

Comparison of three handheld 1-lead ECG / EKG recorders

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(Note: Last revised: 14 September 2008. Technological and software changes occur rapidly. Some of the information, features of units, and software described in this article may have changed since this date and/or might change without notice.)

Introduction

Electrocardiograph (ECG or EKG) machines/recorders are no longer just the large, bulky equipment that they once all were. Even some of the full 12-lead recorders today are small, portable, and operate through desktop and laptop computers.

Now there are even smaller, self-contained, simple, one lead recorders that are handheld, pocket-sized, battery operated, and have their own built-in displays. These new, low-priced, 1-lead handheld ECG recorders have become available for personal, home, and sports use, much as with home blood-pressure/pulse recorders or glucose testers for diabetics. They also are suitable in some emergency situations but only when used by medical or emergency personnel or for obtaining useful information while waiting for emergency help to arrive. Otherwise, they can be used by the general public for non-emergency personal recording of information, such as for baseline information, routine monitoring, or during uncommon events, like with cardiac event recorders. The recordings can then be shown to the person's cardiologist or electrophysiologist or, for non-emergency or simple monitoring purposes, used by the person himself or herself if he or she is able to interpret them. (ECGs and their different "leads" are complex and have a fairly steep learning curve. For a basic introduction, [click here](#).)

In this review I compare three of the (several) single-lead, handheld ECG recorders currently available. They work surprisingly well and include impressive, accompanying computer software for onscreen analyses and printouts. The three models reviewed here are ReadMyHeart, InstantCheck, and PC-80. I have further compared these recorders in the context of using them to achieve sequential 12-lead and exercise-related ("stress") recordings; for that web site, [click here](#).

Important disclaimer: This information is provided for educational, sports-associated (by healthy persons), research, and non-emergency monitoring use only, not diagnostic or emergency uses by untrained persons. In the event of an emergency or suspected-emergency situation, appropriate medical help and facilities should be sought as quickly as possible. The only time that personal ECG recorders should be even considered in urgent, emergency situations would be if problems were to occur in remote locations to obtain useful information and/or while waiting for transportation and help, that is, when the use of the recorders would not delay possible help and might permit the collection of useful information for later use.

Source of 1-lead ECG recorders: The descriptions and information in this web page are based on handheld recorders from Favoriteplus.com, a medical equipment division of Favorite Imports LLC and a worldwide distributor of pulse oximeters, handheld ECG-EKG, & fetal dopplers. They are "an international distributor and global provider of medical devices for the hospital, emergency, home and specialist environments. Established in 1998, ... grown to be one of the most reliable worldwide distributors of new and innovative health products, medical devices and accessories." They have three models of handheld ECG recorders currently available, the FP-RMH, FP-ICH, and FP-180 (PC-80). For further company information about the units and ordering, [click here](#). For information about how to use these three units in 12-lead and exercise contexts, [click here](#). I thank Favoriteplus for providing two of these recorders to me for purposes of this review.

Part of this review includes comparisons with two different standard, clinical 12-lead recorders: the [Nasiff](#) 12-lead PC-based system and the CardioPerfect system, the current version of which is currently available from [Welch Allyn](#). (If you are not already familiar with resting 12-lead ECG recording and would like a basic introduction, [click here](#).)

Views of the three units being compared. Left to right: **ReadMyHeart** (FP-RMH, hereafter referred to as RMH), **InstantCheck** (FP-ICH, referred as IC in the remainder of the article) and **PC-80** (FP180). Top row closed, bottom row open for use.



All three of these recorders will operate with dry-contact skin contacts, for example, with the subject's thumbs placed on the metal contacts. They also have the option of using cables and adhesive skin contact electrodes, as with typical ECG recorders. RMH and IC use two-wire (+ and -) electrodes whereas PC-80

uses the more traditional three wires (+, -, and ground). They are shown below with their wire connections and a sample of adhesive electrodes. Not shown, but also important parts of the systems, are cables for each that connect to the computer for uploading ECG records for analyses and printing. All three recorders also come with good manuals and convenient, protective cases.



Recordings in general are much cleaner, consistent, and more accurate if adhesive electrodes are used rather than the dry skin contacts that are built into the machines. The thumb/skin contacts are definitely more convenient, quicker, and produce good results with practice. But they also usually produce more variability and artifacts than one wants. Here are examples of comparable records with the thumb contacts held in a typical fashion; thumb contacts held with deliberate care in a gentle, steady, careful, and practiced manner; and with adhesive electrodes. There is much more artifact noise in the typical thumb contact example. (Figure from excerpts of RMH results.)

typical thumb contact results, with variability and artifacts



output from careful, gentle thumb contact with practice



typical results using adhesive electrodes



The following sections first describe each unit separately, then show comparisons of their recorder displays, uploaded computer screen displays, printouts, and miscellaneous considerations.

ReadMyHeart



ReadMyHeart is a low cost, lightweight recorder designed to be convenient and for use by an average person with minimal knowledge of reading ECGs, that is, for someone who doesn't need to read or monitor the tracings as they are being recorded. The display (see actual display output in the section

comparing displays below) shows blinking ECG traces during recording, but they are just icons, **not the actual tracings being recorded**. The software and uploaded ECG recordings are remarkably good, actually excellent, and very useful for reading by a cardiologist or anyone who is familiar with reading ECGs.

Features

- Weight with batteries approx. 5 oz. (~130 gm)
- Dimensions: 5 in. x 3 1/4 in. x 3/4 in. (12.5 cm x 8.5 cm x 2.2 cm)
- Batteries: 2 standard 1.5 v size AAA
- Display: record number, date and time, HR, ST, QRS, and noise indicator for records that need to be remeasured
- Instructions for operation and normal range of values included on inside of lid
- Recordings 15 seconds long following a 10 sec initializing
- Starts recording when turned on
- Stores 30 records
- Records are automatically deleted after upload/transfer to computer
- Auto shutoff after 2 minutes from last time one of the buttons is pressed (about a minute and a half after a recording is started, if no further action taken)
- Allows scrolling down through the records
- Manual: clearly written, concise, thorough
- Excellent software, including printout of 3 records per page, with standard grid and measurements

Strengths and Weaknesses

Pros

- Low cost
- Quick start and convenient
- Easy transfer of data to computer with excellent analysis and printout
- Very user friendly computer program

Cons

- Does not display actual ECG trace during recording, only a blinking ECG icon
 - Display not lighted and, thus, requires a room light for operation at night, to know when a recording is finished and to see results
 - Current version of software has a glitch in which notes that are entered into the record (and display on the computer screen) do not printout on the hard copy
-

InstantCheck



InstantCheck is a more complete and more expensive, slightly smaller but slightly heavier cousin of RMH, manufactured by the same company (DailyCare Biomedical Inc.) The recorder has several more options than RMH, a complete menu, and displays the actual ECG tracings during recording and review of records. It also has computer software that is further developed and refined (while still being very user friendly) compared to either RMH or PC-80.

IC's display of the actual ECG as a monitor during recording and subsequent review of records permits a reading of the ECG by a cardiologist or anyone who can read ECGs, as well as confirming that a good record is being obtained during the time of recording. Of the three recorders reviewed here, IC is by far the best one for anyone who is more serious about ECG recording and/or who wants the best possible

records. The main tradeoff is that it also costs more.

Features

- Weight with batteries approx. 5.5 oz. (~140 gm)
- Dimensions: 4 7/8 in. x 3 1/8 in. x 7/8 in. (12.3 cm x 7.8 cm x 2.3 cm)
- Batteries: 2 standard 1.5 v size AAA
- Display: record number, date and time, HR, ST, QRS, a simple interpretation of the recording after it's completed, and, during recording, active monitor of the ECG recording plus HR
- Recordings 30 seconds long following a brief initializing
- Starts up with message and ability to either go to the menus or start recording as desired
- Stores 100 records
- Records are retained in the recorder after upload/transfer to computer and may be deleted (all at a time) from or kept in the recorder as desired
- Auto shutoff after 1 minute from last time one of the buttons is pressed (and after a recording ends, if no further action taken)
- Audible beep at startup and shutoff
- Thorough menu, including scrolling down through the records and review of individual records -- with stopping and restarting as desired
- Manual: clearly written, concise, thorough
- Excellent software, including printout of one, full, 30 second record per page, with standard grid and measurements

Strengths and Weaknesses

Pros

- Quick start and convenient, with option to go either to the menus or start recording
- Display of actual ECG monitoring during recording (and subsequent review of records)
- Stores a large number of records internally
- Numerous options available through the user-friendly menus
- Easy transfer of data to computer with excellent analysis and printout
- Display is not lighted but the recorder includes a red light that displays on the panel during recording, which makes it useful for knowing when a recording is finished at night in the dark without room lights
- Audible beeps lets you know when it goes on and off, without having to look at the screen

Cons

- Higher cost than RMH or PC-80 (but you get what you pay for, perhaps getting even more with all of the included features and options)
 - Relatively short auto turnoff time (1 minute) which can interrupt work, so that the recorder has to be restarted to continue
-

PC-80



PC-80 is not related to RMH or IC and is manufactured by a different company (Shenzhen Creative Industry Co, Ltd). PC-80 is the smallest, lightest, most robust, and handiest of the three recorders reviewed here. It is for someone on the go wanting a unit that takes up little space and for fast recordings. It would take up little room in a briefcase or luggage or even fit easily in a purse.

In its current version (including the software), it is most useful for determining basic arrhythmias rather than full ECG analysis. The software and printouts provide the least useful ECGs for resting ECGs but seems to allow arrhythmias to show through background noise slightly better, that is, it seems less vulnerable to ECG artifacts than RMH or IC. It accentuates or focuses on the R wave, with diminuation of the other waves, including T. It appears to be in an earlier stage of development than the software for RMH or IC. I suspect that later versions will have improved capabilities. Aside from the current software issues, it is a great stand-alone ECG recorder that records and stores ECGs for later review by oneself or a cardiologist (diagnostic interpretations should always be done by an experienced cardiologist). One can simply take the unit to a cardiologist to show the results on the recorder's display screen.

PC-80 starts fast, goes right into recording, and has a fast (30 second) auto shutoff if no further action is taken. It has menus with several options and a rocker panel to select among various choices. Because it starts recording at powerup, one has to either do a recording at the start or wait for it to go through the routine before accessing the menus. The advantage is that it gets right to recording for someone that wants to record as quickly as possible. The downside is that going into recording first can get in the way of going to the other functions.

Features

- Weight with batteries approx. 4 oz. (<100 gm)
- Dimensions: 4 3/8 in. x 2 1/8 in. x 5/8 in. (11.2 cm x 5.5 cm x 1.7 cm)
- Batteries: 2 standard 1.5 v size AAA
- Display: record number, date and time, HR, a smiley (or sad) face, and a simple interpretation of the recording after it's completed, and, during recording, time and active monitor of the ECG

recording

- Recordings 30 seconds long following a brief initializing
- Starts up with message and instructions then starts recording
- Stores 24 records, after which new ones replace the first ones
- Records are retained in the recorder after upload/transfer to computer and may be deleted (one at a time) from or kept in the recorder as desired
- Auto shutoff after 30 seconds from last time one of the buttons is pressed (or analyzing and storing a recording, if no further action taken)
- Option, at a press of button, for screen lighting, so the recorder can be used and viewed at night (when many arrhythmias commonly occur) without having to have room lights on
- Thorough menu, including scrolling down through the records and review of individual records -- with stopping and restarting as desired
- Manual: clearly written, concise, thorough
- Current version of software includes printout of one, full, 30 second record per page, as well as summary of all records; (note: the software uses it's own, basically nonstandard grid and does not provide measurements of ECG waves, just HR and a simple of interpretation of whether the ECG is "normal" or not)

Strengths and Weaknesses

Pros

- Low cost
- Small and takes up little space; extremely convenient
- Quick start and convenient; starts recording when turned on
- Display of actual ECG monitoring during recording (and subsequent review of records)
- Stores (up to 24) records internally and retains individual records as desired (unless they are bumped out by more recent recordings that exceed the 24 maximum)
- Numerous options available through the user-friendly menus
- Easy transfer of data to computer with minimal analysis and printout
- Display is lighted, if desired, which makes it VERY useful for using (in all aspects) at night in the dark without room lights on

Cons

- The current versions of recorder and software produce barely adequate ECG traces for analysis, with minimized (or sometimes even missing) waves except for the R wave (future versions of the recorder and software may correct these problems)
- The "ECG Knowledge" section of the current computer program contains several errors and misinterpretations. For examples, the figure for bigeminy does not contain any premature ventricular contractions (PVC's), whereas the "typically normal ECG" figure does. The figures do not come from PC-80 output but from some other source (with different grid format, etc.). There are several statements of questionable validity in the "ECG Knowledge" section. It is poorly written and in poor English, apparently written by someone for whom English was not their first language. The manual, on the other hand, is better and uses PC-80 output in the figures (and the bigeminy figure is correct). The manual is written in English that is better than the "ECG Knowledge" section of the software, but still appears to be written by someone who is not a native English

writer.

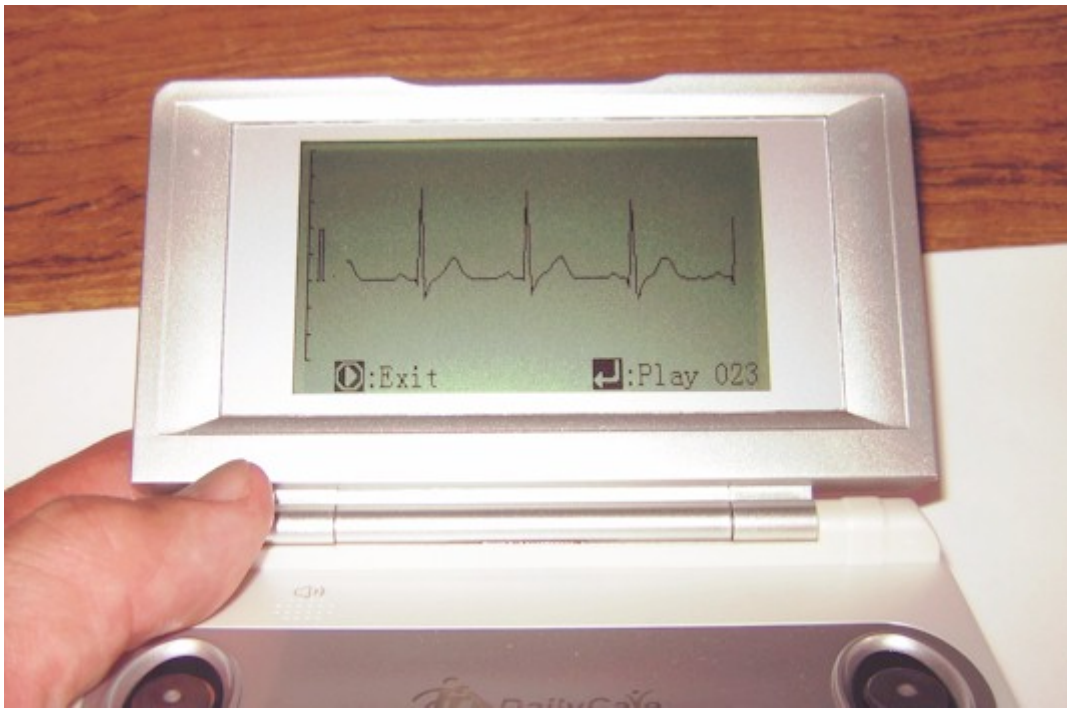
- Non-standard grid system is a distraction
- Current version of software lacks ability to add notes or comments to the record; such notes have to be kept externally and referred back to the record by date and time
- Very short auto turnoff time (30 seconds) might be useful for saving battery and adequate for anyone simply wanting to make recordings, but it routinely interrupts most attempts to work with the records, the recorder has to be restarted to continue, and it can be very annoying

Comparison of recorder displays

ReadMyHeart. Note: The ECG tracings that appear on the display are NOT the actual ECGs but only simple icons that blink on and off during recording. For a display of the actual ECGs during and after recording, see the InstantCheck and PC-80.



InstantCheck



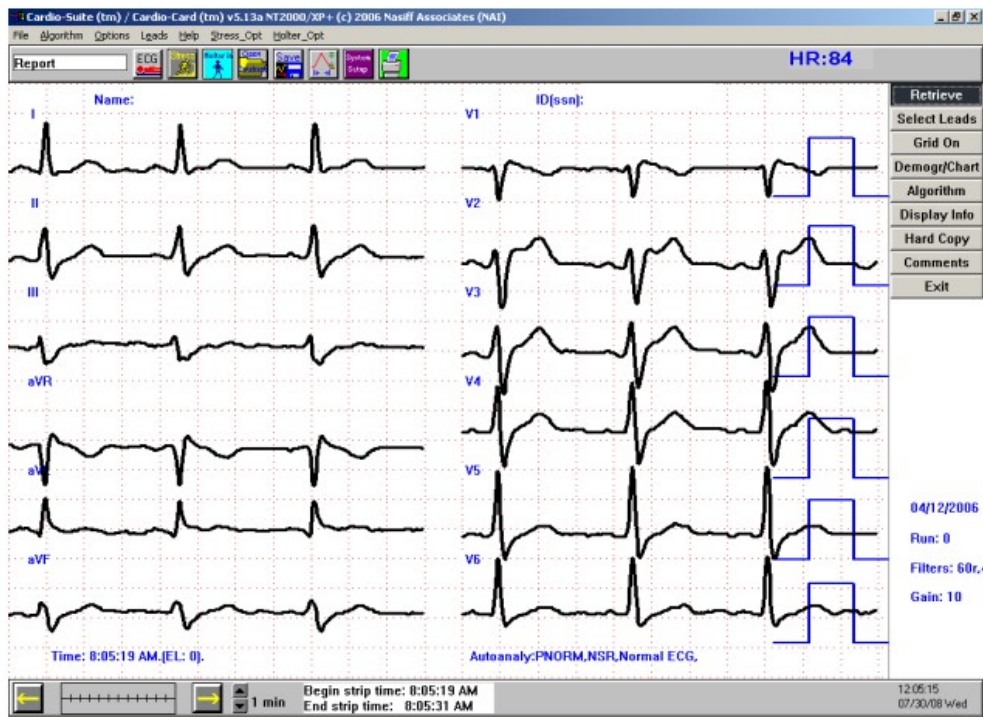
PC-80



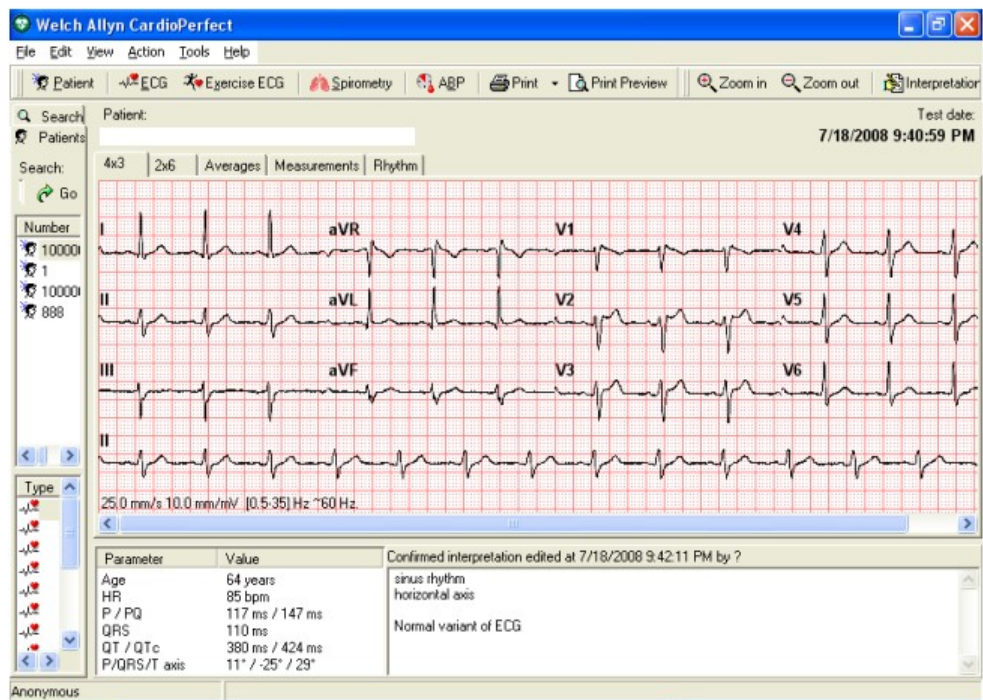
Comparison of computer software and screen displays

(including comparisons with two standard 12-lead systems)

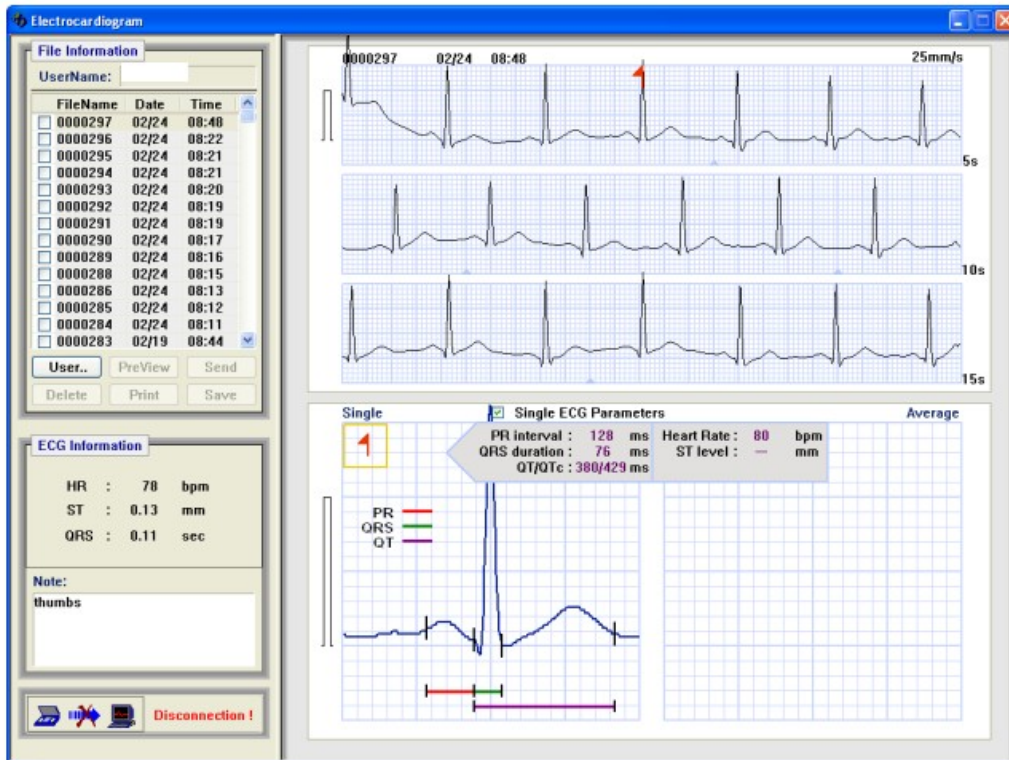
Nasiff Associates, CardioCard Suite, a full function standard 12-lead system. (Note: the menus and operation of this system are more complicated and a bit tedious compared to all of the remaining systems.)



Welch Allyn CardioPerfect Workstation (version 1.5), a full function standard 12-lead system with very easy and user friendly Leads menu system. (Probably one of the best ECG systems [and very expensive] available.)



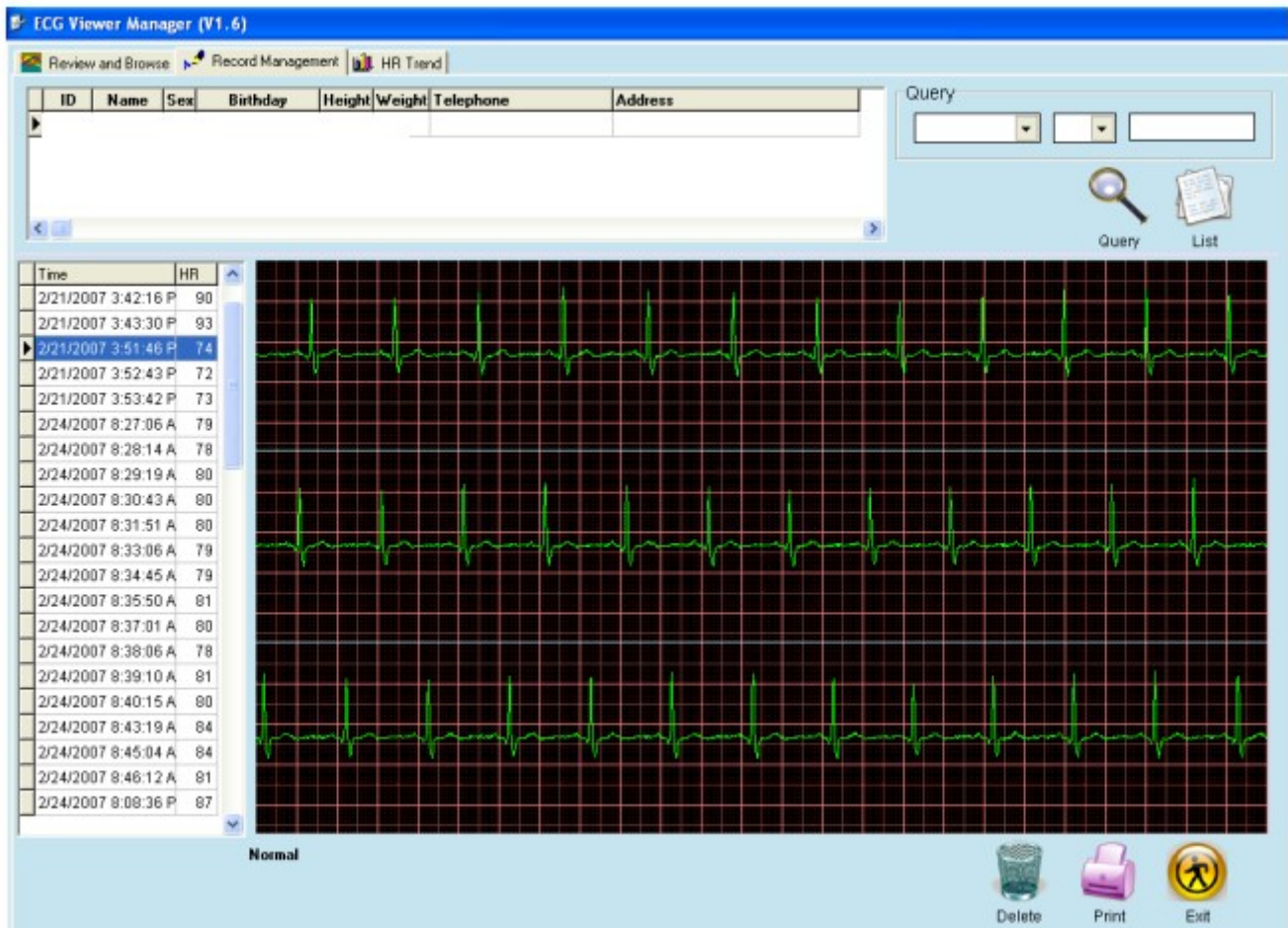
ReadMyHeart. Excellent ECG traces, very user friendly, and includes individual trace or average measurements.



InstantCheck. Excellent ECG traces, very user friendly, and automatically includes average measurements.



PC-80. The software has easy transfer/upload of data from the recorder and moderately user friendly menus, but at the same time is also somewhat awkward, does not use the standard grid pattern (although it is still 25mm/sec), and does not allow entering user notes and comments to supplement the records. Future versions of the software will hopefully improve and correct these problems. The software also seems to accentuate the R wave at the expense of other waves, such as the T wave, which makes standard reading of the output difficult (or impossible in some cases).

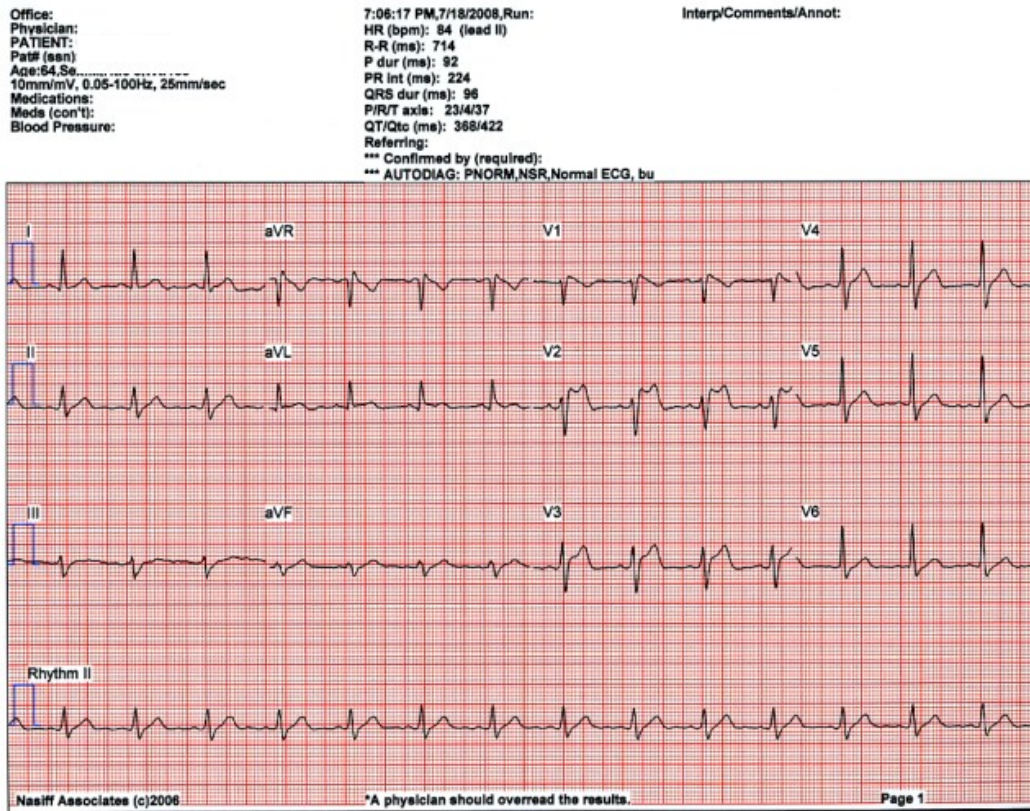


FOR A SIDE-BY-SIDE COMPARISON OF THESE OUTPUTS, in a context of using 1-lead recorders to obtain 12-lead recordings at different limb and chest locations, [click here](#).

Comparison of printouts

(including comparisons with two standard 12-lead systems)

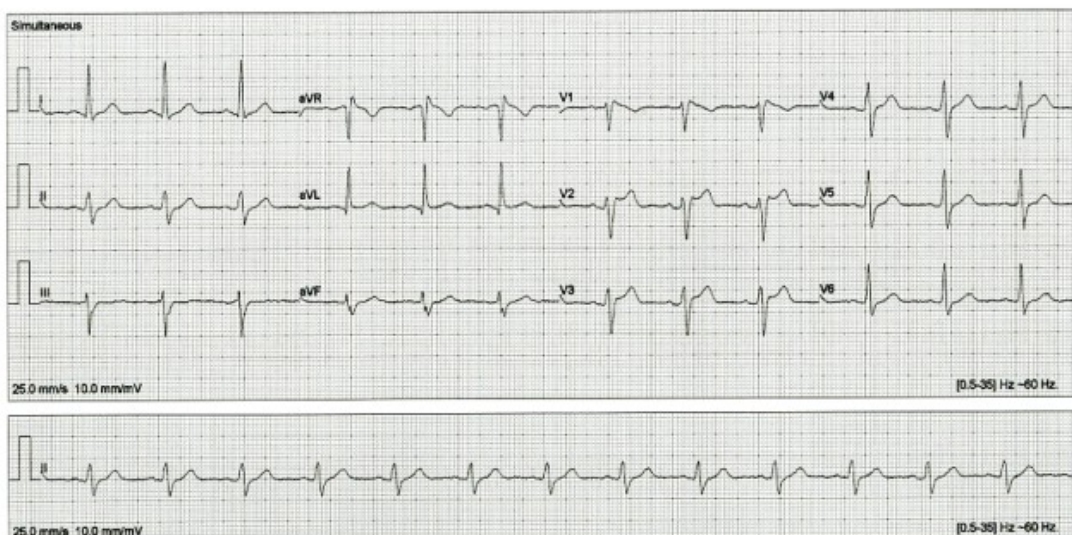
Nasiff Associates, CardioCard Suite, a full function standard 12-lead system.



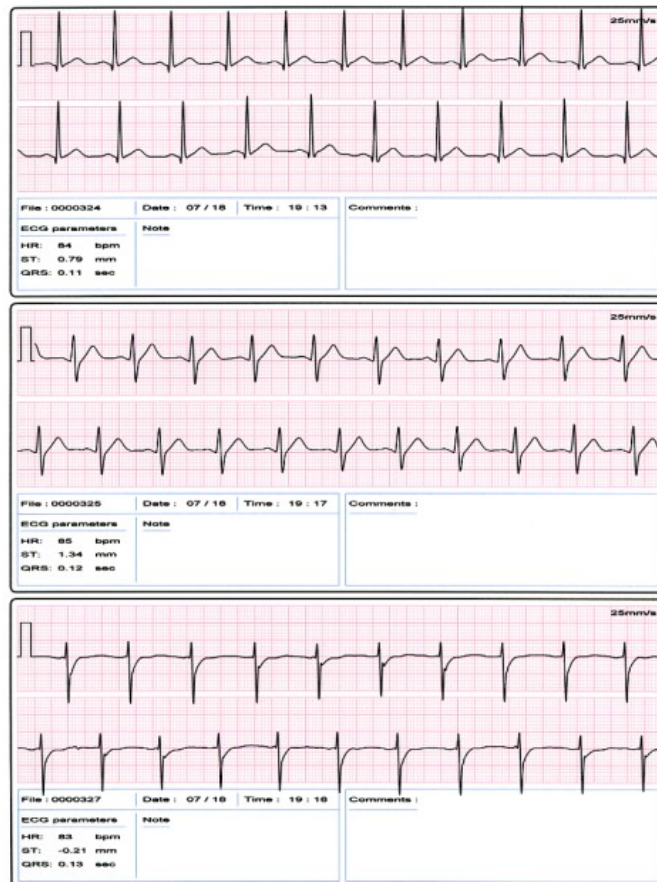
Welch Allyn CardioPerfect Workstation (version 1.5), a full function standard 12-lead system.

Welch Allyn CardioPerfect Workstation

Name: Recorded: 7/18/2008 9:40:59 PM Confirmed interpretation edited at 7/18/2008 9:42:11 PM by ?
Number: Recorded by: sinus rhythm
Gender: Referring physician: horizontal axis
Birthdate: Location: Normal variant of ECG
Comment:
P / PQ: 117 ms / 147 ms
QRS: 110 ms
QT / QTc / QTd: 380 ms / 424 ms / -
P/QRS/T axis: 11° / -25° / 29°
Heart rate: 85 bpm



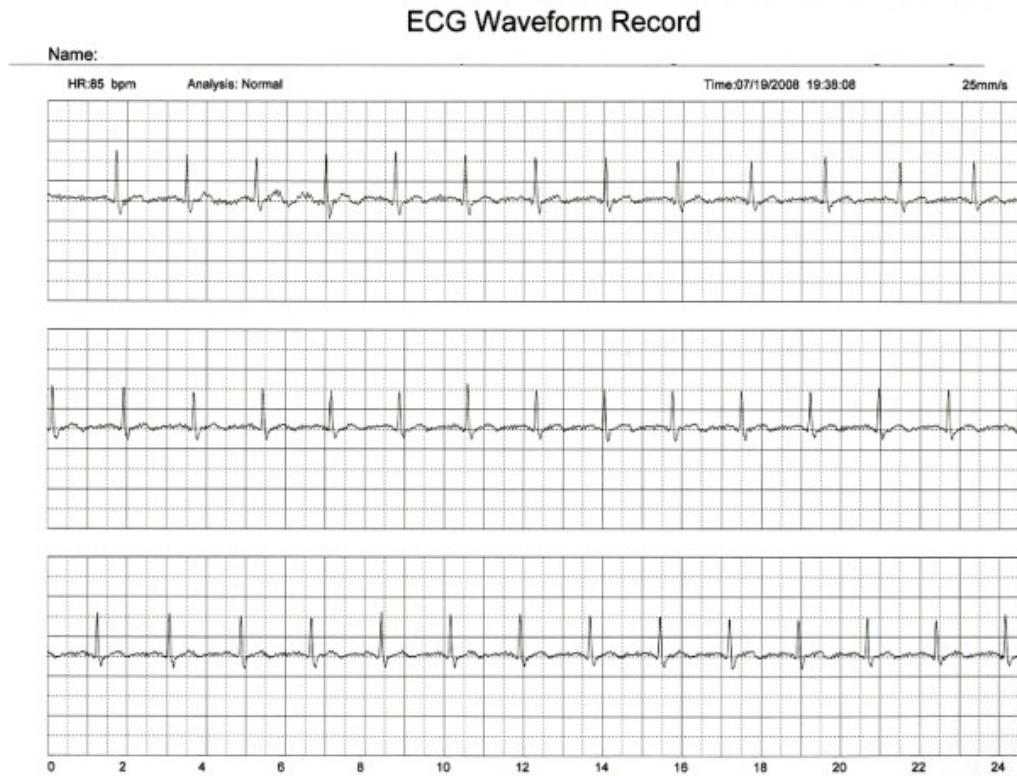
ReadMyHeart. Note that the printout includes 3 records at a time. (These particular examples represent leads I, II, and III respectively. That information was included in the records and displays on the computer screen but, because of the glitch in the system's software, mentioned above in the RMH description, the information does not print out on the hard copy such as shown in this figure.)



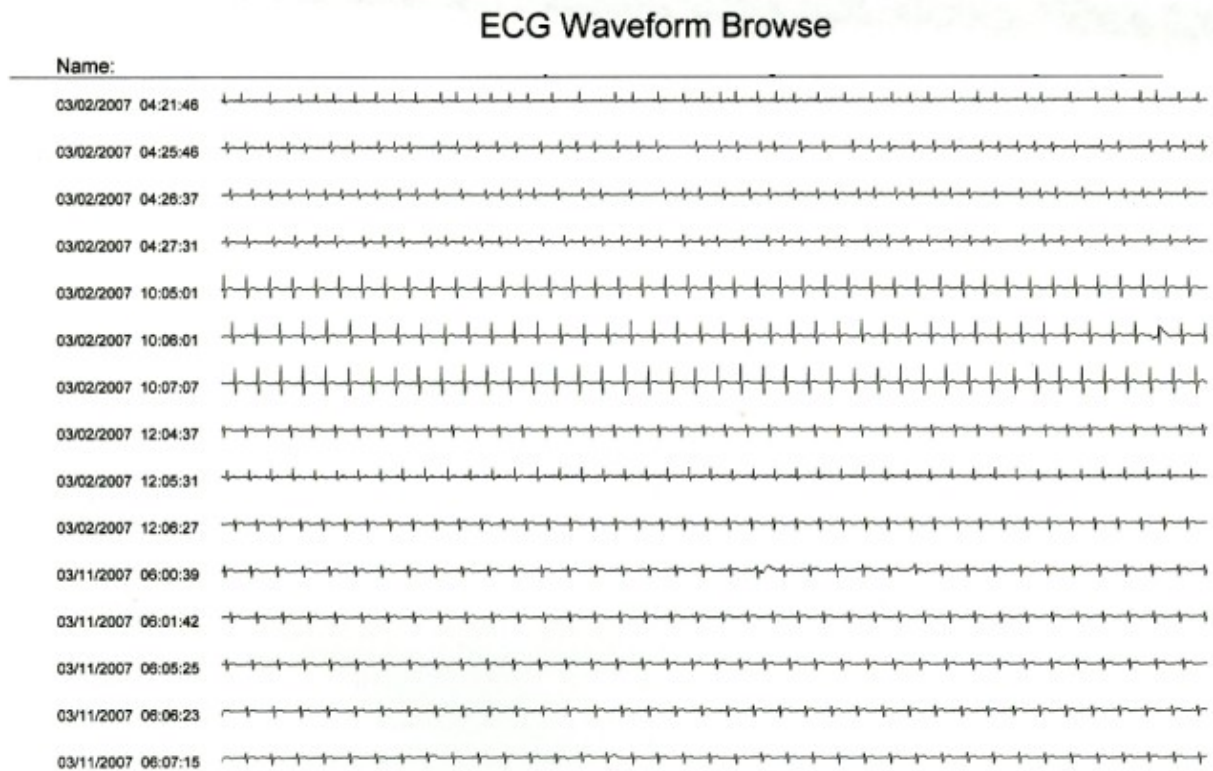
InstantCheck. A very accurate, thorough analysis and printout. The software permits (and prints) comments added by the user.



PC-80. Very basic, without measurements beyond HR and without the option of including user comments (also with its own, nonstandard grid, although still at the standard 25mm/sec speed).



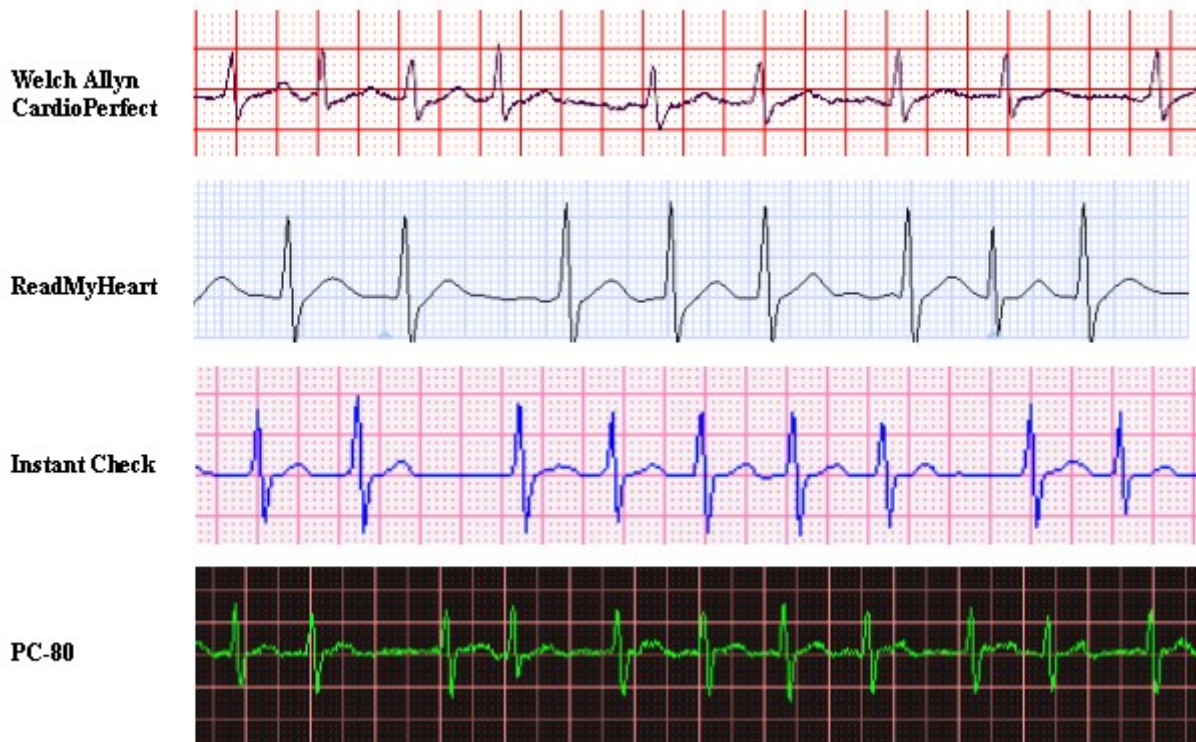
But PC-80 does have a summary feature for printing out summary ECGs for all records:



Examples of ECG records from abnormal heart rhythms

During an atrial fibrillation event, I took the opportunity to make recordings with one of the standard 12-lead units (Welch Allyn Cardio Perfect) and the three 1-lead recorders (using electrodes and lead II for all, including the WA CP). Here are the results:

Atrial fibrillation



Some ECG machines/software provide diagnostic interpretation. I personally prefer not to use machine/computer interpretation for a number of reasons ([click here](#)). But, for what it's worth, some of these 1-lead handheld systems provide limited interpretation. In the case of the above atrial fibrillation, here is what each of the systems provided:

WA CP: "atrial fibrillation with rapid mean ventricular response; moderate intraventricular conduction delay; abnormal ECG"

RMY: (no interpretation)

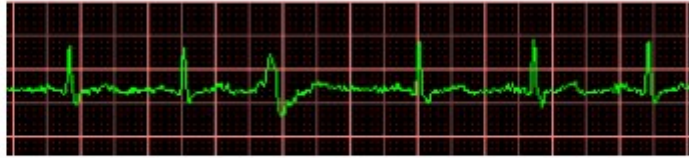
IC: "Irregular Heart Rate"

PC-80: "Suspected fast beat" (and a sad face)

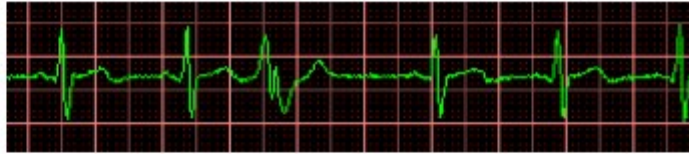
At another time, involving a series of premature ventricular contractions (PVCs), I made recordings with the Welch Allyn Cardio Perfect and the three 1-lead recorders. The RMH and IC were virtually identical to the CardioPerfect results, as in the atrial fibrillation example above, with the PC-80 being the least similar. The PC-80 results are shown below, for two locations (leads I and II), as compared with the WA CP for lead II.

Premature Ventricular Complexes/Contractions (PVCs)

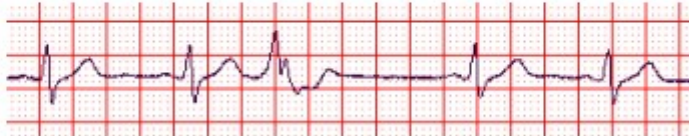
PC-80
hand/skin
contact (85 bpm)



PC-80
with electrodes
lead II (82 bpm)



Welch Allyn
CardioPerfect
lead II (76 bpm)



Comments and Conclusions

The three 1-lead recorders compared here are different from each other and each has its advantages and disadvantages. All work great in their own ways. It would be nice if one could somehow combine the best of all three into a single unit, for example, something like a PC-80 with its size, lighted display, and rocker panel for selecting among menus, but with longer time before auto-shutoff and all of the better features and superior software of the IC.

Since there are tradeoffs among features and one cannot (at present) have the best of all worlds, here are my recommendations:

- For someone wanting a low-cost unit that produces good printouts for reading by someone else (e.g., a cardiologist) or if you don't particularly need to see the actual traces during recording, get the **RMH**.
- If you want a low-cost, small, handy, and fast unit, with easy night use (lighted display) and display of actual ECG traces, but to be used primarily for basic arrhythmia and event recording, the **PC-80** will work good. It is particularly good as a stand-alone unit for one's own review without uploading to a computer, or to take and show to a cardiologist.
- If you have more serious interests in ECG and prefer a more complete, flexible, and multi-option unit, with active monitor of actual traces during recording, and if willing to pay for the added features, get the **IC**.

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