# ACTIVITY BASED COSTING FOR AN INTENSIVE CARE UNIT (ICU) IN CHILE AS A MANAGEMENT TOOL AND FINANCIAL ANALYSIS

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## Abstract

This study has the following purposes: (i) to analyze the importance of characterizing and quantifying the production costs of an Intensive Care Unit (ICU) of a Public Hospital in Chile, with the goal of helping to reduce the debts that every fiscal year they have because of the decreasing in their general incomes which they receive from the state insurer system and the private insurance companies. This happens due to the insurers do not pay the total and real cost of the services. (ii) to develop a set of proposals and recommendations in order to determine the real flows of income and costs in an Intensive Care Unit so that they allow to evaluate the financial sustainability.

Particularly the determination of costs of the services that ICU provide is rather complex due to a not insignificant proportion of costs they have, are overhead costs of shared resources. As a result it is necessary a suitable methodology in order to allocate costs equitably to the centers and activities in this health organizations.

This study suggest or recommend the need of implementing a suitable analytical and management accounting system in the health centers that allow in a transparent manner to determine their financial sustainability.

It is proposed an original approach for calculating health care costs and management in the health centers. The approach is novel and its foundation developed in this job is substantial in order to advance towards new ways to understand the health care costs and the form of financing and sustainability.

## Introducción

The calculation of health production costs is a key issue at least for the following purposes: (i) management of health centers; (ii) support decisións related to financing and sustainability of hospitals and (iii) economic evaluations of health programmes.

Our interest in this project is to contribute to the knowledge of real costs of an Intensive Care Unit (ICU) that utilizes high cost resources and personnel. We consider this as significant in countries like Chile, where the public or private insurer companies should move towards the payment of the real cost of health services that hospitals give to the population.

A great amount of the debt that public hospitals have today can be explained partially by the factor mentioned above. We can cite a study carried out by Alvear et al. (2012) where the authors found that payments made by public insurer was under de real costs en health services in two ICU of public hospitals

The studies about costs calculation in health centers, are still incipient in Chile, and given the complexity of them, is necessary to propose methods in order to capture all the resources involved in health services they provide in the best way feasible.

In this project we used an adaptation of Activity Based Costing Methodology suitable for the case. We also combined this method with the application of Break Even Point for the analysis of revenues, pricing, costing and financial sustainability.

Our basis are previous studies, particularly the work undertaken by Cao PY, Toyabe S, Abe T, et al. (2006) about an intensive care unit in Japan.

Our job has been done in the ICU of Thorax National Institute (TNI), which includes an Intensive Care Unit and an Intermediate Treatment Unit. The TNI is a National Reference Hospital, qualified by Health Ministry of Chile as a high complex unit. It is located in Santiago, Chile. The TNI serves an average of 697 patient every year and has 44 beds.The staff includes 38 physicians, 49 nurses, 8 physical therapists, 56 nursing technician, 15 assistants and 3 clericals workers.

This work is a first exercise which will be needed to deepen and refine in order to include all the complexities such as patient variability, different diseases, length of stay variability and the related use of resources.

In fact the authors of this study, have decided to improve this work in the near future extending it to other Health Care Units in public sector as well as private Health Care facilities. In this way they think to enrich the analysis and formulate a model of costs calculation and report for hospitals unit.

The study is important to improve the internal management and financial sustainability of hospitals as well as to enhance information of cost and resource usage as a tool of public policy. In this way, decision makers will do a much better resource allocation with more accurate economic criteria

At International level have been carried out similar studies. However in Chile is a pioneering study.

## Methods

### *Cost Data*

Global costs at Hospital level were collected from the hospital accounting system related to 2015 fiscal year. Specifically was used the WinSig[1] report with global cost disseminated over the main Hospital cost centers. All the monetary data were updated to december 2016.

The Winsig report aforementioned was analyzed, and debugged. The aim of this analysis was to classify costs in those direct and overhead costs. At the same time the costs were classified in variable and fixed costs.

The direct costs were already allocated at ICU level, however the overhead costs, only were available a global level of the hospital.

In order to allocate overhead costs, was used the Activity based costing (ABC) methodology, identifying a set of 19 activities giving service to the UCI (as shown in the first column of Table 1). In a first phase was carried out a measure of costs in all activities allocating the global hospital costs using variables correlated with the intensity in the resource usage such us physical space in square meters, number of personnel, energy usage, number of tests, and so on. The cost of each activity is shown in the second column of Table 1.

[1] Management Information System for the Windows operating system, developed by Pan american Health Organization, for Health Organizations.

On the other hand, for each of 19 activities, was identified a suitable cost driver with the corresponding total magnitude at activity level. This is shown in the third and fourth columns. The underlying assumption in the cost driver is that more quantity in ICU, more resource ussage must be allocated.

The rate shown in the fifth column of Table 1 is the quotient between the cost of the activity and the total magnitude of cost driver. It depicts the average cost of the corresponding resources of activity for every unit of cost driver.

The sixth column of Table 1 shows the quantity of cost driver in the UCI. Finally the seventh column of Table 1 is the allocated cost from each activity as a result of multiplication of fifht and sixth column (cost unit of activity and cost driver in ICU).

*Revenue Data*

They were obtained from the financial system of the hospital as shown in Table 2. The first column corresponds to a section of the UCI; the second column is the disease or medical specialty of discharge; the third column is the average length of stay; the fourth column is the quantity of inpatient that were in 2015 in that length of stay; the fifth column correponds to the patient days (Pds) which is length of stay multiplied by quantity of inpatient; the sixth column is the price paid by public insurer and the seventh column is the total income for every medical specialty. The total annual revenues for ICU is the summation of seventh column of Table 2.

Table 1

Costs of activities, cost drivers, cost rates and allocation of overhead costs to UCI (CLP Dic. 2016; €1=CLP 700,95)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Activity | Cost | Cost driver | Number of cost drivers | Cost unit of Activity | Number of cost drivers for ICU | Overhead costs for ICU |
| Hospital management | $ 541.638.454 | Managers hours | 14.168 | $ 38.229,7045 | 1.012 | $ 38.688.461 |
| Medical Direction | $ 355.544.894 | Hours of Medical Professionals (Gen. and Consultants) | 146.420 | $ 2.428,2536 | 37.736 | 91.632.578 |
| Administrative Direction | $ 99.425.490 | Administratives and Assistants hours | 265.332 | $ 374,7211 | 34.396 | 12.888.907 |
| Human Ressource Management | $ 314.501.978 | Total hours of Human Resources | 1.303.176 | $ 241,3350 | 290.519 | 70.112.403 |
| Studies Management | $ 114.673.502 | Hours of Consultants, nurses and Physical therapists) | 403.523 | $ 284,1808 | 143.596 | 40.807.226 |
| Nurse Management | $ 91.401.507 | Hours of nurses | 244.480 | $ 373,8609 | 92.589 | 34.615.407 |
| Guarantees Explicit in Health | $ 68.382.231 | Hours of Medical Consultants | 130.700 | $ 523,1999 | 31.464 | 16.461,962 |
| Medical and Statistical Guidance Service | $ 272.496.028 | Hours of Medical Professionals (Gen. and Consultants) | 146.420 | $ 1.861,0574 | 37.736 | 70.228.862 |
| Auditing | $ 56.499.322 | Total costs goods and services | 13.477.686.761 | $ 0,0042 | 1.194.250.712 | 5.015.853 |
| Finance | $ 194.309.732 | Total operation costs | 23.557.218.188 | $ 0,0082 | 3.780.275.076 | 30.998.256 |
| Logistics | $ 362.747.048 | Maintenance costs + General Services | 1.530.981.523 | $ 0,2369 | 91.137.432 | 21.590.458 |
| Informatics | $ 92.306.594 | Total operation costs | 23.557.218.188 | $ 0,0039 | 3.780.275.076 | 14.743.073 |
| Management and development | $ 88.093.702 | Training costs | 31.216.412 | $ 2,8220 | 4.821.172 | 13.605.347 |

Table 2

Occupancy of UCI according to specialty, average of stay, number of patients, patient days, fee and total incomes

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Service | Medical Specialty | Average of stay | Number of patients | Patient days | Fee | Total Income |
| Intensive Care Unit Adults | Cardiology | 2,52 | 31 | 78 | $ 148.374 | $ 11.573.172 |
| | Cardiovascular surgery | 5,23 | 466 | 2.437 | $ 148.374 | 361.587.438 |
| | Congenital Heart disease | 6,03 | 35 | 211 | $ 148.374 | 31.306.914 |
| | Chest surgery | 3,83 | 63 | 241 | $ 148.374 | 35.758.134 |
| | Respiratory diseases | 12,32 | 44 | 542 | $ 148.374 | 80.418.708 |
| | Heart transplant | 77,22 | 9 | 695 | $ 148.374 | 103.119.930 |
| | Lung transplant | 13,88 | 8 | 111 | $ 148.374 | 16.469.514 |
| Intermediate Treatment Unit Adults | Cardiology | 2,16 | 50 | 108 | $ 148.374 | 16.024.392 |
| | Cardiovascular surgery | 3,77 | 82 | 309 | $ 148.374 | 45.847.566 |
| | Congenital Heart disease | 3,80 | 10 | 38 | $ 148.374 | 5.638.212 |
| | Chest surgery | 3,51 | 588 | 2.064 | $ 148.374 | 306.243.936 |
| | Respiratory diseases | 8,46 | 195 | 1.649 | $ 148.374 | 244.668.726 |
| | Heart transplant | 9,00 | 9 | 81 | $ 148.374 | 12.018.294 |
| | Lung transplant | 10,17 | 59 | 600 | $ 148.374 | 89.024.400 |
| Intermediate Treatment Unit Cardiovascular | Cardiology | 3,48 | 227 | 790 | $ 148.374 | 117.215.460 |
| | Cardiovascular surgery | 6,73 | 428 | 2.880 | $ 148.374 | 427.317.120 |
| | Congenital Heart disease | 2,93 | 44 | 129 | $ 148.374 | 19.140.246 |
| | Chest surgery | 1,33 | 12 | 16 | $ 148.374 | 2.373.984 |
| | Respiratory diseases | 6,83 | 6 | 41 | $ 148.374 | 6.083.334 |
| | Heart transplant | 5,46 | 13 | 71 | $ 148.374 | 10.534.554 |
| | | | | | | $ 1.942.364.034 |

*Profit and loss analysis for the ICU*

The revenue data and direct and overhead costs allocated to ICU and classified into variable and fixed allowed to carry out an application of the break even point model. This was done for three scenarios: (i) considering the price paid by the main public insurer company of $ 148.374; (ii) taking into account the minimum average cost of stay in ICUs of two hospitals of Chile in 2011, reported by Alvear et al.(2012) of $ 371.801, and (iii) considering the minimum average cost of stay in ICUs of two hospitals of Chile in 2011, reported by Alvear et al.(2012) updated to december 2016 of $ 447.016.

## Results

*Economic results*

All the economic analysis was carried out taking into account a volume of 13.091 patient days since It is not possible in the short term to expand the UCI capacity and considering that there is no iddle capacity. The total variable costs in this level of volume were $ 1.905.931.913 and the total fixed costs were $3.161.825.368. The total cost (variable + fixed) is equivalent to $ 5.067.757.281.

At the present time, the UCI depends on the revenues that are obtained from the main public insurer company in Chile. The price paid for patient day ($148.374) is ostensibly lower than the real cost of the UCI services. In this scenario, the ICU has a loss amounting to ($ 3.125.393.247) equivalent to (€4.458.822). Every fiscal year this deficit is financed by the budget of the ministry of health. This scenario is shown in Table 3 where you can find a typical variable costing approach: Total revenues, section of variable costs, contribution margin, fixed costs section and the final result. Notice the last column that corresponds to percentages over the total costs.

If the UCI take into account a price for patient day equivalent to the the minimum average cost of stay in ICUs of two hospitals of Chile in 2011, reported by Alvear et al.(2012) of $ 371.801, It will have a loss amounting ($200.510.390), equivalent to (€286.057) (see Table 4).

Table 3

Total amount of the revenue of medical payment considering fee paid by public insurer, and those of direct, indirect and the overhead costs for the ICU
( CLP Dic. 2016; €1=CLP 700,95)

| Ref. | | Partial | Total | % |
|---|---|---|---|---|
| 1 | Revenues from public insurer | | 1.942.364.034 | |
| | VARIABLE COSTS | | | |
| | Variable direct costs | | | |
| | Chemicals products and gases | 4.903.229 | | 0,10% |
| | Pharmaceuticals products | 397.454.914 | | 7,84% |
| | Surgical supplies | 398.826.019 | | 7,87% |
| | Other supplies and services | 278.654.339 | | 5,50% |
| 2 | Subtotal variable direct costs | | 1.079.838.501 | |
| | Hospital overhead costs (ABC allocation) | | | |
| | Clinical Laboratory Tests | 570.110.789 | | 11,25% |
| | Imaging tests | 93.360.553 | | 1,84% |
| | Food service | 76.862.875 | | 1,52% |
| | Sterilization service | 30.154.542 | | 0,60% |
| | Pharmaceuticals supplies | 31.361.364 | | 0,62% |
| | Supply materials | 24.243.289 | | 0,48% |
| 3 | Subtotal overhead costs (ABC allocation) | | 826.093.412 | |
| 2+3 | Total Variable costs | | 1.905.931.913 | |
| M=1- (2+3) | Contribution margin | | 36.432.121 | |
| | | | | |
| | FIXED COSTS | | | |
| | Labor expenses | | | |
| | Labor costs | 2.586.024.364 | | 51,03% |
| | Training costs | 4.821.172 | | 0,10% |
| 4 | Subtotal Labor expenses | | 2.590.845.536 | |
| | Equipment costs | | | |
| | Maintenance and repairs | 64.344.360 | | 1,27% |
| | General services | 26.793.072 | | 0,53% |
| | Charge for hire | 3.525.227 | | 0,07% |
| 5 | Subtotal equipment costs | | 94.662.659 | |

Table 3 To be continued in the next page

Table 3 From the previous page

| | | | | |
|---|---|---|---|---|
| | Hospital overhead costs (ABC allocation): | | | |
| | Hospital management | 38.688.461 | | 0,76% |
| | Medical Direction | 91.632.578 | | 1,81% |
| | Administrative Direction | 12.888.907 | | 0,25% |
| | Human Resource Management | 70.112.403 | | 1,38% |
| | Studies Management | 40.807.226 | | 0,81% |
| | Nurse Management | 34.615.407 | | 0,68% |
| | Guarantees Explicit in Health | 16.461.962 | | 0,32% |
| | Medical and Statistical Guidance Service | 70.228.862 | | 1,39% |
| | Auditing | 5.015.853 | | 0,10% |
| | Finance | 30.998.256 | | 0,61% |
| | Logistics | 21.590.458 | | 0,43% |
| | Informatics | 14.743.073 | | 0,29% |
| | Management and development | 13.605.347 | | 0,27% |
| 6 | Subtotal Hospital overhead costs | | 461.388.793 | |
| 7 | Electricity, water, gas, heating | | 14.928.380 | |
| F=4+5+6+7 | Total Fixed costs | | 3.161.825.368 | |
| M - F | Annual loss | | (3.125.393.247) | |

Notice that considering the aforementioned minimun average cost of ICU service for patient day, updated to december 2016 of $447.016 UCI will have a total benefit of $784.129.175, equivalent to €1.118.673 (see Table 4).

After having analyzed the mentioned scenarios and given that TNI is a public hospital committed to the health of the population and not to the economic benefits, an equilibrium price was determined considering the current volume. This price was $387.117,65 and allows to cover total costs keeping the current volume.

Table 4

Results with three price options
( CLP Dic. 2016; €1=CLP 700,95)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| | Price | Current Volume | Total revenues | Total Costs | Results | Break even Point ($) | Break even point Patient days |
| Public Insurer | 148.374 | 13.091 | 1.942.364.034 | 5.067.757.281 | (3.125.393.247) | 168.571.461.337 | 1.136.125 |
| Min. Average cost (Alvear et al.,2011) | 371.801 | 13.091 | 4.867.246.891 | 5.067.757.281 | (200.510.390) | 5.196.807.781 | 13.977 |
| Min. Average cost (Alvear et al. Currency updated to Dec. 2016) | 447.016 | 13.091 | 5.851.886.456 | 5.067.757.281 | 784.129.175 | 4.689.015.764 | 10.490 |

*Results of the break even point analysis*

The base analysis situation corresponds to a volume of 13.091 patient days (see Table 2) and a price/patient day of $148.374 (public insurer company). The total fixed costs of UCI amount to $3.161.825.368 and the variable cost per patient day is $145.591,01.

The break even points in monetary units and in quantity of patient days are shown in the seventh and eighth columns of Table 4, respectively.

Figure 1 shows the different points of equilibrium analyzed, and their reading can be summarized as follows:

i. The gray line shows the fixed costs of $3.161.825.368, and the red line the total costs considering a scale between 0 and 28.000 patient days (Pds). The latter has its origin from the fixed costs.

ii. Lines starting at the point of origin correspond to total revenues from 0 to 28.000 Pds. The graph shows four of them: Income 1, which corresponds to the income that is obtained with the current price paid by public insurer; Income 2 that shows the revenues that would be obtained if the ICU charges the minimum average cost of stay in ICUs of two hospitals of Chile in 2011, reported by Alvear et al.(2012) of $ 371.801; Income 3 shows the revenues that would be obtained if the ICU charges the minimum average cost reported by the study of Alvear et al. updated to december 2016. Finally, the graphic 1 shows the Income 4 line which depicts the revenues that UCI would receive if It charges the equilibrium price keeping the present volume of 13.091 Pds.

iii. The case of the current price (Income 1) is practically unsustainable, since in order to reach equilibrium, the UCI should hit a volume of 1.136.125 patient days, which is virtually impossible since it would mean carry out large investements in physical spaces, equipment and personnel.

iv. Working with the minimum average cost determined by Alvear et al. (2012) (Income 2), would be much more feasible, because in order to reach equilibrium, the ICU

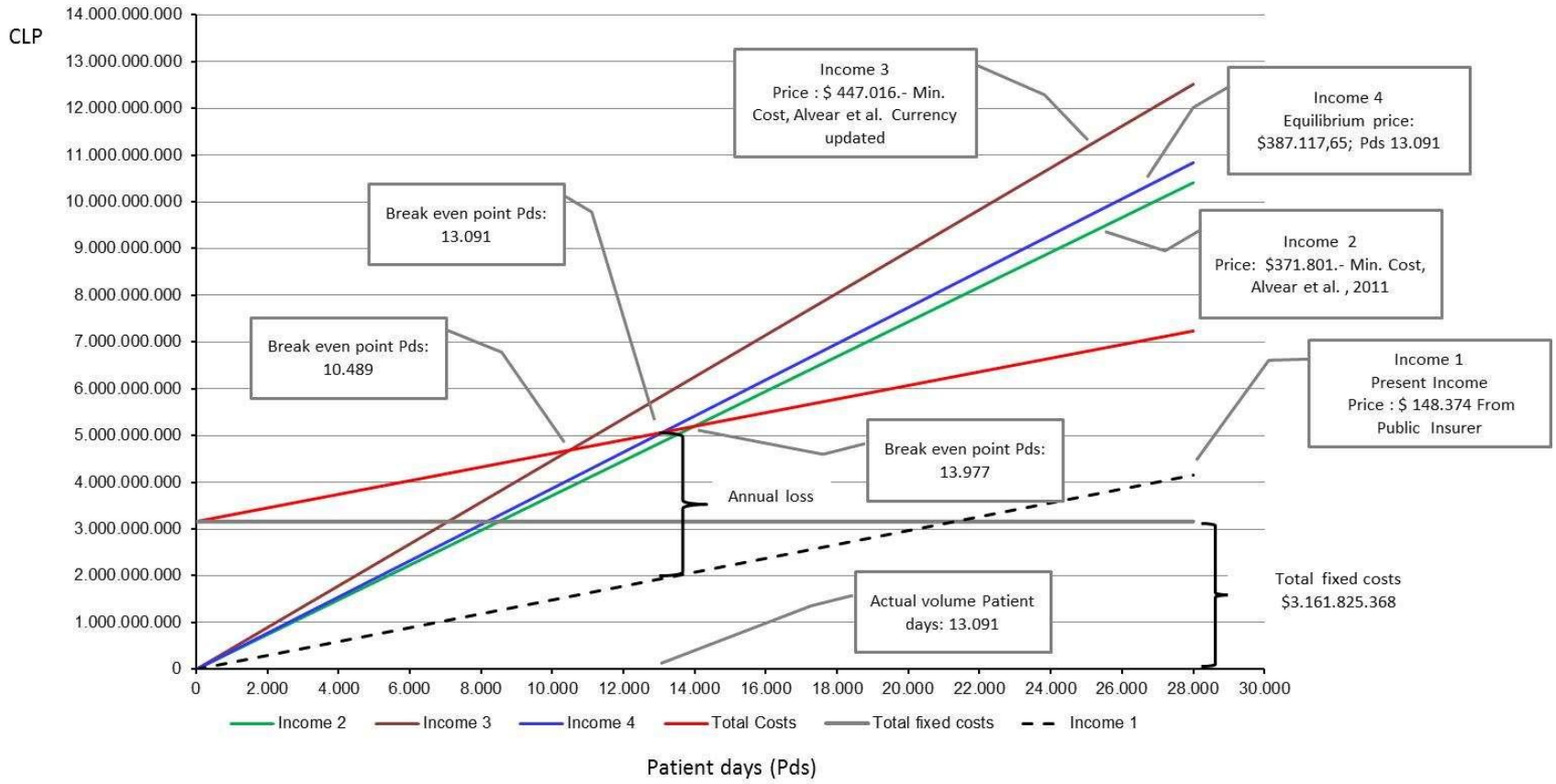
would need to increase its current volume by an average of 7%. The graph shows that the equilibrium corresponds to a volume of 13.977 Pds.

v. The minimum average cost of Alvear et al. updated to December 2016, (Income 3) would allow to achieve surpluses with the current volume of operations. However, since the underlying principle in Public Health is not essentially the economic benefits, this is no a proper recommendation.

vi. An equilibrium price of $387.801 was determined. This is lower than the previous updated minimum average cost. With this price, all the costs of the ICU are covered keeping the current volume of patient days.

Graph 1

Results of a break-even point analysis for the ICU



## Conclusion

It is no surprise that labor costs are one of the most important costs in almost all organizations. In this case, they reach 51% of total costs.

Other direct costs including surgical materials and drugs account for 21% of total costs. Even so 25% of total costs come from the allocation carried out by activity based costing methodology.

Therefore, the application of the ABC methodology allows to adequately complete the determination of the true costs involved in health production, in a unit with high infrastructure utilization, logistical support and diagnostic support services which use high costs equipment and personnel.

The combination of the ABC methodology with the break even analysis allows to construct solid arguments in order to negotiate better price conditions with insurance companies. They should at least pay the actual cost of health services.

This is very important in the health system in Chile as the insurance companies take advantage of the ignorance of Health Centers about the true cost of the different services they provide. As a result the insurance companies pay prices lower than the costs of services.

Income below costs also contributes to generating the hight levels of debt that the public health system has in Chile.

Given the complexities of critical health care it is necessary to refine methods for the determination of more precise costs in order to implement them throughout the public health system. This will allow a greater transparency of the financial information, a much better resource allocation, a better management of Health Centers and what is more important, to maintain a quality health supply for the majority of the population.

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