Journal of Indonesian Medical Laboratory and Science
pISSN 2775-0108 ‖ eISSN 2774-2504

Analysis of clinical chemical quality control unit cost by activity-based costing methods in the laboratory dr. H. A. Rotinsulu Park hospitals

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Received: 2023-09-06
Revised: 2023-09-06
Accepted: 2025-04-27
Available online: 2025-06-01

DOI: https://doi.org/10.53699/joimedlabs.v5i2.235

Citation
Suryadi Arfiah A.N, Kurniawan Entuy, Rahayu Ira Gustira, Rinaldi Sonny Feisal, Hidayatullah Taufik. (2025). Analysis of Clinical Chemical Quality Control Unit Cost by Activity Based Costing Methods in the Laboratory Dr. H.A. Rotinsulu Park Hospitals. Journal of Indonesian Medical Laboratory and Science, 6(1), 72-82. https://doi.org/10.53699/joimedlabs.v5i2.235

Abstract
Hospital laboratories must comply with quality and safety standards as they are responsible for patients' health test results. Laboratory test results must be reliable, so the quality of laboratory services needs to be improved, including implementing quality control measures. Conducting a unit cost analysis for quality control activities is necessary to determine the expenses incurred for each quality control activity. The objective of this writing is to determine the unit cost for Clinical Chemistry Quality Control in the laboratory using the Activity-Based Costing method. Data collection techniques include interviews, observations, and document studies. Various costs are involved in determining the ABC method, including labor costs, depreciation costs for equipment or buildings, and other costs. In addition to cost data, cost drivers are also important in determining them. The equipment used in this research is the Sysmex BX with a total of 14 examination parameters, including glucose, total bilirubin, direct bilirubin, SGOT / AST, SGPT / ALT, total protein, albumin, urea, creatinine, uric acid, cholesterol, triglycerides, HDL, LDL. Based on the research results, the cost of QC for clinical chemistry examinations is Rp. 102,477

Keywords
Activity Based Costing; Clinical chemistry; Unit Cost

1. Introduction

According to (Purwanti, 2022) unit cost is the cost per unit of a product or service calculated using a calculation method. The use of the Activity Based Costing (ABC) method which is one way to calculate each cost incurred in each activity to produce accurate rates because this method is able to measure carefully (Haryanto, et al., 2018). There are several methods of determining costs in the accounting system, namely determining costs using the Traditional Cost System (TCS) method or traditional cost system and Activity Based Costing (ABC) or activity-based costing system.

The traditional cost system (TCS) can cause cost distortions, so it is rarely used. Meanwhile, activity-based costing (ABC) is a new and more effective costing system (Javid, et al., 2015). The TCS method is also related to overhead costs so that it is only centered on distribution and can change the determination of overhead costs (Javid, et al., 2015). The ABC method is very helpful in making decisions because using the ABC system will produce a good price and the costs incurred are more representative of the situation (Nusantara). Using the ABC method can represent more accurate information about the main cost components, as shown by the unit cost of 50.34 USD more with the ABC method per day than the TCS method (Javid, et al., 2015).

The calculation of examination costs using the ABC method is more accurate because it is charged to the activities and resources consumed. For the laboratory, using the ABC method will be more precise and accurate because laboratory services come from different activities (Fahrudi, 2018).The results of laboratory examinations must be reliable so that the quality of laboratory services needs to be improved, one of which is by implementing quality control or quality stabilization. Quality control is an activity or action to ensure the quality of laboratory examination results (Girsang, 1998). Based on research (Muhammad, 2019), it was found that out of 29 laboratories, 21 laboratories (72%) did not conduct QC and 8 laboratories (28%) had conducted QC. Lack of management policies such as the absence of SOPs is a factor in not implementing QC.

Various types of costs in the total cost per test for clinical chemistry examination consist of personnel costs (57.4%), service support costs (22.7%), reagent costs (13.7%), and other costs (6.2%) consisting of equipment costs (4.6%) based on equipment maintenance, depreciation of equipment and related software, control material costs (1.1%), standard material costs (0.1%), equipment-related materials (0.3%) namely sample containers for cobas and depreciation of materials used for analyzers such as columns, and related software, control material costs (1.1%), standard material costs (0.1%), tool-related materials (0.3%) namely sample containers for cobas and depreciation of materials used for analyzers such as columns for chromatography, and special examination materials (0.1%). Based on the total cost research, the cost of control materials and the cost of standard materials are included in QC, so the cost of conducting QC does not reach tens of percent of the total cost of clinical chemistry examination (Declerck, et al., 2021).

With the existence of laboratories that have not done QC, unit cost analysis on quality control activities needs to be carried out research to determine the amount of costs incurred in each quality control activity. Calculation of unit cost quality control is very important for cost control, budget planning, efficiency improvement and performance evaluation.

2. Materials and Methods

2.1. Tools and materials

The population in this study were all data on the cost of Quality Control of clinical chemistry examinations in the laboratory. The samples used are QC costs on clinical chemistry examinations which include glucose, total bilirubin, recycled bilirubin, SGOT, SGPT, total protein, albumin, ureum, creatinine, uric acid, cholesterol, triglycerides, HDL and LDL.

In the form of primary data obtained through interviews and observations to collect information about activities related to quality control, and secondary data obtained from document review in the laboratory including data on facilities and infrastructure, and other supporting documents.

2.2. Methods

The activity-based costing method is used. The first step is to identify activities by determining the classification of activities, namely primary (main) or secondary (supporting), determining the activity category (unit activity or batch activity) and identifying the time of each activity and calculating the total. Then combine all activities (primary and secondary) and identify cost drivers. For indirect costs (overhead costs), identify and then distribute to all existing inspection units based on the cost drivers that have been determined and also distribute to all activities. Charge secondary activity costs to primary activities, identify direct costs and calculate the total, finally calculate unit costs by summing direct costs and indirect costs.

3. Results and Discussion

The laboratory installation of the Dr. H. A. Rotinsulu Lung Hospital meets the requirements for calculating unit costs using the Activity Based Costing method, one of which is facing intense competition and high diversity.

1. Identifying activities:
   Determine the classification of the activity i.e. primary (main) or secondary (supporting). Determine the activity category (unit activity or batch activity). Identify the time of each activity and calculate the total.

Table 1. Activity Identification

Activities	Activity Classification	Activity Categories	Time (Minutes)	Total Primary Time (Minutes)

Remove the control ingredients from the refrigerator and let stand at room temperature	Primary	UA1	10	79
Volumetric rinse with aquabidest	Primary	UA1	1	
Pipette an equal amount of aquabidest with a volumetric pipette into the control material bottle	Primary	UA1	1	
Homogenize, let stand and shake once	Primary	UA1	20	
Select test selection, select sample category, and select QC Sample, use the same lot, save.	Primary	UA1	1	
Store normal control in number 1, pathological in number 2, and calibrator then start	Primary	UA1	1	
Tool running	Primary	UA1	45	

The activities used are the way QC works. All activities include primary activities with the unit activity (UA) category. The total primary time summed up is 79 minutes or 1.3 hours.

2. Combining all activities (primary and secondary)

Table 2. Combination of All Activities

Activities Clinical Chemistry QC	Activity Classification	Activity Categories	Time (Minutes)	Cost Driver
Remove the control ingredients from the refrigerator and let stand at room temperature	Primary	UA1	10	79
Volumetric rinse with aquabidest	Primary	UA1	1	
Pipette an equal amount of aquabidest with a volumetric pipette into the control material bottle	Primary	UA1	1	
Homogenize, let stand and shake once	Primary	UA1	20	
Select test selection, select sample category, and select QC Sample, use the same lot, save.	Primary	UA1	1	
Store normal control in number 1, pathological in number 2, and calibrator then start	Primary	UA1	1	
Tool running	Primary	UA1	45	

There is an additional secondary activity, namely Quality Control of clinical chemistry, which is included in the facility activity category.

4. Identifying cost drivers

Table 3. Cost Driver Identification

Activities Clinical Chemistry QC	Activity Classification	Activity Categories	Time (Minutes)	QC Quantity	Total Primary Time (Minutes)
Remove the control ingredients from the refrigerator and let stand at room temperature	S1	UA1	10	22	1
Volumetric rinse with aquabidest	P1	UA1	1	22	1
Pipette an equal amount of aquabidest with a volumetric pipette into the control material bottle	P2	UA1	1	22	2
Homogenize, let stand and shake once	P3	UA1	20	22	12
Select test selection, select sample category, and select QC Sample, use the same lot, save.	P4	UA1	1	22	5
Store normal control in number 1, pathological in number 2, and calibrator then start	P5	UA1	1	22	5
Tool running	P6	UA1	45	22	1
				Number of CDs	27
				CD P1-P2	27

The total number of cost drivers will be used to calculate the rate per cost driver.

4. Identify indirect costs (overhead costs)

Table 4. Total Overhead Cost per Day

No.	Cost Component	Total Cost of Laboratory Services (Rp)
A	Depreciation Expense	
	1. Building Depreciation	6.420
	2. Depreciation of Non-Medical Equipment	1.515
B	**Cost**	
	1. Non-Medical BHP Fee	336
	2. General Costs	4.634
C	Maintenance Cost	
	1. Tool Maintenance	8.617

Total Cost	21.523

The total overhead cost of IDR 21,523 was obtained from depreciation costs, operational costs, and maintenance costs. The largest cost comes from the cost of tool maintenance costs

5. Distribute overhead costs to all existing inspection units based on predetermined cost drivers.

Table 5. Overhead Cost Distribution

Inspection	Total Cost (Rp.)	Total Cost Driver	*Rate Per Cost Driver*
QC Clinical Chemistry	21.523	27	797

$$\textit{Rate Per Cost Driver} = \frac{Total\ Overhead\ Cost\ (Rp.)}{Total\ cost\ driver}$$

The calculation of the rate per cost driver is influenced by the number of cost drivers.

Table 6. Overhead Cost per Inspection Unit

Inspection	QC inspection in one day	QC Overhead Cost
QC Clinical Chemistry	1	797

$$\text{Overhead cost per Unit} = \frac{Rate\ per\ cost\ driver}{Jumlah\ QC\ dalam\ satu\ hari}$$

The overhead cost results that have been calculated by the rate per cost driver will be applied to the examination unit in the secondary activity.

7. Distribute indirect costs across activities

Table 7. Distribution of Indirect Costs to Activities

Activities	Activity Classification	Activity Categories	Time (Minutes)	QC Quantity	Cost Driver	BTL
Clinical Chemistry QC	S1					797
Remove the control ingredients from the refrigerator and let stand at room temperature	P1	UA1	10	22	1	797
Volumetric rinse with aquabidest	P2	UA1	1	22	1	797
Pipette an equal amount of aquabidest with a volumetric pipette into	P3	UA1	1	22	2	1.594

the control material bottle						
Homogenize, let stand and shake once	P4	UA1	20	22	12	9.566
Select test selection, select sample category, and select QC Sample, use the same lot, save.	P5	UA1	1	22	5	3.986
Store normal control in number 1, pathological in number 2, and calibrator then start	P6	UA1	1	22	5	3.986
Tool running	P7	UA1	45	22	1	797
				Number of CDs	27	
				CD P1-P2	27	

Secondary activities use indirect costs in table 4.6. which has been calculated the rate per cost driver, while in the primary activity, indirect costs come from the cost driver divided by the total cost driver multiplied by the total indirect cost of Rp.21,523 which comes from table 4.

8. Charge the cost of secondary activities to primary activities.

Table 8. BTL Rate per Primary Activity

Activities	Activity Classification	Activity Categories	Time (Minutes)	QC Quantity	Cost Driver	BTL	S ke P	S1	BTL per Primer Activity	Rate BTL/ Activity Primer
Clinical Chemistry QC	S1					797	PI-P8			
Remove the control ingredients from the refrigerator and let stand at room temperature	P1	UA1	10	22	1	797	PI-P8	30	827	38
Volumetric rinse with aquabidest	P2	UA1	1	22	1	797	PI-P8	30	827	38
Pipette an equal amount of aquabidest with a volumetric pipette into the control material bottle	P3	UA1	1	22	2	1.594	PI-P8	59	1.653	75
Homogenize, let stand and shake once	P4	UA1	20	22	12	9.566	PI-P8	354	9.920	451
Select test selection, select sample	P5	UA1	1	22	5	3.986	PI-P8	148	4.133	

category, and select QC Sample, use the same lot, save.										
Store normal control in number 1, pathological in number 2, and calibrator then start	P6	UA1	1	22	5	3.986	PI-P8	148	4.133	188
Tool running	P7	UA1	45	22	1	797	PI-P8	30	827	188
				Number of CDs	27			797		
				CD P1-P2	27					

There are different BTL rates per primary activity, with the formula:
S1 = (Cost driver)/(Total cost driver) × secondary BTL. BTL per primary activity = S1 + primary BTL. Rate of BTL per primary activity = (BTL per primary activity)/(Number of QCs) As proof that the value of S1 is correct, the total S1 must match the BTL column in S1. Based on these calculations, BTL per activity and BTL rate per primary activity are different for each activity.

9. Identify direct costs and calculate the total.

Table 9. Total direct costs

Direct Costs	Total (Rp.)
Control Material Cost	59.240
Medical BHP Fee	6.539
Employee Costs	20.468
Tool Cost	15.215
Total Direct Cost	**101.462**

Direct costs amounted to Rp.101,462 with the largest cost coming from the cost of control materials for one run for 14 parameters. The following is how the costs are calculated:
Control material cost = Quantity (μL) × Unit price (Rp.). Medical BHP cost = Quantity (pcs) × Unit price (Rp.). Medical BHP consists of masks and handscoons, so it is calculated according to the QC usage time. QC medical BHP cost = Unit price × (QC time (hour))/(Service time (hour)). Employee cost per QC = Employee cost per hour (Rp.) × QC time (hour). Medical device cost = QC time (Rp.) × Device depreciation cost per hour (Rp.)

10. Calculate the unit cost by summing up direct costs and indirect costs.

Before calculating the unit cost by summing up direct and indirect costs, indirect costs are charged to each activity. There are seven primary activities, obtained a total BTL based on activities of Rp.1,015 and direct costs of Rp.101,462.

Table 4.10. Unit Cost Calculation Results

Description	Rate BTL per activitas (Rp.)	Clinical Chemistry QC
Direct Costs		101.462
BTL		
P1	38	38
P2	38	38
P3	75	75
P4	451	451
P5	188	188
P6	188	188
P7	38	38
Total BTL	1.015	1.015
Unit Cost	1.015	102.477

QC Clinical Chemistry P1 - P7 is obtained from the BTL rate per activity, then total each primary activity from P1 to P7 and get the unit cost of QC clinical chemistry for one run of Rp.102,477 from the formula: Unit cost = Direct Cost + Total BTL

To use the Activity Based Costing (ABC) method, you must first fulfill the application requirements in order to get the benefits. In using the ABC method, there are costs needed to make calculations including labor costs, depreciation costs for both equipment and buildings and other costs. In addition to cost data, it is also necessary to determine cost drivers such as maintenance frequency, labor hours, and number of patients (Kartini, 2019).

The choice of unit cost calculation method is a challenge for hospitals because it can cause errors, namely a very large difference in the results of total costs. Unit cost calculations using the ABC method have been widely used by hospitals to conduct studies of service products with results that vary from those that are in accordance with unit costs to those that are overcoasting or undercoasting. High unit costs can lead to high tariffs as well so that the competitive nature of the market will be lost, otherwise if the unit cost is smaller than it should be, it will be risky for the hospital because it can lose money (Purwanti, 2022).

Laboratories in practice require QC to ensure that the tools are in good performance, the main function of QC is to ensure that laboratory results are reliable and accurate besides that QC can help in identifying and minimizing errors that may occur. Laboratory QC can affect operational costs because it involves the use of control material reagents, the costs involved in QC can contribute to laboratory operational costs including the cost of maintenance, repair or replacement of equipment. The calculation of laboratory QC unit costs involves identifying activities, classifying activities based on primary and secondary activities.

The examination tool used is sysmex bx with reagents that match the examination parameters. The control material used consists of normal and pathological, if QC does not enter calibration, every 4 - 6 days. The sysmex bx tool is able to perform 14 types of examinations, namely glucose, total bilirubin, recruited bilirubin, SGOT / AST, SGPT / ALT, total protein, albumin, ureum, creatinine, uric acid, cholesterol, triglycerides, HDL, LDL, one of which is to assess liver function, janutng, kidney and others. Before the device is used, QC is carried out with normal (level 1) and pathological (level 2) control materials.

Based on the results of the calculation, the direct cost of clinical chemistry once running for 14 parameters is IDR 101,462. Direct costs are obtained from material costs, employee costs, and tool costs which are calculated based on QC inspection time. There is also an overhead cost of Rp.21,523, a large source of overhead costs is obtained from maintenance costs. Then from indirect costs, the rate per cost driver is calculated, in line with the theory (Sumiati, et al., 2019) in (Mulyadi, 2007) the assignment of indirect costs to inspection units is influenced by the rate per cost driver and the calculation of the rate per cost driver is influenced by the total cost driver. If the cost driver is higher, the rate per cost driver will be lower.

The first overhead cost is used to calculate the rate per cost driver. Meanwhile, the second indirect cost is used for charging to each primary and secondary activity. The final result of indirect costs that have been charged to each activity in the QC examination of clinical chemistry, there are seven activities obtained a total of Rp.1,015. Unit cost is obtained from the sum of direct costs and indirect costs. Direct costs amounted to Rp.101,462 and indirect costs amounted to Rp.1,015, so the unit cost of QC clinical chemistry for one run for 14 parameters was Rp.102,477.

5. Conclusions

Based on the results of the study, it can be concluded that the unit cost of QC clinical chemistry for one run is obtained at Rp. 102,453.

Acknowledgments: Thank you to Dr. H. A. Rotinsulu Lung Hospital and Poltekkes Kemenkes Bandung for helping and supporting this research.

Funding: None.

Conflicts of Interest: There are no conflicts of internet.

Author Contributions: AANS: conceived the original idea. EK and TH: provided suggestions. IGR and SFR: reviewed the suggestions and evaluated the research results until the drafting of the manuscript.

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