GE Healthcare

Sonography-based Automated Volume Count (SonoAVC): an efficient and reproducible method of follicular assessment

Todd D. Deutch, MD
Clinical Reproductive Endocrinology and Infertility Fellow
The Jones Institute for Reproductive Medicine at Eastern Virginia Medical School

Alfred Z. Abuhamad, MD
Chairman of Obstetrics and Gynecology
Eastern Virginia Medical School

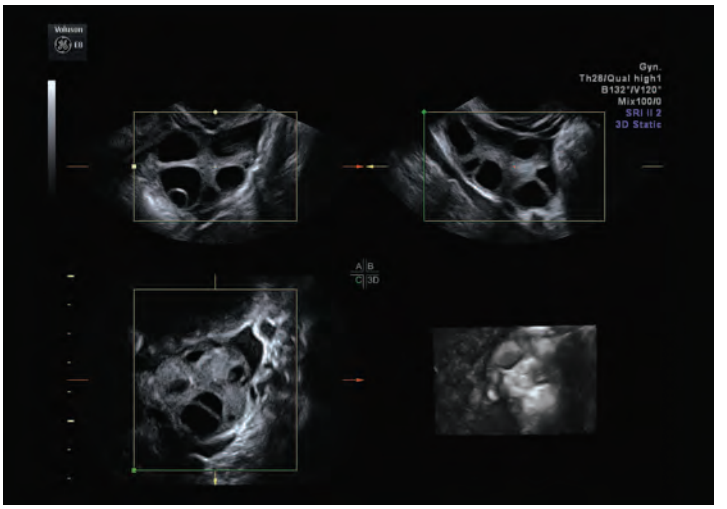
Introduction

Historically, follicular assessment utilizing two-dimensional (2D) ultrasound imaging has been met with many challenges, inconsistencies and irregularity from user to user. During controlled ovarian hyper-stimulation cycles, error in measurement and evaluation continue to be a challenge. Significant inter-observer and intra-observer variability contribute to potential discrepancies during follicular assessment using 2D ultrasound[1]. These discrepancies might lead to incorrect timing of human chorionic gonadotropin administration and decreased pregnancy rates. Performing the procedure utilizing three-dimensional (3D) ultrasound has been shown to increase the efficiency and reproducibility of follicular ultrasound measurement and evaluation[4,5]. In addition, 3D ultrasound allows for the standardization of ultrasound exams through the automated multi-planar approach[2,3].

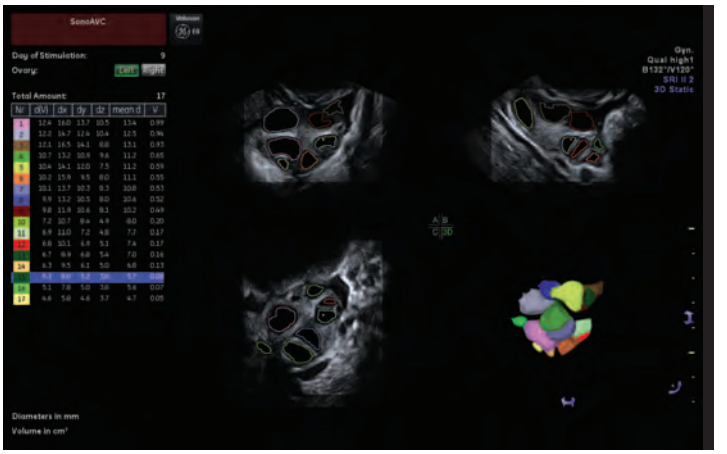
The ability to automate follicular assessment using ultrasound enhances the efficiency and reproducibility of follicular volume measurement. Displaying ovarian follicles in a 3D mode allows for an easy visual depiction of the geometric shape of individual follicles and thus enhances the optimal evaluation of the stimulated ovary. A software that automates and simplifies follicular assessment has great promise in clinical practice. SonoAVC (Sonography-based Automated Volume Count) represents a giant step towards that goal.

SonoAVC helps to identify and measure follicles within a 3D volume (Figure 1). SonoAVC standardizes the process of follicular assessment and decreases inter-observer and intra-observer variability[5]. SonoAVC increases the efficiency of ultrasound follicular monitoring by eliminating the need to measure each individual follicle[4,5].

Figure 1: The SonoAVC automatically finds and measures the ovarian follicles.



Render mode view of the ovary before the use of SonoAVC.



Render mode view of the ovary after the use of SonoAVC to automatically find and measure the ovarian follicles.

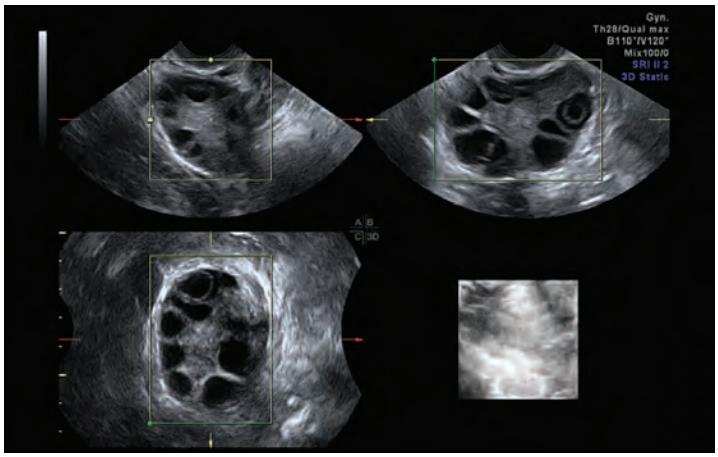
Volume imaging enables SonoAVC

Volume Ultrasound is a method of acquiring an anatomical volume dataset. Each volume dataset can be manipulated to display high-definition, multi-dimensional images that can be viewed in any plane. Automated SonoAVC, in conjunction with Volume Ultrasound, allows the user to help identifying, measure and analyze ovarian follicles during stimulation.

The SonoAVC identifies individual follicles and generates the following parameters: volume, the relaxed diameter or d(V) the mean diameter, and the X, Y and Z diameters. In order to obtain these measurements the region of interest box should be adjusted to include the ovary. Care should be taken to ensure that the region of interest (ROI) is large enough to encompass the entire ovary (Figure 2a). Once the ROI is accepted, SonoAVC will help to identify the ovarian follicles and helps determine the volumetric parameters for each follicle (Figure 2b). Next the user pages through the ovarian volume and deselects any non-ovarian follicles. Increasing separation will increase the software's ability to differentiate each individual follicle (Figure 3). Furthermore, increasing or decreasing the growth will increase or decrease the volume of each selected follicle (Figure 4). Once optimization of the volume has been completed for both the left and the right ovary, the ovarian data is added to the report.

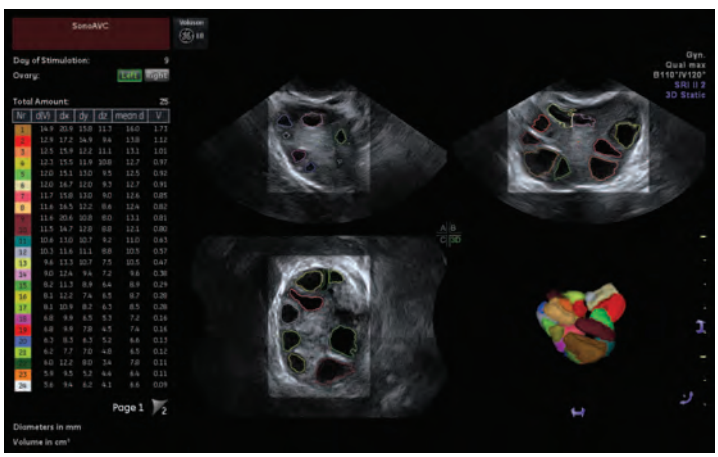
Another tool to aid in follicular assessment is the application of VOCAL* (Virtual Organ Computer-aided AnaLysis), which (Figure 2c) will decrease the potential number of non-ovarian follicles that are identified by SonoAVC.

Figure 2a: Use of the region of interest (ROI) box to define the ovary



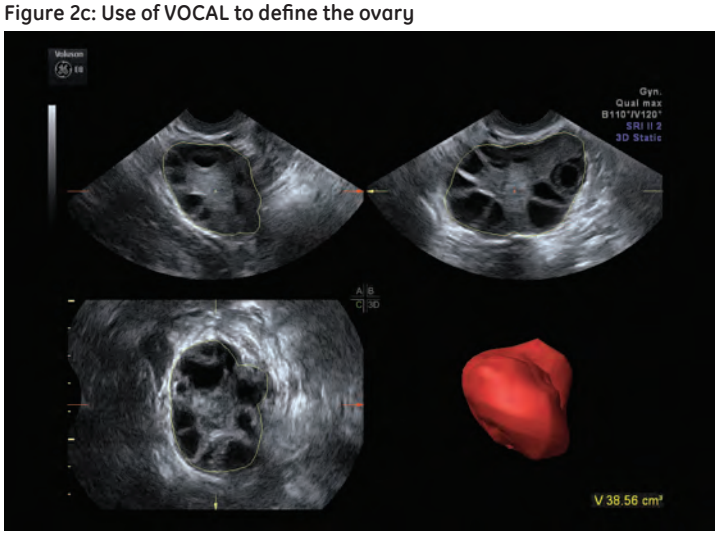
The ROI box is adjusted to ensure that the entire ovary is included in the ROI. Care must be taken to ensure that the amount of non-ovarian tissue which is included in the ROI box is kept to a minimum.

Figure 2b: Use of the SonoAVC to automatically identify and measure ovarian follicles



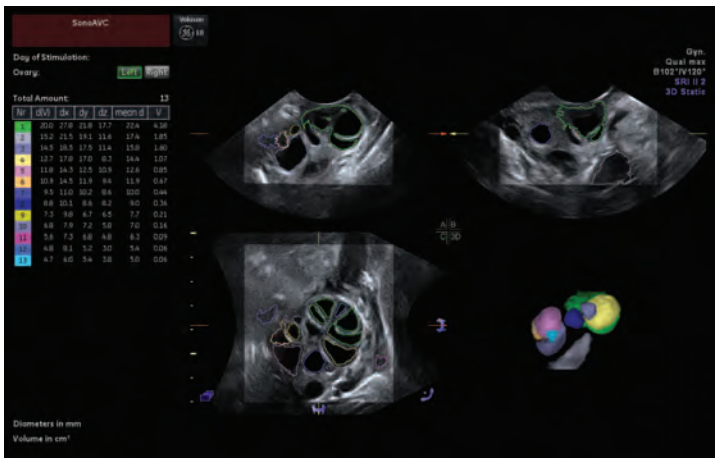
After the ROI is accepted, SonoAVC automatically detects and measures the ovarian follicles.

Figure 2c: Use of VOCAL to define the ovary



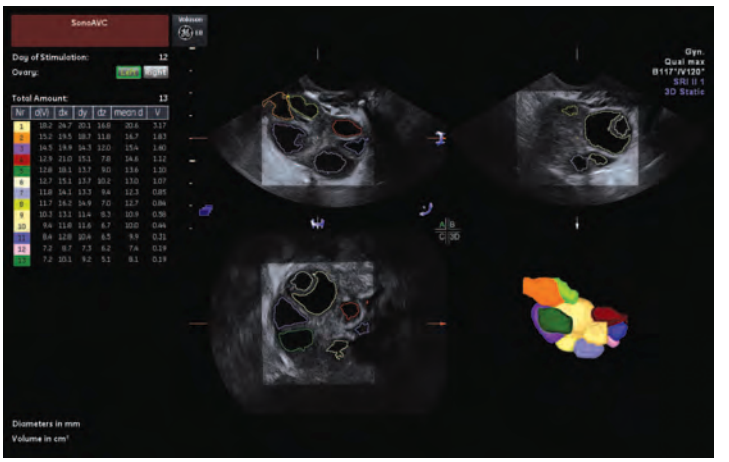
VOCAL can be used to define the ovary as the region of interest.

Figure 3: Use of the separation function

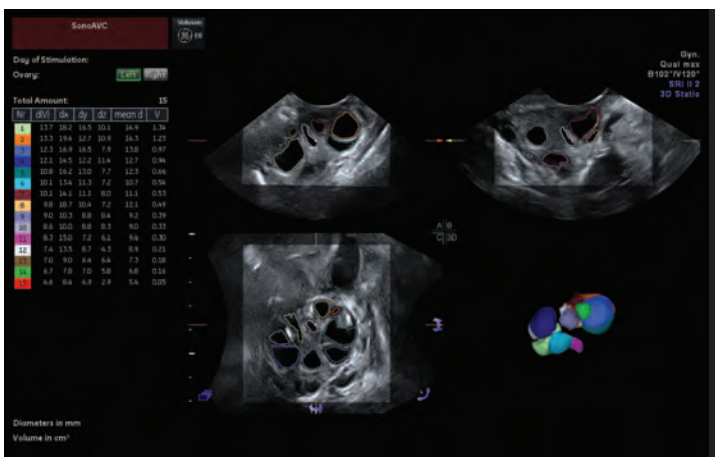


The separation function is set to mid. As can be seen by the large area outlined in green, several follicles are grouped together as one.

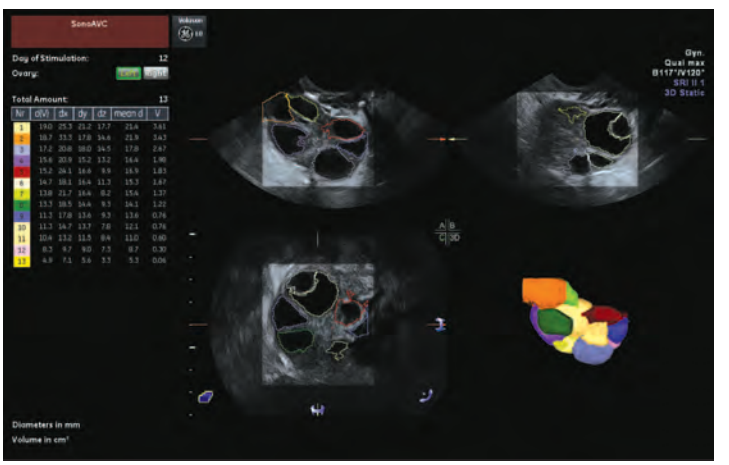
Figure 4: Use of the growth function



The growth function is set to minimum. As can be seen SonoAVC underestimates the borders of the ovarian follicles.



The separation function is set to maximum. The follicles that were previously grouped together as one have now been separated out. SonoAVC helps to recognize and measure each individual follicle.



The growth function is set to maximum. As can be seen SonoAVC now overestimates the borders of the ovarian follicles.

Volumetric Parameters

SonoAVC will help to calculate multiple volumetric parameters for each selected follicle (Figure 5). For each follicle the measurement parameters include the following:

Mean diameter - calculated from an average of the x, y and z diameters

X, Y, and Z diameter - calculated using a best fit ellipsoid model

Volume measurement (the follicular volumes and d(V)s) - measured using the actual follicles as depicted by SonoAVC. For each follicle, d(V) is defined as the diameter of a perfect sphere, given that the volume of the sphere is equal to the calculated follicular volume. Therefore, the d(V) represents what the diameter of the follicle would be if there was no external pressure on the follicle.

Reporting capability

The SonoAVC report includes all of the above volumetric parameters for each ovary and all follicles (Figure 5). In addition, a graphing function provides the user an overall impression of the number and size of the follicles in each ovary. The graph displays the day of stimulation on the x-axis. The y-axis can display the mean follicular diameter, the follicular volume or the relaxed follicular diameter (Figure 6).

Figure 5: The follicular volumetric parameters

Ovary: Left Total#: 18							Ovary: Right Total#: 15						
Nr.	d(V) mm	dx mm	dy mm	dz mm	mn.d mm	V cm³	Nr.	d(V) mm	dx mm	dy mm	dz mm	mn.d mm	V cm³
1	14.5	24.3	19.4	9.3	17.7	1.59	1	12.2	14.9	12.6	10.3	12.6	0.96
2	12.1	14.8	12.5	10.2	12.5	0.93	2	12.2	15.7	13.5	10.3	13.2	0.94
3	12.1	15.7	13.5	10.1	13.1	0.93	3	10.4	12.8	10.5	9.6	11.0	0.59
4	10.4	12.7	10.4	9.7	10.9	0.58	4	10.3	12.2	11.7	8.6	10.9	0.57
5	10.3	12.2	11.9	8.5	10.9	0.57	5	10.1	13.7	10.3	8.4	10.8	0.54
6	10.0	13.5	10.2	8.3	10.7	0.52	6	9.9	14.3	10.9	6.7	10.7	0.50
7	9.7	14.3	11.0	6.5	10.6	0.48	7	9.6	14.4	9.3	7.6	10.4	0.46
8	9.4	14.3	9.1	7.4	10.2	0.43	8	9.3	12.7	9.2	7.5	9.8	0.41
9	8.9	11.7	9.0	7.3	9.3	0.37	9	7.0	10.6	8.2	4.7	7.8	0.18
10	7.2	10.7	8.3	4.8	7.9	0.19	10	6.9	10.3	6.7	5.9	7.7	0.17
11	6.7	10.8	7.0	4.7	7.5	0.16	11	6.8	10.9	7.0	4.7	7.5	0.16
12	6.6	10.0	6.7	4.9	7.2	0.15	12	6.8	10.1	6.8	5.1	7.3	0.16
13	6.5	8.7	6.4	5.2	6.8	0.14	13	6.7	9.0	6.7	5.4	7.0	0.16

The report displays the volumetric parameters for the right and left ovarian follicles.

The report includes a graphic display of the number and size of each ovarian follicle. The top graph includes the right ovarian follicles and the bottom graph includes the left ovarian follicles. The Y-axis can be adjusted to display either the relaxed follicular diameter (d(V)), the mean follicular diameter (mn.d), or the follicular volume (V).

SonoAVC graphic report
Figure 6a: Relaxed follicular diameter d(V)

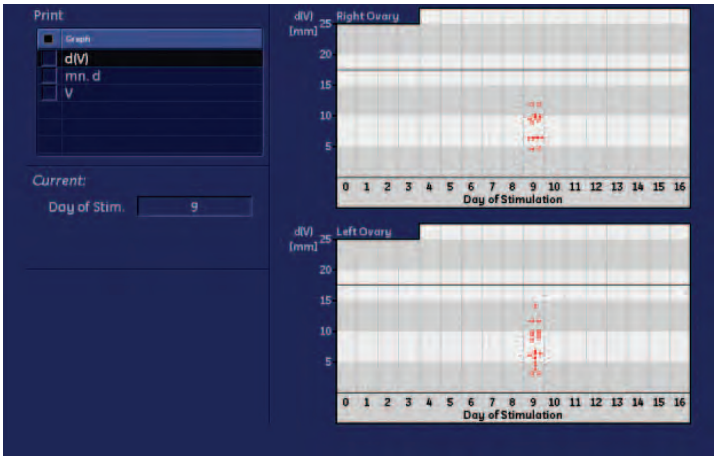


Figure 6b: Mean follicular diameter (mn.d)

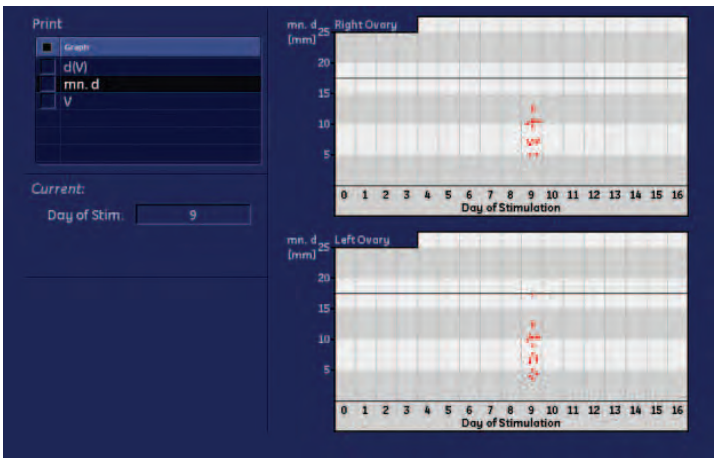
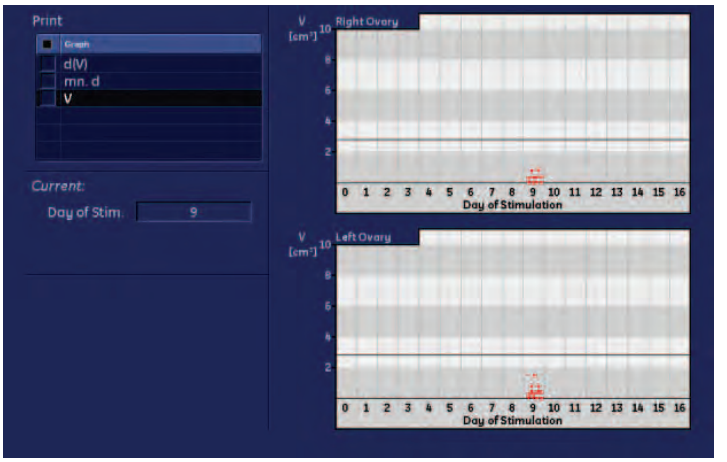


Figure 6c: Follicular volume (V)



Conclusions

A reproductive endocrinologist utilizing the Voluson E8 and the proprietary SonoAVC automated software can dramatically increase the utility of 3D ultrasound and follicular assessment. SonoAVC standardizes follicular measurements and decreases intra-observer and inter-observer variability[5]. In addition, SonoAVC increases the efficiency of follicular monitoring[4,5] The software eliminates the need to measure the diameters of each individual follicle and the graphic display gives the user the ability to quickly assess the number of follicles and their volumetric parameters. SonoAVC offers an reproducible and efficient way to monitor follicular development in patients undergoing controlled ovarian hyper-stimulation[4,5,6]. Based upon our experience with SonoAVC, the software has the potential to simplify follicular assessment and enhance the efficiency and reproducibility of ultrasound follicular monitoring.

About the Author's Institution

The Jones Institute for Reproductive Medicine is world renowned for its success in treating all types of endocrine and fertility problems. Services provided by the Institute include endocrine and infertility and endocrine evaluation, ovulation induction, artificial insemination, in vitro fertilization, and sperm and pre-embryo cryopreservation. Specialized reproductive surgery is available with experience in laser surgery, microsurgery, hysteroscopy (office and inpatient), as well as treatment for congenital anomalies and endometriosis. Consultation services are available for pelvic pain, heavy menstrual flow, and other gynecologic problems.

Using SonoAVC on the Voluson E8 ultrasound system:

- A transvaginal ultrasound is performed using a 3D imaging probe (RIC 5-9 or RIC 6-12)
- Optimize the gain and harmonics for optimum image quality
- Select 3D imaging mode, adjust quality settings
- Adjust volume angle to include entire ovary and acquire volume
- Adjust 3D box over area of interest
- Select SonoAVC to evaluate the ovarian follicles
- Increase or decrease growth or follicular separation
- Select follicles manually if they are not identified
- Display report and chart

References

1 Forman RG, Robinson J, Yudkin P, Egan D, Reynolds K, Barlow DH. What is the true follicular diameter: an assessment of the reproducibility of transvaginal ultrasound monitoring in stimulated cycles. Fertil Steril. 1991;56:989-92.

2 Benacerraf BR, Shipp TD, Bromley B. Improving the efficiency of gynecologic sonography with 3-dimensional volumes: a pilot study. J Ultrasound Med. 2006;25:165-71.

3 Abuhamad A. Automated multiplanar imaging: a novel approach to ultrasonography. J Ultrasound Med 2004;23:573-576

4 Deutch TD, Abuhamad AZ, Matson DO, Bocca S, Stadtmauer LA, Oehninger SC. Clinical evaluation of a novel automated follicular assessment software program in women undergoing controlled ovarian hyperstimulation for in vitro fertilization using three dimensional sonography. Fertility and Sterility 2007; 88:S80

5 Deutch TD, Abuhamad AZ, Matson DO, Bocca S, Stadtmauer LA, Oehninger SC. Automated calculation of ovarian follicular diameters using three dimensional sonography in women undergoing in vitro fertilization (IVF): a prospective evaluation of a novel software. Fertility and Sterility 2007; 88:S80

6 Deutch TD, Abuhamad AZ, Bocca S, Stadtmauer LA, Oehninger SC. Automated assessment of follicular volumetric parameters using three dimensional sonography: a prospective validation of a novel software program. Fertility and Sterility 2007; 88:S81

DOC1193780

UNITED KINGDOM
GE Medical Systems Ultrasound
71 Great North Road
Hatfield, Hertfordshire
AL9 5EN
T 44 1707 263570
F 44 1707 260065

EUROPE
GE Healthcare GmbH
Beethovenstr. 239
42655 Solingen
Germany
T 49 212-28 02-0
F 49 212-28 02 28

AMERICAS
GE Healthcare
9900 Innovation Drive
Wauwatosa, WI 53226
U.S.A.
T 1 888 202 5582

ASIA
GE Healthcare Clinical
Systems ASIA
1105-1108 Maxdo Center
8 XingYi Road, Shanghai
200336
T 86 21 5257 4640
F 86 21 5208 0582

Healthcare Re-imagined

GE is dedicated to helping you transform healthcare delivery by driving critical breakthroughs in biology and technology. Our expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, and biopharmaceutical manufacturing technologies is enabling healthcare professionals around the world to discover new ways to predict, diagnose and treat disease earlier. We call this model of care “Early Health.” The goal: to help clinicians detect disease earlier, access more information and intervene earlier with more targeted treatments, so they can help their patients live their lives to the fullest. Re-think, Re-discover, Re-invent, Re-imagine.

GE imagination at work

Printed in Austria, 300-12-U021E