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# Training on The Operation and Maintenance of Ultrasonography (USG) Equipment for Healthcare Workers to Improve Diagnostic Services at Community Health Centers in South Krembangan Surabaya

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**ABSTRACT** Ultrasonography (USG) is widely used in primary healthcare because it is non-invasive, radiation-free, affordable, and capable of real-time imaging, particularly for maternal care, abdominal examination, and early disease screening. However, many healthcare workers at Community Health Centers (Puskesmas) have limited competence in operating USG equipment and performing routine preventive maintenance, which leads to suboptimal use of available devices and may compromise diagnostic quality. This community service program aimed to improve healthcare workers' knowledge and practical skills in the proper operation and preventive maintenance of USG equipment. A one-day educational-participatory approach was implemented at the South Krembangan Community Health Center, Surabaya, combining lectures, interactive discussions, demonstrations, supervised hands-on practice, and a preventive maintenance workshop. Fifteen participants, comprising general practitioners, midwives, nurses, and electromedical technicians, were recruited through purposive sampling. Effectiveness was evaluated using a 20-item knowledge test in a one-group pretest-posttest design, a 30-indicator practical competency checklist, and a satisfaction questionnaire, and the data were analyzed descriptively. Mean knowledge scores rose from 61.8 before training to 90.7 afterward, an improvement of 46.8%, with reduced score variation indicating more consistent understanding. In the practical assessment, 80% of participants attained the "Excellent" category and the remaining 20% the "Good" category, and none required additional basic training. Participants also reported high satisfaction with both the theoretical and practical components of the program. In conclusion, the training substantially improved participants' competence in operating and maintaining USG equipment, thereby supporting better diagnostic services at primary healthcare facilities. Continuous mentoring and periodic competency evaluation are recommended to sustain these outcomes.

**INDEX TERMS** Ultrasonography, Equipment Training, Preventive Maintenance, Community Health Center, Diagnostic Service

## I. INTRODUCTION

Ultrasonography (USG) has become a cornerstone of diagnostic imaging in primary healthcare because it is portable, relatively low-cost, and free from ionizing radiation, which makes it suitable for use by trained non-radiologists at the point of care [1]–[3]. In Indonesia, USG services at Community Health Centers (Puskesmas) are expected to improve the quality of antenatal care [4]. Nevertheless, field evaluations of Puskesmas show that the implementation of USG examinations remains uneven, with human resources and infrastructure repeatedly identified as limiting factors [5], [6].

The value of installed equipment depends on whether it is operated correctly and maintained consistently. Evidence from low-resource health systems shows that a substantial share of medical devices remains unused or non-functional because of missing spare parts, weak maintenance routines, and poor alignment with local conditions [7], [8]. Maintenance performance is further shaped by management systems and workforce factors in clinical engineering [9], [10]. For USG, inadequate handling also carries an infection-control dimension, because transducers can retain microorganisms unless appropriate disinfection is applied [11], [12]. Preliminary observations at the South Krembangan Community Health Center revealed similar problems: staff had limited experience with newly installed USG units, and practices in parameter adjustment, probe handling, and preventive maintenance varied.

Training has been widely adopted to close such

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competency gaps. A recent scoping review concluded that effective point-of-care ultrasound (POCUS) training in low-resource settings relies on context-adapted content, local trainers, and hands-on practice [13]. Structured programs for midwives in Malawi improved knowledge and practical competence in basic obstetric scanning [14], [15], and an intensive five-day workshop series in Kenya markedly increased post-training scores among mid-level providers [16]. Simulation-based courses improved image interpretation, image acquisition, and confidence among nurse practitioners, with gains retained at follow-up [17]. Learning-curve evidence indicates that image-quality components differ in difficulty for novices, supporting stepwise supervised practice [18]. More recently, remote expert feedback [19] and artificial intelligence (AI) guidance [20] have been explored to support less experienced operators.

Despite these advances, most training initiatives concentrate on image acquisition and interpretation, whereas the operational and preventive-maintenance responsibilities of frontline users receive little attention. Conversely, the maintenance literature mainly addresses system-level solutions, such as computerized maintenance management and managed equipment services [8], [9], rather than the competence of the clinicians and technicians who handle the device daily. Within the literature reviewed here, no study was found that combines equipment operation, probe care, and basic preventive maintenance in a single multi-professional training intervention at Indonesian Puskesmas.

Accordingly, this community service program aimed to improve the knowledge and practical competence of healthcare workers in operating and maintaining USG equipment at the South Krembangan Community Health Center, Surabaya. The contributions of this work are as follows:

1) An integrated training model is proposed that combines lectures, demonstrations, supervised hands-on practice, and a preventive maintenance workshop for operating and maintaining USG equipment.
2) The training is delivered to a multi-professional group of general practitioners, midwives, nurses, and electromedical technicians, linking clinical and technical competencies at the primary care level.
3) The effectiveness of the program is quantified through knowledge gain, structured practical competency assessment, and participant satisfaction.
4) A replicable framework is provided to support sustainable USG use in Puskesmas.

The remainder of this article is organized as follows. Section II describes the study design, participants, training procedures, instruments, and data analysis. Section III presents the results on knowledge improvement, practical competency, preventive maintenance competency, and participant satisfaction. Section IV discusses the findings in relation to previous studies, and Section V concludes the article.

## II. METHODS

### A. STUDY DESIGN

This community service program used a prospective, non-randomized, one-group pretest–posttest design delivered through an educational-participatory approach. All participants received the same intervention, and no control group was included. Outcomes were therefore assessed as within-group change, an approach whose inferential limits are well recognized in health professions education [21]. The evaluation followed the Kirkpatrick framework: participant satisfaction (reaction) and knowledge and practical skills (learning) were measured [24]. Knowledge was assessed before and after training, practical competency was assessed using a structured checklist, and qualitative information was gathered through observation, participant feedback, and post-session group discussions.

### B. SETTING AND PARTICIPANTS

The program was conducted at South Krembangan Community Health Center, Surabaya, East Java, Indonesia, in June 2026. This facility was selected because it had recently received USG equipment and its staff required competency development for diagnostic services. Participants were recruited by purposive sampling, in which individuals are deliberately chosen for their relevance to the study objective [22]. Eligible participants (1) were actively involved in patient examination using USG, (2) had been assigned by the health center management, (3) agreed to attend the entire program, and (4) completed both the pretest and the posttest. The final sample comprised 15 healthcare workers: four general practitioners, six midwives, three nurses, and two electromedical technicians. Participation was voluntary, and all enrolled participants completed the program.

### C. TRAINING PROCEDURE

The training was delivered in one full day and comprised five sequential stages. Stage I, pre-training assessment. Participants completed a 20-item multiple-choice knowledge test covering basic ultrasound physics, safety principles, equipment components, probe selection, image optimization, infection prevention, preventive maintenance, and basic troubleshooting.

Stage II, theoretical session. Instructors delivered interactive multimedia lectures on diagnostic ultrasonography principles, wave physics, system components, transducer types and functions, knobology (gain, depth, focus, time-gain compensation, and frequency), standard operating procedures (SOPs), patient preparation, basic image interpretation, electrical safety, infection prevention and control, and routine preventive maintenance. Participants were encouraged to raise questions from their daily practice.

Stage III, demonstration and hands-on practice. Instructors first demonstrated correct operation on a clinical ultrasound unit. Each participant then practiced individually under direct supervision, covering start-up and shutdown, probe installation, preset selection, patient positioning, adjustment of gain, depth, focus, and time-gain compensation, image acquisition, image storage and documentation, probe cleaning and disinfection, routine inspection of cables and connectors, and identification of common operational errors. Performance was scored with the structured observation checklist described below.

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Stage IV, preventive maintenance workshop. This session addressed the tasks users perform before referring equipment to biomedical engineers: daily visual inspection; inspection of the monitor, probes, cables, ventilation, power supply, and battery; cleaning; storage; and maintenance documentation. Participants also learned to recognize early signs of malfunction that require professional service.

Stage V, post-training evaluation. Participants retook the identical knowledge test, repeated the practical competency assessment under the same criteria, and completed a satisfaction questionnaire.

### *D. INSTRUMENTS*

Four instruments were used. (1) The knowledge questionnaire consisted of 20 multiple-choice items. (2) The practical competency checklist contained 30 indicators covering equipment operation, patient preparation, image optimization, safety procedures, and preventive maintenance. It was developed from hospital biomedical engineering maintenance guidelines. (3) The satisfaction questionnaire used a five-point Likert scale to rate training materials, instructor performance, practical session effectiveness, facilities, and overall implementation. (4) An observation sheet was used by instructors to record participant engagement during practical sessions. Experts in biomedical engineering and diagnostic ultrasonography reviewed all instruments to establish content validity, which is the minimum validity evidence expected for questionnaire-based instruments [23].

### *E. DATA COLLECTION AND DATA ANALYSIS*

Quantitative data comprised pretest and posttest knowledge scores, practical competency scores, and satisfaction ratings. Qualitative data comprised instructor observations, participant feedback, and group discussions held after the practical session.

Data were analyzed descriptively using Microsoft Excel. The mean, standard deviation, frequency distribution, and percentage improvement were calculated. Knowledge improvement was computed as:

$$Improvement\ (\%) = \left[\frac{(Posttest - Pretest)}{Pretest}\right] \times 100$$

**TABLE 1**
**Practical Competency Assessment Categories**

| Score | Category |
|---|---|
| **86–100** | Excellent |
| **76–85** | Good |
| **60–75** | Fair |
| **<60** | Needs Improvement |

Practical competency scores were classified as Excellent (86–100), Good (76–85), Fair (60–75), or Needs Improvement (<60), as shown in Table 1. No inferential statistical test was applied.

### *F. ETHICAL CONSIDERATIONS*

Permission was obtained from the health center management before implementation. Participants were informed of the objectives and procedures and agreed voluntarily to take part. Personal data and assessment results were kept confidential and used only for educational evaluation and scientific publication. The program followed the principles of beneficence, confidentiality, and respect for participants' rights, consistent with the Declaration of Helsinki [25].

## III. RESULTS



**FIGURE 1. Counseling Session on the Operation and Preventive Maintenance of Ultrasonography (USG) Equipment for Healthcare Workers at South Krembangan Community Health Center, Surabaya.**

The community service program entitled "Training on the Operation and Maintenance of Ultrasonography (USG) Equipment for Healthcare Workers to Improve Diagnostic Services at Community Health Centers in South Krembangan, Surabaya" was successfully conducted in June 2026. The activity consisted of theoretical lectures, practical demonstrations, hands-on training, competency evaluation, and preventive maintenance workshops. All participants completed the entire training program.

FIGURE 1 illustrates the counseling and educational session conducted at the South Krembangan Community Health Center as part of the community service program. The session was attended by healthcare workers, including midwives, nurses, and other medical personnel, who actively participated in discussions led by the training team. During this session, participants received an overview of the objectives of the program, the importance of ultrasonography (USG) in primary healthcare services, and the role of proper equipment operation and preventive maintenance in ensuring diagnostic accuracy and patient safety.

The educational session emphasized the fundamental principles of ultrasound technology, standard operating procedures (SOP) for USG examinations, infection prevention and control during ultrasound procedures, and routine preventive maintenance practices. Participants were encouraged to share their experiences and discuss challenges encountered during daily clinical practice. This interactive approach facilitated knowledge exchange between instructors and participants while promoting active engagement throughout the learning process.

The counseling activity served as an important introductory phase before the practical training sessions. It provided participants with a common understanding of the theoretical concepts that would later be applied during hands-on demonstrations and competency-based practice. The active participation observed during the session indicated a high level of interest among healthcare workers

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in improving their knowledge and skills related to ultrasonography services.



**FIGURE 2 Theoretical Session on the Operation of Ultrasonography (USG) Equipment, Including Explanation of the Main System Components, Operational Controls, Scanning Parameter Optimization, and User-Level Preventive Maintenance for Healthcare Workers at South Krembangan Community Health Center, Surabaya.**

Following the counseling session, participants attended a theoretical lecture focusing on the principles of ultrasonography (USG) operation and equipment management. As shown in FIGURE 2, the instructor introduced the main components of the ultrasound system while demonstrating the functions of the control panel, display monitor, and transducer. Healthcare workers, including physicians, midwives, nurses, and electromedical personnel, actively observed the explanation and participated in interactive discussions regarding the proper use of the equipment.

During this session, participants were introduced to the basic principles of diagnostic ultrasonography, including ultrasound wave propagation, image formation, transducer selection, and optimization of scanning parameters such as gain, depth, focus, and Time Gain Compensation (TGC). The instructor also explained the importance of following standard operating procedures (SOPs) to ensure patient safety, improve diagnostic image quality, and minimize operational errors during clinical examinations.

In addition to equipment operation, the session emphasized user-level preventive maintenance procedures that should be routinely performed before and after each examination. Participants learned correct techniques for cleaning and disinfecting ultrasound probes, inspecting cables and connectors, verifying system readiness, and recognizing early signs of equipment malfunction. These preventive measures are essential to maintain equipment performance, extend service life, and support the continuity of diagnostic services at the Community Health Center.

The interactive learning approach encouraged participants to ask questions related to their daily clinical practice, allowing the instructor to provide practical solutions to common operational challenges. This activity helped participants strengthen their understanding of both the theoretical and technical aspects of ultrasonography before proceeding to the hands-on practical session.

### *A. PARTICIPANT CHARACTERISTICS*

A total of fifteen healthcare workers participated in the training program. The participants represented multidisciplinary healthcare professionals who routinely use ultrasonography equipment during clinical services. Most participants were midwives because maternal healthcare services constitute one of the major clinical activities performed at the Community Health Center. More than two-thirds of the participants had at least five years of professional experience.

**TABLE 2**
**Characteristics of Participants**

| Characteristics | Number (n=15) | Percentage (%) |
|---|---|---|
| **General Practitioner** | 4 | 26.7 |
| **Midwife** | 6 | 40.0 |
| **Nurse** | 3 | 20.0 |
| **Electromedical Technician** | 2 | 13.3 |
| **Female** | 11 | 73.3 |
| **Male** | 4 | 26.7 |
| **Working Experience < 5 years** | 5 | 33.3 |
| **Working Experience 5–10 years** | 6 | 40.0 |
| **Working Experience >10 years** | 4 | 26.7 |

### *B. KNOWLEDGE IMPROVEMENT*

**TABLE 3**
**Comparison of Pretest and Posttest Scores**

| Indicator | Pretest | Posttest | Improvement |
|---|---|---|---|
| **Mean Score** | 61.8 | 90.7 | 46.8% |
| **Highest Score** | 80 | 100 | - |
| **Lowest Score** | 45 | 82 | - |
| **Standard Deviation** | 8.42 | 5.31 | - |

Participants' knowledge was evaluated using twenty multiple-choice questions administered before and after the training. The average knowledge score increased from 61.8 ± 8.42 before training to 90.7 ± 5.31 after training, representing an improvement of 46.8%. The reduction in score variation after the intervention indicates that participants achieved a more consistent understanding of ultrasonography operation and preventive maintenance. The greatest improvement was observed in topics related to probe selection, ultrasound image optimization, preventive maintenance procedures, and troubleshooting techniques.

### *C. PRACTICAL COMPETENCY ASSESMENT*

**TABLE 4**
**Practical Competency Results**

| Competency Category | Score | Participants | Percentage (%) |
|---|---|---|---|
| **Excellent** | 86–100 | 12 | 80.0 |
| **Good** | 76–85 | 3 | 20.0 |
| **Fair** | 60–75 | 0 | 0 |
| **Needs Improvement** | <60 | 0 | 0 |

Participants' practical skills were evaluated using a competency checklist consisting of thirty assessment criteria covering equipment preparation, image acquisition, patient safety, documentation, and preventive maintenance. Most participants (80%) successfully performed all essential operational procedures independently, including equipment initialization, transducer selection, optimization of scanning parameters,

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image acquisition, image storage, and routine preventive maintenance.

Common improvements observed after the training included:

a. Correct adjustment of gain and depth parameters.
b. Proper selection of examination presets.
c. Improved transducer handling techniques.
d. Better understanding of infection prevention protocols.
e. Correct execution of probe cleaning and disinfection procedures.
f. Proper equipment shutdown and storage.

### D. PREVENTIVE MAINTENANCE COMPETENCY

TABLE 5
Preventive Maintenance Skills

| Assessment Item | Competent (%) |
|---|---|
| Visual inspection of equipment | 100 |
| Probe inspection | 93.3 |
| Cable inspection | 93.3 |
| Monitor inspection | 100 |
| Cleaning and disinfection | 100 |
| Power supply inspection | 86.7 |
| Equipment documentation | 93.3 |
| Storage procedures | 100 |

Participants were also evaluated regarding their ability to perform routine maintenance of ultrasonography equipment. Almost all participants demonstrated satisfactory competency in conducting daily preventive maintenance according to the manufacturer's recommendations and biomedical engineering guidelines.

### E. PARTICIPANT STATISFACTION

TABLE 6
Participant Satisfaction

| Evaluation Aspect | Mean Score |
|---|---|
| **Training Materials** | 4.82 |
| **Instructor Competency** | 4.93 |
| **Practical Demonstration** | 4.91 |
| **Hands-on Practice** | 4.95 |
| **Discussion Session** | 4.80 |
| **Training Facilities** | 4.76 |
| **Overall Satisfaction** | 4.86 |

Participants evaluated the quality of the training program using a five-point Likert scale. Overall participant satisfaction reached 4.86 out of 5.00, indicating that the training program was perceived as highly beneficial and relevant to participants' daily clinical responsibilities. Several participants suggested conducting similar training programs periodically to strengthen competency and keep healthcare workers updated with advances in ultrasound technology.

### F. OVERALL TRAINING OUTCOMES

Comparison between the initial assessment and the final evaluation demonstrated substantial improvements in both theoretical knowledge and practical competency. The findings indicate that the educational intervention successfully enhanced healthcare workers' competence in operating ultrasonography equipment safely and effectively. Participants became more confident in selecting appropriate examination parameters, acquiring diagnostic images, performing routine preventive maintenance, and recognizing common operational problems requiring technical assistance. Furthermore, the implementation of standardized operational procedures introduced during the training is expected to improve equipment reliability, reduce preventable equipment failures, and enhance the quality of diagnostic services provided at the South Krembangan Community Health Center.

TABLE 7
Summary of Training Outcomes

| Indicator | Before Training | After Training |
|---|---|---|
| Knowledge Score | 61.8 | 90.7 |
| Practical Competency | Fair | Excellent |
| Preventive Maintenance Skill | Moderate | Excellent |
| Participant Confidence | Moderate | High |
| Overall Satisfaction | 4.86 | 5 |

## IV. DISCUSSION

### A. INTERPRETATION OF THE FINDINGS

This program was designed to strengthen the operation and preventive maintenance competence of healthcare workers using USG equipment, and the descriptive results point in a consistent direction. The mean knowledge score rose from 61.8 to 90.7, an improvement of 46.8%, and the lowest individual score increased from 45 to 82. The standard deviation also narrowed from 8.42 to 5.31, indicating that participants converged toward a more uniform level of understanding rather than only a few individuals improving. The largest gains occurred in probe selection, image optimization, preventive maintenance, and troubleshooting.

The practical results complement the knowledge results. Twelve participants (80%) reached the “Excellent” category and three (20%) reached “Good”, and none remained in the “Fair” or “Needs Improvement” categories. Competence in user-level maintenance was highest for visual inspection, monitor inspection, cleaning and disinfection, and storage (all 100%), and lowest for power supply inspection (86.7%). A plausible explanation is that power supply checks involve electrical safety, a topic that demands more technical background than visual or cleaning tasks and may require more supervised repetition for non-technical staff. Satisfaction was uniformly high (overall mean 4.86 of 5.00), with hands-on practice (4.95) and instructor competency (4.93) rated above training facilities (4.76). This pattern suggests that participants valued supervised, practical learning most.

These outcomes are most plausibly explained by the sequence of the program rather than by any single component. Lectures established a shared conceptual basis, demonstrations modeled correct technique, and individual supervised practice allowed errors to be corrected immediately. Such context-adapted, hands-on delivery is the feature most often identified with effective ultrasound

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training in resource-limited settings [13]. The inclusion of electromedical technicians alongside clinicians probably also helped, because it exposed clinical staff to equipment-oriented reasoning and exposed technicians to clinical workflow. Because the same knowledge test was used before and after training, part of the gain may reflect familiarity with the items, and the findings should be read as improvements in measured knowledge and observed skill rather than as proven changes in everyday practice.

### *B. COMPARISON WITH PREVIOUS STUDIES*

The magnitude and direction of the knowledge gain are consistent with earlier training programs for non-specialist providers. In Malawi, ultrasound-naive midwives improved their mean knowledge score from 10.2 to 18 and most passed the practical assessment after a structured package [14], and a Kenyan workshop series for mid-level providers likewise showed marked post-training score increases [16]. Simulation-based training improved image interpretation, image acquisition, and confidence among Japanese nurse practitioners [17]. A scoping review of midwife-performed obstetric ultrasound in Africa also supports training of non-physician staff as a route to wider antenatal access [28]. The present result therefore reinforces the view that short, structured, hands-on courses can produce meaningful short-term gains across professions.

The gain observed here (about 29 points) exceeds the roughly 10-percentage-point post-test increase reported for a blended online and simulation course among in-service professionals [30]. This difference should not be interpreted as superior design. It is more likely explained by differences in baseline knowledge, the scope of the content, and the assessment instruments, and by the fact that the present study assessed participants immediately after a single day of intensive instruction.

The study differs from most of this literature in its content. Published programs concentrate on image acquisition and diagnostic interpretation [14]–[18], whereas the present program also trained participants to inspect, clean, store, and document the equipment. This emphasis aligns with evidence that devices in low-resource facilities frequently remain unused or non-functional because of poor upkeep and weak fit with local conditions [7], [8], and that maintenance depends on workforce capacity and management systems [9], [10]. The high competence in cleaning and disinfection (100%) is also consistent with infection-control concerns about transducers [11], [12] and with a recent report that targeted education and resources improved probe-cleaning thoroughness in point-of-care ultrasound [32].

The present study resembles earlier work in the level at which outcomes were measured. A recent scoping review found that evaluations of POCUS training in low- and middle-income countries rely mainly on short-term outcomes and basic knowledge or skill levels, with few workplace-based assessments [26]. This is also true here, and it limits comparison with studies that follow participants over time. For example, midwives largely retained obstetric ultrasound knowledge six months after training [27], and nurse practitioners retained gains at four months [17]. Our design cannot show whether retention was comparable.

### *C. LIMITATIONS AND IMPLICATIONS*

Several limitations should be considered. First, the sample was small (n = 15) and drawn from one health center through purposive sampling, which restricts generalization to other facilities, professions, and equipment models. Second, there was no control group or randomization, and only descriptive statistics were used, so the improvements cannot be attributed to the training with certainty [21]. Third, the identical pretest and posttest, the immediate timing of the posttest, and the involvement of the instructors in scoring may have inflated the observed gains. Fourth, the evaluation reached only the reaction and learning levels of the Kirkpatrick framework; behavior in routine work and organizational results, such as fewer breakdowns or better image quality, were not measured [24]. Finally, satisfaction ratings were close to the scale ceiling, which limits their ability to discriminate between program components.

Despite these limitations, the findings carry practical implications. For health center managers and program planners, deploying USG units should be accompanied by user training that covers operation, cleaning, inspection, and documentation, not only scanning technique. Doing so addresses a failure mode documented in other settings, where equipment is installed but not used or maintained [7], [8]. Multi-professional sessions that include electromedical technicians can establish a common vocabulary for reporting faults early and may reduce avoidable downtime, although this expectation requires empirical confirmation through service and repair records.

For policy, the results support the broader strategy of placing ultrasound in primary care and sharing tasks among non-physician providers. Evidence from rural Kenya shows that nurse-midwife-provided antenatal ultrasound can substantially increase scan coverage in primary care facilities [29], which is the type of service expansion that Puskesmas are expected to deliver [4]. Such expansion is likely to be sustainable only if providers keep their competence and equipment remains serviceable.

Future work should therefore (1) use multicenter, controlled designs with larger samples, (2) add follow-up assessments at three to six months, (3) record equipment-related indicators such as downtime, repair requests, and probe-cleaning compliance, and (4) include clinical indicators such as image quality and diagnostic concordance. Blended formats that combine online refreshers with brief supervised practice may offer a cost-efficient way to maintain skills, since they have produced retention comparable to in-person teaching with fewer faculty hours [31]. Together, these steps would move evaluation from short-term learning toward sustained practice change.

## V. CONCLUSIONS

This community service program aimed to improve the knowledge and practical competence of healthcare workers in operating and maintaining ultrasonography (USG) equipment at the South Krembangan Community

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Health Center, Surabaya, in order to support diagnostic services at the primary care level. A one-day, educational-participatory training combining lectures, demonstrations, supervised hands-on practice, and a preventive maintenance workshop was delivered to 15 participants, comprising general practitioners, midwives, nurses, and electromedical technicians. The findings indicate that the aim was achieved. The mean knowledge score increased from 61.8 to 90.7, an improvement of 46.8%, while the standard deviation decreased from 8.42 to 5.31, reflecting a more uniform understanding among participants. In the practical assessment, 12 participants (80%) were classified as "Excellent" and three (20%) as "Good", and none fell into the "Fair" or "Needs Improvement" categories. Competence in user-level preventive maintenance ranged from 86.7% to 100% across the assessed items, with the lowest value recorded for power supply inspection, and participants rated the program highly, with an overall satisfaction score of 4.86 out of 5.00. These results suggest that integrating equipment operation, probe care, and basic maintenance into a single supervised training can strengthen the competence of multi-professional teams who use USG equipment daily. However, the conclusions are limited by the small sample from a single facility, the absence of a control group, the use of identical pretest and posttest items, and the immediate timing of the evaluation, so the results should be interpreted as short-term, descriptive improvements. Future work should apply the program in multiple health centers with larger samples and a comparison group, include follow-up assessments three to six months after training to examine retention, and add refresher modules, including blended or online formats, to sustain competence. Further studies should also monitor equipment-related indicators, such as downtime, repair requests, and probe-cleaning compliance, together with clinical indicators, such as image quality and diagnostic concordance, to determine whether improved competence translates into more reliable equipment and better diagnostic services at community health centers.

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## DATA AVAILABILITY

The data supporting the findings of this study (anonymized pretest and posttest knowledge scores, practical competency scores, and satisfaction ratings) are available from the corresponding author upon reasonable request. Individual participant data are not publicly available to protect participant confidentiality.

## AUTHOR CONTRIBUTION

Conceptualization, [A.A.] and [B.B.]; methodology, [A.A.]; investigation, [A.A.], [C.C.] and [D.D.]; formal analysis, [B.B.]; data curation, [C.C.]; writing – original draft preparation, [A.A.]; writing – review and editing, [A.A.], [B.B.], [C.C.] and [D.D.]; supervision, [B.B.]; project administration, [A.A.]; funding acquisition, [B.B.]. All authors have read and agreed to the published version of the manuscript.

## DECLARATIONS

### *ETHICAL APPROVAL*

The activity was carried out with permission from the management of South Krembangan Community Health Center. Participation was voluntary, and participants were informed about the objectives and procedures. Confidentiality was maintained throughout.

### *CONSENT FOR PUBLICATION PARTICIPANTS*

Participants were informed of the objectives of the program and took part voluntarily. Personal data were kept confidential and analyzed under anonymized codes, and photographic documentation was used only with participant consent.

### *COMPETING INTERESTS*

The authors declare no competing financial or personal interests that could have influenced the work reported in this paper.

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