP2 and OP3 procedures were assessed at €1133 (SD = €1783), €1570 (SD = €2078) and €1750 (SD = €2583), respectively (table 1).

The mean costs of separate kidney, liver, pancreas, intestine, heart, lung and heart–lung block recovery, regardless of the organs recovered, were assessed at €1432 (SD = €1342), €502 (SD = €782), €354 (SD = €475), €362 (SD = €1559), €542 (SD = €955), €977 (SD = €1196) and €737 (SD = €637), respectively (table 1).

The costs of all organ recovery combinations identified are presented in table 2 and arranged from the most frequent to the least frequent procedure.

Changing population of deceased organ donors between 2007 and 2014

In France, the number of organ donors slightly increased from 1575 in 2007–1612 in 2014. Although donors were predominantly men, the gap between male and female donors tended to narrow over time. During this period, the mean age of donors gradually

Table 1 Hospital stays and organ recovery procedure cost assessment in France from 2007 to 2014 (2014 Euros)

		N	Mean	SD	Min	Max
1st evaluation	Hospital stays	12 629	7469	10 894	344	166 703
	Surgical DRG	2980	18 202	17 126	881	166 703
	Medical DRG	9649	4153	4264	344	4264
2nd evaluation	Hospital stays	12 629	7469	10 894	344	166 703
	OP1	7254	6483	9045	469	112 891
	OP2	434	6033	6669	495	48 205
	OP3	4941	9044	13 239	344	166 703
3rd evaluation	Recovery procedure					
	OP1	7254	1881	1577	172	36 734
	OP2	434	2188	1835	732	24 035
	OP3	4941	2368	2343	306	32 625
4th evaluation	Organ recovered					
	Kidneys	11 921	1432	1342	126	32 625
	Liver	8791	502	782	37	36 734
	Pancreas	1450	354	475	54	9008
	Intestine	233	622	1559	78	21 269
	Heart	3972	542	955	86	27 559
	Lung	1798	977	1196	277	32 169
	Heart–lung	324	737	637	182	7004
Sensitivity analysis	Recovery procedure					
	OP1	7254	1133	1783	23	36 734
	OP2	434	1570	2078	39	24 035
	OP3	4941	1750	2583	12	32 625

OP, Organ Procurement.

Table 2 Prevalence and cost of organ recovery combinations between 2007 and 2014 in France (2014 Euros)

	<i>N</i>	Mean	SD	Min	Max
Liver–kidneys	3868	1535	1465	172	23 707
Kidneys	2830	1867	1657	270	32 625
Liver–kidneys–heart	1513	1977	1879	319	19 634
Liver–kidneys–heart–lung	643	1922	1932	230	23 487
Liver	555	1949	2266	441	36 733
Kidneys–heart	540	1565	1611	269	21 564
Liver–kidneys–heart–pancreas	505	1986	1839	337	22 071
Liver–kidneys–lung	425	1863	1663	617	19 912
Liver–kidneys–heart–lung–pancreas	309	1780	1833	430	24 035
Liver–kidneys–pancreas	267	1774	2133	297	24 839
Liver–kidneys–block heart–lung	169	1710	1301	567	9922
Heart	127	3174	3881	410	27 559
Liver–kidneys–lung–pancreas	115	1729	1737	632	17 416
Kidneys–heart–lung	94	1740	1360	248	7545
Liver–kidneys–pancreas–block heart–lung	89	2068	2246	435	14 404
Kidneys–lung	72	1686	1039	595	7487
Liver–kidneys–intestine	67	1687	1241	352	5508
Liver–heart	42	1836	1649	729	10 293
Kidneys–pancreas	41	1417	1136	258	7502
Liver–kidneys–heart–intestine	40	1925	1194	583	6454
Kidneys–heart–pancreas	31	1451	809	520	4511
Lung	21	4628	7010	1031	32 168
Kidneys–block heart–lung	21	1669	850	733	3542
Intestine	20	3177	4534	382	21 268
Liver–heart–lung	19	1755	822	611	4479
Liver–intestine	19	1682	1169	290	4273
Kidneys–heart–lung–intestine	19	1968	1907	934	8234
Liver–lung	16	1927	707	1207	3334
Liver–kidneys–heart–pancreas–intestine	16	3451	2877	394	11 694
Liver–kidneys–lung–intestine	12	2098	1732	951	6934
Liver–heart–intestine	10	1455	749	575	2688
Liver–pancreas	10	2747	4157	848	14 532
Kidneys–lung–block heart–lung	9	N/A	N/A	N/A	N/A
Heart–lung	8	1129	864	456	2927
Liver–kidneys–pancreas–intestine	8	1761	955	735	3915
Kidneys–heart–block heart–lung	8	N/A	N/A	N/A	N/A
Kidneys–lung–pancreas	7	1894	997	698	3850
Liver–kidneys–heart–lung–pancreas–intestine	6	1305	233	1008	1698
Pancreas	6	3122	3050	1041	9007
Kidneys–heart–lung–pancreas	6	1448	665	825	2723
Block heart–lung	5	2223	1393	1141	4665
Liver–heart–pancreas	5	5732	7808	1447	19 615
Liver–kidneys–heart–pancreas–block heart–lung	5	N/A	N/A	N/A	N/A
Liver–kidneys–intestine–block heart–lung	5	1639	714	424	2179
Kidneys–pancreas–block heart–lung	5	1585	246	1259	1938
Liver–heart–lung–pancreas	4	2566	2187	1327	5844
Liver–lung–pancreas–intestine	3	1241	262	940	1420
Liver–kidneys–pancreas–intestine–block heart–lung	3	3530	1752	2026	5454
Liver–pancreas–block heart–lung	2	1319	367	1059	1578
Liver–lung–pancreas	2	1332	93	1266	1399
Liver–block heart–lung	1	1300	N/A	1300	1300
Liver–heart–pancreas–intestine	1	1442	N/A	1442	1442
Liver–heart–lung–pancreas–intestine	1	1810	N/A	1810	1810
Liver–pancreas–intestine	1	2545	N/A	2545	2545
Liver–kidneys–heart–pancreas–intestine–block heart–lung	1	N/A	N/A	N/A	N/A
Liver–kidneys–heart–lung–intestine	1	655	N/A	655	655
Liver–kidneys–lung–pancreas–block heart–lung	1	N/A	N/A	N/A	N/A
Total	12 629	1788	1779	173	36 733

N/A, not applicable.

increased from 50 to 57 years. Female donors were generally older than male donors, and this difference slightly increased over the course of this study (table 3).

Although the number of donors increased only marginally between 2007 and 2014, the number of organs recovered increased more dramatically. In fact, the number of organs recovered from donors gradually increased from 2.22 in 2007–2.32 in 2014. The number of organ recovery procedures with only one organ recovered progressively decreased, while the number of organ recovery procedures with 2, 4 or 5 organs recovered simultaneously increased (table 3).

Discussion

The use of the national hospital discharge database and the national cost study made it possible to assess, for the first time on a large scale, the different costs pertaining to organ recovery activities and to follow the evolution of these practices over eight consecutive years in the French healthcare system. The primary achievement of this study is the exploitation of data from 12 629 donors and 28 482 recovered organs, providing considerable validity to the results. The mean cost of a hospital stay during which an organ recovery procedure was performed was assessed at €7469 (SD = €10 894)

Table 3 Deceased donors' population characteristics and practices between 2007 and 2014 in France

	2007	2008	2009	2010	2011	2012	2013	2014	Total
Donors	1575	1588	1526	1535	1602	1577	1614	1612	12 629
Men	988	941	944	883	939	896	938	911	7440
Women	587	647	582	652	663	681	676	701	5189
Age	50.26	51.75	51.35	52.70	53.36	54.59	56.24	56.95	53.43
Men	48.37	49.84	48.88	50.21	50.72	52.44	53.83	53.62	50.96
Women	53.44	54.52	55.38	56.08	57.11	57.42	59.57	61.28	56.98
Number of organs	3503	3473	3427	3451	3655	3608	3619	3746	28 482
1	475	497	430	417	456	422	440	383	3520
2	528	556	563	582	542	587	616	645	4619
3	355	319	313	326	367	317	330	324	2651
4	179	178	172	159	177	197	185	202	1449
5	37	34	44	50	55	51	41	55	367
6	1	3	4	1	4	3	2	3	21
7	0	1	0	0	1	0	0	0	2
Organs/donor	2.22	2.18	2.24	2.24	2.28	2.29	2.24	2.32	2.26

but differed greatly for medical DRGs €4153 (SD = €4264) and surgical DRGs €18 202 (SD = €17 126). Brain death donors were distributed into more than 430 DRGs reflecting the diversity of analyzed cases and explaining the large standard deviations in assessed costs. The implementation of a specific methodology considering the strengths and weaknesses of the exploited databases allowed us to present different components of the costs associated with organ recovery activities.

These costs might be used as unit costs in economic evaluations performed in the French context and as a reference for international cost comparisons. Our results will allow hospital managers performing organ recovery to compare their own cost accounting data to national average costs and to compare their practices to national trends for better resource management. Moreover, organ recovery activities are currently paid by fee-for-service.¹⁹ This requires payers to reimburse the healthcare provider for each service performed without incentive to implement cost-saving measures. As national benchmark metrics, these cost and practice data could be used by policy makers for building new payment models based on performance and efficiency.

The majority of economic publications addressing issues related to organ grafts have focused on the cost of organ transplantation. In a major publication including 1333 patients who underwent solid organ transplantation between 1995 and 2003 in Canada, Levy et al. were unable to estimate costs prior to transplantation because economic data on costs associated with organ donation were not available.²⁰ The cost of kidney and pancreas procurement in the Italian healthcare system was assessed at \$1400, which is close to our estimate.⁹ In Spain, a cost-benefit estimation found that kidney procurement cost \$3162.²¹ This estimate is higher than our estimate of €1432 for kidney recovery, but the difference can be explained by the inclusion of the cost of preservation fluid.

In the USA, as in France, the government must find solutions to address the increasing costs of organ procurement and organ shortages. A recent US study compared costs between organ recoveries performed in hospitals and those performed in an organ procurement organization (OPO) facility.²² The mean cost of recovery per donor was assessed at \$33 164 (SD: \$13 578) in American hospitals vs. \$16 153 (SD: \$5698) in the OPO, with the authors concluding that organ recovery performed at an OPO facility is an effective way to minimize organ recovery costs. However, we should be cautious in comparing France with the US. The US costs are higher mainly because of a price effect. Moreover, the difference may also be explained by the integration in the American study of building construction costs, which alone represent two-thirds of the total cost. Furthermore, the organ yield was assessed as 2.7 organs per donor recovered in US hospitals vs. 3.4 organs per donor in OPO facilities. In French hospitals, the

organ yield was assessed as 2.3 per donor. As in the US, the externalization of organ recovery activities through the development of OPO facilities in France could not only reduce costs but also increase the number of available organs.

The main limitation of our work concerns the costing method used. Bottom-up microcosting is considered the best method to estimate hospital service costs.²³ However, as individual costs were not available, organ recovery stays were valued at the DRG level from the national average cost database. Moreover, surgery and anaesthesia were assessed using the RCI, although the RCI does not reflect the actual time spent by surgeons and anaesthesiologists.¹⁷ Mercier et al. suggested the introduction of a time-driven activity-based costing method to provide more accurate weighting with minimal adjustment.²⁴ However, this weighting method seems to be more appropriate for single institutions rather than a national database. The first costing method used to assess the cost of organ recovery procedures is preferred over the second method because surgical DRG data more accurately reflect the cost of surgery and anaesthesia for a surgical procedure. Effectively, the sensitivity analysis highlights the underestimation of the organ recovery costs when they were valued by real medical DRG data.

Extrapolation of our method to other countries requires the availability of both a national hospital discharge database and a national cost study. A majority of developed countries have both databases, making it possible to conduct similar analyses to better understand organ recovery activities and to enable future comparisons. For years, France has ranked among the top 10 countries for organ recovery worldwide, which gives more weight and representativeness to results arising from the exploitation of the French databases.

The globalization of organ shortage issues and global trends regarding the control of healthcare budgets force states to optimise available resources, which involves analysis of the costs incurred, the results obtained and constant innovation of strategies for responding to this vital problem.²⁵ Although costs are the main challenge for the successful functioning of organ recovery activities, other aspects such as organization modalities should be considered to increase the availability of organs.²⁶

Acknowledgements

The authors would like to acknowledge Hugo Rabier and Gwen Grguric for contributions to the data management and statistical analysis.

Supplementary data

Supplementary data are available at *EURPUB* online.

Funding

None.

Conflicts of interest: None declared.

Key points

- The use of national databases made it possible to assess organ recovery costs on a nationwide scale and to follow the evolution of practices over a long period.
- The mean cost of hospital stays during which an organ recovery procedure was performed was assessed at €7469 (SD = €10 894) but differed greatly for medical DRGs at €4153 (SD = €4264) and surgical DRGs at €18 202 (SD = €17 126).
- Although the number of donors increased only marginally, the number of organs recovered increased more dramatically due to changes in practices.
- Extrapolation of the methodology to other countries requires the availability of both a national hospital discharge database and a national cost study.
- Cost management is the main challenge for the successful functioning of organ recovery activities, but other aspects such as organization modalities should be considered to increase organ availability.

References

- 1 Watson CJE, Dark JH. Organ transplantation: historical perspective and current practice. *Br J Anaesth* 2012; 108:i29–42.
- 2 Johnson RJ, Bradbury LL, Martin K, Neuberger J, UK Transplant Registry. Organ donation and transplantation in the UK—the last decade: a report from the UK national transplant registry. *Transplantation* 2014; 97:S1–S27.
- 3 Global Observatory on Donation and Transplantation. Organ Donation and Transplantation Activities, 2014. [Internet]. GODT. Available at: <http://www.transplant-observatory.org/summary/> (5 June 2017, date last accessed).
- 4 Vanholder R, Annemans L, Brown E, et al. Reducing the costs of chronic kidney disease while delivering quality health care: a call to action. *Nat Rev Nephrol* 2017; 13:393–409.
- 5 Fédération des Associations pour le Don d'Organes et de Tissus humains [Internet]. France Adot. 2016. Available at: https://blog.france-adot.org/tableaux-sur-la-greffe-en-france_20160202/ (5 June 2017, date last accessed).
- 6 Plan 2017–2021 pour la greffe d'organes et de tissus [Internet]. Available at: http://social-sante.gouv.fr/IMG/pdf/plan_2017-2021_pour_la_greffe_d_organes_et_de_tissus.pdf (5 June 2017, date last accessed).
- 7 Blotière PO, Tuppin P, Weill A, et al. The cost of dialysis and kidney transplantation in France in 2007, impact of an increase of peritoneal dialysis and transplantation. *Nephrol Ther* 2010; 6:240–7.
- 8 Guignard AP, Oberholzer J, Benhamou PY, et al. Cost analysis of human islet transplantation for the treatment of type 1 diabetes in the Swiss-French Consortium GRAGIL. *Diabetes Care* 2004; 27:895–900.
- 9 Lenisa L, Castoldi R, Socci C, et al. Cost analysis of kidney-pancreas and kidney-islet transplant. *Transplant Proc* 1995; 27:3061–4.
- 10 Armstrong GT. Assessment of organ acquisition costs for an Australian public health system. *J Transpl Coord Off Publ North Am Transpl Coord Organ NATCO* 1996; 6:39–43.
- 11 Clark D. AOPO sheds light on organ acquisition costs, responds to survey data. *Nephrol News Issues* 1993; 7:12, 16.
- 12 Lamarsalle L, Hunt B, Schauf M, et al. Evaluating the clinical and economic burden of healthcare-associated infections during hospitalization for surgery in France. *Epidemiol Infect* 2013; 141:2473–82.
- 13 Boudemaghe T, Belhadj I. Data resource profile: the French national uniform hospital discharge dataset database (PMSI). *Int J Epidemiol* 2017; 46:392–392d.
- 14 Technical Agency for Information on Hospital Care. The National Cost Studies, 2016. [Internet]. Available at: http://www.atih.sante.fr/sites/default/files/public/content/70/atih_national_cost_studies.pdf (11 January 2018, date last accessed).
- 15 Hrifach A, Brault C, Couray-Targe S, et al. Mixed method versus full top-down microcosting for organ recovery cost assessment in a French hospital group. *Health Econ Rev* 2016; 6:53.
- 16 Bellanger MM, Tardif L. Accounting and reimbursement schemes for inpatient care in France. *Health Care Manag Sci* 2006; 9:295–305.
- 17 Quissac E, Groseil S. Finalité et définitions des indices de Coût Relatif (ICR). *Financ Hospital* 2008; 14:14–20.
- 18 Sommer A. Les ICR: à utiliser sans modération par les établissements de soins. [RCI: to use without moderation by care facilities]. *Financ Hospital* 2008; 16:20–6.
- 19 Agence de la Biomédecine. Modalités de financement 2014 des activités de prélèvement et de greffe d'organes, de tissus et de cellules souches hématopoïétiques [Internet]. Available at: https://www.agence-biomedecine.fr/IMG/pdf/plaquette_financement_t2a2014.pdf (11 January 2018, date last accessed).
- 20 Levy AR, Sobolev B, James D, et al. The costs of change: direct medical costs of solid organ transplantation in British Columbia, Canada, 1995–2003. *Value Health J Int Soc Pharmacoecon Outcomes Res* 2009; 12:282–92.
- 21 Domínguez J, Harrison R, Atal R. Cost-benefit estimation of cadaveric kidney transplantation: the case of a developing country. *Transplant Proc* 2011; 43:2300–4.
- 22 Doyle M, Subramanian V, Vachharajani N, et al. Organ donor recovery performed at an Organ Procurement Organization-based facility is an effective way to minimize organ recovery costs and increase organ yield. *J Am Coll Surg* 2016; 222:591–600.
- 23 Mogorossy Z, Smith PC. *The Main Methodological Issues in Costing Health Care Services: A Literature Review*. York: Centre for Health Economics, 2005. [Internet]. Available at: <http://www.york.ac.uk/che/pdf/rp7.pdf> (11 January 2018, date last accessed).
- 24 Mercier G, Naro G. Costing hospital surgery services: the method matters. *PLoS One* 2014; 9:e97290.
- 25 Naghibi O, Naghibi M, Nazemian F. Factors affecting length of hospitalization in kidney transplant recipients. *Exp Clin Transplant Off J Middle East Soc Organ Transplant* 2007; 5:614–7.
- 26 Johnson CP, Kuhn EM, Hariharan S, et al. Pre-transplant identification of risk factors that adversely affect length of stay and charges for renal transplantation. *Clin Transpl* 1999; 13:168–75.