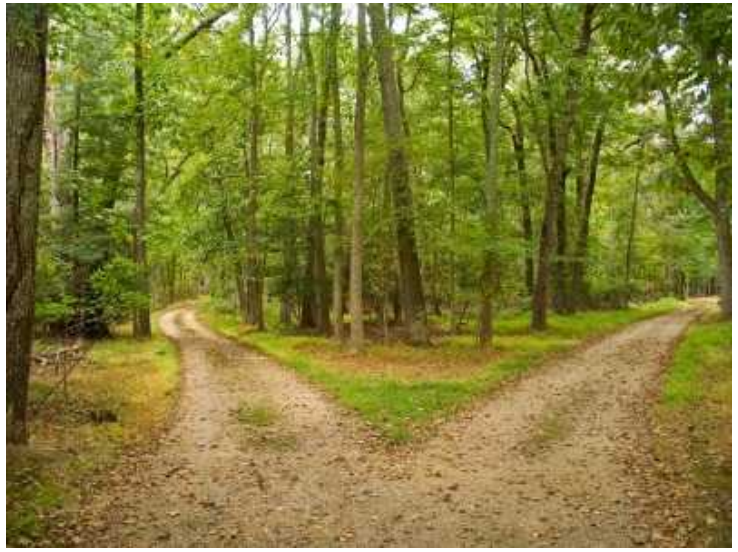
Troubleshooting medical equipment



The most common error in troubleshooting is to rush down the wrong path, perhaps because of a misunderstanding or misdirection from the staff.

A structured approach helps to avoid the most common errors.

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Medical Instrumentation in the Developing World
Robert Malkin, Editor

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Introduction: Troubleshooting

Before you start

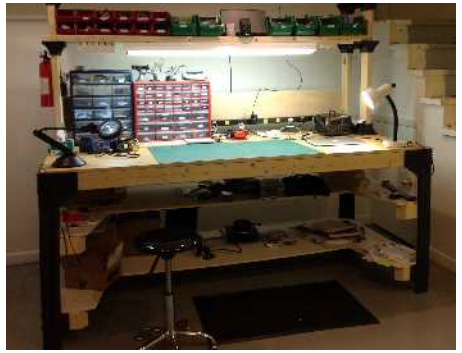
Consider safety first. Know the hazards that are associated with the device be it electrical, mechanical, chemical, gas or bacterial. If you are unsure about a hazard, consult someone else before beginning.

As a minimum, re-familiarize yourself with the equipment's principles of operation and clinical use. If you can find the manual, read it.

Most of the problems you will encounter are related to user error. Another quarter are related to power supply issues. You should always consider these two possibilities before all else.

Of the remaining problems, the most likely to be solved are those related to the presence or absence of the proper inputs and outputs. In other words, the problem is related to some other piece of equipment, which itself has either a user error or power supply problem.

Inspection



If at all possible, remove the equipment from the patient floor to a quiet, clean bench where you can work without interruption. Look at the device and all the information that may be around it.

Are there any notes from the users? Is there a description of the problem or is it just labelled “broken”? Is there a name of the person who found the problem? Is there an error log on the device? Is there evidence of a drop, spill, smoke, heat or other damage?

If there is evidence of a **(fluid) spill** it must be considered hazardous and cleaned by someone trained to handle hazardous spills. Spills, even non-hazardous ones are usually conductive and can cause shorts in the device circuitry. Some solutions are very thick and can act as glue that will overload motors on a pump. Always follow the Universal Precaution Procedures against infectious agents.

Inspection

Next look at any connectors, power cords, input or output cables to be sure that they are in the correct positions and secure. Check the positions of all switches and controls to be sure that they are correctly positioned and working.

Before moving any switch or cable, take a digital photo of the control panel. That way you will be able to go back to the device's original settings.

Assuming that there are no signs of mechanical damage to the device, do a "self-test" or "calibration" on the device. This may also give you the "error log" on the device, which must be reviewed and problems noted.

Look at the device history (if it exists), and the service manual (if you can find it) to be sure that you have covered what needs to be done to operate the device properly and to determine if the problem has occurred in the past. If it is a repeat problem, try to determine how it was repaired before.

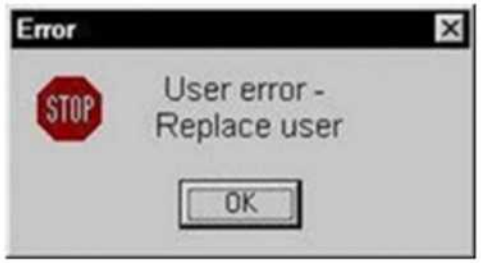
Listen to the User

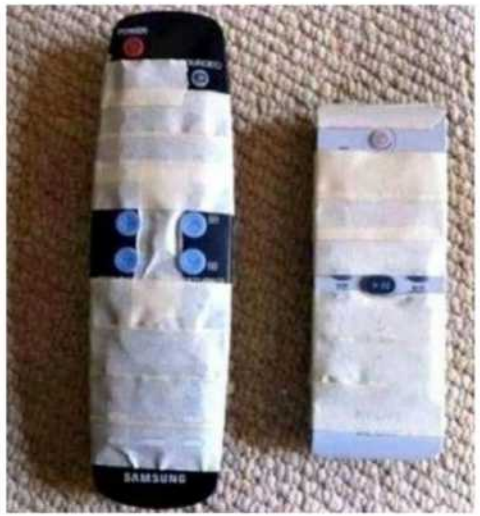
Interview the user. In most cases, the user is not the person who gave you the equipment. So, ask questions until you find the user of the device. You want to talk directly to the user of the device. Many problems arise from misunderstanding between the user and the person who gave you the equipment.

Carefully listen to the user's complaint about device. Find out what they see as the problem. What has changed with the outputs or process? Is it still within normal ranges or not? Has the speed of the process changed? Has the use of consumables increased?

It is common for a user or an operator to not know all the functions of a device. To avoid looking foolish they will give bad answers to questions outside of their knowledge. Also, it is common for a user to not tell you a piece of information which is critical to diagnosing the problem. The opposite is also true. Sometimes the user says they know exactly what the problem is, when in fact they are merely guessing. You must act as a detective, listening to everything, but rejecting and accepting facts as you piece together a hypothesis concerning the problem with the equipment

Suspect user error



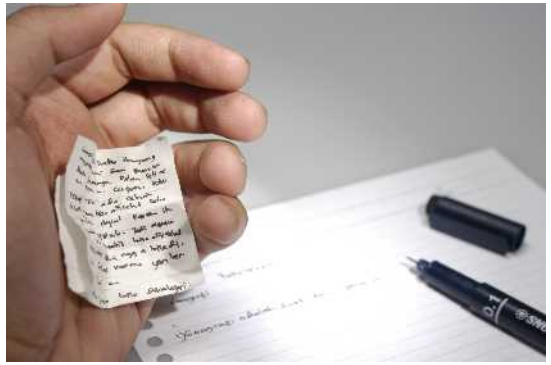


Always suspect user error. If you have followed the first steps, then you have not, as yet, opened the device. Verify again that the device is, in fact, malfunctioning. Nearly half of the time, the device is operating correctly; the person is simply using it incorrectly. Follow the recommended testing described here.

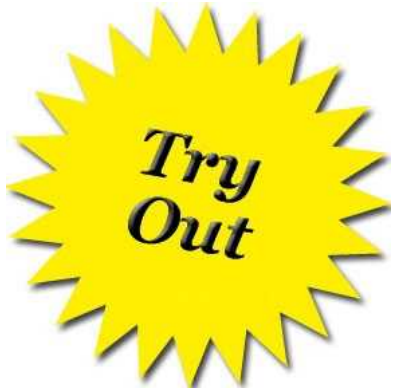
If the device is operating as you expect, then the problem is user error. But what type? Attempt to determine if the problem is language, incorrect settings or a misunderstanding of what the equipment is capable of doing.

- If the problem is a misunderstanding of the equipment's abilities, perhaps you can suggest an alternative.
- If the problem is programming, or settings, see if you can permanently program or fix the devices function. Consider taping over switches or labelling the correct setting.
- If the problem requires a sequence of steps to resolve; or it is a language problem. Consider creating a "cheat sheet" that can be attached to the machine (next slide).

Suspect user error: make a cheat sheet

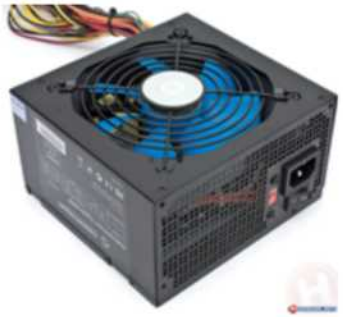


A cheat sheet is a simple explanation of the device's operation (or the specific operation that is causing the problem). Write short, direct sentences that describe how to accomplish the task. These should be accompanied by drawings wherever possible. A digital camera and the internet café can be used to create a sequence of "how-to" photos. Often the photos tell the story better than the words.

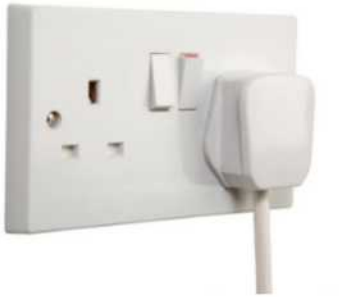


Be sure to try out the sheet with the nurse or doctor before attaching it to the device. Have them attempt the operation using the sheet – and without your intervention. If you have to say anything while they attempt the operation, then the cheat sheet needs revision.

Suspect the power supply



There is one more area to test, before opening the device: the power supply. Does the device power up at all? The signs that a device is powered up include indicator lamps, the screen is lit, hearing a fan or motor running, pressure/flow indicators not on zero, a warming of the device. On pneumatic, hydraulic or vacuum powered units do you hear or see leaks?



First, check for the obvious. Is it plugged in, (both ends of the power cord)? Is the outlet "live"? Is the power cord good (try another one)? Is there a second power switch on the unit? Is the fuse good (less than one ohm)? Is the breaker open (push the reset). Are the batteries of the proper type, installed correctly and charged?

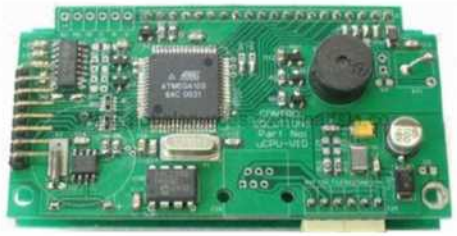
After checking the obvious, recheck the device. If it still won't power up, or it powers up, but won't operate correctly, you will need to **remove the covers.**

Suspect the power supply

Now that the cover is off, be very careful. In most modern equipment there is more than one power supply in an instrument. There are often ±5, ±12 or 15 volt power supplies for the logic circuits, 60 to 120 volts for motors and certain displays, plus high voltage power supplies, up to 150,000 V. You will need to check each of them to see if they are producing the expected voltages.

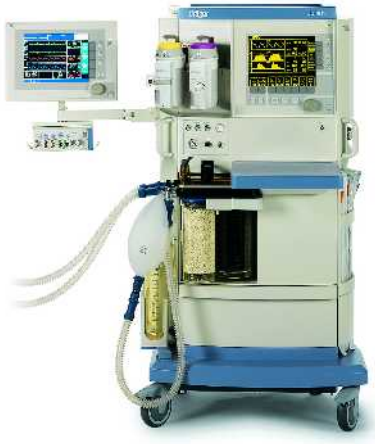
Never work alone on a device with the cover off and the power on. Double check that you are wearing no jewellery. Latex or rubber gloves offer some protection from high voltages. Place your probe leads with care to avoid shorting out two lines. Proceed slowly.

Look for dust build-up over fans or vent holes, fluid spills, loose hardware, etc. Make sure all the chassis components are secure. Look for signs of heat, smoke or burned components. Look at any fluids carefully.



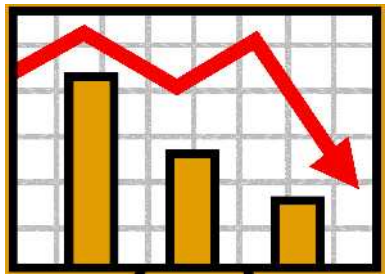
Next, move on to the circuit boards. Are they properly seated? Is there dust or spills on them? Are there signs of heat build-up? Are the components secure on the boards? Correct problems as you find them. You might look over the solder connections on the boards to be sure that there are no “cold” joints from previous repairs. You might also want to clean the connectors with a pencil eraser. Take note of any prior repairs: They are clues to current problems.

Power Supply or User Error Somewhere Else



If you have ruled out user error and power supply, and the problem is not one of the common errors listed in this manual, then there are only two other categories of error that are worth your time investigating: **input and output errors.**

Input errors can cause an otherwise operating device to appear to have failed. Find out where the input comes from? Is it a cable, electrode, probe, tissue sample, liquid sample? What, if anything, has changed on the input? If the device tests blood or tissue samples are they properly prepared? Are the samples being presented correctly?



If the device works on your bench, but not on the patient, there still may be a device problem, but more likely it is an input problem. As dumb as it may seem, is the patient alive? Has the patient's condition changed? Is there more movement, (shaking, shivering, thrashing around in the bed)? Did an electrode or other sensor fall off? Are the lead wires and cable good?

Problem with output device

The output of a device is its final product. In many cases it is a delivered energy, a graph or a display. If the device appears to be working, but the display is faulty, try to devise an alternative display. Working equipment is too precious to abandon due to display errors.

In older equipment, you can sometimes find a voltage which is proportional to the desired output. If this is the case, consider displaying this voltage on a multimeter and giving the user a table to convert from volts to the desired units. Perhaps a display from another device can be used. Be as creative as possible before abandoning the device due to display errors.

END

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see https://www.thet.org/