

A MobilDrTech White Paper

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## **TELEMEDICINE STETHOSCOPES**

# TELEMEDICINE STETHOSCOPES

## INTRODUCTION

Electronic stethoscopes evolved from traditional acoustic stethoscopes because low sound volume was frequently an issue and it could be difficult for some clinicians to correctly identify subtle clues in an auscultation. Electronic stethoscopes convert acoustic sound waves from the chestpiece into electronic signals that can then be processed for enhanced listening.

For telemedicine use, stethoscope audio signals are digitized with analog to digital conversion (ADC) and can be amplified to increase volume. In addition, ambient noise reduction and dynamic frequency filtering can be applied to clarify the sound and better isolate the different audio frequencies at various body sites, i.e. heart, lungs, carotids, bowel, etc.

Digital audio streams can then be encoded, transmitted over the Internet and decoded at the far end. This can be done in live examinations (real time telemedicine) or by recording auscultations and forwarding the files for evaluations by remote clinicians at a future point in time (store and forward telemedicine).

The purpose of this white paper is to provide a current overview of the most commonly used stethoscopes in real time telemedicine programs in the United States.

It is our hope that our customers and potential customers will find it a useful tool and that it will save them valuable time and effort when researching and selecting stethoscopes in order to add remote auscultation into their telemedicine programs or platforms.

## ABOUT MOBILDRTECH

Engineers at MobilDrTech, Inc. have designed, built and deployed telemedicine systems for 17 years in numerous medical markets. In the process, they have dealt with many device vendors and evaluated dozens of diagnostic devices used in telemedicine encounters. MobilDrTech is currently an authorized reseller for many telemedicine industry device manufacturers. Devices sold include stethoscopes, otoscopes, dermatoscopes, general examination cameras, mobile carts and a variety of other telemedicine components and devices. To provide full disclosure, MobilDrTech, Inc. is an authorized reseller of RNK Products' telemedicine stethoscopes. <http://www.usbsteth.com>

## METHODOLOGY

To be as thorough and accurate as possible, the authors reviewed FDA 510k approval documents, patent filings and awards, market reports, industry research and manufacturers' package inserts, websites and marketing material. We also drew heavily on our own knowledge base and product testing experience. Information in this white paper is based on facts and data available to the authors at the time of writing and may be subject to change. Any mistakes or inaccuracies are purely unintentional and, if we have inadvertently misrepresented any products, we apologize and would appreciate receiving the correct information from the manufacturer. [support@mobildrtech.com](mailto:support@mobildrtech.com)

## HISTORY OF TELEMEDICINE STETHOSCOPES

The evolution of the modern telemedicine stethoscope has occurred in a series of steps over the last sixty to seventy years. Beginning in the 1950's, multiple companies attempted to connect electronic amplifiers and microphones to analog stethoscopes to address low volume issues but none of these early pioneers were commercially successful. Later, electronic stethoscopes were developed and successfully marketed that included amplification and ambient noise reduction. For an in-depth look at the evolution of stethoscope from analog to digital devices, see <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5757962/>. This paper highlights the advancement made by the modern digital stethoscope including the clinical application of this tool in advancing care for patients suffering from cardiovascular disease.

The history of stethoscopes used specifically for telemedicine can be traced back almost 25 years to 1994 when American Telecare, Inc. (ATI) of Eden Prairie, Minnesota launched a stethoscope with an analog output that worked directly with normal telephone lines. In August 1996, a patent was awarded to ATI and the inventor, C. Richard Abbruscato, an engineer and CTO at the company. The patent, #5,550,902, was for "Remote Stethoscope Signal Processing System", which would make it the first U.S. telemedicine stethoscope patent.

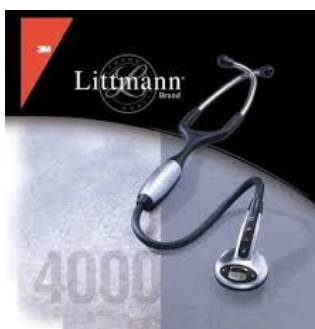
In 1996, ATI launched a digital telemedicine stethoscope that produced a digital signal on an RS232 interface that fed into a modem which could be sent over a normal (POTS) telephone line. Another patent, #5,841,846, was awarded to Abbruscato in November 1998 for "Digital Telephonic System for Stethoscope Signal Processing". This was the second telemedicine stethoscope patent.

With the advent of analog to digital conversion (ADC), various methods of connecting to computers and other devices were developed. A key element, audio signal transmission over the Internet was developed and now allows for live, real time remote diagnostic auscultations.

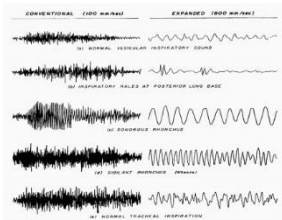
ATI continued developmental efforts and introduced the CareTone line of stethoscopes in the late 1990's that was designed for high quality heart and lung sounds to pass over either analog or digital connections. The ATI CareTone was used in many early telemedicine programs and even on NASA Space Shuttle missions to monitor astronauts' medical signals.



In 1995, 3M™ Corporation, after purchasing a stethoscope company from David Littmann, began development of the 3M™ Littmann® Electronic Stethoscope Model 2000, which was introduced in the late 1990's after several years of development and clinical trials. This was still an analog device, however, that simply amplified the stethoscope sounds.



3M™ then launched the Model 4000 in September of 2000. The Model 4000 provided infrared data transmission of recorded sounds to either another Model 4000 or an IBM compatible PC, giving users the option of sharing or storing the sounds. The FDA 510k approval sent to Jizhong Jin was classified as a "Radiofrequency Transmitter and Receiver". The approval was for "Substantial Equivalency" to a predicate system, the ATI CareTone Telephonic Stethoscope. The Model 4000 was the first stethoscope that could transmit sounds to a computer via infrared technology without needing connecting wires or cables.



Around 2001, Stethographics introduced PC-based software which enabled a phonocardiograph. This was a graphic representation of cardiologic and pulmonologic sounds which could be interpreted according to related algorithms. This feature is included on several telemedicine stethoscopes and in a number of audio handling software products today.

An early pioneer in telemedicine stethoscopes was Clive Smith, founder of Thinklabs® in 1991. In December 2002, he was awarded patent #6498854 for a “Transducer for Sensing Body Sounds”. Subsequently, Thinklabs® introduced the ds32, ds32a and ds32a+ model stethoscopes which were sold for ten years from 2003 – 2013. The ds32 was the first stethoscope to use EmD (Electromagnetic Diaphragm) technology to provide clearer electronic amplification. These were replaced by Thinklabs® current offering, the Digital One, also designed by Smith.



The 3M™ Littmann® Model 3000 incorporated ambient noise reduction capability as a result of 3M™’s developmental partnership with Bang & Olufsen and was introduced in September 2005. This model, which did not have recording features like the Model 2000 quickly became the most widely sold electronic stethoscope in the world.

Around the time the Model 3000 was being developed, a short range wireless technology called Bluetooth was becoming popular because it did not require line-of-sight like infrared to connect devices wirelessly. Then, in 2009, the Bluetooth equipped 3M™ Littmann® Model 3200 was introduced.

In November 2010, 3M™ introduced the Scope-to-Scope Teleauscultation System. When coupled with the 3M™ Littmann® Model 3200, it significantly enhanced physicians’ ability to conduct remote stethoscope diagnostics while in live two-way interactive video conferences. This system was used on the International Space Station and is still marketed for telemedicine auscultations today.



Another early pioneer was RNK Products. Founded by C. Richard Abbruscato after his departure from American Telecare Inc. (ATI), RNK continued to develop and improve telemedicine stethoscope technology. With Abbruscato as the inventor, RNK has been awarded four patents for telemedicine stethoscopes covering the TR stethoscope line, PCP-1 and PCP-USB model stethoscopes and related software. In the early 2000’s, RNK introduced the TR1, TR1-EF and TR-USB stethoscopes which all required transmitter/receiver boxes to encode and decode the audio signals. These are still sold by the manufacturer and by Value Added Resellers (VARs).

### 3.5 mm Mic Port Stethoscopes



AMD-3725

GlobalMed StethOne

Although newer options are available, this out-of-band solution is still supported by the manufacturer and packaged with several proprietary telemedicine software systems.

These models have been mostly supplanted, however, by newer standalone stethoscopes with either mic port, USB port or Bluetooth connectors, but they still have some utility, particularly with legacy telemedicine programs using Polycom and Tandberg (now Cisco) video conference hardware systems.



In 2011, RNK introduced the PCP-1, which had a unique design with a single head, but one that did not incorporate the traditional tubes and binaurals form factor. Imbedded in the chestpiece is an amplifier and microphone. Signal processing is accomplished through the audio circuitry of the connected PC. Connection to the PC is via standard 3.5 mm microphone jack.

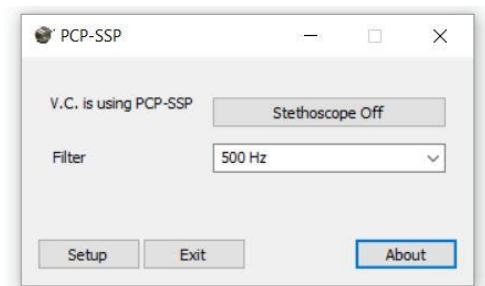
Introduced in 2014, The Thinklabs® Digital One also used a single head design without tubes and binaurals and promoted the capability of amplifying internal sounds by over 100 times vs acoustic stethoscopes. It was designed to provide users with extreme audio performance, enabling any problems to be clearly heard. It is the currently marketed product from Thinklabs® and is reviewed below.



In 2015, RNK received patent # 9185496 for a “Piezo Element Stethoscope” and FDA approval for the PCP-USB telemedicine stethoscope which, like the PCP-1, had amplification and Piezo sensing microphone imbedded in the chestpiece. Also imbedded on this chestpiece were analog to digital converter (ADC), encoder, formatter and USB interface chip. Since the PCP-USB contains all the key audio processing elements built into the stethoscope, it provides consistent quality independent of the quality of the user’s PC audio circuitry. This was the first and, to date,

only USB connected stethoscope to be FDA approved for the U.S. market.

In July 2016, RNK received FDA approval for a new version of its’ Auscultation Anywhere software named PCP-SSP. This in-band product could be used with almost all desktop video conference platforms and works by integrating a driver accessible by the VC platform which allows it to send the stethoscope sounds over the audio channel of the video conference software. It does not require a separate channel to operate. When used with the PCP-USB stethoscope, PCP-SSP adds frequency filtering, ability to mute room mic when conducting an auscultation and the ability to listen locally at the patient site.



In 2018, RNK also developed an API/SDK which can be used to integrate PCP-SSP features into webRTC based proprietary telemedicine platforms. Other stethoscope manufacturers have SDKs as well for their proprietary software systems and it is recommended that users “try before you buy” to make sure the software package fits with the videoconference platform in use.

## CURRENT TELEMEDICINE STETHOSCOPES – CONSIDERATIONS

The clinical setting, telehealth platform and personal preferences of the providers should all be considered before selecting a stethoscope for integration into a telemedicine program.



A primary consideration when selecting a telemedicine stethoscope is how the stethoscope connects to the computer or device running the videoconference platform.

There are basically 3 ways to connect stethoscopes:

1. 3.5 mm microphone jack
2. USB connector
3. Bluetooth wireless

Wired connections are generally considered more reliable than Bluetooth and do not require batteries or an external power source since they draw power from the mic port or USB port. Nevertheless, some customers require a wireless solution and are usually satisfied with their choice of Bluetooth connected devices.

Selection criteria most frequently considered are:

- Wired or Wireless Connection
- Power Source – Batteries, External Power, Port Power
- Volume Adjustment
- Controls – External Buttons, Switches or Software Selections
- Frequency Filters
- Local Listening Ability
- Adaptable for Adult and Pediatric Use
- Regulatory Certifications
- Clinic vs Consumer Grade
- Software Availability
- API Adaptation to Proprietary Platforms
- Established vs Startup Manufacturers
- Recurring Fees
- Cost of Ownership

For convenience we have grouped the stethoscopes reviewed below by connection type.

## 3.5 MM MIC PORT STETHOSCOPES

### RNK PCP-1

The PCP-1 telemedicine stethoscope has a single head design with the analog to digital conversion (ADC) built into the chest piece and can be used without software as a standalone external microphone. It can be selected in video conference platforms as the primary microphone when conducting an auscultation. Any PC, MAC or video conference device with a microphone jack will recognize the stethoscope as an external microphone.

Sound quality is excellent but use without stethoscope software requires switching back and forth between the stethoscope and main video conference microphone. Additionally, frequency filtering and local monitoring features are not available without software. Also, the PCP-1 has an internal amplifier but relies on the audio circuitry of the PC for audio processing and handling so that, on some PCs with marginal audio circuitry, newer stethoscopes like the PCP-USB can sound better.



The PCP-1 is a good choice on platforms where there is an available mic port but no vacant USB ports.



### Cardionics E-Scope

Another early stethoscope with microphone port connection is the Cardionics E-Scope. Often marketed to physicians with hearing difficulties, this stethoscope has a traditional tube and binaurals form factor with a double sided chest piece (Bell and Diaphragm), a 1/8" microphone jack and a USB accessory connector for a headset. The E-Scope II has the lowest acquisition cost for stethoscopes without accompanying software.

### Thinklabs® Digital One

A more recent entry and one that, like the PCP-1 was designed with a single head and no traditional tubing and earpieces form factor is the Thinklabs® Digital One. The stethoscope produces high quality sound and the amplification is among the highest of any digital stethoscopes. Filtering is built into the stethoscope head and is adjustable with external setting controls. The Thinklabs® Digital One is an open stethoscope that allows for recording and sharing data with third party audio handling apps or devices. It is priced competitively among stethoscopes used without software. The more technical design with external controls and settings can, however, present ease-of-use challenges for non-technical end users.



## USB CONNECTED STETHOSCOPES

### RNK PCP-USB



In the last several years, many customers have migrated from mic port to USB stethoscopes. Of the stethoscopes reviewed, there is currently only one USB connected stethoscope, although it is marketed under several brand names.

The PCP-USB stethoscope has become the workhorse auscultation device of many telemedicine programs in the US and across the world. It carries both FDA 510k approval and the CE mark.

The PCP-USB has an imbedded amplifier plus analog-to-digital converter (ADC), encoder, formatter and USB interface chip. Since the PCP-USB contains all the key audio processing elements built into the stethoscope, it provides consistent quality independent of the quality of the user's PC audio circuitry. Sound quality is excellent and total cost of ownership is the lowest among any of the digital transmission stethoscopes reviewed when used with transmission software.

The PCP-USB stethoscope can be used with RNK's original sSOIP Auscultation Anywhere software (out-of-band) or with the newer PCP-SSP software (in-band). It can also be used standalone, without software, by switching the audio source manually in the videoconference software.

The PCP-USB is sold with various software packages by Value Added Resellers (VARs) including those shown below.



**AMD-3750**



**MobilDrTech PCP-USB**



**GlobalMed ClearSteth**

## BLUETOOTH CONNECTED STETHOSCOPES

### 3M™ LITTMANN®3200

The earliest and, perhaps, best known Bluetooth connected digital stethoscope is the 3M™ Littmann® 3200 which provides end to end connectivity when used with its TeleSteth™ System software. Although, an excellent stethoscope and perfectly acceptable for telemedicine, the need for a stethoscope at both the patient and physician site along with high recurring software license fees have caused many providers to move to other options over the last several years.



### Eko



The Eko Core is an analog to digital converter (ADC) hardware device that attaches to the tube of traditional form factor stethoscopes. It comes packaged with an analog stethoscope and the adapter has an on-off switch that allows it to be used in electronic or analogue mode, if the batteries run out. This white paper looks at the Eko Core used with Livestream software for real time telemedicine auscultations.

While the Eko Core can be used without the Livestream transmission software, that option is store and forward only using the provided app and has not been included in chart comparisons. For those interested only in store and forward auscultations and have their own favorite stethoscope they would like to adapt, the adapter can be purchased without a stethoscope for \$199.

### JedMed OMNISteth™

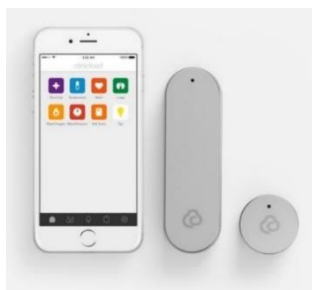
The most recent telemedicine stethoscope introduction is the JedMed OMNISteth™. This stethoscope appears to be an upgraded or rebranded version of the Cardiart DS101 Professional Electronic Stethoscope manufactured by IMEDIPLUS, a Taiwanese stethoscope company. Due to its' very recent introduction, there is little experience with it to date.





The stethoscope has the traditional tube and binaurals form factor and connects via both 3.5 mm mic port and Bluetooth 4.0. Filter settings are external on the stethoscope head with three settings, B/D/W. It has a 1.5" screen on the head. An interesting feature is a button for selecting organ templates. These are used to provide preset auscultation settings and provide visual data for saving auscultations into EMRs or other records.

### New Market Entries



Currently, development of consumer grade stethoscopes is ongoing in anticipation of the growth of home telehealth. Several new products have been announced including ClinCloud (left), a stethoscope and thermometer device which attaches to smartphones and Stetsee (right), a stethoscope that also attaches to a smartphone app. The Stetsee website claims that Stetsee is the world's first artificial intelligence (AI) enabled stethoscope system.



Eko has also announced the Eko Duo which consists of a stethoscope paired with a single lead ECG. The product can pair with tablet apps to provide phonocardiograms. The company is just beginning to ship pre-orders and currently has a reservation form on their website. Expected pricing is \$349.

TytoCare, Ltd., based in Netanya, Israel, received FDA 510k approval in late 2016 and announced Pro, Clinic and Home versions of a multifunctional device that includes a camera, thermometer and stethoscope with otoscope and tongue depressor attachments. Their marketing material shows store and forward capability or live remote examinations with EHR integration possible. This product has been launched slowly over the last 1-2 years with selected large health systems and other partner organizations but is not yet generally available. The website has a form for submitting pre-orders and clinical trials are ongoing.



None of these newer products yet have significant market share in the mainstream telemedicine stethoscope market but these and others, particularly those marketed for home use, bear watching and will be the subject of a future review.

## FEATURES AND COST COMPARISON CHARTS

Understanding the features offered with each stethoscope is vital to the selection process if providers want to get the best fit for their practice or clinical setting. While some of the comparisons in the charts below are somewhat subjective, an attempt has been made to provide an overview of the similarities and differences between various options. By necessity, the charts are somewhat small and may be difficult to read. For anyone who wishes to download the charts in a larger, landscape format, they can be downloaded here:

<https://dta0yqvfnusi.cloudfront.net/usbst28863394/2018/12/Telemedicine-Stethoscope-Charts-5c1fb7177dd61.pdf>

**Chart # 1**

This chart compares the main features of telemedicine stethoscopes used with transmission hardware or software in real time telemedicine examination settings.

**Chart # 2**

This chart compares the acquisition cost of hardware and software for these same stethoscopes and includes recurring fees and license costs to arrive at 1, 3 and 5 year cost of ownership numbers.

**Chart # 3**

This chart compares stethoscopes that may be used without software and simply selected as the microphone in the videoconference software when conducting an auscultation.

## SUMMARY / CONCLUSION

The list of reviewed products includes the most frequent choices for real time telemedicine auscultation but is not intended to be all inclusive. If we have missed any products that should be included, we will be happy to review any manufacturer's information for future updates of this document. No attempt has been made to include all technical specifications of the products reviewed. Rather, the authors have attempted to provide a general overview of currently available solutions as a starting point for providers' selection process. We have also not rated the stethoscopes on audio quality since that is often subjective to the listener and we strongly recommend testing any stethoscope on the provider's own platform before purchasing.

All stethoscopes reviewed are fine products and are appropriate for use in telemedicine encounters. Providers should be able to review the data and descriptions presented in this white paper and form a basis for conducting their product research. There is obviously no one "best" telemedicine stethoscope. The appropriate choice one for any provider is the one that best meets the selection criteria selected by the provider as most important for their clinical and business settings.

All products reviewed except the Cardionics Ausculet II (hardware sending and receiving units required at both ends) require software to process and send the audio over the Internet in real time telemedicine situations.

Most manufacturers have proprietary software packages sold with the stethoscopes (see Charts 1 & 2) and some recommend use of open source audio handling middleware.

Four products reviewed (see Chart 3) may be used with videoconference software and hardware platforms as external microphones without additional software but may not have the full range of features and quality enhancements available in software enhanced systems.






If you have found this information helpful or if you have any constructive criticism for future papers, we would appreciate hearing your comments. <https://www.telemedicinesupply.com/pages/contact>

See below for product comparison charts or download them in larger, landscape format from this link. <https://dta0yqvfnusiq.cloudfront.net/usbst28863394/2018/12/Telemedicine-Stethoscope-Charts-5c1fb7177dd61.pdf>

## CHART 1

Chart # 1

## STETHOSCOPE USED WITH DIGITAL TRANSMISSION HARDWARE OR SOFTWARE

TELEMEDICINE STETHOSCOPE FEATURES COMPARISON	RNK PCP-USB w/ PCP-SSP Software 	3M™ Littmann® 3200 w/ TeleSteth™ System 	Eko Core w/ Telemedicine Livestream Software 	Cardionics Ausculette II Telemedicine System 	JedMed OMNISteth™ w/ MedImaging Software 
In-Band* or Out-of-Band**	In-Band	Out-of-Band	Out-of-Band	Out-of-Band	Out-of-Band
Connection to PC	USB Port	Bluetooth	Bluetooth 4.0 LE	Special Cable	3.5mm mic port & BT 4
Power Source	USB Port Always On	AA Batteries (50-60 hours)	Rechargeable Li-Ion Battery (9 hours)	Battery or AC Line - Wall Transformer	AAA batteries (8 hours)
Frequency Range & Filter Options	20Hz-2000Hz 5 Filter Settings (Software)	20Hz-2000Hz 3 Filter Settings (Manual)	20Hz-2000Hz (Bell/Diaphragm Double Side Head)	20-2000Hz 3 Filter Settings (Manual)	20Hz-2000Hz 3 Filter Settings B/D/W (Manual)
Amplification***	Yes - To Max of PC's Mic & Speaker Amplification	24X Acoustic***	40X Acoustic***	Yes – Max Amplification N/A	24X Acoustic***
Volume Adjustment	PC Volume Control Continuous Settings	External Manual Controls 8 Settings	External Manual Controls 7 Settings	Volume Control Knob	External Manual Controls # Settings N/A
Pediatric Use	Yes - 1 1/3" (33mm) Raised Center – Ideal for Pedi & Infant Use	Yes - Adult, Pedi and Infant Use	Yes - Pediatric Diaphragm Included – Switchable with Bell	Yes - Pediatric and Adult Use	Yes - 25 mm Pedi Head /40 mm Adult Head
Record & Forward	Yes - Separate Software	Yes - 12 exams	Yes – Record w/ App	Unknown	Yes - 160 exams****
Visualization	Yes w/ Third Party Apps	Yes w/ StethAssist™	Yes – On App	No	1.5 in screen
OS Compatibility	Windows	Windows	Android/iOS/Win (Beta)	Info Not Available	Info Not Available
API/SDK	Win/WebRTC- Chrome/Android/iOS	Win XP-7/Fedora Core/Android	Win/iOS/Android	Info Not Available	Info Not Available

\*In-Band Software transmits the audio signal through the audio channel of the video conference platform

\*\*Out-of-Band Software transmits the audio signal on a separate channel from the video conference platform

\*\*\*Amplification ratings for stethoscopes are shown as maximum amplification vs traditional acoustic stethoscopes. All digital stethoscopes have adjustable volume levels and maximum volumes will vary.

\*\*\*\*Organ button selects body area templates with preset frequency ranges for recording.

Disclaimer: Chart data is based on currently available information and may be subject to change with product updates or pricing changes

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## CHART 2

Chart # 2

**COST COMPARISON - STETHOSCOPES USED WITH DIGITAL TRANSMISSION HARDWARE OR SOFTWARE**

<b>TELEMEDICINE STETHOSCOPES – TOTAL COST OF OWNERSHIP</b>	<b>RNK PCP-USB w/ PCP-SSP Software</b>	<b>3M™ Littmann® 3200 w/ TeleSteth™ System</b>	<b>Eko Core w/ Telemedicine Livestream Software Service</b>	<b>Cardionics Ausculette II Telemedicine System</b>	<b>JedMed OMNISTeth™ w/ MedImaging Software</b>
Stethoscope	\$489	\$399 X 2 = \$798*	\$299	\$1500 X 2 = \$3000**	\$480 X 2 = \$960***
Software License	\$165 one-time / patient site	\$750 X 2 = \$1500/yr	None	Hardware Digital Transmission	\$1100 lifetime license
Recurring Fees	None	None	\$40/mo/patient site	None	\$50/yr/stethoscope
1 Year Cost	\$654	\$2298	\$779	\$3000	\$2160
3 Year Cost	\$654	\$5298	\$1739	\$3000	\$2360
5 Year Cost	\$654	\$8298	\$2699	\$3000	\$2560

\* Stethoscopes required at sending and receiving sites for real-time auscultation

\*\* Digital transmission via hardware boxes – Units required on sending and receiving ends

\*\*\* Second stethoscope for JedMed not required but recommended by manufacturer for best quality sound

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## CHART 3

Chart # 3

## STETHOSCOPE USED AS EXTERNAL MICROPHONE W/O SOFTWARE

TELEMEDICINE STETHOSCOPE FEATURES COMPARISON				
	RNK PCP-USB w/o Software	RNK PCP-1 w/o Software	Cardionics E-Scope II w/o Software	Thinklabs® Digital One w/o Software
				
Microphone Switching	Switch Mic in VC Software	Switch Mic in VC Software	Switch Mic in VC Software	Switch Mic in VC Software
Connection to PC	USB Port	3.5 mm Mic Port	1/8 in male Stereo Jack & USB Accessory Connector	3.5 mm Mic Port
Power Source	USB Port Always On	Mic Port Always On	AAA Battery (4.5 mo Regular Use)-Auto Off After 1.5-2 Min	Rechargeable Li-Ion Battery (100-125 exams)-Auto Off Can Be Set To 1-10 Minutes
Frequency Range & Filter Options	20Hz-2000Hz No Frequency Selections w/o Software	20Hz-2000Hz No Frequency Selections w/o Software	20Hz-2000Hz Heart and Breath Filter Settings (Manual)	20Hz-2000Hz 5 Filter Settings (Manual)
Amplification*	Yes – To Max of PC's Mic & Speaker Amplification	Yes – To Max of PC's Mic & Speaker Amplification	30X Acoustic*	100X Acoustic*
Volume Adjustment	PC Volume Control Continuous Settings	PC Volume Control Continuous Settings	External Manual Controls 64 Settings	External Manual Controls 10 Settings
Pediatric Use	Yes – 1 1/3" (33 mm) Raised Center – Ideal for Pediatric & Infant Use	Yes – 1 1/3" Raised Center – Ideal for Pediatric & Infant Use	Supplied w/ Specialist Adult Diaphragm That May Be Changed to Specialist Adult or Specialist Pediatric Bell	46 mm Adult Diaphragm Has Been Used for Pediatric Patients
Record & Forward	Yes – Separate Software Required	Yes – Separate Software Required	Yes w/Connecting Cable (cat. No. 711-7128)	Yes w/Thinklink Connector
Visualization	No – Yes w/ Third Party Apps	No – Yes w/ Third Party Apps	No – Yes w/ Third Party Apps	No – Yes w/ Third Party Apps
Ease of Use**	1	1	2	3
Cost	\$489	\$399	\$335	\$499

\*Amplification ratings for stethoscopes are shown as maximum amplification vs traditional acoustic stethoscopes.

All digital stethoscopes have adjustable volume levels and maximum volumes will vary.

\*\*Ease of Use Scale 1=Easiest-No External Buttons or Switches 2=External Manual Controls on Stethoscope Head 3=Most Technical for End User

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