



Robert Malkin's
Developing World Healthcare Technology Laboratory
at Duke University

Biomedical Technician's Assessment Instrument Package

June 2016



The Biomedical Technician's Assessment Instrument Package includes the foundations of survey instruments, survey scripts, and reference materials used in the assessment of biomedical technician's impact on hospitals in Honduras, Rwanda, and Cambodia. In these studies, impact was defined as the technician's ability to decrease out-of-service medical equipment in the hospital. For each assessment, the instruments were tailored to the specific country program yet the fundamental questions, presented here, were always included to ensure comparability across countries and years.

Demographic and technical information about the hospital is taken from the hospital, technician, and hospital administrators. The status of the medical equipment within five departments (operating theatres, radiology, emergency, maternal and neonatal intensive care, and clinical labs) is reported by the technician and the head of each department. A work history of corrective maintenance, preventative maintenance, and management actions were reported by the technicians.

This package includes the instrument and the script for each of the seven fundamental surveys. The instrument was used during the survey while the script was used as a training tool for each interviewer and translator. The instrument was translated into the appropriate language and was given to the interviewee upon request.

If you need more information or have questions, please get in touch with the Developing World Healthcare Technology Laboratory at Duke University through sending an email to Dr. Robert Malkin at robert.malkin@duke.edu.









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We are from Duke University which is partners with Engineering World Health (EWH) and the GE Foundation. EWH is a nonprofit that works on improving health around the world through biomedical engineering. We have training courses in Rwanda, Honduras, Nigeria, Ghana, & Cambodia. Our purpose in conducting this assessment of hospitals is to better understand if our programs are appropriate and helpful. We will be conducting this assessment at your hospital over the following two days. During this time, we hope to do three things. 1) Speak to you for approximately 45 minutes 2) Speak to the hospital technicians and see their workshop and 3) Survey the hospital's medical equipment in five departments. We want to look at equipment in the Operating Room, Clinical Laboratory, Imaging, Neonatal and Maternity, and Emergency Room. We would like to ask for your permission to conduct this work in your hospital for the next two days.

Position	Name	Phone Number	Email	Years at Hospital

Script	Form
General Information <ol style="list-style-type: none"> 1. What population does your hospital serve? (# of people)? 2. How many beds are in your hospital? 3. What is your usual occupancy rate? (% of beds filled on average) 4. How many inpatients does your hospital see in a year? 5. How many outpatients does your hospital see in a year? 6. How many operating rooms are in use? 7. How many ICU beds does your hospital have? 	General Information <ol style="list-style-type: none"> 1. Population Served: 2. # of Beds: 3. Occupancy rate: 4. Inpatients: 5. Outpatients: 6. # OR: 7. # ICU Beds:
Equipment Information <ol style="list-style-type: none"> 8. What % of your equipment do you estimate is donated? 9. What % of your equipment do you estimate is in service? 10. Did your hospital buy any medical equipment in the last 12 months? 11. Do you have a log of purchased equipment you have bought? May I see the log? May I take a picture of this log? 12. Does your hospital have money set aside each year to spend on equipment? <i>If yes, how much?</i> <i>May I see the budget? May I take a picture of the budget?</i> 13. Does your hospital have money set aside each year to spend on spare parts and accessories? <i>If yes, how much?</i> 14. Over the past 12 months, how much money has been spent on spare parts and accessories? 15. Who approves the order of the spare parts and accessories? 16. Who orders the spare parts and accessories? 17. How many times in the last month was a request for spare parts and accessories approved? 18. Does the hospital maintain an inventory of medical equipment? <i>May I see the inventory? May I take a picture of the inventory?</i> 	Equipment Information <ol style="list-style-type: none"> 8. % Donated: 9. % in service: 10. Bought: Y / N 11. Log: Y / N   12. Equipment Budget: <input type="checkbox"/>None, <input type="checkbox"/> _____   13. Components Budget: <input type="checkbox"/>None, <input type="checkbox"/> _____ 14. Money spent: 15. Who approves: 16. Who orders: 17. # times: 18. Inventory: Y / N  
Interaction with Technician <ol style="list-style-type: none"> 19. How many medical equipment technicians are there at the hospital? (technician = anybody who repairs medical equipment) 20. Do you have a regular meeting with the technicians? 21. How often do you talk with your technician? 22. What topics do you most commonly talk about with the technician? 	Interaction with Technician <ol style="list-style-type: none"> 19. # Techs: 20. Regular meeting: Y/ N 21. How often: 22. Topics:

Hospital:

Date:



<p>Technician Satisfaction</p> <p>23. When was the last time you hired a technician?</p> <p>24. When was the last time you fired a technician?</p> <p>25. When was the last time a technician was promoted? Why were they promoted?</p> <ul style="list-style-type: none"> ○ What increased responsibilities result from promotion? <p>26. Has overall number of technicians increased, decreased, or stayed the same in the last five years? <i>By how many technicians has the overall number changed?</i></p>	<p>Technician Satisfaction</p> <p>23. Technician hired:</p> <p>24. Technician fired:</p> <p>25. Promoted:</p> <p>Why:</p> <p>Increased responsibilities:</p> <p>26. Change in number: Increased/Decreased/Stay Same</p> <p>How many:</p>				
<p>Reporting</p> <p>27. Does your technician provide you any written reports?</p> <p>28. What was the date of the last report you received?</p> <p>29. What do you use the information in reports for?</p>	<p>Reporting</p> <p>27. Tech provides reports Y/ N</p> <p>28. Date:</p> <p>29. Use:</p>				
<p>Presence of other programs/NGOs</p> <p>30. Which aid organizations (NGO or governmental) donate medical equipment to your hospital?</p> <p>31. Which aid organizations (NGO or governmental) provide training on medical equipment?</p> <p>32. In the last 12 months, how many pieces would estimate you have received?</p> <p>33. In the last four years, how many pieces would you estimate you have received?</p>	<p>Presence of Other Programs/NGOs</p> <p>30. Donate Equipment:</p> <p>31. Provide Training:</p> <p>32. Last year:</p> <p>33. Last four years:</p>				
<p>Service Contractors/ Service Providers</p> <p>34. Does the MOH provide service contracts for any equipment?</p> <p>35. Does the hospital negotiate for service contracts for any equipment?</p> <p>36. Does your hospital use fee for service / one time providers?</p> <p><i>If yes to SC probe on:</i></p> <p>37. Are parts, accessories, & consumables included in the contract?</p> <p>38. What are the names of the service contractors? What equipment do they work on?</p> <p>39. Who negotiates and signs the contract? (list title, department)</p> <p><i>If yes to fee for service probe on:</i></p> <p>40. What is the budget for fee for service?</p> <p>41. How many times in the 12 months have you contact a fee for service technician?</p> <p>42. Has this changed over the four years?</p>	<p>Service Contractors/ Service Providers</p> <p>34. Use MOH SC? Y / N / Don't Know</p> <p>35. Use Hospital SC? Y / N / Don't Know</p> <p>36. Fee for service? Y / N / Don't Know</p> <p>37. Parts: Y / N / Don't Know</p> <p>38.</p> <table border="1" style="width: 100%;"> <thead> <tr> <th style="width: 50%;">Names</th> <th style="width: 50%;">Types</th> </tr> </thead> <tbody> <tr> <td style="height: 100px;"></td> <td></td> </tr> </tbody> </table> <p>39. Who:</p> <p>40. Budget:</p> <p>41. Last year:</p> <p>42. Changed:</p>	Names	Types		
Names	Types				



Purpose: The Director Survey allows the research team to be formally introduced to the hospital administration, gain demographic information about the hospital, understand the level of involvement the administration has with the hospital technicians, and confirm previously granted permission to conduct the research.

Required Participants:

Two members of the research team
Director (if the Director is not available, then this survey may be conducted with the sub-director)
Translator

Optional Participants:

Sub-Director
Head of Maintenance, or someone who is aware of the procedure for purchasing medical equipment
Administrator, or someone who is aware of basic hospital statistics (inpatients, outpatients, etc.)
Technician

Reference Documents: There are no reference documents needed for this instrument.

Allotted Time: 45 Minutes – 1 Hour

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Director Survey to the participants. The second member of the research team will be responsible for recording the participants' responses and collecting/taking pictures of any physical documents presented during the meeting. This instrument can be sent over to the Director's office in advance. It is not unlikely for the Director to be unaware of some of these questions; therefore, if the instrument is sent over prior to the meeting, the hospital can arrange for the appropriate and informed administrators to be a part of the meeting.

1. Start the meeting with an introduction of the research participants and an exchange of business cards. Then inform the participants of the purpose of the research study, the specific actions the research team will perform over the following days, the amount of time needed with the Director, and verbal confirmation of the Director's permission for this research to be conducted in the hospital.
2. Record the position, name, phone number, email address, and number of years at the hospital of each participant. At the minimum, the Director information will be recorded. If the technician attends this interview, it is not necessary to obtain his information at this time as the information will be recorded in the Technician Survey.
3. Interview the Director according to the left hand side of the Director Survey labeled "Script"
4. Record the participant's responses on the right hand side of the Director Survey labeled "Form"
 - Anytime this symbol [🔍] is present, circle the 🔍 if the research team has seen the requested document
 - Anytime this symbol [📷] is present, circle the 📷 if the research team took a picture or scanned the requested document



We are from Duke University which partners with Engineering World Health (EWH) and the GE Foundation. EWH is a nonprofit that works on improving health around the world through biomedical engineering. We have training courses in Rwanda, Honduras, Nigeria, Ghana, and Cambodia. We will be conducting an assessment at your hospital over the following two days. During this time, we will spend the majority of our time with you and your biomedical department. First, we would like to ask you questions about your role as biomedical technician. This survey will take approximately 45 minutes, is that okay with you?

-----**Speak to every person who works in the maintenance or biomedical department (if more than one continue on back)**-----

Introduction

1. What is your name?
2. What is your email address?
3. What is your phone number?
4. How many years have you worked at this hospital?
5. What is your job title?
6. Did you attend the EWH program?
7. Have you had any previous BMET Training? If yes, ask the technician to describe their previous trainings.
8. What languages do you speak?
9. Do you speak English? If yes, please give the technician the English test and record appropriately.
10. Did you graduate from high school?
11. Did you graduate from Technical School? What was your major?
12. Did you graduate from University? What was your major?
13. Did you attend any other forms of education? If yes, please ask the technician to describe that form of education.

Introduction





1. Name:
2. Email Address:
3. Phone Number:
4. Years:
5. Title:
6. EWH: Y / N
7. BMET Training: Y / N
Description:
8. Languages:
9. English: Y / N
Test Score:
10. High School: Y / N
11. Technical School: Y / N Major:
12. University: Y / N Major:
13. Other: Y / N
Description:

-----**Talk to the lead technician and other technicians that are responsible for repairs and maintenance in the maintenance department**-----

Parts

14. When you are repairing medical equipment and you need a replacement part, how do you get the replacement parts?
15. Where do you get the spare parts you need?
16. Do you have any paperwork?
May I see a copy? May I take a picture?
17. Who do you have to request the part from?
18. When was the last time you requested a spare part?
19. How long did it take you to receive it?
20. Do you feel you are able to get the parts you need?
21. What are the barriers to getting the parts you need?
22. Do you have a room or cabinet of spare parts at the hospital?
May I see a copy? May I take a picture?
23. What part of the budget does money for spare parts come from?



Parts

14. How:
15. Where:
16. Parts acquisition paperwork? Y / N
 
17. Who request:
18. Last request:
19. Wait time:
20. Able to get parts: Y / N
21. Barriers to parts:
22. Parts storage: Y / N
 
23. Parts budget:

Hospital Hierarchy

24. Who is your boss? Who is that person's boss? (continue until director to draw hierarchy)
25. Do you provide any reports to the hospital administration? May I see a copy? May I take a picture of the reports?

Hospital Hierarchy

25. Reports to administration? Y / N
 

Hospital:

Date:



<u>Effort percentage</u>	<u>Effort Percentage</u>	<u>Tech 1</u>	<u>Tech 2</u>
26. What percentage of your time do you spend working on facilities issues (electricity, water, air conditioning)?	26. Facilities:		
27. What percentage of your time do you spend working on medical equipment?	27. Equipment:		
28. Of the time you work on medical equipment, what percentage is on repairs?	28. Repairs:		
29. Of the time you work on medical equipment, what percentage is on preventative maintenance?	29. Maintenance:		
30. Of the time you work on medical equipment, what percentage is on management actions (paperwork, work tickets, reports)?	30. Paperwork:		
31. What are the other responsibilities you have at the hospital?	31. Other Resp:		
32. What percentage of your time do you spend on these other responsibilities?	32. % Other Resp:		
33. Are there any types of equipment you are not allowed to work on?	33. Allowed:		
34. Are there any departments that you are not allowed to work in?	34. Departments:		
35. Are there any types of equipment you choose not to work on?	35. Choose:		
Service Contractors/ Service Providers			
36. Does the Ministry of Health provide service contracts for any medical equipment?	36. Use MOH SC? Y / N / Don't Know		
37. Does the hospital negotiate for service contracts for any medical equipment?	37. Use Hospital SC? Y / N / Don't Know		
38. Does your hospital use fee for service one time providers?	38. Fee for service? Y / N / Don't Know		
<i>If yes to SC probe on:</i>			
39. Are parts, accessories, & consumables included in the contract?	39. Parts: Y / N/ Don't Know		
40. What are the names of the service contractors? What equipment do they work on?	40.		
	Names	Types	
41. Who negotiates and signs the contract? (list title, department)	41. Who:		
<i>If yes to fee for service probe on:</i>			
42. What is the budget for fee for service?	42. Budget:		
43. How many times in the last year have you contact a fee for service technician?	43. Last year:		
44. Has the number of times the hospital contacted a fee for service technician increased, decreased, or stayed the same over the past four years? Why?	44. Changed: Increase/Stay Same/Decrease Why:		
Shop Which of the following tools do you have? 36-42: How often do you use it (D W M)?			
<input type="checkbox"/> 1	<input type="checkbox"/> 6	<input type="checkbox"/> 11	<input type="checkbox"/> 16
<input type="checkbox"/> 2	<input type="checkbox"/> 7	<input type="checkbox"/> 12	<input type="checkbox"/> 17
<input type="checkbox"/> 3	<input type="checkbox"/> 8	<input type="checkbox"/> 13	<input type="checkbox"/> 18
<input type="checkbox"/> 4	<input type="checkbox"/> 9	<input type="checkbox"/> 14	<input type="checkbox"/> 19
<input type="checkbox"/> 5	<input type="checkbox"/> 10	<input type="checkbox"/> 15	<input type="checkbox"/> 20
<input type="checkbox"/> 21	<input type="checkbox"/> 26	<input type="checkbox"/> 31	<input type="checkbox"/> 36
<input type="checkbox"/> 22	<input type="checkbox"/> 27	<input type="checkbox"/> 32	<input type="checkbox"/> 37
<input type="checkbox"/> 23	<input type="checkbox"/> 28	<input type="checkbox"/> 33	<input type="checkbox"/> 38
<input type="checkbox"/> 24	<input type="checkbox"/> 29	<input type="checkbox"/> 34	<input type="checkbox"/> 39
<input type="checkbox"/> 25	<input type="checkbox"/> 30	<input type="checkbox"/> 35	<input type="checkbox"/> 40
<input type="checkbox"/> 41	<input type="checkbox"/> 42	<input type="checkbox"/> 43	<input type="checkbox"/> 44
May we take see your workshop and your tools? May we take a picture of your shop?			
Shop condition:			

Supplies: How often are you able to get these items for the repairs you need: *Always (A), Often (O), Rarely (R),Never (N)*

Hospital:

Date:



<input type="checkbox"/> 1	<input type="checkbox"/> 4	<input type="checkbox"/> 7	<input type="checkbox"/> 10	<input type="checkbox"/> 13	<input type="checkbox"/> 16	<input type="checkbox"/> 19	<input type="checkbox"/> 22
<input type="checkbox"/> 2	<input type="checkbox"/> 5	<input type="checkbox"/> 8	<input type="checkbox"/> 11	<input type="checkbox"/> 14	<input type="checkbox"/> 17	<input type="checkbox"/> 20	<input type="checkbox"/> 23
<input type="checkbox"/> 3	<input type="checkbox"/> 6	<input type="checkbox"/> 9	<input type="checkbox"/> 12	<input type="checkbox"/> 15	<input type="checkbox"/> 18	<input type="checkbox"/> 21	<input type="checkbox"/> 24

Interaction with Director

45. How often do you meet with the director?
46. What topics do you typically discuss?

Requests for technical assistance

47. In the last 12 months, who did you contact when you needed assistance with a repair?
Name: What is the name of the company or the person's name who you contacted? (Other technicians, regional repair unit, foreign support, outside repair agency, service contractors)
Time: How many times did you contact this person in the past 12 months?
Mode: How did you contact this person? (Phone call, email, face to face, facebook)
In/Out: Was the person located inside or outside of the country?

Incoming Equipment & Tech Status

48. Who purchases medical equipment at the hospital? Are you involved when a piece of equipment is purchased?
49. Is incoming equipment recorded?
May I see a copy? May I take a picture of this record?
50. Who accepts incoming equipment? (title and department) Are you involved?
51. Who installs incoming equipment? (title and department) Are you involved?
52. Who trains users on how to use the equipment? (title and department) Are you involved?
53. Where do you keep the medical equipment manuals?
54. How many do you have?
May I see the manuals? May I take a photo of the manuals?

Workflow – Fill out work tickets

55. When a piece of equipment is broken, which person lets you know that it is broken?
56. How does this person let you know?
57. Do you have any paperwork for the request?
May I see a copy? May I take a picture of the paperwork?
58. (If 2+ tech) After you know a piece of equipment needs repair, how do you decide who repairs it?
59. Do you record the repairs you make?
May I see a copy? May I take a picture of the repairs?





Interaction with Director

45. Interactions:
46. Topics:





Requests for technical assistance

Name	# times	Mode	In/Out
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Incoming Equipment & Tech Status

48. Purchased by:
Tech involved: Y / N
49. Recorded? Y / N
 
50. Received by :
Tech involved: Y / N
51. Installed by: _
Tech involved: Y / N
52. User training by:
Tech involved: Y / N
53. Manuals placed:
54. Number of Manuals:
 

Workflow

55. Who:
56. How:
57. Request Paperwork: Y / N
 
58. Delegation if more than one tech:
Whoever available Head Tech By
Specialty
59. Repair Paperwork: Y / N
 



Purpose: The Technician Survey allows the research team to gain information about the technician's educational background, the proportion of the technician's time spent working on medical equipment, relationship between the technician and the administration, and how the technician acquired spare parts and accessories needed for medical equipment.

Required Participants:

Two members of the research team
Translator
Technician

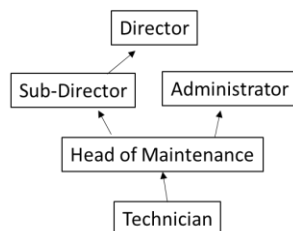
Reference Documents:

English Test
Tool List
Supply List

Allotted Time: 45 Minutes – 1 Hour

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Technician Survey to the technician. The second member of the research team will be responsible for recording the participants' responses and collecting/taking pictures of any physical documents presented during the meeting.

1. If the technician was not a part of the Director meeting, then start the meeting with an introduction of the research participants and inform the participants of the purpose of the research study.
2. Interview the technicians according the left hand side of the Technician Survey labeled "Script"
3. Record the participant's responses on the right hand side of the Technician Survey labeled "Form"
 - Anytime this symbol [📄] is present, circle the 📄 if the research team has seen the requested document
 - Anytime this symbol [📷] is present, circle the 📷 if the research team took a picture or scanned the requested document
4. For question 9, use the "English Test" Reference Sheet. If the technician reported that he/she can speak English, then give the technician the English Test. The technician will need to do read and response to the three questions provided. For every question the technician answers correctly, the technician will be allotted one point. Therefore, the final score will be out of 3 points
5. For question 24, create a flow chart of the hospital hierarchy. See the example below:





6. For the section titled "Shop", use the "Tool List" Reference Sheet. Hand the reference sheet to the technician. One researcher can guide the technician through the reference sheet inquiring if the technician has each tool. The other researcher will only check the corresponding box if the technician has positively identified having the tool. For tools 36-42, if the technician identifies having the tool, the researcher needs to ask if the technician uses that tool daily, weekly, or monthly. The second researcher will record either a D for daily, W for weekly, or M for monthly next to tools 36-42. The name of each tool should be translated and placed on the yellow part of the reference sheet prior to the technician interview.
 - The researchers should take photos of the workshop space. These pictures should include but is not limited to medical equipment being stored/repaired in the workshop, tools, spare parts and accessories, computer, and manuals.
7. For the section titled "Supplies", use the "Supply List" Reference Sheet. Hand the reference sheet to the technician. One researcher can guide the technician through each supply and inquire if the technician has access to that each supply Always, Often, Rarely, or Never. The name of each supply should be translated and placed on the yellow part of the reference sheet prior to the technician interview.
8. For question 47, list each person or company the technician reached out to for help over the past 12 months. For each person/company listed, record the number of times the technician contacted the person/company, how the technician contacted them, and if the person/company was located inside or outside the country.



Equip # 1	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO: SCO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 2	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO: SCO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 3	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO: SCO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 4	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO: SCO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 5	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO: SCO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						

Hospital:

Date:



Equip # 6	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 7	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 8	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 9	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						
Equip # 0	Type:	Manf and H#:	Problem:			
Dept:	Source: D P L	Name of Source:	Time in Hospital: yrs	Down: d m y	NU: R NU NCN NUT D Other:	
Room # & Description:	Fixer: I O B N	War / Cont / FFS Name:	Status: F PF NF NU	PPM / R / MANG	TO:	UO:
Have it: CNIP / time / money / Not available locally / Have it How long: Single Use / Many Patients / Lifetime From: LM / Capital / MOH / Intl / Other						

Hospital:

Date:



Purpose: The Equipment Survey allows the research team to document the amount of functional equipment in each of the five visited departments. Furthermore, this survey allows the research team to understand the barriers the technician faces to repairing the partially and non-functional equipment.

Required Participants:

Two members of the research team

Translator

Technician

User- someone from the department that is a primary user of the medical equipment, typically this is the head of the department

Reference Documents:

Medical Equipment List

Allotted Time: 5 hours

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Equipment Survey Script and recording the participants' response. The other research team member will be responsible for identifying all the medical equipment in each department and taking pictures. The pictures should include the medical equipment, serial number, hospital inventory number, and any donation labels. If the piece of medical equipment is hooked up to a patient, the patient must not be included in any of the pictures.

This survey needs to be completed for each piece of equipment in five departments:

Clinical Labs: Any room or hospital section where patient samples are analyzed

Operating Theaters: Any room or hospital section where surgery takes place with general anesthesia. A procedure room where surgery is performed under local or no anesthesia will not be included.

Radiology: Any room or hospital section where medical imaging takes place

Maternity and Neonatal: Any room or hospital section providing care for pregnant women before, during or after childbirth, including infant nurseries. The neonatal department is any room or hospital section where babies 28 days old or less are treated

Emergency Room: Any room or hospital section meant to treat patients who require rapid treatment

1. The technician and the research team will go visit the first department and identify the head of the department. Introduce the research team and the procedure for this survey to the head of the department.

Say: "We are from Duke University which is partners with Engineering World Health and the GE Foundation. We are here to do a survey of all the medical equipment in your department. We would like ask you a few questions about each piece of equipment and take pictures of the equipment. This survey will take approximately 1 hour. Do you have any questions we can answer before we start the survey?"

2. Identify the first piece of medical equipment that will be surveyed.
3. Create a unique number for each piece of medical equipment. Write this number in the "Equip #" box.
4. Write down which department the medical equipment is located in the "Dept" box.



5. Assign each room visited in the department a new room number. Write this room number and a short description of the room in the "Room # & Description" box.
6. Refer to the Medical Equipment List and write down the corresponding acronym in the "Type" box.
7. If the name of the manufacture and the hospital inventory number are visible, write this information in the "Manf and H#" box.
8. The researcher now needs to identify the source of the medical equipment. This question should be answered by the user of the medical equipment.

Say: "Was this piece of medical equipment donated, purchased, or loaned?"

Circle donate ("D"), purchased ("P"), or loaned ("L"), according to the user's response, in the "Source" box.

If the user identified that the piece of equipment was donated, then the researcher needs to identify which company donated the equipment.

Say: "Which company donated this piece of equipment?"

Write down this response in the "Name of Source" box.

If the user identified that the piece of equipment was purchased, then the researcher should write Hospital in the "Name of Source" box.

If the user identified that the piece of equipment was loaned, then the researcher needs to identify which company has loaned the equipment to the hospital.

Say: "Which company loaned this piece of equipment?"

Write down this response in the "Name of Source" box.

9. The researcher now needs to identify who is responsible to perform preventative and corrective maintenance on this piece of medical equipment. This question should be answered by the user of the medical equipment.

Say: "Who is responsible for fixing this piece of equipment?"

If the user responds that it is the in-house technician, then circle the "I" in the "Fixer" box. Skip to step 11.

If the user responds that it is an outside technician, then circle the "O" in the "Fixer" box.

If the user responds that it is both the in-house technician and the outside technician, then circle the "B" in the "Fixer" box.

If the user responds that no one is responsible for the equipment, then circle the "N" in the "Fixer" box. Skip to step 11.

10. The researcher now needs to identify if the piece of equipment is still under warranty, if there is a service contract for the piece of equipment, or if the hospital pays fee for service to repair this piece of equipment.

Say: "Is this piece of medical equipment under warranty, service contract, or do you use fee for service?"

Circle the warranty ("War"), service contract ("Cont"), or fees for service ("FFS") in the "War/Cont/FFS" box.



Say: "Which company is responsible for the [warranty, service contract, fee for service]?"

Write this response next to the Name in the "War/Cont/FFS" box.

11. The researcher need to identify how long the piece of medical equipment has been in the hospital.

Say: "How long have you had this piece of equipment?"

Write this time down in the "Time in Hospital" box.

12. The researcher needs to identify the current status of the piece of medical equipment. Refer to the definitions below.

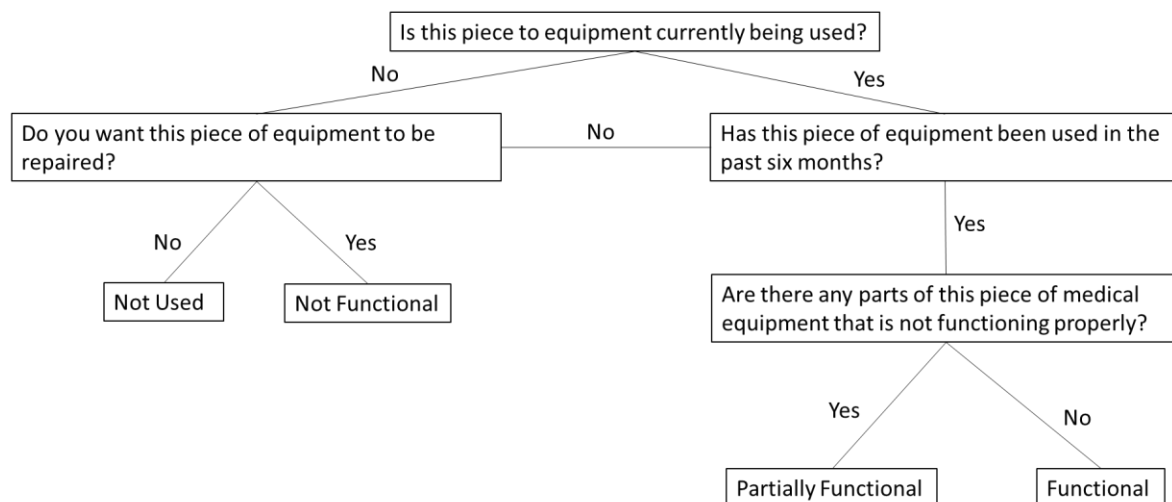
Functional: Any equipment that had been used in the last six months and is described as fully functional from the user

Partially functional: Any equipment that was being used but did not have all the clinical functions needed as defined by the user

Not Functional: Any equipment that could not be used on patients or had not been used in the last six months but the user considered it clinically necessary and wanted it to be repaired

Not Used: Any equipment that was not being used on patients or had not been used in the last six months and which will not be repaired. Equipment in this category was assigned an additional status of retired, never used, no user training, not clinically needed, duplicate, or other.

Use the below flow chart in order to determine which questions to ask the user and to identify how the final status of the piece of equipment will be categorized.



Circle the appropriate functional ("F"), partially functional ("PF"), not functional ("NF"), or not used ("NU") in the "Status" box.



13. If the user responded that the status was partially functional or not functional, the researcher needs to identify the problem, the amount of time the equipment has been down, and the obstacles. If the user responded that the status was functional or not used, proceed directly to step 14.

Say: "Why isn't this piece of equipment fully functional?"

Write down the response in the "Problem" box.

Say: "How long has this piece of equipment not been fully functional?"

Write down the response in the "Down" box.

Say to the technician: "Why haven't you repaired this piece of equipment?"

Categorize the technician's response into one or more of the following:

- 0: The user told me he/she does not need it to treat patients
- 1: I didn't know it was broken
- 2: I know it's broken, but I haven't looked at it yet
- 3: I need training on repairing this equipment
- 4: I don't have the authority to touch it. I need permission
- 5: I don't have the tools that I need
- 6: I don't have the components (spare parts, accessories, supplies) needed

Write down the corresponding number in the "TO" box. If the technician answered number 6, then the researcher needs to identify why the technician does not have the components available. If the technician did not answer number 6, then skip this section and proceed to the section beginning with "Say to the user".

Say to the technician (if responded that number 6 was an obstacle): "Why don't you have the component you need?"

Categorize the technician's response into at least one of the following:

- CNIP: I don't know how to identify the component
- Time: I have not had time to install the component
- Money: The hospital does not have money for the component
- Not Available Locally: The component is not available locally
- Have it: I have the component

Circle the appropriate category in the "Have it" box.

Say to the technician (if responded that number 6 was an obstacle): "How long should this component last?"

Categorize the technician's response into one of the following:

- Single Use: This component should only be used for one patient and then another one would be needed.
- Many Patients: This component should be expected to be replaced regularly throughout the lifetime of the piece of equipment
- Lifetime: This component should be expected to last the lifetime of the equipment.



Circle the appropriate category next to the "How Long" Section in the "Have it" box.

Say to the technician (if responded that number 6 was an obstacle): "Where is the component available?"

Categorize the technician's response into one of the following:

- LM: In the local market
- Capital: In the capital city
- MOH: Through the Ministry of Health
- Intl: Through an international source
- Other: A different place than any of the above categories

Circle the appropriate category next to the "From" Section in the "Have it" box.

Say to the user: "Why aren't you using this piece of medical equipment?"

Categorize the user's response into at least one of the following categories:

- 1: I don't have the necessary user training
- 2: I don't have the components (spare parts, supplies, accessories) the equipment needs.
- 3: I need to tell the technician/biomedical department to come repair this equipment or provide user training
- 4: I have already requested that the technician/biomedical department come repair this equipment or provide user training.

Write the corresponding number to the user's response in the "UO" box.

If the piece of medical equipment is under a service contract, say to the technician: "Why hasn't the service contractor repaired this piece of medical equipment?"

Categorize the response into at least one of the following categories:

- A: I have not called the service contract provider
- A1: Because I do not have the authority to call the service provider
- B: I don't know what is covered by the service contract and/or who the contract is with
- C: I have called the service contract provider but they have not come yet or are not responding helpfully
- D: I have called the service contract provider but they have come and were unable to fix the equipment
- D1: Because they were unable to obtain the necessary spare part
- D2: Because they could not diagnose the problem with the machine
- E: The service contract does not cover the needed spare part, accessory, or consumable needed to return the equipment to service

Write the corresponding letter and number to the technician's response in the "SCO" box.

14. If the status of the medical equipment was reported as "Not Used", then the researcher needs to identify why the piece of equipment is not used.

Say: "What is this piece of medical equipment not used?"

Categorize the user's response into one of the following categories:



R: Retired
NU: Never Used
NCN: Not clinically needed
NUT: No user training
D: Duplicate but fully functional
Other: A different reason that the equipment is not used

15. The second researcher needs to take a picture of the unique Equipment number on the Equipment Survey. Then take a picture of the medical equipment, serial number, hospital inventory number, and any donation stickers on the medical equipment.
16. Repeat steps 2-15 for each piece of medical equipment in the department.
17. Repeat steps 1-16 for the each of the five departments.



Case #: __1	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	
Case #: __2	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	
Case #: __3	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	
Case #: __4	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	
Case #: __5	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Hospital:

Date:



Case #: __6	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Case #: __7	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Case #: __8	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Case #: __9	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Case #: __0	Problem:	Date Began: ____ / 201__	Assistance? N / Y Who? Phone Email F to F
Equip Type:	What they did:	Internet? N / Y	Opened? N / Y
# of pieces:		Parts: Single Use / Many Patients / Lifetime	
Paperwork: Y / N	BTA skills:	Type Part:	
		Where stocked: L / MOH / Int /Capital	
		Repair Time: d m y	
		Resolved: Fully / Partially / Unresolved	

Hospital:

Date:



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Repair Survey
BMET Assessment

Hospital:

Date:



Purpose: The Repair Survey allows the research team to gain information about the number of times the technicians perform corrective maintenance on the medical equipment in the hospital. This sheet records the details of repairs including the date of the repair, the problem addressed, if outside assistance was used, and how long it took for the technician to perform the repair.

Required Participants:

One member of the research team
Translator
Technician

Reference Documents:

BTA Skills

Allotted Time: 1 hour

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Repair Survey Script and recording the participants' response.

1. Introduce the technician to the next survey.

Say: "In this next survey, we will be asking you questions about the number of times you have performed repairs over the past 12 months. This sheet will take approximately 1 hour. Before we start this survey, please gather all the paper documentation you have for the repairs."

2. It is important to identify the repairs in a systematic manner. Typically, it is best to go through the technician's paperwork and discuss each repair individually. After the research team has discussed each paperwork repair, then the research team should probe the technician if they completed any other repairs in the past 12 months. It can be helpful for the research team to use the Medical Equipment List to ensure that they have asked about each type of medical equipment.
3. The researcher needs to create a case number for each identified repair. In the upper left box, the technician can write the correct case number.
4. The researcher now needs to identify the type of medical equipment the technician repaired.

Say: "What type of medical did you repair?"

Write the type of medical equipment in the box labelled "Equip Type".

5. The research will now identify the number of pieces that were repaired at the same time. If the repair is completed on a separate date, then the repairs would be considered separate cases.

Say: "How many pieces of that type of equipment did you repair during that one instance?"

Write the number of reported pieces of equipment in the "# of pieces" box.

6. If the technician is referencing completed paperwork to discuss this repair, the researcher needs to circle the Y in the "Paperwork" box. The research team will need to take a picture or scan all repair paperwork. If the technician is using their memory to report this repair, then the researcher needs to circle the N in the "Paperwork" box.



7. The researcher will now identify the problem with the medical equipment.

Say: "For this repair, what was the reported problem with the piece of medical equipment?"

Write down the reported issues in the "Problem box".

8. The researcher needs to identify how the technician repaired the medical equipment.

Say: "What steps did you take in order to repair the medical equipment?"

Write down the description of the technician's repair process in the "What they did" box.

9. The technician needs to use the BTA Reference Sheet to identify any BTA skills that the technician performed. It is the responsibility of the research team to identify the BTA skills while the technician described how a piece of medical equipment was repaired. Then the technician needs to write down the appropriate BTA skill numbers in the "BTA skills" box.
10. If the technician identified the use of a spare part during the repair process, the researcher should write down the identified spare parts in the "Type Part" box. If the technician did not identify a spare part during the repair process, then skip to step 13.
11. The research team then needs to ask the technician if the spare part will be used for one patient ("Single Use"), many patients ("Many Patients"), or the lifetime ("Lifetime") of the medical equipment. The researcher needs to circle the appropriate lifetime of the spare parts in the "Parts" box.
12. The research team needs to identify where the technician got the spare parts.

Say: "Where do you go to obtain this spare part?"

The research team will then need to categorize the technician's response into at least one of these four categories: local market ("L"), ministry of health ("MOH"), international market or online ("Int"), a market in the capital city ("Capital"). Then the researcher will circle the appropriate location of the spare part in the "Where stocked" box.

13. The researcher will now identify which month and year the repair was conducted. Write the month and year in the "Date Began" box.
14. The researcher needs to identify if the technician had assistance completing the repair.

Say: "Did you have any assistance to complete this repair?"

If the technician responds in the negative, circle the N in the "Assistance" box and proceed to step 15.

If the technician responds in the affirmative, circle the Y in the "Assistance" box.

Say: "Who was the person who helped you with the repair?"

Write the name of this person or company next to Who in the "Assistance" box.

Say: "How did you contact this person or company?"

The researcher will need to categorize the technician's response into one of three categories: text or phone call ("Phone"), website or email ("Email"), or face to face ("F to F"). Then the researcher will circle the appropriate way of contacting assistance in the "Assistance" box.



15. The researcher will now identify if the technician used the internet during the repair process.

Say: "Did you use any websites or other sources on the internet to complete this repair?"

If the technician responds in the negative, then circle the N in the "Internet" box. If the technician responds in the affirmative, then circle the Y in the "Internet" box.

16. The researcher will now identify if the technician opened up the piece of medical equipment during the repair.

Say: "Did you open this piece of medical equipment during the repair process?"

If the technician responds in the negative, then circle the N in the "Opened" box. If the technician responds in the affirmative, then circle the Y in the "Opened" box.

17. The researcher will now identify how long it took for the technician to repair the piece of equipment. The repair time should begin when the technician became aware of the status of the medical equipment. The repair time should end when the technician either repaired the equipment or concluded that the piece of equipment could not be repaired.

Say: "How long did it take you to repair this piece of equipment from the time you became aware of the problem to when you fixed the equipment?"

Write this reported time down in the "Repair Time" box. Then circle days ("d"), months ("m"), or years ("y") to specific how long it took the technician to repair the equipment.

18. The researcher will now identify the ending status of the medical equipment.

Say: "Is the medical equipment now fully functional, partially functional, or non-functional?"

Categorize and circle the technician's response into fully functional ("Fully"), partially functional ("Partially"), or non-functional ("Unresolved") in the "Resolved" box.

19. Repeat steps 3- 18 until the researcher and the technician has discussed each repair the technician has conducted in the past 12 months.



In this next survey, we will be asking you questions about the number of times you have performed planned preventative maintenance over the past 12 months. This sheet will take approximately 30 minutes. Before we start this survey, please gather all the paper documentation you have for preventative maintenance actions.

Script	Form
General Information 1. Do you have paper documentation for preventative maintenance? 2. Do you have a schedule for the preventative maintenance you perform? 3. How often are you not able to complete the scheduled preventative maintenance? 4. What percentage of PPM are you eventually able to complete? 5. How many days delay does it take for you to complete the preventative maintenance? 6. What barriers to performing preventative maintenance do you face to complete it as scheduled?	General Information 1. PPM: Y / N 2. Perform: Y / N 3. Not Able: 4. % Unable: 5. Days Delay: 6. Barriers:



Equipment Type	Memory / Paperwork	Times Completed / Times Planned	# worked on	Contact anyone for assistance	Open the machine	Clean the machine	Calibrate	Use any parts	What did you do? [describe, list, info from other questions]
PAMO	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
SUMA	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
OXCO	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
AUCL	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
OPTA	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ESUM	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ANMA	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
XRAY	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ULTR	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
REFR	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
MICS	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
DFIB	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
PHLI	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	

Hospital:

Date:



Equipment Type	Memory / Paperwork	Times Completed / Times Planned	# worked on	Contact anyone for assistance	Open the machine	Clean the machine	Calibrate	Use any parts	What did you do? [describe, list, info from other questions]
CENTR	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ECGR	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
VENT	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
WABA	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
HEAN	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ORLI	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
ININ	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
INFW	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
BPMA	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
CLOV/LAIN	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
NEBU	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
FEMD	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	
FLPU	M / P	/		Y N Who:	Y N	Y N	Y N	Y N Parts:	

Hospital:

Date:



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Preventative Maintenance
BMET Assessment

Hospital:

Date:



Purpose: The Preventative Maintenance Sheet allows the research team to gain information about the number of times the technicians perform preventative maintenance on the medical equipment in the hospital. This sheet records the details of how the technicians perform preventative maintenance.

Required Participants:

- One member of the research team
- Translator
- Technician

Reference Documents: No reference documents are needed.

Allotted Time: 30 Minutes

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Preventative Maintenance Sheet and recording the participants' response.

1. Interview the technician according the left hand side of the Preventative Maintenance Sheet labeled "Script."
2. Record the participant's responses on the right hand side of the Preventative Maintenance Sheet labeled "Form"
 - Anytime this symbol [🔍] is present, circle the 🔍 if the research team has seen the requested document
 - Anytime this symbol [📷] is present, circle the 📷 if the research team took a picture or scanned the requested document
3. The researcher will now ask about the preventative maintenance performed on each type of medical equipment in the hospital. The current sheet does not include balances, magnetic resonance imaging equipment, micropipettes, and pulse oximeters. If these types of equipment were present in the hospital, the researcher should also probe on these types of equipment.
4. The research team will need to ask about each piece of medical equipment that is present in the hospital.
5. The researcher will then identify if the technician has any paperwork for the preventative maintenance performed. If the technician has paperwork, the researcher should circle the "M" in the "Memory/Paperwork" column. If the technician does not have any paperwork for the preventative maintenance, then the researcher should circle the "P" in the "Memory/Paperwork" column.
6. The research team needs to identify the number of times preventative maintenance was performed on the piece of equipment in the past times months and the number of times that maintenance was planned.

Say: "How many times in the past 12 months have you performed preventative maintenance on patient monitors?"

Write this reported number on the left hand side of the "/" in the "Times Completed / Times Planned" column.

Say: "How many times did you plan to perform preventative maintenance on patient monitors in the past 12 months?"

Write this reported number on the right hand side of the "/" in the "Times Completed / Times Planned" column.

7. The researcher will then need to identify the number of pieces of that type of equipment the technician worked on.

Say: "How many patient monitors did you perform preventative maintenance on each time you completed the maintenance?"

Write this reported number in the "# worked on" column.



8. The researcher will now ask about the technician's assistance during preventative maintenance.

Say: "While performing preventative maintenance on patient monitors, did you contact anyone for assistance?"

If the technician responds in the negative, circle the N in the "Contact anyone for assistance" column and proceed to step 9.

If the technician responds in the affirmative, circle the Y in the "Contact anyone for assistance" column. The researcher then needs to ask who the technician contacted.

Say: "Who did you contact for help?"

Write the reported person next to the "Who" in the "Contact anyone for assistance" column.

9. The researcher will now ask if the technician opened the machine during preventative maintenance.

Say: "Did you open the medical equipment while performing preventative maintenance on patient monitors?"

If the technician responds in the negative, circle the N in the "Open the Machine" column. If the technician responds in the affirmative, circle the Y in the "Open the Machine" column.

10. The researcher will now ask if the technician cleaned the machine during preventative maintenance.

Say: "Did you clean the medical equipment while performing preventative maintenance on patient monitors?"

If the technician responds in the negative, circle the N in the "Clean the machine" column. If the technician responds in the affirmative, circle the Y in the "Clean the machine" column.

11. The researcher will now ask if the technician calibrated the medical equipment.

Say: "Did you calibrate the medical equipment while you performed preventative maintenance?"

If the technician responds in the negative, circle the N in the "Calibrate" column. If the technician responds in the affirmative, circle the Y in the "Calibrate" column.

12. The researcher will now ask if the technician used any other parts during the preventative maintenance.

Say: "Did you use any spare parts while you performed preventative maintenance on patient monitors?"

If the technician responds in the negative, circle the N in the "Use any parts" and proceed to Step 13.

If the technician responds in the affirmative, circle the Y in the "Use any parts" and then the researcher needs to follow-up with the types of spare parts used.

Say: "What spare parts did you use while performing preventative maintenance on patient monitors?"

Write the identified spare parts next to the "Parts" section in the "Use any parts" column.

13. Use the "What did you do?" column to write down any additional information the technician identified.

14. Repeat steps 4- 13 until the researcher has discussed each type of medical equipment.



In this survey, we will be asking you questions about the management actions you have performed over the past 12 months. This survey will take approximately 30 minutes.

Script	# of times	Description of Steps
1. How many times have you created an inventory? Please describe your process to create an inventory.		
2. How many times have you updated the inventory? Please describe your process to update an inventory.		
3. How many times have you created a Planned Preventative Maintenance Schedule? Please describe how you create a Planned Preventative Maintenance.		
4. How many times have you ordered spare parts? Please describe your process to order spare parts.		
5. How many times have you written a report for the hospital administration? Please describe what topics are written in your reports.		
6. How many times have you written a report for Ministry of Health? Please describe what topics are written in your reports.		
7. How many times have you developed a budget? Please describe how you develop a budget.		
8. How many times have you written a budget request? Please describe what you include in your budget request.		
9. How many times have you planned for the replacement of medical equipment? Please describe how you plan for the replacement of medical equipment.		
10. How many times have you decided a broken piece of equipment should stay permanently broken? Please describe which types of equipment you decommissioned and how many of each type.		
11. How many times have you installed a piece of equipment? Please describe the installation process.		
12. How many times have you attended meetings with hospital administrators? Please describe what you discuss during these meetings.		
13. How many times have you attended meetings with your boss? Please describe what you discuss during these meetings.		
14. How many times have you presented at the meetings with hospital administration? Please describe what topics you presented on in these meetings.		

Hospital:

Date:



15. How many times have you called a service contractor? Please specify which service contractors you called and for what reasons.		
16. How many times have you called a private company or private technician? Please specify which private companies or technician you called and for what reasons.		
17. How many times have you developed purchasing goals? Please describe how you develop purchasing goals.		
18. How many times have you performed electrical safety testing of medical equipment? Please describe how you perform an electrical safety test.		
19. How many times did you identify training needs of the users? Please describe the training needs and the actions you took.		
20. How many times did you perform user training?	<i>Gather this information from the informal survey sheet</i>	



Purpose: The Management Action Survey allows the research team to gain information about technician's involvement in the management of the medical equipment and their interactions with administrators.

Required Participants:

One member of the research team
Translator
Technician

Reference Documents: No reference documents are needed.

Allotted Time: 30 Minutes

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Management Actions Survey and recording the participants' response.

1. Interview the technician according the left hand side of the Management Action Survey labeled "Script."
2. Record the participant's responses on the right hand side of the Management Actions Survey labeled "# of times" and "Description of Steps".



Equipment Type	User Training ¹	Changed Equipment Settings ²	Used Testing Equipment ³	Functional Testing	What did you do? [additional information]
_1	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_2	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_3	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_4	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_5	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_6	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_7	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_8	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_9	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	
_0	Y N <u>Frequency:</u> <u>Number of People:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	Y N <u>Frequency:</u>	

¹ Use the number of user of trainings gathered here to fill out the “User Training” section on the Management Actions Instrument

² Add the number of times the technician changed the equipment setting gathered here to repairs performed in order to calculate the final corrective actions performed

³ Add the number of times the technician used testing equipment into the total number of preventative actions

Hospital:

Date:



Robert Malkin's
Developing World Healthcare Technology Laboratory
at Duke University

Informal Equipment Interaction
BMET Assessment

Hospital:

Date:



Purpose: The Information Equipment Interaction Sheet allows the research team to gain information about times when the technician checked on the medical equipment but did not perform planned preventative maintenance and it allows the researchers to gain more extensive information that will get re-categorized as either a management or corrective action.

Required Participants:

One member of the research team
Translator
Technician

Reference Documents:

Medical Equipment List

Allotted Time: 30 Minutes

Method: This is an interview-assisted survey. One member of the research team will be responsible for asking the questions via the Informal Equipment Interaction Sheet and recording the participants' response.

1. Preface this survey by saying:

"In this next survey, we will be asking you questions about the number of times you have provided user training, calibrated medical equipment, changed equipment settings, and used testing equipment for each type of medical equipment present in your hospital. We are only interested in the actions you have performed in the past 12 months. This sheet will take approximately 30 minutes. Do you have any questions before we start this survey?"

2. Use the Medical Equipment List reference sheet to systematically go through the equipment in the hospital. The research team will need to ask about each piece of medical equipment that is present in the hospital.

Say: "Let's first discuss anesthesia machines [or the first type of medical equipment on the medical equipment list present in the hospital]."

Write ANMA in the left hand column under Equipment Type.

3. The researcher will now ask about the number of times the technician performed user training on the specific piece of equipment in the past 12 months. User training is defined as the technician teaching at least one user (such as a doctor or nurse) about at least one specific action for a piece of medical equipment. For example, the technician may teach a nurse about to properly clean out a suction machine after the nurses uses it or the technician may teach the entire department staff about how properly unplug/plug a piece of equipment in order to take care of the cord's longevity or be aware of safety issues.

Say: "In the past 12 months, have you performed any training to the hospital staff on the anesthesia machines"

If the technician responds in the negative, circle the N in the User Training box and proceed to step 4.

If the technician responds in the affirmative, circle the Y in the User Training box. The researcher needs to ask about the number of times the technician performed this user training and the number of people who attended each training.



Say: "How many times in the past 12 months, did you perform trainings on the anesthesia machines"

Write this number under "Frequency" in the User Training box on the line corresponding with medical equipment being discussed.

Say: "In each of these training, how many people were present?"

Write the number of people present under "Number of People" in the User Training box.

4. The researcher will now ask about the number of times the technician changed equipment setting on the specific piece of equipment in the past 12 months. Changed equipment setting is defined as the technician being called to a department due to a non-functional piece of equipment and the only action the technician needed to take was change the settings in order for the piece of equipment to become functional.

Say: "In the past 12 months, have you ever been called to the department because the anesthesia machine was broken and upon your evaluation of the equipment, the only action you needed to perform was to change the equipment settings?"

If the technician responds in the negative, circle the N in the Changed Equipment Settings box and proceed to Step 5.

If the technician responds in the affirmative, circle the Y in the Changed Equipment Settings box. The researcher needs to ask about the number of times the technician changed the equipment settings.

Say: "How many times have you had to change the anesthesia machine's settings in the past 12 months?"

Write this number under the "Frequency" in the Changed Equipment Settings box

5. The researcher will now ask about the number of times the technician used testing equipment on this piece of equipment. If the technician did not specify having the appropriate testing equipment for the piece of equipment in the Technician Survey, then the researcher can skip this question and proceed to Step 6.

Say: "In the past 12 months, have you ever used testing equipment on the anesthesia machine?"

If the technician responds in the negative, circle the N in the Used Testing Equipment box and proceed to Step 6.

If the technician responds in the affirmative, circle the Y in the Used Testing Equipment box.

Say: "How many times did you use this testing equipment on the anesthesia machine in the past 12 months?"

Write this number under the "Frequency" in the Used Testing Equipment box and the type of testing equipment used in the "What did you do?" box.

6. The researcher will now ask about the number of times the technician performed a functional test on this piece of equipment. A functional test is defined as the technician turning the piece of equipment on and then performing no other action.

Say: "In the past 12 months, have you ever turned on the anesthesia machine to make sure it is working, performed no action, and then turned it off upon seeing if it was working or not?"

If the technician responds in the negative, circle the N in the Functional Testing box and proceed to Step 7.



If the technician responds in the affirmative, circle the Y in the Functional Testing box. The researcher needs to ask about the number of times the technician performed a functional test in the past 12 months.

Say: "How many times in the past 12 months, did you perform that action?"

Write the number under the "Frequency" in the Functional Testing box.

7. Record any additional information the technician explains in the "What did you do?" box.
8. Repeat Steps 2-7 until every type of medical equipment has been discussed. Use the "Medical Equipment List" reference to systematically go through the equipment.
9. Calculate the total number of user training. First, multiply the number of people by its corresponding frequency number. Second, add together all of these sub-totals to calculate the total number of user training. Write the total number of user trainings in the "User Training" section on the Management Actions Instrument.
10. Calculate the total number of changed equipment settings by summing all the frequency numbers. This number should get added into the total number of corrective actions.
11. Calculate the total number of using testing equipment by summing all the frequency numbers. This number should get added into the total number of preventative actions.



Reference: English Test

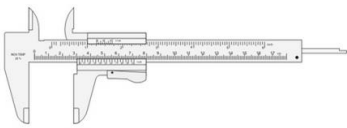
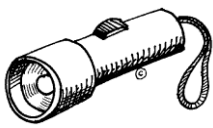

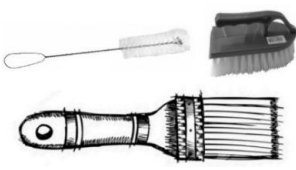
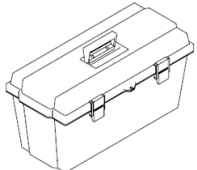


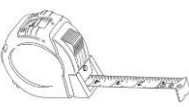

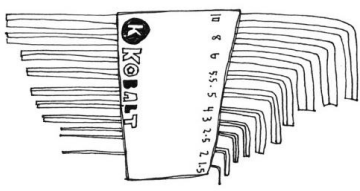
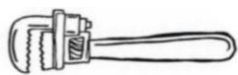


This is the Reference Sheet for the Language Section of the Technician Survey. Please have the technician read and respond to each of the below statements.

1. What are your normal work hours?
2. What is your job title?
3. Show me your tool box.





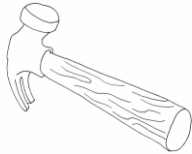

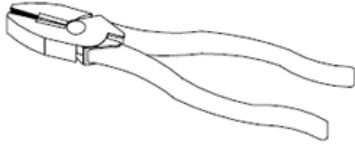
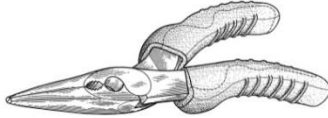

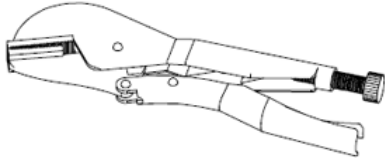




Reference: Tool List


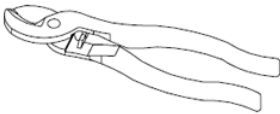
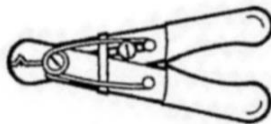
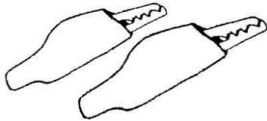
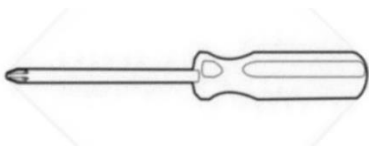
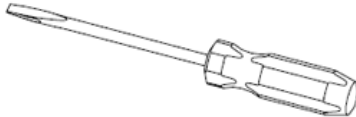


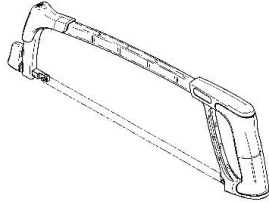
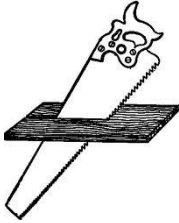


This is the Reference Sheet for the Shop Section of the Technician Survey. Prior to the survey each tool needs to be translated into the local language. The translated word should be placed in the yellow space below each picture.

 1 [] 1 Calipers	 2 [] 2 Flashlight	 3 [] 3 Calculator
 4 [] 4 Brush for Cleaning (any)	 5 [] 5 Tool Case	 6 [] 6 Glasses / Safety Goggles
 7 [] 7 Magnifying Lens	 8 [] 8 Measuring Tape	 9 [] 9 Cable Ties
 10 [] 10 Allen Wrench Set	 11 [] 11 Pipe wrench  12 [] 12 Adjustable crescent wrench	 13 [] 13 Box wrench set

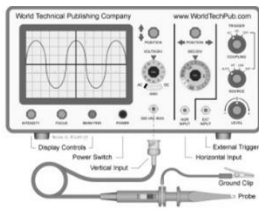







 <p>14 []</p> <p>14 Level</p>	 <p>15 []</p> <p>15 File</p>	 <p>16 []</p> <p>16 Electrical Tape</p>
 <p>17 []</p> <p>17 Rubber or plastic mallet</p>	 <p>18 []</p> <p>18 Hammer</p>	 <p>19 []</p> <p>19 Socket Set</p>
 <p>20 []</p> <p>20 Pliers, Lineman's</p>	 <p>21 []</p> <p>21 Pliers, Needle-nose</p>	 <p>22 []</p> <p>22 Pliers, Slip Joint</p>
 <p>23 []</p> <p>23 Pliers, Vise Grip (mole)</p>	 <p>24 []</p> <p>24 Pocket Knife</p>	 <p>25 []</p> <p>25 Razorblade Scraper</p>



 26 [] 26 Utility Knife, With Blades	 27 [] 27 Wire cutters	 28 [] 28 Wire Stripper
 29 [] 29 Alligator Clip Leads	 30 [] 30 Philips Screwdriver	 31 [] 31 Flat Tip Screwdriver
 32 [] 32 Miniature/Jeweler's Screwdriver Set	 33 [] 33 Soldering Iron	 34 [] 34 Metal Saw
 35 [] 35 Wood Saw	 36 [] 36 Pressure meter	 37 [] 37 Multimeter



 <p>38 []</p> <p>³⁸ Oscilloscope</p>	 <p>39 []</p> <p>³⁹ Electrical Safety Analyzer</p>	 <p>40 []</p> <p>⁴⁰ Cardiac Simulator</p>
 <p>41 []</p> <p>⁴¹ Electrosurgical Analyzer</p>	 <p>42 []</p> <p>⁴² Defibrillator Analyzer</p>	 <p>43 []</p> <p>⁴³ Tap and Die Set</p>



Reference: Supply List

This is the Reference Sheet for the Supply Section of the Technician Survey. Prior to the survey, each supply needs to be translated into the local language. The translated word should be placed in the yellow space next to each number.

Electrical

1. Wire nuts []
2. Solder flux []
3. A spool of spare wire []
4. Heat shrink tubing []
5. Sandpaper []
6. Spare resistors []
7. Desoldering braid, bulb, sucker []
8. Spare lightbulbs []
9. Velcro strips []
10. Caulk []

Mechanical

11. Cleaning solvents like alcohol, acetone, or ammonia []
12. Steel wool []
13. Thin penetrating oil []
14. Grease / machine oil []
15. Spare screws []
16. Super glue or cyanoacrylate []
17. Compressed air, can or machine []
18. Epoxy []

Plumbing

19. Rubber patch kit []
20. Access to rubber gasket replacement material []
21. Replacement O rings []
22. Gloves []

Power

23. Spare fuses []
24. Access to spare batteries []



Reference: Medical Equipment List

Code	Equipment Type
ANMA	Anesthesia Machines
AUCL	Autoclaves
BALA	Balances (electronic clinical lab)
BPMA	Blood Pressure Machines (manual & NIBP)
CENTR	Centrifuges (including hematocrits)
CLOV	Clinical Laboratory Ovens
DFIB	Defibrillators
ECGR	Electrocardiographs
ESUM	Electrosurgery Machines
FEMD	Fetal Monitors and Fetal Dopplers
FLPU	Fluid Pumps (feeding, IV infusion/syringe, blood etc.)
HEAN	Hematology Analyzers (including electrolyte analyzers)
ININ	Infant Incubators
INFW	Infant Warmers
LAIN	Laboratory Incubators
MARI	Magnetic Resonance Imaging
MIPI	Micropipettes (manual, electronic, not disposable)
MICS	Microscopes
MICT	Microtomes & Cryostats
NEBU	Nebulizer
OPTA	Operating Tables
ORLI	OR Lights and Other Lights
OXCO	Oxygen Concentrators
PAMO	Patient Monitors
PHLI	Phototherapy Lights
PUOX	Pulse Oximeters
REFR	Refrigerators
RERM	Respiration Rate Meters and Apnea Monitors
SUMA	Suction Machines (rotary, diaphragm, thermotic, venture)
ULTR	Ultrasounds
VENT	Ventilators
WABA	Water Baths, Stir Plates, and Hot Plates
WAPU	Water Purifiers (for clinical lab)
XRAF	X-ray (fixed – radiographic and/or fluoroscopic unit)
XRAP	X-ray (portable – such as C-arms)
XRFP	X-ray Automatic Film Processor



Reference: Biomedical technician's assistant (BTA) Skills

Electrical Simple

- **Connections**

- 3 - Broken Wires inside cable
- 10 - continuity tester
- 8 - Desoldering
- 5 - heat shrink tubing (diameter)
- 4 - Proper use of electrical tape
- 9 - Selecting wire (diameter, type (solid/stranded), insulation, material (aluminum, copper))
- 7 - Soldering (stranded wires, solid wires, to PCB board)
- 6 - Wire nuts

- **Connectors**

- 12 - Broken housing
- 13 - Cleaning of connections (Q-tips, isopropyl alcohol)
- 14 - Conductive epoxy
- 16 - Loose Connectors
- 17 - Strain Relief
- 18 - Wire/ rod to replace pins of a connector

- **Fabrication (cables, electrodes, plates)**

- 19 - Cables (simple cables, shielded cables)
- 20 - ECG Cables
- 21 - ECG Electrodes
- 22 - Patient Reference Plates for ESUs
- 23 - Temperature Probe Cables

- **Heating Element**

- 25 - Replacement of Heating Element
- 26 - Replacement of temperature sensing device

- **Lighting/ Indicators**

- 28 - cleaning bulb connections
- 29 - cleaning high temperature/ high intensity bulbs
- 30 - Fixtures (electrical rewiring, mechanical adaptations)
- 31 - Replacement of Light bulbs (incandescent, fluorescent, LED)

- 32 - Replacing Analog Meters

- **Switches**

- 34 - Cleaning Contacts
- 35 - Selecting Replacement Switches

Mechanical

- **Attachment**

- 37 - drilling holes (in metal, ceramic & wood)
- 38 - epoxy
- 39 - loosening frozen nuts
- 40 - nails/ hammer
- 41 - plastic anchors
- 42 - Selecting replacement screws
- 43 - soldering (brass tubing)
- 44 - superglue
- 45 - tightening nuts
- 46 - tools for adjusting bolt/screw choosing different heads
- 47 - understanding welding
- 48 - zip ties

- **Calibration**

- 50 - BP machines
- 55 - Centrifuge
- ? - Defibrillator
- 51 - ECG monitor
- 52 - Oxygen concentrator
- 53 - Scale
- 54 - Sphygmomanometer
- ? - Training
- 56 - Ventilator volume/ rate

- **Casing**

- 58 - hinges
- 59 - latches/locks/interlocks
- 60 - Panels/ doors (from wood, sheet metal)

- **Cleaning**

- 62 - Cleaning inside of things (pipe cleaners, Q-tips, tweezers with a bit of cloth)
- 63 - cleaning lens/using lens paper
- 64 - compressed air
- 65 - rust/ sanding



- 66 - Using a damp cotton cloth
(water, soap and water,
clorox, acetone, alcohol)
- **Lubrication**
 - 68 - greasing/ oiling
 - 69 - thin penetrating oils
 - 70 - unfreezing painted joints

Motors

- **Belts/ Gears/ Shafts/ Coupling**
 - 72 - Bent Shaft (vibration and wobbling)
 - 73 - Loose/ tighten
 - 74 - Lovejoy Coupling (vibration/
slipping)
 - 75 - Squealing/slipping/ low power
 - 76 - worn cracks/ glazing
(replacing belt)
- **Brush Substitution**
 - 78 - Filing down
 - 79 - Shim
 - 80 - Spring adjustment (attached
to brush)
 - 81 - Spring repair
- **Cleaning/ Lubrication**
 - 83 - Arcing grooves in commutator
(removal with emery paper)
 - 84 - Arcing grooves in commutator
(Removal with lathe)
 - 85 - Brush frozen away from
commutator (cleaning)
 - 86 - Grinding/ high pitched squeal
(foreign objects)
 - 87 - Lubricant (type, reservoir)
 - 88 - Repack bearings
 - 89 - Squealing/ Grinding/
Overheating
- **LoveJoy coupling**
 - 91 - Sheared key
- **Tightening/ Attachment/ Balance**
 - 93 - Mounting of motor
 - 94 - Set Screws(Loc-tite/superglue)
 - 95 - Vibration and motor

Plumbing

- **Blockages**
 - 97 - Cleaning
 - 98 - Descaling

- 99 - Routing
- **Connections**
 - 101 - Clamps
 - 102 - Fitting adaptors
 - 103 - Hose Barb w/ clamp
 - 104 - Threaded pipe connector
- **Filters**
 - 106 - Cleaning
 - 107 - Fabrication
 - 108 - Substitution
- **Leaking**
 - 110 - Cutting Tubes
 - 111 - epoxy
 - 112 - Finding Holes
 - 113 - Melting Tube
 - 114 - Rubber Patches
 - 115 - superglue
 - 116 - Tape
- **Seal**
 - 118 - Caulk
 - 119 - Creating a gasket
 - 120 - Jars/lids for Suction machines
- **Rings**
 - 121 - O-rings
 - 122 - Sealing autoclave doors

Power Supply

- **Batteries**
 - 124 - Building/ adapting a charger
for rechargeable cells
 - 125 - Cleaning
 - 126 - Identification of
leaking/corrosive batteries
 - 127 - Replacing batteries with a
wall transformer
 - 128 - substituting for batteries for
primary cells
 - 129 - substituting for batteries for
rechargeable cells
- **Fuse**
 - 131 - fuse substitution
 - 132 - identifying a blown fuse
- **Plug/cable**
 - 134 - Adding proper grounding
 - 135 - Fabricating power cords
 - 136 - Outlets and plugs for different



voltages/countries (determine
frequency voltage, determine
configuration)

- **Regulator**

- 138 - Diagnose regulator problems
- 139 - Replacing/adapting regulators

- **Transformer**

- 141 - Adapting wall transformers
- 142 - Diagnosing a transformer that
needs to be rewound (appropriate
people to rewind transformers)
- 143 - Voltage conversion transformers