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Enhancing Laboratory Efficiency: A Community Service Program for Centrifuge Maintenance at Randegansari Husada Hospital

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ABSTRACT The Community Service Program of Poltekkes Kemenkes Surabaya was conducted to resolve the problems pertinent to equipment maintenance at the Randegansari Husada Hospital, focusing on the centrifuge equipment in its laboratory. This program also included counseling and provided practical assistance to the hospital staff with the knowledge and skills for the proper maintenance of equipment. Activities recorded in this include the data of the centrifuge units, detection of damage, improvement of performance through a preventive maintenance program, and performance testing using a digital tachometer. Calibration showed that the centrifuge had a relative error of 1.37% at 3000 RPM and was within the acceptable error limit of 10%. Verification in time, at 300 seconds, gave a relative error of 4.89% which was also within acceptable limits. Such efforts go a step further to ensure the centrifuge works well in contributing toward better diagnostic accuracies. The program took a portion of this staffing challenge when it embarked on the training of a medical laboratory technician, insisting that improved and sustained equipment reliability meant improved health service delivery. These would then increase at the hospital to limit malfunctioning of equipment for overall quality care.

INDEX TERMS Centrifuge, Inspection, Preventive Maintenance.

I. INTRODUCTION

The community service program implemented by Poltekkes Kemenkes Surabaya through an autonomous framework is an approach to increasing the capacity of community members to meet independence and prosperity through the use of community capabilities. This can help in the development of using resources efficiently and optimally by the community members. It has been felt that, in the current context of the framework, this program is operationalized in a partnership between Embu University and Randegansari Husada Hospital, with a community orientation that guides and counsels laboratory personnel and technologists on the custody of medical equipment, especially the maintenance of laboratory apparatus, such as centrifuges.

A centrifuge is a piece of equipment that can separate all the organelles from each other as per their densities through sedimentation. Herein, the centrifuge employs rotation or spinning of a tube that contains a solution to aid separation in terms of density. The major determinant of how a sample is analyzed through the centrifuge is the speed at which it spins. This speed, however, varies with the type of sample being tested and that is why certain RPM choices or motor speeds apply to a centrifuge. Studies on morning urine tests carried out on a centrifuge show that with increasing speed of centrifugation, the outcomes of the examination of morning urine sediment are better[1]

Increased use of laboratory equipment, especially the centrifuge, increases the chance of damage at Randegansari Husada Hospital. The lack of sufficient medical analyst manpower, absence of biomedical technicians, and even financial capacity have an impact on the negative health service system at Randegansari Husada Hospital.

The PKM activities aim to help address the issues faced by the community, particularly in the Driyorejo area of Gresik, in a comprehensive, multi-sectoral manner within an institutional framework at Randegansari Husada Hospital, which serves as a partner. To support these activities, supporting data is needed regarding the general overview, health status, healthcare resource situation, and healthcare

efforts at Randegansari Husada Hospital in Gresik. Furthermore, this PKM activity is an application of several previous studies, including "Microcontroller-Based Tachometer Equipped with Timer Features" by M. Ehikhamenle*, B.O. Omijeh, published in the journal The American Journal of Electrical and Electronic Engineering, 2017 is a low-cost digital tool that can be used to measure the speed of rotating objects[2] [3][4].

Correct maintenance procedures of rotors provide optimal performance, long life, and safety for the personnel working with centrifuge rotors.[5] Precise and accurate centrifugation techniques are necessary to avoid preanalytical errors. [6] Regular maintenance can minimize the risk of equipment failure, ensuring optimal performance and preventing damage to sensitive samples.

Standardizing protocols for relative centrifugal force (RCF) and centrifugation time is crucial for consistent results across different laboratory settings[7]. The introduction of automated centrifugation systems could dramatically reduce human interference with sample processing. With an automated system in a laboratory workflow, one could maintain constant working conditions for real-time observation while working and continuously enhance the throughput by minimizing any possible delays. [8][9][10]

The situation regarding health status, healthcare resources, healthcare services, and disease cases at Randegansari Husada Hospital, as obtained from the Community Satisfaction Survey in Gresik City from 2016 to 2021, reveals several challenges faced by the institution. One significant issue is the need for counseling and assistance in maintaining centrifuge equipment using a digital tachometer. This need is crucial for ensuring that the centrifuge operates efficiently and accurately, ultimately contributing to better diagnostic outcomes in laboratory settings[11].

Additionally, there has been an increase in the frequency of centrifuge usage at Randegansari Husada Hospital, which has made the equipment more susceptible to damage. The higher usage rates mean that the centrifuge is more likely to experience wear and tear, necessitating more frequent maintenance and oversight. This situation underscores the importance of proper training and resources for the staff responsible for managing these devices to minimize the risk of malfunction and maintain the reliability of laboratory test results.

Furthermore, the inadequate handling of the centrifuge can be attributed to a shortage of medical analyst personnel and the absence of biomedical technicians at the hospital. This staffing issue has a direct impact on the quality of healthcare services provided at Randegansari Husada Hospital. The lack of trained personnel limits the hospital's ability to effectively maintain and repair laboratory equipment, which can lead to delays in patient care and compromise the overall effectiveness of the healthcare system. Addressing these challenges through targeted training and resource allocation is essential for improving healthcare service delivery in the region.

II. METHOD

The method to be used in carrying out the PKM activities is counseling and assistance in the maintenance of the centrifuge for the participants. The PKM Team Leader from Poltekkes Kemenkes Surabaya requests the head of the Puskesmas or their representative to appoint two health technical personnel as participants to receive counseling and assistance from the PKM Team. The PKM Team asks Puskesmas to inventory and collect the centrifuge equipment available at the hospital for condition assessment. They begin providing counseling and assistance to participants through direct demonstrations, starting with recording the technical specifications of the equipment (brand, model, type, serial number, etc.) on a worksheet[12]. After recording, the equipment is assessed according to its condition. If the equipment is functioning normally, the team will demonstrate cleaning and maintenance procedures following operational protocols with participant assistance. They will then verify the RPM of the centrifuge using a tachometer and document the findings. If the equipment has minor damage and does not require replacement parts, the PKM Team can assist in repairs, which will also be verified with a tachometer. If the equipment has minor damage requiring replacement parts that are available from the hospital, repairs will be made immediately. However, if the necessary parts are not available, a report will be submitted to the hospital. In cases of severe damage, regardless of whether replacement parts are needed, the team will report the issue directly to the hospital and document it accordingly.

III. IMPLEMENTATION

The implementation of the Independent PKM activities in counseling and assistance for the maintenance of laboratory equipment involves monitoring the function and calibration/verification of the centrifuge at Randegansari Husada Hospital. The results achieved in this Independent PKM activity are as follows:

1. Technical specifications of the centrifuge have been recorded.
2. Identification of centrifuge equipment that is damaged and requires maintenance has been completed.
3. Maintenance of one centrifuge has been successfully carried out.Calibration/verification of one centrifuge has been accomplished.
4. Counseling and assistance have been provided to one medical laboratory technical staff (analyst) in maintaining the centrifuge equipment.

Below are photos from the PKM activities conducted at Randegansari Husada Hospital: **FIGURE 1** Repairs the centrifuse involving students majoring in Electromedical Engineering, then a feasibility function test of the **FIGURE 2** tool is carried out which aims to ensure the performance of

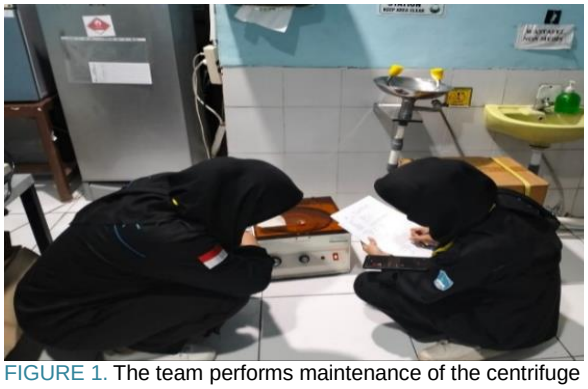

FIGURE 1. The team performs maintenance of the centrifuge

the tool. **FIGURE 1 and 2**, The team conducts maintenance and functional checks on the centrifuge to ensure its optimal performance. As part of this process, they test the motor speed of the centrifuge using a digital tachometer. This

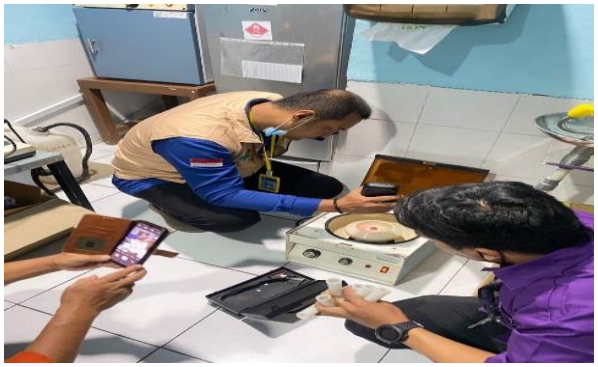

FIGURE 2. The team performs function checks of the centrifuge

careful examination allows the team to assess the operational efficiency of the centrifuge, ensuring it meets the required specifications for accurate laboratory results.

The team records and processes data on the worksheets, ensuring accurate documentation of the maintenance activities performed on the centrifuge. Following this, the team reports the results of the centrifuge maintenance activities, providing a comprehensive overview of the work completed and any findings identified during the process. This systematic approach not only enhances the reliability of the data collected but also contributes to the ongoing improvement of laboratory equipment management at the hospital[13].

IV. RESULTS AND DISCUSION

The results from **TABLE 1** provide an overview of the calibration and verification of the centrifuge motor speed at 1000, 2000, and 3000 RPM. At 1000 RPM, the reading of 2945.21 RPM indicated a significant error of -1945.21 RPM, resulting in a relative error of -194.52%, suggesting a potential malfunction. At 2000 RPM, the reading of 2907.71 RPM yielded an error of -907.71 RPM and a relative error of -45.39%, still indicating

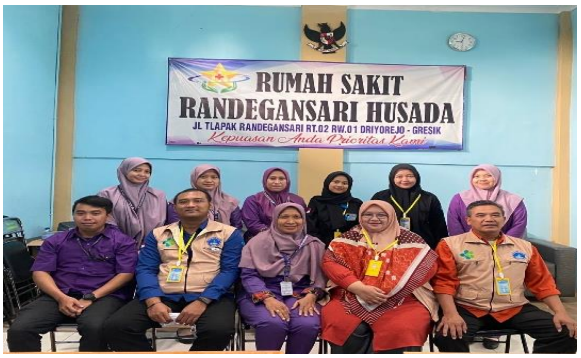

FIGURE 4. Team reports results

underperformance. In contrast, the measurement at 3000 RPM showed an actual reading of 2958.87 RPM with a minor error of 41.13 RPM and a relative error of 1.37%, which is within the acceptable range. Given the high relative errors at lower speeds, laboratory personnel must use a 3000 RPM setting for effective separation processes. The discrepancies in the lower RPM measurements

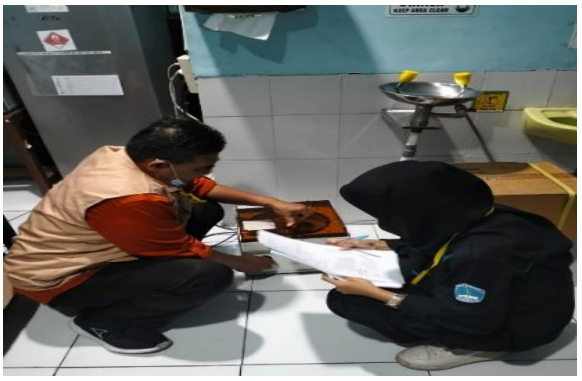

FIGURE 3. The team records the data

highlight the importance of regular calibration and maintenance to ensure reliability and minimize downtime. Overall, while the centrifuge performs satisfactorily at 3000 RPM, further investigation and corrective actions are needed for the lower settings to improve laboratory efficiency and accuracy.

In the **TABLE 2** presents the results of time verification for the centrifuge equipment. Based on the data, the measured reading was 300 seconds, while the standard value was 314.67 seconds, resulting in an error of -14.67 seconds. This corresponds to a relative error of -4.89%, which is well within the permissible error limit of ±10%. The uncertainty in the measurement was calculated as ±0.95 seconds, with a relative uncertainty of ±0.32%.

These results indicate that the time measurement for the centrifuge operation is accurate and within the acceptable

TABLE 1
CENTRIFUGE MOTOR SPEED CALIBRATION RESULTS

No.	Device Reading (RPM)	Standard Designation (RPM)	Error (RPM)	Relative Error (%)	Maximum Allowable Error	Measurement Uncertainty (RPM)	Relative Uncertainty (%)
1.	1000	2945.21	-1945.21	-194.52	±10%	±0.75	±0.075
2.	2000	2907.71	-907.71	-45.39	±10%	±2.30	±0.115
3.	3000	2958.87	41.13	1.37	±10%	±0.67	±0.022

range. The low relative error (-4.89%) suggests that the centrifuge's timing function is reliable, ensuring consistent performance in line with operational standards. The uncertainty values further affirm the precision of the measurements, ensuring that the device is functioning correctly during its use in the laboratory.

TABLE 2
VERIFICATION RESULTS OF CENTRIFUGE TIME MEASUREMENT

No.	Device Reading (s)	Standard Designation (s)	Error (s)	Relative Error (%)	Maximum Allowable Error	Measurement Uncertainty (s)	Relative Uncertainty (%)
1.	300	314.67	-14.67	-4.89	±10%	±0.95	±0.32

Based on the calibration/verification results of the centrifuge motor speed, the allowable error at a motor speed of 3000 RPM was found to be 1.37%[14]. During the counseling session, it was recommended that operators select the motor speed of 3000 RPM, as this setting is within the acceptable error margin. This recommendation is necessary because the control panel of the centrifuge does not display the RPM selection values. For the time test, the relative error was 4.89%, which is also within the maximum allowable error limit of 10%. These findings suggest that the centrifuge operates accurately within the acceptable error range, particularly at 3000 RPM, ensuring reliable performance for laboratory use[15].

COUNSELING

The target community members considered strategic for involvement in this community service program include several key groups. First, the academic community, particularly lecturers and students, are engaged in the program. Second, hospital staff working directly in the laboratory who frequently use the centrifuge are involved. Lastly, technical personnel at the hospital, even if they are not from the biomedical engineering department, are also included as important participants in the program.

1. The PKM Team Leader from Poltekkes Kemenkes Surabaya asked the Head of the Health Center (Puskesmas) or their representative to appoint two health technicians to the PKM team as participants who will receive training and assistance from the PKM Team of Poltekkes Kemenkes Surabaya.
2. The PKM team also requested the health center to take inventory and collect centrifuge equipment available at the hospital for condition checks.
3. The PKM team began providing training and assistance to the participants through direct demonstrations. The activity started by recording the technical specifications of the equipment (brand, model, type, serial number, etc.) on the worksheet.
4. After the data was recorded, the equipment was identified based on the level of damage, if any.
5. If the equipment was in normal condition, the team conducted cleaning and maintenance of the centrifuge according to operational procedures with participant assistance. This was followed by verification, where the centrifuge's RPM was measured according to the equipment settings using a tachometer, and the results were recorded.
6. If the equipment was found to have minor damage and did not require spare parts replacement, the PKM team assisted in repairing it and then verified it using a tachometer.
7. If the equipment had minor damage that required spare parts, and the hospital had the parts available, the repairs were made immediately. If the parts were not available, the issue was reported to the hospital and recorded.
8. If the equipment was severely damaged, whether it required spare parts, the issue was reported directly to the hospital and noted in the records.

V. CONCLUSION

In line with the objectives of the community service program (PKM) focused on providing counseling and assistance in the maintenance and calibration/verification of centrifuge equipment at RS Randegansari Husada, several key outcomes were achieved. The technical specifications of the centrifuge were successfully recorded, and the equipment that was still functional but required maintenance was identified. One centrifuge underwent

maintenance, and its calibration showed a relative error of 1.37% at a motor speed of 3000 RPM, which falls within the acceptable limit of ≤10%. Similarly, a time test conducted at 300 seconds resulted in a relative error of 4.89%, also within the allowable limit of ≤10%. Additionally, one laboratory technician received counseling and guidance on how to properly maintain the centrifuge equipment. These results highlight the successful implementation of the PKM program in ensuring proper equipment functionality and enhancing the technical skills of medical personnel.

REFERENCES

[1] G. Madabhushi, *Centrifuge modelling for civil engineers*. CRC press, 2017.

[2] M. Ehikhamenle and B. O. Omijeh, "Design and development of a smart digital tachometer using At89c52 microcontroller," *American Journal of Electrical and Electronic Engineering*, vol. 5, no. 1, pp. 1–9, 2017.

[3] P. Studi, S. Terapan, A. Negara, and F. Vokasi, "Analisis Survei Kepuasan Masyarakat Pada Pelayanan Kesehatan Ibu Dan Anak (KIA) Di Puskesmas Gayungan Kota Surabaya Analysis Of Community Satisfaction Survey On Maternal And Child Health Services at Puskesmas Gayungan Kota Surabaya 1 Ratu Egalitarian Putri Fatahillah, 2 Noviyanti."

[4] W. A. Setianto, "Inovasi e-Health Dinas Kesehatan Kota Surabaya." [Online]. Available: http://nasional.

[5] T. Goodman, "Centrifuge Rotor Maintenance," *GIT Lab J Eur*, vol. 12, pp. 38–39, 2008, [Online]. Available: https://api.semanticscholar.org/CorpusID:63739820

[6] C. Sonmez *et al.*, "An important source of preanalytical error in medical laboratories: Centrifugation," *Turkish Journal of Biochemistry*, vol. 46, no. 4, p. 399, Aug. 2021, doi: 10.1515/TJB-2020-0262.

[7] R. J. Miron, N. R. Pinto, M. Quirynen, and S. Ghanaati, "Standardization of relative centrifugal forces in studies related to platelet-rich fibrin," 2019, *Wiley Online Library*.

[8] A. J. MacH, J. H. Kim, A. Arshi, S. C. Hur, and D. Di Carlo, "Automated cellular sample preparation using a Centrifuge-on-a-Chip," *Lab Chip*, vol. 11, no. 17, pp. 2827–2834, Sep. 2011, doi: 10.1039/c1lc20330d.

[9] T. Hoang, N. Moskwa, and K. Halvorsen, "A 'smart' tube holder enables real-time sample monitoring in a standard lab centrifuge," *PLoS One*, vol. 13, no. 4, Apr. 2018, doi: 10.1371/journal.pone.0195907.

[10] T. Roberts, M. Smith, and B. Roberts, "Observations on Centrifugation: Application to Centrifuge Development," 1999. [Online]. Available: https://academic.oup.com/clinchem/article-abstract/45/11/1889/5643382

[11] S. Ghanaati, C. Mourão, E. Adam, R. Sader, H. Zadeh, and S. Al-Maawi, "The role of centrifugation process in the preparation of therapeutic blood concentrates: Standardization of the protocols to improve reproducibility," *Int. J. Growth Factors Stem Cells Dent*, vol. 2, no. 3, p. 41, 2019.

[12] S. M. J. UK, "Technical specification," *Electron Tube Center, Japan*.

[13] D. A. Abowitz and T. M. Toole, "Mixed method research: Fundamental issues of design, validity, and reliability in construction research," *J Constr Eng Manag*, vol. 136, no. 1, pp. 108–116, 2010.

[14] W. Wankoff, T. Lauletta, and R. Shah, "Evaluation of High-and Low-Speed Centrifuges," *J Water Pollut Control Fed*, pp. 1568–1573, 1981.

[15] R. L. Hoffman, "An improved technique for particle size measurement," *J Colloid Interface Sci*, vol. 143, no. 1, pp. 232–251, 1991.