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Activity-based cost analysis in catheter-based angiography and interventional radiology

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Abstract The aim of this study was to analyse the costs of the interventional radiology unit and to identify the cost factors in the different activities of catheter-based angiographies and interventional radiology. In 1999 the number of procedures in the interventional radiological unit at Tampere University Hospital was 2968; 1601 of these were diagnostic angiographies, 526 endovascular and 841 nonvascular interventions. The costs were analysed by using Activity Based Cost (ABC) analysis. The budget of the interventional unit was approximately 1.8 million Euro. Material costs accounted for 67%, personnel costs for 17%, equipment costs for 14% and premises costs for 2% of this. The most expensive products were endografting of aortic aneurysms, with a mean price of 5291 Euro and embolizations of cerebral aneurysms (4472 Euro). Endografts formed 87.3% of the total costs in endografting and Guglielmi detachable coils accounted for 63.3% of the total costs in embolizations. The material costs formed the majority of the costs, especially in the newest and most complicated endovascular treatments. Despite the high cost of angiography equipment, its share of the costs is minor. In our experience ABC system is suitable for analysing costs in interventional radiology.

Keywords Costs and cost accounting · Interventional radiology · Radiology and radiologists · Socioeconomic issues

Introduction

Use of interventional radiology has greatly increased in the course of the past 20 years. There have appeared various new endovascular techniques such as vascular embolizations with Guglielmi detachable coils (GDC) and revascularizations (angioplasty, stenting, endografts for aorta aneurysms). These new tools have brought new treatment options for diseases, which formerly could only be treated by open surgical procedures. Intracranial aneurysms and aortic aneurysms are now routinely treated by endovascular technique. On the other hand, this has added to the activity and expenses of the radiological units. The health care organizations and policy makers are increasingly interested in the costs of health care. This is evidenced by many cost–benefit and cost-effectiveness analyses appearing in the medical literature [1, 2, 3]; however, analyses dealing with catheter-based angiography and interventional radiology have rarely been published, although radiological interventions have increased in number and techniques. Activity-based cost analysis (ABC) has been used in many service organizations and achieved great benefits when planning activity and budget, because the costs can then be more precisely allocated to their resources and also the cost factors of the activities that form the product can be evaluated [4]. Comprehensive ABC analysis in an interventional radiologic unit has never, to our knowledge, been reported. In order to introduce a new method of treatment both cost–benefit and cost-effectiveness analyses should be done, but they are reliable first when they are preceded by an acceptable cost accounting.

In the next two decades the number of elderly people will increase so rapidly that, whatever happens to the incidence and prevalence of peripheral vascular disease, the workload for a vascular service will increase significantly. In Finland, in the district of Tampere University Hospital, the total amount of peripheral vascular procedures will rise by 40.5% during the next 20 years [5]. Optimal utilization and economic evaluation of limited health care resources is needed and should be based on reliable cost accounting.

The aim of this study was to analyse the costs of the interventional radiology unit and to identify the cost factors in the different activities of catheter-based angiographies and interventional radiology.

Materials and methods

Tampere University Hospital is one of the five university hospitals in Finland with approximately 1200 beds. In 1999, a total of 124,784 examinations or interventions were performed at the Department of Radiology. Diagnostic catheter-based angiographies and interventional procedures were done in the separate unit for interventional radiology. This study concentrates on the costs of the activities in the interventional radiology unit. Computed tomography and solely US-guided interventions were not included, because their work was allocated to that modality.

The number of procedures in the interventional unit was 2968 (Table 1). A single procedure begins when the patient comes to the angiosuite and ends when he leaves the suite. Of the procedures, 54% were diagnostic angiographies, 17% endovascular and 28% nonvascular interventions. Approximately half of the endovascular interventions were embolizations or sclerotherapies and half were revascularizations. Most of the embolizations were performed in the head and neck region (n=146). There were 61 peripheral embolizations (mostly acute bleedings in body or extremity) and 40 vascular sclerotherapies using absolute alcohol for venous malformations and alcohol or OK-432 for lymphatic malformations. The revascularizations consisted of 162 angioplasties, 56 vascular stentings, 36 thrombolyses and 22 endografts for aortic aneurysms. There were 841 nonvascular interventions, including various urological and biliary interventions and drainages of abdominal fluid collections.

The interventional unit consists of two suites with angiography equipment (Bicor and Multistar, Siemens, Erlangen, Germany). The first one is equipped with a biplane C-arm angiography system optimized for neurodiagnostics and interventional procedures, and the latter one is equipped with a ceiling mounted C-arm system for peripheral diagnostic and interventional work. Nonvascular interventions were performed in both suites. Besides these, there is one ultrasound scanner (Aloka SSD-1400 DynaView) for image-guided interventions. There were two full-time and two part-time interventional radiologists employed, six radiographic technicians and one assisting nurse. The full-time radiologists worked 38.25 h per week and part-time radiologists worked 20 h per week. Patient precare and aftercare was carried out in the operating rooms, because there were no other rooms reserved for this purpose. The images taken during the interventions were printed out on film sheets with a laser imager (3 M Dry View), and the interpretation of the procedure was done from the film. The interpretations were dictated and recorded and the typist wrote the text. There were 11 weekly meetings with clinicians, during which the interventions were discussed. One interventional radiologist attended the clinical meetings, and the total time spent there was approximately 5.5 h/week.

The budget of the entire radiology department in 1999 was approximately 9 million Euro including the share of the interventional unit (approximately 1.8 million Euro).

Table 1 Catheter-based angiographies and interventional radiology: figures for 1 year. *AVM* arteriovenous malformations; *GDC* Guglielmi detachable coils

Procedures	*N*	%
Catheter-based angiographies (*n*=1601)		54
Nonselective angiographies	166	
Selective angiographies	1435	
Embolizations and endovascular sclerotherapies (*n*=250)		8
Embolizations of cerebral aneurysms (with GDC coils)	75	
Embolizations of cerebral AVMs and dural fistulae (with glue)	49	
Embolizations of tumours in head and neck (with polyvinyl alcohol particles)	22	
Embolizations in body and extremities	61	
Sclerotherapies of venous malformations and lymphangiomas	40	
Application of vena cava filters	3	
Revascularizations (*n*=276)		9
Angioplasties	162	
Vascular stenting	56	
Thrombolysis and thrombectomies	36	
Endografting of aortic aneurysms	22	
Nonvascular interventions (*n*=841)		28
Antegrade pyelographies	44	
Nephrostomies	91	
Ureteral dilatations	14	
Ureteral stenting	8	
Percutaneous transhepatic cholangiographies	71	
Biliary external–internal catheter drainage	95	
Biliary dilatations	38	
Biliary stenting	12	
Drainage of abdominal fluid collections	183	
Exchange of drainage catheters	250	
Miscellaneous nonvascular procedures	35	
Total no. of procedures: 2968		100

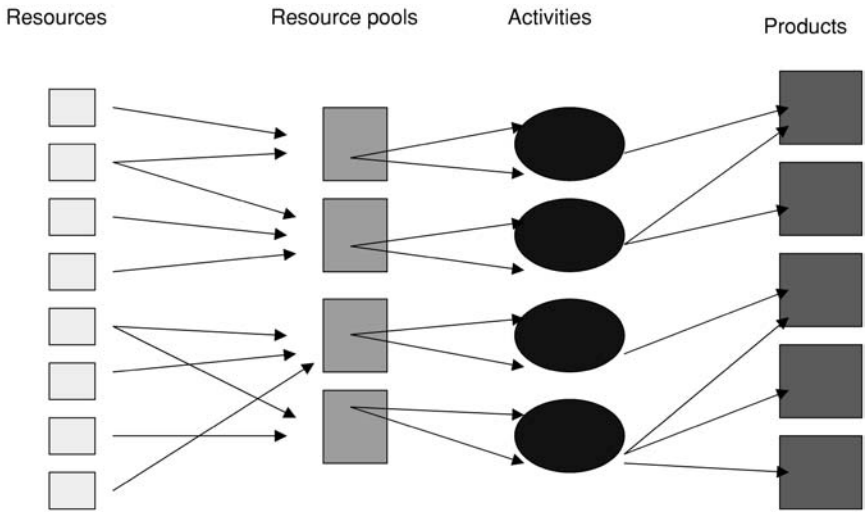


Fig. 1 Principles of Activity Based Cost accounting. The costs of the resources are allocated to resource pools. The intervention is divided into activities to which the costs of resource pools are allocated according to cost drivers. The activity costs are allocated to products using activity drivers. Several resource pools can be utilized for an activity, and an activity can be divided into several products

Table 2 Example of the contents of the activities in angioplasty

Activities	Contents
Main procedure	Procedure from puncture to pull out of catheter
Preparation of intervention and patient	Office work in the intervention unit (e.g. scheduling, book keeping, order of material) Preparation of the patient for the intervention in the unit
Aftercare of patient	Compression of puncture site after angioplasty and preparation of the patient for the transport to the clinical department
Information from the intervention	Hard-copy printing and image interpretation Reporting (dictating and typing of the interpretation)
Clinical meetings	Meetings with the clinicians, where the interventions are discussed Consultation with the patient before and after the intervention

Cost analysis

All costs directly related to activities in interventional radiology were counted from the perspective of the interventional unit. The overhead costs for the hospital and the radiology unit were not included. They were only approximately 5% of the total budget. Patient premedication, general anaesthesia and pre- or aftercare on the ward were not included, because these costs were directly charged from the budgets of the wards.

The information concerning cost and consumption was acquired from the hospital accounting department and from inventory files. The costs of the resources were divided into four main categories: personnel; equipment; premises; and materials. Personnel costs consisted of salaries (including taxes and social security) and educational expenses. The educational expenses were 1% of the payroll. Equipment costs consisted of investments, maintenance and updating costs. Premise costs consisted of capital investments and running costs such as electricity, water, cleaning and furnishing. Because the storage room was limited, the material was purchased at the same rate as it was used; thus, material costs consisted of the actually used material.

The costs were analysed using Activity Based Cost Analysis (Ecomed/IC Digital Equipment Corporation). The ABC model is shown in Fig. 1 and Table 2. The authors identified all activities required in the production of catheter-based angiographies and interventions. There were a total of 34 different activities that were divided into five main categories: main procedure; preparation of intervention and patient; aftercare of patient; information of the intervention; and clinical meeting. The process model was defined for each product line. Resource pools and cost drivers were identified for each activity.

Costs of resources were collected into 30 resource pools, each of which contained functionally or spatially related resources. For example, the costs of the biplane C-arm angiography system and the rent of its' room were allocated to the resource pool "angiosuite 1" and the pool "microcathetering kit" was formed of the costs of the microcatheters, microwires, connectors, etc. The resources were allocated to pools according to their real use. Costs were allocated to activities according to resource use as expressed by cost drivers. For example, the costs of the pool "angiosuite 1" and the pool "microcathetering kits" were divided by the help of cost drivers into activities that utilize those pools such as "embolizations with GDC coils" and embolizations with glue". Cost drivers for personnel, equipment and premises were defined as the time required for the activity multiplied by the frequency of this activity, and for materials as the actual amount used. The number of personnel required was taken into account when allocating the personnel costs. The information on average time, number of personnel and materials required was collected from the logbook of 1999. The activity-based costs were allocated to products in proportion to the numbers performed. If the diagnostic angiography was continued with intervention (e.g. angioplasty) during the same session, the procedures were registered separately, according to the common way in Finland. In these cases the routine sterile supplies, such as patient drapes, syringes and bowls, were included only in the diagnostic procedure.

Acquisition costs of equipment were distributed over the period 1989–1999. The angiography equipment was purchased in 1989 and 1996. The total cost of both pieces of equipment was all together 1.7 million Euro. The capital investment was depreciated in equal installments. The amortization period of both angiography machines was 15 years, for an ultrasound scanner and a laser imager it was 8 years and for X-ray tubes 5 years, which corresponds to their real utilization time at our hospital. Three cost comparisons were performed. In the baseline calculations the amortization period was set at 15 years and the interest rate for invested capital for angiosuites was defined as 4%. In addition, we carried out a sensitivity analysis in which the amortization period for angiography equipment was set at 15 years and the interest rates at 0 and 8%, respectively. In Finland the hospitals are largely community subsidized. That means all equipment to be purchased is paid immediately, not loaned, so the interest rate of 0% was also analysed. Finally, the amortization period was set at 10 years and interest rate at 4%.

The invoice during 1999 for the interventional unit was obtained from the hospital bookkeeping. These prices were based on previous traditional cost accountings. The revenues were compared with the costs accounted for by ABC analysis.

Costs were calculated in Euro.

Results

In 1999 the budget of the interventional unit was approximately 1.8 million Euro. Material costs accounted for 67% (1,252,070 Euro), personnel costs for 17% (309,466 Euro), equipment costs for 14% (254,624 Euro) and premises costs for 2% (28,256 Euro) of this. Of the personnel costs radiologists accounted for 148,005 Euro, radiographic technicians for 141,278 Euro and other personnel for 20,183 Euro. Diagnostic catheter-based angiographies accounted for 34%, embolizations and vascular sclerotherapies accounted for approximately 35%, revascularizations accounted for 17% and nonvascular interventions 14% of the costs (Table 3). The most expensive products of the endovascular interventions were embolizations of cerebral aneurysms (4472 Euro) and AVMs (3082 Euro) and endografting of aortic aneurysms (5291 Euro). Biliary stenting was the most expensive product of the nonvascular interventions (1374 Euro).

Of the total costs of the interventional radiology, 89% originated from the main procedures of the activities. Of the costs, 10% came from the preparations for the interventions as well as precare and aftercare of the patients. The image interpretation and typing (information on the intervention) accounted for 1.2% and clinical meetings 0.6% of the costs (Table 4). Concerning the vascular interventions, the main procedure was the most expensive activity in cerebral embolizations (98%), in vascular stenting (95%) and endografting of aortic aneurysms

Table 3 Costs of the products in the interventional unit (in Euro)

Products	*N*	%	Cost (Euro)			
			Total		Mean of one product	Product costs (%)
Catheter-based angiographies (*n*=1601)		54	623,742			34
Nonselective angiographies	166			52,112	314	
Selective angiographies	1435			571,630	398	
Embolizations and endovascular sclerotherapies (*n*=250)		8	650,939			35
Embolizations of cerebral aneurysms	75			335,391	4472	
Embolizations of cerebral AVMs and dural fistulas	49			150,994	3082	
Embolizations of tumours in head and neck	22			39,218	1783	
Embolizations in body and extremities	61			111,002	1820	
Sclerotherapies of venous malformations and lymphangiomas	40			9220	231	
Application of vena cava filters	3			5113	1704	
Revascularizations (*n*=276)		9	305,813			17
Angioplasties	162			75,860	468	
Vascular stenting	56			78,159	1396	
Thrombolysis and thrombectomies	36			35,388	983	
Endocrafting of aortic aneurysms	22			116,406	5291	
Nonvascular interventions (*n*=841)		28	263,921			14
Antegrade pyelographies	44			7968	181	
Nephrostomies	91			41,250	453	
Ureteral dilatations	14			6443	460	
Ureteral stenting	8			2590	324	
Percutaneous transhepatic cholangiographies	71			12,857	181	
Biliary external–internal catheter drainages	95			51,083	538	
Biliary dilatations	38			17,487	460	
Biliary stenting	12			16,482	1374	
Drainage of abdominal fluid collections	183			60,629	331	
Exchange of drainage catheters	250			39,448	158	
Miscellaneous nonvascular interventions	35			7685	220	
Total no.: 2968		100	1,844,415		621	100

Table 4 Costs of the activities in interventional radiology unit (in Euro)

Products	Main procedure		Preparation of intervention and patient		Aftercare of patient		Information of the intervention		Clinical meetings		Total	
	Euro	%	Euro	%	Euro	%	Euro	%	Euro	%	Euro	%
Catheter-based angiographies												
Nonselective angiographies	40,782	78	5685	11	3787	7	572	1	1285	2	52,112	100
Selective angiographies	473,685	83	49,145	9	32,741	6	11,112	2	4948	1	571,630	100
Embolizations and endovascular sclerotherapies												
Embolizations of cerebral aneurysms (with GDC coils)	330,272	98	2569	1	1711	1	581	0.2	259	0.1	335,391	100
Embolizations of cerebral AVMs and dural fistulae (with glue)	147,650	98	1678	1	1118	1	379	0.3	169	0.1	150,994	100
Embolizations of tumours in head and neck (with PVA particles)	37,717	96	753	2	502	1	170	0.4	76	0.2	39,218	100
Embolizations in body and extremities	106,839	96	2089	2	1392	1	472	0.4	210	0.2	111,002	100
Sclerotherapies of venous malformations and lymphangiomas	6490	70	1370	15	913	10	310	3	138	1	9220	100
Application of vena cava filters	4908	96	103	2	68	1	23	0.5	10	0.2	5113	100
Revascularizations												
Angioplasties	64,803	85	5548	7	3696	5	1254	2	559	1	75,860	100
Vascular stenting	74,337	95	1918	2	1278	2	434	1	193	0.3	78,159	100
Thrombolysis and thrombectomies	32,931	93	1233	3	821	2	279	1	124	0.4	35,388	100
Endografting of aortic aneurysms	114,904	99	753	1	502	0.6	170	0.2	76	0.1	116,406	100
Nonvascular interventions												
Antegrade pyelographies	4964	62	1507	19	1004	13	341	4	152	2	7968	100
Nephrostomies	35,039	85	3117	8	2076	5	705	2	314	1	41,251	100
Ureteral dilatations	5487	85	479	7	319	5	108	2	48	1	6443	100
Ureteral stenting	2044	79	274	11	183	7	62	2	28	1	2590	100
Percutaneous transhepatic cholangiographies	8011	62	2432	19	1620	13	550	4	245	2	12,857	100
Biliary external–internal catheter drainage	44,598	87	3254	6	2168	4	736	1	328	1	51,083	100
Biliary dilatations	14,894	85	1301	7	867	5	294	2	131	1	17,487	100
Biliary stenting	15,663	95	411	2	274	2	93	1	41	0.3	16,482	100
Drainage of abdominal fluid collections	48,142	79	6267	10	4175	7	1417	2	628	1	60,629	100
Exchange of drainage catheters	22,384	57	8562	22	5704	14	1936	5	862	2	39,448	100
Miscellaneous nonvascular procedures	5296	69	1199	16	799	10	271	4	121	2	7685	100
Total	1,641,838	89	101,646	6	67718	4	22,269	1.2	10,943	0.6	1,844,415	100

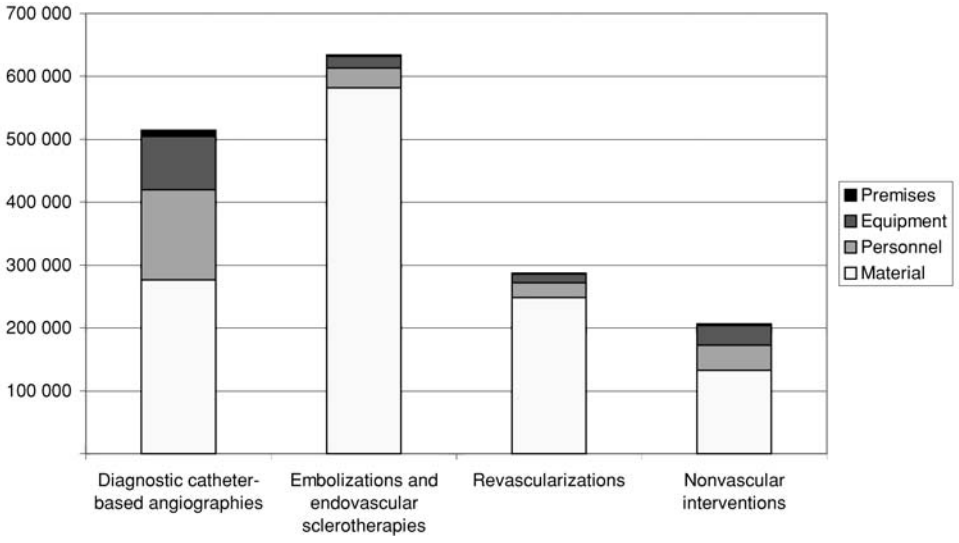


Fig. 2 Cost categories in main activities (in Euro)

Table 5 Material used in some costly main activities (in Euro). *PTA* percutaneous transluminal angioplasty

	Main activity	Material	Total cost	Cost of one procedure	% of the product costs
Catheter-based angiographies	Selective angiography	Catheters and wires	77,771	54	14
		Contrast medium	63,687	44	11
		Other material	106,332	74	19
Embolizations	Embolization with GDC coils	Coils	212,340	2831	63
		Microcatheter kits	85,686	1142	26
		Contrast medium	3329	44	1
		Other material	9314	124	3
	Embolization with glue	Glue	1611	33	1
		Microcatheter kits	111,963	2285	74
		Contrast medium	1923	39	1
		Other material	19,034	388	13
Revascularizations	Angioplasty	PTA balloons and manometers	41,938	259	55
		Contrast medium	2397	15	3
		Other material	4758	29	6
	Vascular stenting	Stents	50,011	893	64
		PTA balloons and manometers	14,497	259	19
		Contrast medium	1657	893	2
		Other material	304	5	0.4
	Endografting of aortic aneurysms	Endografts	101,637	4620	87
		Contrast medium	976	44	1
		Other material	6540	297	6
Nonvascular procedures	Biliary stenting	Stents	10,717	893	65
		PTA balloons and manometers	3107	259	19
		Contrast medium	89	7	0.5
		Other material	65	5	0.4

(99%). The main procedure of biliary stenting (95%) was the most expensive activity in nonvascular interventions. In catheter-based angiography the main procedure formed 78–83% of total costs.

Material costs were the largest cost factor in all main procedures (Fig. 2). In the group "embolizations and endovascular sclerotherapies" it formed 92% and in "revascularizations" 87% of the total costs of the main procedure; otherwise, it was 54–64%.

In embolizations coils and microcathetering kits formed the largest part of the total costs of the product (Table 5). In embolizations with GDC coils the coils ac-

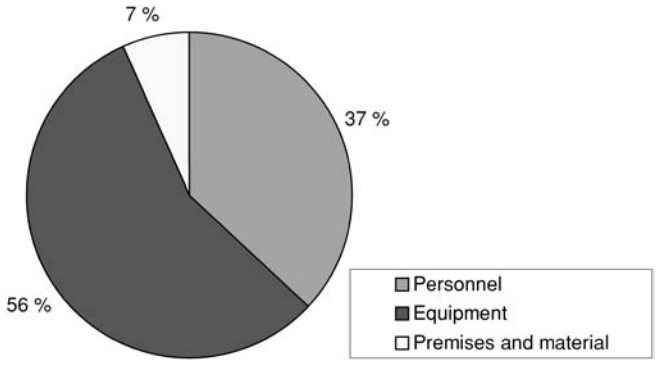


Fig. 3 Cost factors in assisting work

counted for 63% and microcathetering kits for 26% of the total costs of the product. In embolizations with glue the microcathetering kits formed 74% of the total costs. In vascular stenting stents formed 64% and in endografting of aortic aneurysms endografts formed 87% of the total costs.

The costs for assisting work, preparation for the intervention, as well as pre- and aftercare of the patients were considerable: 0.2 million Euro (10% of the total costs). Fifty-six percent (95,243 Euro) of this sum came from equipment, 37% (62,725 Euro) from personnel and 7% (11,396 Euro) from other expenses (Fig. 3). Most of this activity took place in the operating room and thus reserved both the room and the equipment.

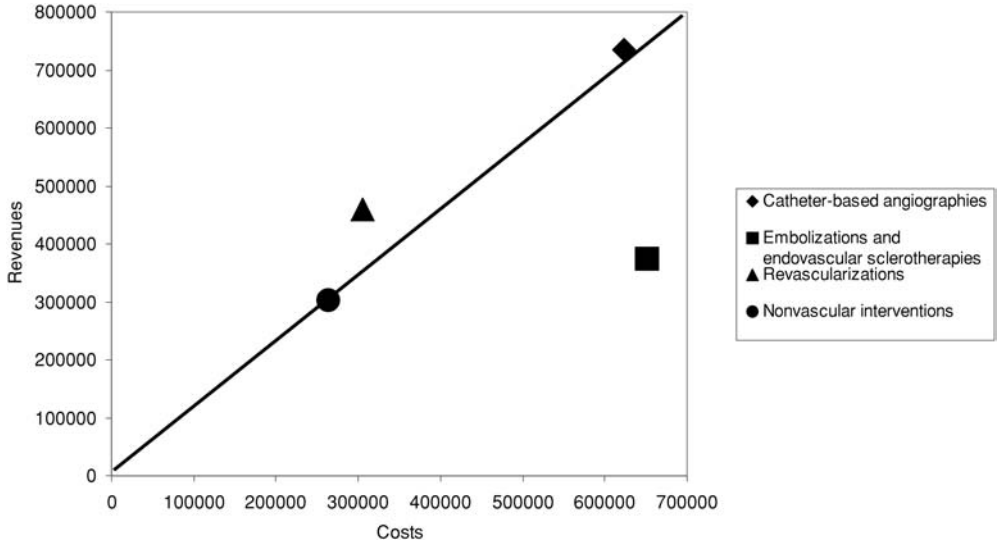
The effect of the length of the amortization period of the capital good was analysed by defining the amortization period for angiography equipment as 10 and 15 years (baseline calculation) and interest rate as 4%. A shorter amortization period increased the total costs by 2.5% (45,563 Euro). The influence of the interest rate was analysed by determining it for 0, 4 and 8% with an amortization period of 15 years. The change from 0 to 4% increased the costs by 2.6% and the change to 8% increased the costs by 5.2%.

According to the hospital bookkeeping the revenues in 1999 were 1,870,246 Euro. This price setting was achieved by using conventional cost accounting. By using ABC the costs were 1,844,415 Euro. The prices in the product group "embolizations and endovascular sclerotherapies" were underestimated, which was followed with low revenues in that product group, approximately half of the costs analysed with ABC (Fig. 4). This was compensated by slightly higher prices in the other vascular product groups. The nonvascular products had been rated the same as the ABC costs were. As a whole, the interventional unit yielded a small profit in 1999 (25,831Euro).

Discussion

Interventional radiology has been active during the past 10 years at Tampere University hospital. During the past 4 years the number of interventions has not changed much. Meanwhile the various techniques of treatment have become established; therefore, the material of this study is considered to be representative when analysing the costs at our interventional unit. The radiological cost analyses are generally done with a conventional cost-accounting method. In recent years a few reports have been published using activity-based cost analyses. Alanen et al. [6] used this method to analyse the costs of plain-film radiography in a partially digitized radiology department, and Cohen et al. [7] used this method in an academic radiology department to determine the effect of the current teaching paradigm on clinical productivity. Laurila et al. [8] analysed a paediatric radiology unit to obtain an informative and detailed picture of resource utilization in order to support its pricing and manage-

Fig. 4 Comparison of revenues to costs in 1999 (in Euro)



ment. Saini et al. [9] measured the technical cost of different categories of CT examinations. Enzmann et al. [10] made the financial analysis of a mammography service to determine whether the key underlying economic drivers of this service were aligned with the public's expectations. Only few cost identifications for interventional radiological units have been done, and we know of none that have been done using the ABC analysis. The ABC accounting was originally designed for use in industry and service producing units [4]. It has also been found to serve well in analysing the service units of health care [11]. The ABC analysis is based on the fact that activity creates costs, unlike in conventional accounting where the products create the costs. When using ABC accounting, especially indirect costs are allocated to products more accurately than in conventional accounting. Besides identifying the cost factors, one can analyse them in the different activities. We chose to perform our cost calculations with the ABC system, because it enabled us to trace the different activities and thus gave a more precise allocation of the costs in the activities and final products [11].

Costs are divided into direct and indirect costs. Direct costs are traceable to the performance of an intervention and they are divided into fixed and variable. The salaries of the ordinary personnel and depreciation are examples of fixed costs. When activity increases they remain unchanged up to a certain limit, until the activity increases so much that the capacity is not enough and more investments are needed. Variable costs, such as materials, drug and contrast media costs, follow the activity changes. The fixed costs are considerable in health care. The fixed costs were 84% and variable costs 16% in the cost analyses for hospitals [12]. The share of variable costs varied between 25 and 42% [12, 13]. In a radiology department the share of the variable costs varies between the different modalities. At a university hospital they were 10% in conventional radiography, 26% in contrast examinations, 37% in CT and 19% in MRI [14]. At our intervention unit the share of variable costs was much higher (67%). The material costs formed the majority of the costs, especially in the newest and most complicated endovascular treatments. It is especially these interventions that have increased and are most likely to increase even more in the near future. This will also increase the variable costs. For example, when beginning a new embolization method to treat the aneurysms, it means that supplies must be provided in order to be able to embolize the aneurysms that are of different sizes, sometimes quite infrequently. On the other hand, because the demand for health care services cannot be precisely predicted, overcapacity is needed. This means that the interventional units at university hospitals have more economic requirements than other hospitals, which should be taken into account when dividing the shares of health care.

Indirect costs, such as administrative and overhead cost of the hospital and radiology department, were not included in this analysis. They formed approximately 5% of the budget of the department. Their allocation is usually done in terms of percentage in conventional accounting. This increases the costs of expensive interventions more than in ABC analysis, where allocation is more precisely determined. Indirect costs should be taken into account particularly when making a cost–benefit and cost-effectiveness analysis.

When practising interventional radiology one often gets into a situation where the resolution of the angiography equipment is insufficient. This happens, for example, in neurovascular interventions. The equipment should be technically modern and function reliably. The capital investments form only a small part (14%) of the total costs. The shortening of the amortization period by 5 years adds only 2.5% to the costs; therefore, timely renewing of the equipment does not mean much pressure to raise the prices. In our opinion, this increase in costs is not much when compared with the advantage of working with modern equipment when doing interventional radiology which needs a lot of accuracy.

The main procedures (86%) made up the majority of costs of the interventional radiology. The preparation for the intervention and patient care made up a considerable share of the costs (10%, 1.1 million FIM/year) at our unit. Patient care took place in the operating room also monopolizing the equipment, because there was no separate room reserved for this purpose. Removing patient precare and aftercare from the operating rooms would release equipment and would make increased throughput possible.

Our ABC analysis revealed a surprisingly large difference between the revenue and costs of embolizations and endovascular sclerotherapies, even though the number of interventions had been correctly forecast when preparing the budget. There are probably several reasons leading to this. One of the most important reasons leading to poor prices is obviously the incorrect allocation of microcathetering kits and embolic agents (GDC coils). In 1999 a new GDC coil generation (3D coils) was put into use and we were forced to supply a large share of these coils, which was not taken into account when setting the prices. The rapid and often unforeseeable development of new treatments causes great difficulties when preparing a budget. There should be an interventional radiologist participating in the cost accounting and price setting in order to better forecast the changes in activities. Conventional cost accounting has been found to overcost high-volume products and undercost low-volume products, thus giving a false picture of the relation between production and costs [15]. This is probably not an essential reason for the divergence mentioned previously.

There is not much published about cost accounting in radiology or especially in interventional radiology. In the

future the question of whether the massively increased costs, due to new devices used in interventional radiology, are outweighed by increased benefits for the patient must be more precisely investigated; therefore, cost–benefit and cost-effectiveness analyses are the next step in order to allocate the limited financial resources of all health care systems appropriately.

This work presents a cost analysis of a Finnish interventional unit. The local community largely subsidizes the health care in Finland. The patient pays only a minimal price for the hospital stay. This is noticeable when comparing our results with "free market situations". The operating life of the equipment in the Finnish hospital system is usually long, and in this study the amortization period of the equipment corresponds to the real utilization time; however, the cost construction of the activities is presumably about the same in all units practising catheter-based angiography and interventional radiology, so they should be directly comparable.

Conclusion

In conclusion, reliable cost accounting is essential when planning the activity and budget for an interventional radiology unit. The ABC is recommended for the analysis of service organizations. In our experience it is also suitable for interventional radiology. The material costs are the most important cost factor in interventional radiology, especially in more complicated endovascular procedures. Despite the high cost of angiography equipment, its share of the costs is minor. The ABC analysis also evaluates the activity and it disclosed surprisingly high equipment costs of patient care in the operating room, because most of the pre- and aftercare of the patient took place in the operating room and thus both the room and the equipment had to be reserved.

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