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Cost of neonatal care in the referral hospital of Lausanne (Centre Hospitalier Universitaire Vaudois, CHUV), Switzerland

The general public frequently questions the legitimacy for intensive medical treatment of a newborn child with high perinatal risks (premature babies under 1500 g, asphyxiated full term neonates, etc.). The reasons given are first that the results on a medium to long term basis are often disappointing and second that the medical costs, in specialised centers with highly qualified personnel, are very expensive. The first objection does not stand up to an objective appraisal for both clinical and ethical reasons[1,2]. A study of the second objection is the subject of this work.

In 1988/1989, the general management of the CHUV introduced a cost accounting procedure in order to determine – as near as possible to the complex day to day picture of a referral university hospital – the cost per patient treated and the daily cost of the different hospital departments. The CHUV is therefore now in possession of all the necessary medico-technical data for studying the neonatology unit from a financial point of view.

Before listing the results obtained, the method by which these costs have been calculated will be explained.

Method

Cost accounting takes into consideration the fact that the hospital is a provider of a wide variety of services (for instance operative procedures, laboratory tests, supervision of the patients, etc.). Furthermore, it is based on the hospital structure. In the case of the CHUV, there are 330 sections, grouped into 75 departments, 17 of which are clinical departments (also called central departments) and the rest – ancillary departments. Let it be added that a department is considered as a clinical department when its doctors have full responsability for their patients.

Each clinical department is charged, in accordance with the cost accounting procedure applied to the CHUV, with it's *direct costs* drawn from the hospital accounts and with those *indirect costs* engendered by it in connection with the other sections of the hospital. The latter costs are related to either one or a combination of the following services:

- medical services:
  for instance, medical consultations, operative procedures and hospitalisation in an intensive care unit
- medico-technical services:
  functional exploration, laboratory tests, imaging investigation
- general support services:
  meals, dietary advice, drugs, housekeeping, laundry, transportation, maintenance, data processing
- administrative services:
  general management, reception work, personnel, accounts and invoice offices

The hospital expenses used in this accounting procedure do not take into consideration either ambulatory activites or research and teaching where these costs have been clearly identified. Furthermore, the indirect costs do not include the building depreciation (or rent) and interests on capital employed. The indirect charges are calculated by means of the *reciprocal allocations* method. In the case of the CHUV, this method leads to the resolution of 330 linear equations equal to the number of sections taken into consideration[3–6].

About the reciprocal allocations method

In cost accounting, each section is analysed as being both the demander of services, thus generative of

costs, as well as the supplier of services for other sections, the latter being charged with the corresponding costs (cost drivers). In other words, the activity of any one section spent in supplying services to other units is charged to the units concerned and reversely the activity generated elsewhere in the hospital for the account of a given unit is charged to it. Thus the cost to effect connection between section A → section B of standard accountancy is transformed through cost accounting into a dynamic vision of exchanges inside the hospital with section A ↔ section B interlinked. Technically speaking, the interrelated cost system takes shape in the above-mentioned linear equations, which are resolved thanks to a mathematical iterative process (reversed matrix). Finally this leads the subsidiary sections, who serve solely as support units to others, to have their total costs attributed to the latter. On the other hand, those whose mission it is to function as final departments, dealing directly with the patients, are charged with the total costs of the hospital.

Mathematical formalisation of the reciprocal allocations method

Four ancillary departments

A Personnel office
B Computing
C Finance
D Imaging

Two central departments

E Surgery
F Medicine

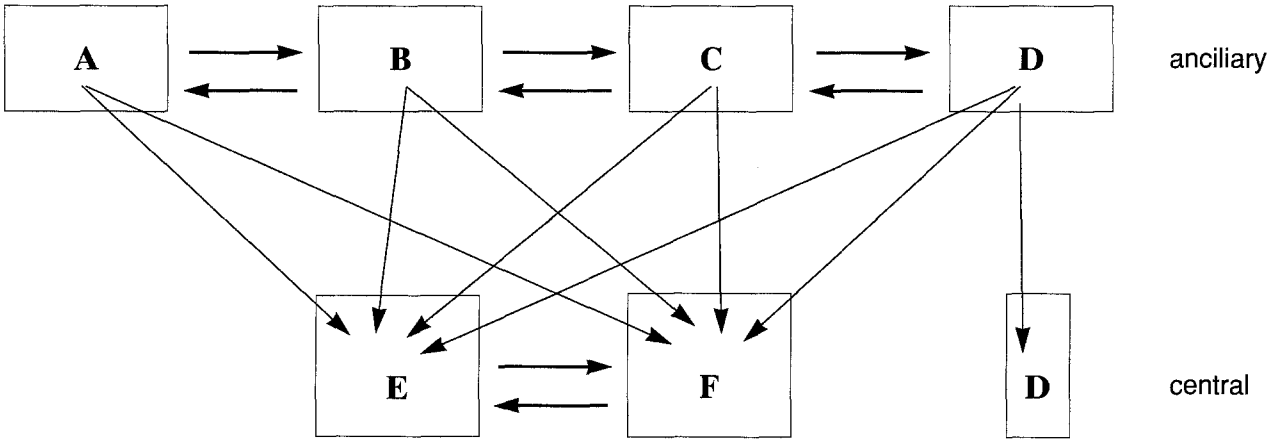
A system of six linear equations with six unknown factors is established as follows:

Matrix of six equations with six unknown factors (unknown factors: A, B C, D, E, and F)

A	= a			+	%B	+	%C					
B	= b	+	%A			+	%C					
C	= c	+	%A	+	%B							
D	= d	+	%A	+	%B	+	%C					
E	= e	+	%A	+	%B	+	%C	+	%D	+		+ %F
F	= f	+	%A	+	%B	+	%C	+	%D	+	%E	
Sum of % A–F			100%		100%		100%		70%		40%	20%

To be noted:

- The constant of each equation that is to say a, b, c, d, e, f, represents the direct cost of the department, the rest of the equation gives the indirect charges.
- The sum of the percentages of A add up to 100%. This implies that A will be charged in its totality to the central departments. The same remark goes for B and C.
- The sum of the percentages is not equal to 100% in the case of D (imaging). The difference represents the final part of the department's activity. In other words, a certain percentage of D's work (help in diagnosis) is for the other departments in the hospital but D also does its own patient-oriented work (therapeutic) and this is its full responsability (cardiac catheterisation for instance).
- E (surgery) and F (medicine) also benefit from one another's services, which are put down as reciprocal charges, for example interdepartment medical consultations or accommodation of patients.
- The following diagram sets out the principle of reciprocal allocations.



Results

Global results for 1991

Figure 1 (cost per case) and 2 (daily cost) and Table 1 give, for the 17 clinical departments, the total cost per case (discharge) and per day. *The total cost for hospitalisation in 1991 came to SFR 336938372.–* that is 76.1 % of the global expenses for the CHUV.*

The total costs (direct and indirect) per case (Fig. 1) for cost accounting purposes go from SFR 25769.– for the patient in cardiac surgery down to SFr. 6062.– for the patient hospitalised in the gynecology unit. The cost of a newborn baby hospitalised in the neonatology unit comes to SFr. 20721.– (healthy newborn babies staying with their mothers are not included in the neonatology division). This figure comes in third position down the list just after that for patients in the rheumatology and rehabilitation department.

The order of classification of the 17 hospital clinical departments for total daily cost is completely different (Fig. 2). Here cardiac surgery with SFr. 2126.– and plastic surgery with SFr. 1686.– are the most expensive. Both departments have patients who spend days either in the surgery intensive care unit or in the burn centre, days charged as indirect costs. A certain number of patients in other departments further down the list also require intensive care services: paediatrics (SFr. 1440.–), neurosurgery (SFr. 1320.–). As for neonatology, which is in fifth place, the daily cost comes to SFR 1191.–.

It is particularly instructive to juxtapose the two ways of accounting, that is the cost per case and the cost per day for every one of the 17 clinical departments (see Fig. 3). Three departments stand out with a relatively low cost per day but with a high cost per case. For instance, the rheumatology and rehabilitation department appears in second position for the cost per case (SFr. 23107.–) but is listed in the last position for the cost per day (SFr. 588.–). The high cost per case in rheumatology is explained by the long stay in the hospital caused by the medical nature of the disease. The dermatology and orthopaedic-traumatology patients are similar cases with lengthy stays in the hospital.

In order of classification per case, the neonatology department is listed third out of the 17 services. Neonatology is undoubtedly an expensive department. Two reasons can be given:

- *Relatively lengthy stay* which entails a fairly high position of the cost per case figures (third place) compared with the cost per day ones (sixth place). The average length of stay in neonatology was 17.4 days in 1991 as against the CHUV average of 11.8 days.
- *Relatively high number of days in the intensive care unit*, the question being is to know whether or not the intensive care in neonatology represents a reasonable or excessively high cost. This point is developed later on.

* The totals are in current swiss francs.

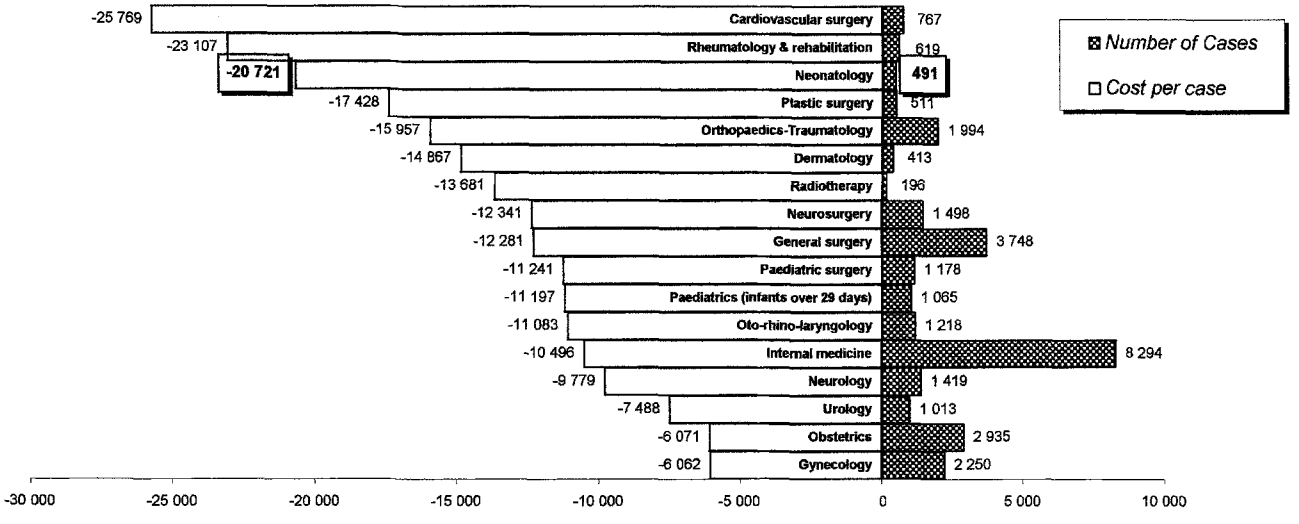


Figure 1. *CHUV: 1991 Cost per case (discharge).*

Department		Total costs SFR	Patients discharged (departments)	Clinical department hospitalisation days	Cost per case SFR	Clinical department cost per day SFR
CCV	Cardiovascular surgery	19764983	767	9296	25769	2126
CHG	General surgery	46028920	3748	41734	12281	1103
CPR	Plastic surgery	8905480	511	5282	17428	1686
NCH	Neurosurgery	18486633	1498	14006	12341	1320
ORL	Oto-rhino-laryngology	13499079	1218	11795	11083	1144
OTR	Orthopaedics-traumatology	31818192	1994	48421	15957	657
URO	Urology	7585291	1013	9240	7488	821
	Total surgery	*146088578*	*10749*	*139774*	*13591*	*1045*
DDM	Internal medicine	87053168	8294	96230	10496	905
DER	Dermatology	6139888	413	9644	14867	637
NLG	Neurology	13875728	1419	17131	9779	810
RMR	Rheumatology and rehabilitation	14303491	619	24312	23107	588
	Other Medicine	34319107	2451	51087	14002	672
	Total Medicine	*121372275*	*10745*	*147317*	*11296*	*824*
GYN	Gynecology	13638558	2250	13161	6062	1036
OBS	Obstetrics	17817476	2935	20535	6071	868
	Total GYN-OBS	31456035	5185	33696	6067	934
CHP	Paediatric surgery	13241456	1178	12209	11241	1085
NAT	Neonatology	10174135	491	8545	20721	1191
PED	Paediatrics	11924446	1065	8281	11197	1440
	Other M-E	35340037	2734	29035	12926	1217
	Total mother and child	*66796071*	*7919*	*62731*	*8435*	*1065*
RTH	Radiotherapy	2681448	196	2966	13681	904
	Total Radiotherapy	*2681448*	*196*	*2966*	*13681*	*904*
	Total CHUV hospitalisation	*336938372*	*29609*	*352788*	*11380*	*955*
	Ambulatory activity	67437417				
	Research	19174093				
	Oncology	4197259	294	1678	14276	2501
	Outpatients medico-technical activity	6771592				
	Costs out of CHUV	3145331				
	Total	*437664064*				
	Receipts deductible from expenditure	15396025				
	Investments on exploitation	6613726				
	Provision of depreciation and financial interests on investments	−17094621				
	Total CHUV – accounts 1991	*442579194*				

Table 1. *Cost accounting of the CHUV 1991 results.*

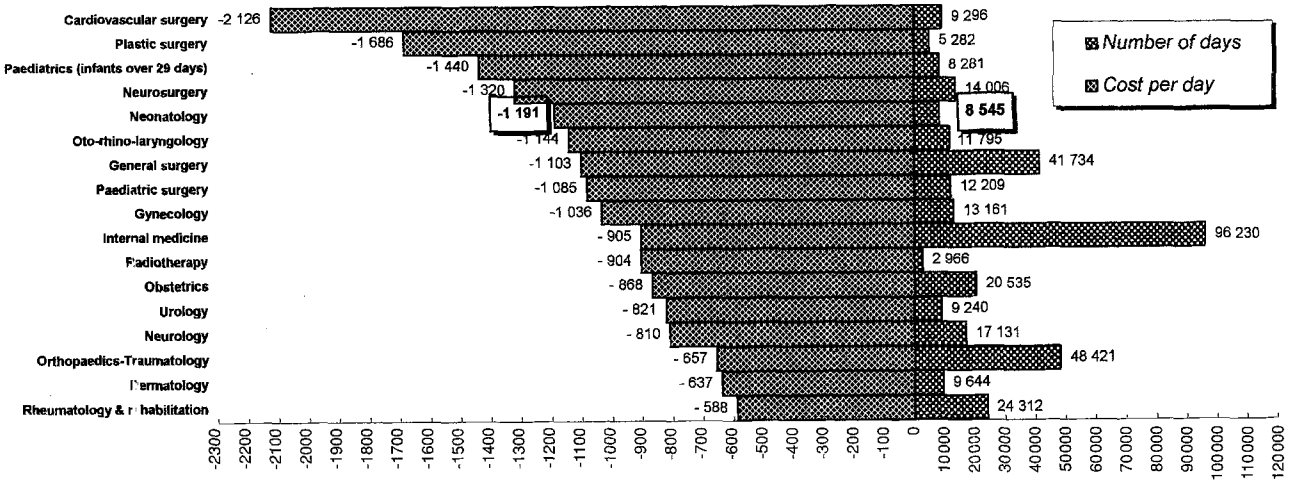


Figure 2. *CHUV: 1991 Cost per day.*

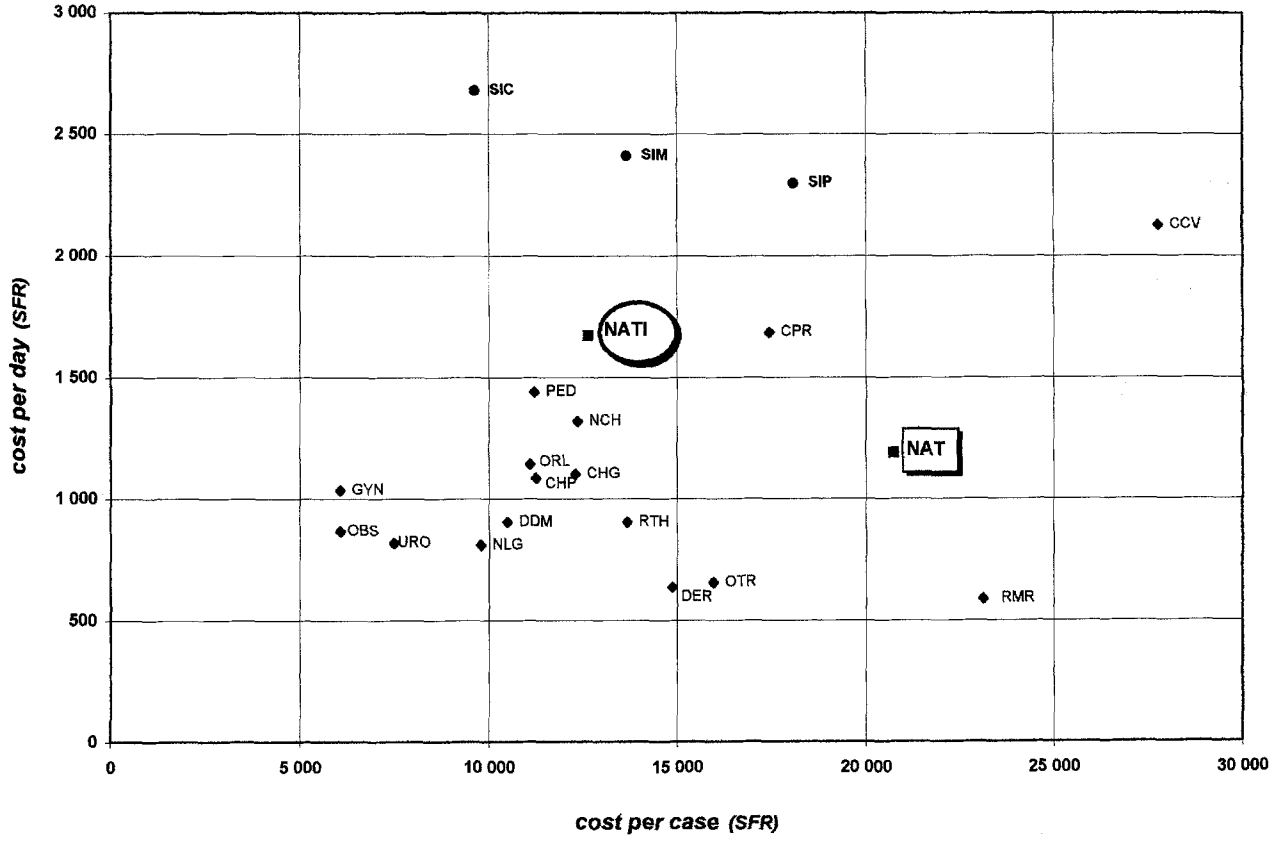


Figure 3. *CHUV: 1991 cost per case and cost per day. SIC: surgical intensive care. SIM: medical intensive care. SIP: medical and surgical intensive care of paediatrics. NATI: neonatology intensive care, for the other abbreviations, please refer to Table 1.*

Results for patients in intensive care

The cost accounting, by the reciprocal allocations method, enables us to reconstitute the cost of the ancillary sections. A comparative table of costs in the intensive care units has been made, see below.
From the point of view of the cost per day, hospitalisation in the neonatology unit appear to be by far the least expensive. It comes to SFr. 1673.– whereas surgery is the most expensive at SFr. 2680.– and the group average is SFr. 2329.–.

On the other hand, the length of hospitalisation is high with 7.5 days as against an average of 5.3 days and only 3.6 days in surgery. Therefore, the cost per case in neonatology (SFr. 12605.–) is close to the average cost per case (SFr. 12350.–).

Neonatology results in 1994

The analysis conducted in 1991 for all the clinical departments of the CHUV was taken up in 1994 for the department of neonatology exclusively. Table 3 gives the global results for all the patients of the department but it also gives a break down of figures for the intensive care unit on one hand and the unit which looks after patients in need of special care (but not highly technical treatment) on the other.
The total cost per day in this division came to SFr 1613.– in 1994 (compared with 1991: + SFr. 422.–); a day in the intensive care unit amounted to SFr. 2106.–. This figure is inferior to those of 1991

	Patients discharged	Days in the hospital	Average length of stay	Direct costs	Indirect costs	Total costs	Cost per case	Cost per day
Surgical intensive care	1235	4496	3.6	8688545	3366610	12055155	9621	2681
Medical intensive care	945	5350	5.7	8526930	4377180	12904110	13655	2412
Paediatric intensive care	365	2868	7.9	4581556	2012709	6594265	18066	2299
Neonatology intensive care	393	2961	7.5	3021789	1931964	4953753	12605	1673
Total intensive care	2956	15675	5.3	24818820	11688463	36507283	12350	2329

Table 2. *1991 cost per day/per case in the four intensive care units.*

	Patients leaving	Days in the hospital	Average length of stay	Direct costs	Indirect costs	Total costs	Cost per case	Cost per day
Neonatology	425	7254	17.0	7370955	4328973	11699928	27529	1613
of which:								
Intensive care unit	393	2555	6.5	3388859	1990283	5379142	13687	2106
Special care unit	425	4699	11.0	3982096	2338691	6320787	14872	1345

Table 3. *Neonatology division 1994.*

	Neonatology division	Special care unit	Intensive care unit	
	Total amount	Total amount	Total amount	%
Salaries	838	716	1062	51%
Drugs	38	31	52	2%
Blood	12	10	16	1%
Neonatals nutrition	51	42	69	3%
Disposables	99	80	134	6%
Radiology[a]	51	41	68	3%
Laboratories	115	93	154	7%
Other medical and medico-technical services	103	84	139	7%
Logistics	224	182	302	14%
of which:				
Housekeeping and laundry	63	51	85	
Heavy equipment and maintenance	86	70	116	
Miscellaneous (transportation for ex.)	75	61	101	
Administration	82	66	110	5%
Total	1613	1345	2106	100%

[a] without brain echocardiography. These examinations are performed by the neonatology doctors and the related costs are accounted for in the doctors' salaries.

Table 4. *Cost components of the total 1994 cost per day.*

for the intensive care units in other departments.

Table 4 gives the cost components of a day spent by a neonate in neonatology coverage costs, that is in both the special care and the intensive care units as well as the overall average cost of neonatology. Figure 4 illustrates the cost per day in the intensive care unit.

Discussion

The setting up of an analysis of the full costs of each clinical department has allowed us, for the first time at the CHUV, to collect relevant information about the cost per case and the daily cost. As far as neonatology is concerned, the cost per case in 1991 amounted to SFr. 20721.– which leads to an actualized cost of SFr. 27529.– for 1994.

We have not compared our results with those of other studies. On the other hand, the figures available allow us to compare the total cost per patient (and by day) between the different clinical departments of the CHUV and estimate the total cost of a neonate. This cost, of SFr. 20721.– for 1991, is high chiefly because the related average length of hospitalisation is much higher (17.4 days) than the average one (11.8 days). This can be put down more to the general condition of the patient (early delivery, insufficient intra-uterine growth) than to a specific pathology. The child must put on weight (approximately 2000 g) before being given back to its mother. Let it be added that although the total cost per day of a neonate is listed above average, it is at the same time distinctly lower than the costs of other departments – such as cardiac surgery, plastic surgery, paediatrics or neurosurgery – which take into account intensive care services for numerous patients.

A comparison of the four intensive care units of the CHUV (surgical intensive care SIC, medical intensive care SIM, medical and surgical intensive care of paediatrics SIP, neonatology intensive care NATI) shows that a day spent in the neonatology intensive care unit is not as expensive as for the other units. The cost for NATI came to SFr. 1673.– in 1991, whereas SIC SIM and SIP amounted respectively to SFr. 2681.–, SFr. 2412.– and SFr. 2299.–.

At first glance this may seem paradoxical. A detailed analysis of various components of the total cost per day provides us with a few explanations.

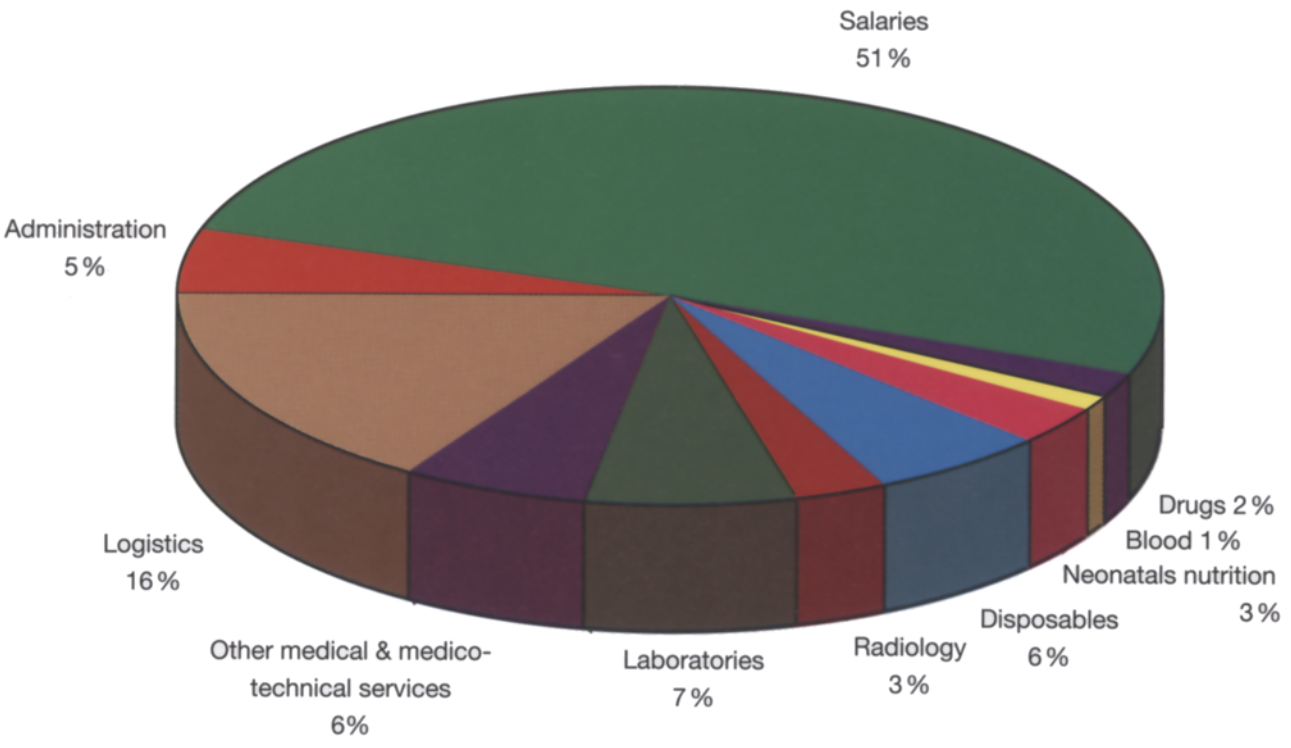


Figure 4. *CHUV Intensive care unit neonatology.*

Although the calculated costs per patient and per day for doctors and nurses are identical for the four intensive care units (approximately SFr. 1204.–), there are, on the other hand, big differences as regards drug consumption, utilization of radiology services and laboratory exams.

The cost per day in drugs in neonatology intensive care represents 2.2%. The percentage for paediatrics amounts to 4.1% and it goes from 7.5% for the medical intensive care unit to 8.9% for the surgical intensive care unit. In absolute terms, the daily cost in drugs for the neonatology intensive care units is of SFr. 46.– whereas it is of SFr. 94.– in paediatric intensive care, SFr. 179.– in medical intensive care and SFr. 238.– in surgical intensive care. A reasonable explanation for this is that the dosage of drugs is calculated with regards to the weight or the surface area of the patient. As the differences in weight (or surface area) between a newborn baby (500–2000 g) and an adult (65–70 kg) are big, the neonatology unit can thus economise on drugs.

The same goes for laboratory and radiology exams. The daily cost of radiology tests, for a patient in neonatology intensive care, is SFr. 59.– in comparison with an average of SFr. 132.– for the three other intensive care units. The difference is not as marked for the laboratory tests: the totals are of SFr. 159.– for neonatology against an average of SFr. 227.–.

Conclusion

The total cost per case in neonatology, including hospitalisation in both the special care and the intensive care units, is high because the average length of stay is long. The cost per day in the intensive care unit is however inferior for the neonate as it is for the other patients, children and adults, requiring intensive care services. Let it be added that the total cost per case in neonatology is cheaper than the cost per case of those patients of the CHUV who are taken in charge by cardiac surgery of rheumatology and rehabilitation clinical departments.

The financial argument given for not having a newborn child with perinatal risks benefiting from highly technial (and therefore expensive) health care does not, in consequence, seem more judicious than it would be for a child or an adult in need either cardiac surgery departments skills or a lengthy treatment in the rheumatology and rehabilitation department.

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