

TriMark Publications

May 2017  
Volume: TMRIMG17-0501



MEDICAL IMAGING  
MARKETS  
*(SAMPLE COPY, NOT FOR RESALE)*

Trends, Industry Participants, Product Overviews and Market Drivers

**TABLE OF CONTENTS**

1. Overview 17

1.1 Statement of This Report 17

1.2 Scope of This Report 17

1.3 Methodology 19

1.4 Executive Summary 20

2. Medical Imaging Technologies: An Overview 22

2.1 X-Ray 22

2.1.1 Types of X-Rays 22

2.1.1.1 Applications of X-Ray (Radiography) 23

2.1.1.2 Reduced Payments for Analog X-Ray in the U.S. from 2017 24

2.2 Computed Radiography (CR) 25

2.3 Digital Radiography (DR) 27

2.3.1 Refinements in Digital Radiography Systems 28

2.3.2 Digital Detectors 28

2.3.3 Cassette-Based Solutions 29

2.3.4 Benefits of Digital Radiography 30

2.4 Fluoroscopy and C-Arms Systems 32

2.4.1 C-Arm Machines with Cost Price \$10,000 to \$30,000 32

2.4.2 C-Arm Machines with Cost Price \$30,000 to \$50,000 32

2.4.3 C-Arm Machines with Cost Price \$50,000 to \$70,000 33

2.4.4 C-Arm Machines with Cost Price \$70,000 to \$120,000 33

2.4.5 Points to be Considered While Buying a C-Arm System 33

2.4.5.1 Digital Detector vs. Image Intensifier 33

2.4.5.2 II Size 34

2.4.5.3 II Magnification Modes 34

2.4.5.4 Generator Size 34

2.4.5.5 Current Price Range 34

2.5 Mammography 34

2.5.1 Film/Screen Systems for Mammography 35

2.5.2 Full Field Digital Mammography 35

2.5.3 Clinical Applications of Mammography Systems 35

2.5.4 Components of a Mammography System 35

2.5.5 List Price of Select Mammography Systems 35

2.5.6 Points to be Considered While Buying a Mammography System 35

2.5.6.1 Detector Size 36

2.5.6.2 Image Resolution 36

2.5.6.3 Upgradability 36

2.6 Bone Densitometry Scanners 36

2.7 Computed Tomography (CT) 37

2.7.1 Types of CT Scanners 37

2.7.1.1 16 Slice CT Scanners 38

2.7.1.2 32 to 40 Slice CT Scanners 38

2.7.1.3 64 Slice CT Scanners 38

2.7.1.4 Wide-Bore CT Scanners 39

2.7.1.5 Greater Than 64 Slice CT Scanners 39

2.8 MRI Scanners 40

2.8.1 Types of MRI Scanners 40

2.8.1.1 High-Field MRI Scanners 40

2.8.1.2 Low-Field MRI Scanners 41

2.8.1.2 Low-Field MRI Scanners 41

2.8.1.3 Upright MRI Scanners 41

2.8.2 MRI Machines that Cost \$150,000 or Less 41

2.8.3 MRI Machines That Cost \$150,000 to \$300,000 41

2.8.4 MRI Machines That Cost \$250,000 to \$400,000 42

2.8.5	MRI Machines That Cost >\$400,00	42
2.8.6	Expected Lifetime of MRI System	42
2.9	Ultrasound Scanners	42
2.9.1	Types of Ultrasound	42
2.10	Single Photon Emission Computed Tomography (SPECT)	44
2.10.1	Medical Application of SPECT Imaging	44
2.10.2	Leading SPECT System Manufacturers	45
2.10.3	Market Leading SPECT Systems	45
2.11	SPECT/CT	46
2.11.1	Clinical Applications of SPECT/CT	46
2.11.2	Market Leading SPECT/CT Systems	46
2.12	Positron Emission Tomography (PET)	47
2.12.1	Clinical Applications of PET	48
2.13	PET/CT	48
2.13.1	Clinical Applications of PET/CT	48
2.14	Picture Archiving and Communications System (PACS)	49
2.14.1	Medical Image Workstation	50
2.14.2	Radiology Reporting Workstation	50
2.14.3	Mammography Workstation	50
2.14.4	Cardiology Workstation	51
3.	Medical Indications Addressed by Imaging Modalities	52
3.1	Relative Use of Imaging Modalities in Oncology	52
3.2	Relative Use of Imaging Modalities in Cardiology	53
3.3	Relative Use of Medical Imaging Modalities in Neurology	54
3.4	Relative Use of Imaging Modalities in Musculoskeletal Disorders	55
4.	Market Analysis	57
4.1	Summary of Medical Imaging Market	57
4.2	Medical Imaging Market by Geography	59
4.3	Top Ten Companies in Medical Imaging Equipment	60
4.4	Global Market for X-Ray Systems	63
4.4.1	Percent Share of X-rays by Product Type	64
4.4.2	Geographical Share of X-Ray Market	64
4.5	Global Market for Ultrasound by Technology	65
4.5.1	Geographic Share of Diagnostic Ultrasound Market	67
4.5.2	Percent Share of Ultrasound Market by Application	68
4.6	Global Market for MRI by Technology	69
4.6.1	Percent Share of MRI Geographical Markets	70
4.6.2	Percent Share of MRI Procedures by Application	71
4.6.3	Market Leaders in MRI Scanners	72
4.7	Global Market for CT Scanners	72
4.7.1	CT Scanners Market by Geography	74
4.8	Global Market for Nuclear Imaging Equipment	75
4.8.1	Nuclear Imaging Equipment Market Share by Geography	76
4.8.2	Market Leaders in Nuclear Imaging Equipment	76
4.8.3	Percent Share of Global SPECT Market by Indication	77
4.8.4	Percent Share of Worldwide PET Market by Indication	78
4.9	Global Market for Breast Imaging Equipment	78
4.9.1	Market Leaders in FFDM	80
4.9.2	Market Leaders in Digital Breast Tomosynthesis (DBT)	80
4.10	Global Market for Fluoroscopy and Mobile C-Arms	81
4.10.1	Market Leaders in Fluoroscopy and Mobile C-Arm	82
4.11	Global Market for Medical Imaging Software	83
4.12	Global Market for PACS	84
4.12.1	PACS Market Share by Company	85
4.13	Global Market for Bone Densitometers	86
4.13.1	Percent Share of Bone Densitometer Market by Technology	87

4.13.2	Global Market for Bone Densitometry by Geography	88
4.14	Global Market for Refurbished Diagnostic Imaging Equipment Market	89
4.14.1	Global Market for Refurbished Medical Imaging Equipment by Technology	90
5.	Medical Imaging Market Data from Select Countries	92
5.1	U.S. Market for Diagnostic Imaging Equipment	92
5.1.1	Average Cost of Imaging Procedures in the U.S. Hospital Setting	93
5.1.2	Average Expenses per Procedure by Modality in the U.S. Free-Standing Imaging Centers	94
5.1.3	Number of CT Procedures in the U.S.	95
5.1.3.1	U.S. Distribution of CT Sites by Site Type	96
5.1.3.2	Distribution of CT Scanners in the U.S. by Slice Count	97
5.1.3.3	CT Procedure Mix in the U.S.	98
5.1.4	Mammography in the U.S.	100
5.1.5	MRI in the U.S.	101
5.1.5.1	MRI Procedure Mix in the U.S.	102
5.1.5.2	Distribution of Installed Base of MRI Systems by Bore Type, by Site Type in the U.S.	104
5.1.5.3	Distribution of Installed Base of MRI Systems by Magnet Field Strength in the U.S.	105
5.1.5.4	MRI Installed Base in the U.S. by Field Strength	107
5.1.6	Number of Clinical PET Scans, Sites and Units in the U.S.	108
5.1.6.1	Clinical PET Scan Trends in the U.S.	109
5.1.6.2	PET Clinical Patient Scan Mix in the U.S.	110
5.1.6.3	PET/CT and PET Oncology Study Mix in the U.S.	111
5.1.6.4	PET/CT Installed Base in the U.S. by Number of CT Slices	112
5.2	Medical Imaging in Canada	113
5.2.1	Computed Tomography (CT)	113
5.2.2	Magnetic Resonance Imaging	113
5.2.3	Single-Photon Emission Computed Tomography	113
5.2.4	Positron Emission Tomography/Computed Tomography (PET/CT)	114
5.2.5	Positron Emission Tomography/Magnetic Resonance Imaging (PET/MRI)	114
5.2.6	Single-Photon Emission Computed Tomography/Computed Tomography (SPECT/CT)	114
5.2.7	Picture Archiving Communication System (PACS)	114
5.2.8	Leading Medical Imaging Companies in Canadian Market	115
5.2.9	Growth Rate for Medical Imaging Equipment in Canada	116
5.2.10	Market Share for Major Imaging Devices in Canada	117
5.3	European Market for Medical Imaging in Select Countries	118
5.3.1	Installed Bases of Major Medical Imaging Modalities in Europe	119
5.3.2	Age Profile of CT Scanners in Major European Healthcare Markets	120
5.3.2.1	Age Profiles of CT Scanners in Select Region/Country	122
5.3.2.2	Upgraded and Replaced CT Units in Europe	123
5.3.2.3	Density of CT Units in Select Region/Country	124
5.3.3	Age Profile of MRI in Select Region/Country	125
5.3.3.1	Density of MRI Units in Select Region/Country	126
5.3.4	Profile of X-Ray Angiography Units in Major European Healthcare Markets	127
5.3.4.1	Age Profile of X-Ray Angiography in Select Region/Country	128
5.3.4.2	Density of X-Ray Angiography in Select Region/Country	129
5.3.5	Age Profile of PET Scanners in E.U.	130
5.3.5.1	Age Profile of PET in Select Region/Country	131
5.3.5.2	Density of PET in Select Markets	132
5.4	Chinese Market for Medical Imaging Equipment	133
5.5	Indian X-Ray Market	134
5.5.1	Indian Digital Radiography Market (DR)	135
5.5.2	Indian Ultrasound Market	136
5.5.2.1	Indian Color Doppler Equipment Market	137
5.5.2.2	Indian Color Ultrasound Market	138
5.5.3	Indian CT Scanners Market	139
5.5.4	Indian MRI Market	140
5.5.5	Indian SPECT and PET Market	141

6.	Company Profiles	142	
6.1	Siemens Healthcare	142	
6.1.1	Angiography Products	142	
6.1.1.1	Artis One	142	
6.1.1.2	Artis Q	142	
6.1.1.3	Artis Zeego	142	
6.1.1.4	Artis Pheno	143	
6.1.1.5	Artis Zee	143	
6.1.1.6	Artis QZen	143	
6.1.1.7	MIYABI Angio-CT	143	
6.1.2	Mobile C-Arms from Siemens	143	
6.1.2.1	Cios Alpha	143	
6.1.2.2	Cios Fusion	143	
6.1.2.3	Cios Connect	143	
6.1.2.4	Cios Select	144	
6.1.2.5	Arcadis Orbic 3D	144	
6.1.2.6	Siremobil Compact L	144	
6.1.3	CT Scanners from Siemens	144	
6.1.3.1	SOMATOM Force	144	
6.1.3.2	SOMATOM Drive	144	
6.1.3.3	SoMATOM Definition Flash	144	
6.1.3.4	SOMATOM Definition Edge	145	
6.1.3.5	SOMATOM Definition AS	145	
6.1.3.6	SOMATOM Perspective	145	
6.1.3.7	SOMATOM go.Up	145	
6.1.3.8	SOMATOM go.Now	145	
6.1.3.10	SOMATOM Scope	145	
6.1.3.11	SOMATOM Emotion	145	
6.1.3.12	SOMATOM Spirit	146	
6.1.4	Remote Controlled Fluoroscopy Systems	146	
6.1.4.1	Luminos dRF Max	146	
6.1.4.2	Luminos Fusion	146	
6.1.4.3	Luminos Select	146	
6.1.5	Magnetic Resonance Imaging Systems from Siemens	146	
6.1.5.1	MAGNETOM Aera	146	
6.1.5.2	MAGNETOM Amira	146	
6.1.5.3	MAGNETOM Sempra	146	
6.1.5.4	MAGNETOM Espree eco	147	
6.1.5.5	MAGNETOM Avanto eco	147	
6.1.5.6	MAGNETOM Essenza	147	
6.1.5.7	MAGNETOM Vida	147	
6.1.5.8	MAGNETOM Skyra	147	
6.1.5.9	MAGNETOM Prisma	147	
6.1.5.10	MAGNETOM Verio	147	
6.1.5.11	MAGNETOM Spectra	148	
6.1.6	Mammography Systems from Siemens	148	
6.1.6.1	Mammomat Inspiration	148	
6.1.6.2	Mammomat Fusion	148	
6.1.7	Molecular Imaging Systems from Siemens	148	
6.1.7.1	Biograph mCT Flow PET/CT	148	
6.1.7.2	Biograph mCT	148	
6.1.7.3	Biograph Horizon	148	
6.1.7.3	Biograph mMR	149	
6.1.7.4	Symbia Intevo	149	
6.1.7.5	Symbia Intevo Excel	149	
6.1.7.6	Symbia T Series	149	

6.1.8	Ultrasound Systems from Siemens	149
6.1.8.1	ACUSON SC2000	149
6.1.8.2	ACUSON X700	149
6.1.8.3	ACUSON X300 PE	150
6.1.8.4	ACUSON X150	150
6.1.8.5	ACUSON P300	150
6.1.8.6	ACUSON S2000	150
6.1.8.7	ACUSON S1000	150
6.1.8.8	ACUSON S3000	150
6.2	GE Healthcare	151
6.2.1	GE's Bone Health Imaging Products	151
6.2.1.1	Lunar iDXA	151
6.2.1.2	Prodigy	151
6.2.1.3	Achilles	151
6.2.2	Computed Tomography from GE	151
6.2.2.1	Revolution EVO	151
6.2.2.2	Revolution CT	152
6.2.2.3	Optima CT660	152
6.2.2.4	Optima CT540	152
6.2.2.5	Optima CT660 FREEdom Edition	152
6.2.2.6	Optima CT 580 W	152
6.2.3	MRI from GE Healthcare	152
6.2.3.1	SIGNA Architect	152
6.2.3.2	SIGNA Pioneer	153
6.2.3.3	Discovery MR750w GEM 70 cm	153
6.2.3.4	Discovery MR750 60 cm	153
6.2.3.5	SIGNA PET/MR 60 cm	153
6.2.4	Mammography Equipment from GE Healthcare	153
6.2.4.1	Senographe Pristina	153
6.2.5	Nuclear Imaging Systems from GE Healthcare	153
6.2.5.1	Discovery MI	153
6.2.5.2	Discovery IQ	154
6.2.5.3	Discovery MI DR	154
6.2.5.4	Discovery NM CT 670	154
6.2.5.5	Optima NM CT 640	154
6.2.5.6	Infinia Hawkeye 4	154
6.2.6	Select Radiography Systems from GE Healthcare	154
6.2.6.1	Proteus XR/f	154
6.2.6.2	Discovery XR656 PLUS	154
6.2.6.3	Definium 5000	155
6.2.7	Select Fluoroscopy Systems from GE Healthcare	155
6.2.7.1	Precision 600FP	155
6.2.8	Select Ultrasound Systems from GE Healthcare	155
6.2.8.1	Voluson E10	155
6.2.8.2	LOGIQ E9 XDclear 2.0	155
6.2.8.3	LOGIQ F8	155
6.2.8.4	Vivid E95	155
6.3	Philips Healthcare	156
6.3.1	CT Devices from Philips	156
6.3.1.1	iQon Spectral CT	156
6.3.1.2	iCT Family	156
6.3.1.3	Ingenuity	156
6.3.1.4	Brilliance CT Big Bore	157
6.3.1.5	MX16 EVO	157
6.3.2	MRI from Philips Healthcare	157
6.3.2.1	Ingenia 1.5T	157

6.3.2.2	Ingenia 1.5T CX	158
6.3.2.3	Ingenia 1.5T S	158
6.3.2.4	Ingenia 3.0T	158
6.3.3	Diagnostic Radiography/Fluoroscopy from Philips	158
6.3.3.1	Juno DRF	158
6.3.3.2	EasyDiagnost Eleva DRF	158
6.3.4	Mammography Systems from Philips	159
6.3.4.1	MicroDose SI	159
6.3.4.2	IntelliSpace Breast	159
6.3.5	Digital Radiography Systems from Philips	159
6.3.5.1	DigitalDiagnost	159
6.3.5.2	MobileDiagnost	159
6.3.5.3	DuraDiagnost	159
6.3.6	Ultrasound Systems from Philips	159
6.3.6.1	EPIQ 7	159
6.3.6.2	EPIQ 5	160
6.3.6.3	Affinity 70	160
6.3.6.4	Affinity 50	160
6.3.6.5	CX 50	160
6.3.6.6	CX 50 xMatrix	160
6.3.6.7	ClearVue 850	160
6.3.6.8	Lumify	161
6.3.6.9	ClearVue 350	161
6.4	Toshiba Medical Systems Corporation	161
6.4.1	Computed Tomography (CT) from Toshiba	161
6.4.1.1	Aquilion ONE/Genesis Edition	161
6.4.1.2	Aquilion ONE VISION Edition	161
6.4.1.3	Aquilion ONE	161
6.4.1.4	Aquilion PRIME	162
6.4.1.5	Aquilion CXL Series	162
6.4.1.6	Aquilion RXL Edition	162
6.4.1.7	Aquilion Lightning	162
6.4.1.8	Aquilion LB	162
6.4.1.9	Alexion Advance Edition	163
6.4.1.10	Alexion	163
6.4.1.11	Alexion Access Edition	163
6.4.2	MRI from Toshiba	163
6.4.2.1	Vantage Titan 3T	163
6.4.2.2	Vantage Titan	163
6.4.2.3	Vantage Elan	163
6.4.3	Ultrasound from Toshiba	164
6.4.3.1	Aplio i-Series	164
6.4.3.2	Aplio 500	164
6.4.3.3	Aplio 400	164
6.4.3.4	Aplio 300	164
6.4.3.5	Xario	164
6.4.4	Fluoroscopy Systems from Toshiba	164
6.4.4.1	Ultimax-iFPD Version	164
6.4.4.2	Ultimax-i I.I. Version	165
6.4.4.3	ZEXIRA I.I. Version	165
6.4.4.4	Kalare	165
6.4.4.5	WINSCOPE Plessart EX8	165
6.4.4.6	WINSCOPE Plessart VIVO	165
6.4.5	Radiography Systems from Toshiba	165
6.4.5.1	RADREX-I FPD System	165
6.4.5.2	RADREX	165

6.4.6	Mammography from Toshiba	166
6.4.6.1	MGU-1000A	166
6.4.7	Mobile C-Arm from Toshiba	166
6.4.7.1	Surginix (SXT-2000A)	166
6.4.7.2	Clearscope 1000	166
6.4.8	Nuclear Imaging from Toshiba	166
6.4.8.1	Celesteion	166
6.5	Fujifilm Corporation	167
6.5.1	Computed Radiography Systems from Fujifilm	167
6.5.1.1	FCR Prima II	167
6.5.1.2	FCR Prima T2	167
6.5.1.3	FCR Prima T	167
6.5.1.4	FCR Capsula X	167
6.5.1.5	FCR Capsula XLII	167
6.5.1.6	FCR XG5000 Plus	168
6.5.1.7	FCR Profect CS Plus	168
6.5.2	Digital Radiography from Fujifilm	168
6.5.2.1	FDR AcSelerate	168
6.5.2.2	FDR D-EVO Suite	168
6.5.2.3	FDR Visionary Suite	168
6.5.2.4	FDR Smart f	168
6.5.3	Digital Mammography System from Fujifilm	169
6.5.3.1	AMULET Innovality	169
6.5.3.2	AMULET f/s	169
6.5.3.3	AMULET	169
6.5.4	Ultrasound Systems from Fujifilm	169
6.5.4.1	FC1	169
6.5.4.2	SonoSite SII	169
6.5.4.3	SonoSite Edge II	170
6.5.4.4	SonoSite iViz	170
6.5.4.5	SonoSite X-Porte	170
6.5.4.6	SonoSite NanoMaxx	170
6.5.4.7	SonoSite M-Turbo	170
6.5.4.8	Vevo MD	170
6.6	Carestream Health Inc.	171
6.6.1	DR Systems from Carestream	171
6.6.1.1	DRX-Evolution Plus	171
6.6.1.2	DRX-1 System	171
6.6.1.3	DRX-Ascend	171
6.6.1.4	DRX – Mobile Retrofit	171
6.6.1.5	DRX-Revolution	172
6.6.1.6	DRX-Transportable	172
6.6.2	CR Systems from Carestream	172
6.6.2.1	DirectView CR System	172
6.6.2.2	Vita Flex CR System	172
6.6.2.3	Vita CR System	172
6.6.3	Cone Beam CT Solutions from Carestream	173
6.6.3.1	Carestream OnSight 3D Extremity System	173
6.6.3.2	CS 9300 System	173
6.6.3.3	CS 8100 3D System	173
6.6.4	Fluoroscopy from Carestream	173
6.6.4.1	DRX-Excel	173
6.6.4.2	DRX-Excel Plus	173
6.6.5	Analog System from Carestream	174
6.6.5.1	DRX-Ascend System	174
6.6.5.2	Motion Mobile X-Ray System	174



6.6.6	Ultrasound Systems from Carestream	174
6.6.6.1	Touch Prime	174
6.6.6.2	Touch Prime XE	174
6.6.7	Digital Mammography Systems from Carestream	175
6.6.7.1	CARESTREAM DRX-1 System	175
6.6.7.2	CARESTREAM DRX Mobile Retrofit Kits	175
6.6.7.3	CARESTREAM DRX-Revolution Mobile X-Ray System	175
6.6.7.4	CARESTREAM DRX-Evolution Plus	175
6.6.7.4	CARESTREAM DRX-Ascend System	176
6.7	Hitachi Medical Systems America Inc.	176
6.7.1	MRI Systems from Hitachi	176
6.7.1.1	Oasis 1.2T	176
6.7.1.2	Echelon Oval 1.5T	176
6.7.1.3	Echelon 1.5T	176
6.7.2	CT Systems from Hitachi	177
6.7.2.1	SCENARIO 128-Slice	177
6.7.2.2	SUPRIA 16-Slice	177
6.7.3	Ultrasound Systems from Hitachi	177
6.7.3.1	ARIETTA 70	177
6.7.3.2	ProSound Alpha 7	177
6.7.3.3	Noblus	177
6.7.3.4	Profound F37	178
6.7.3.5	SOFIA	178
6.7.3.6	Profound F75	178
6.7.4	X-Ray Systems	178
6.7.4.1	DX-D 100	178
6.7.4.2	DX-D 300	179
6.7.4.3	DR 400	179
6.7.7.4	DX-D 600	179
6.8	Konica Minolta Medical Imaging U.S.A. Inc.	180
6.8.1	Konica's Digital Radiography Products	180
6.8.1.1	AeroDR HD Detector	180
6.8.1.2	KDR AU System Advanced U-Arm	180
6.8.1.3	AeroRemote	180
6.8.1.4	AeroDR LT	180
6.8.1.5	AeroDR XE	180
6.8.1.6	AeroDR Flat Panel Detector	181
6.8.2	Ultrasound Systems from Konica	181
6.8.2.1	J5 Ultrasound	181
6.8.2.2	Sonimage HS 1	181
6.8.2.3	Sonimage P3	181
6.8.3	Computed Radiography from Konica	181
6.8.3.1	Xpress CR	181
6.8.3.2	Sigma II CS-7S CR	181
6.8.3.3	NanoCR W/CS-7	181
6.8.3.4	ImagePilot	182
6.8.3.5	ImagePilot Sigma	182
6.8.4	Konica's Digital Mammography	182
6.8.4.1	Xpress CR – Contact Mammography	182
6.8.4.2	REGIUS 110 HQ	182
6.9	Shimadzu Corporation	182
6.9.1	Angiography Systems from Shimadzu	182
6.9.1.1	Trinias F12/C12 Mix Package	182
6.9.1.2	BRANSIST alexa F12/C12	183
6.9.2	Fluoroscopy from Shimadzu	183
6.9.2.1	Sonialvision G4	183

6.9.2.2	Sonialvision Safire 17	183	
6.9.2.3	Sonialvision Versa 100R/100	183	
6.9.2.4	Flexavision F3	183	
6.9.2.5	Fluorospeed 300	183	
6.9.3	Mobile C-Arm from Shimadzu	183	
6.9.3.1	Opescope Acteno	183	
6.9.3.2	WHA-200 Opescope Activo	184	
6.9.4	Radiography from Shimadzu	184	
6.9.4.1	RADspeed Pro EDGE	184	
6.9.4.2	RADspeed Pro V4	184	
6.9.4.3	RADspeed Pro MC	184	
6.9.4.4	RADspeed Pro MF	184	
6.9.4.5	RADspeed fit	184	
6.9.4.6	Ezy-Rad Pro ETX Version	184	
6.9.5	Mobile X-Rays from Shimadzu	185	
6.9.5.1	MobileDaRt Evolution MX7 Version	185	
6.9.5.2	MobileDaRt Evolution EPX Version	185	
6.9.5.3	MOBILEART eco	185	
6.10	Varian Medical Systems, Inc.	185	
6.10.1	Oncology Software from Varian Medical	185	
6.10.1.1	360 Oncology	185	
6.10.1.2	Eclipse Treatment Planning System	185	
6.10.1.3	RapidPlan Knowledge-Based Planning Software	186	
6.10.1.4	VariSeed LDR Treatment Planning System	186	
6.10.1.5	Vitesse HDR Treatment Planning System	186	
6.10.1.6	Acuros BV	186	
6.10.1.7	ARIA Oncology Information System	186	
6.10.1.8	Velocity	186	
6.10.1.9	Fullscale Oncology IT Solution	186	
6.10.1.10	BrachyVision Brachytherapy Treatment Planning System	187	

## APPENDIX

Appendix 1: Basic Principles of CT Scanning	188
Appendix 1.1: Field of Use	190
Appendix 1.2: Technical Considerations	190
Appendix 1.3: Total Scan Time and Scan Length	191
Appendix 1.3.1: Clinical Requirements	191
Appendix 1.3.2: Gantry Rotation Time	191
Appendix 1.3.3: Detector Array Length	191
Appendix 1.3.4: X-Ray Tube	194
Appendix 1.3.5: Image Quality	194
Appendix 1.3.6: Spatial Resolution	195
Appendix 1.3.7: Contrast Resolution	197
Appendix 1.3.8: Temporal Resolution	197
Appendix 1.3.9: Image Artifacts	199
Appendix 1.3.10: Ionizing Radiation and Patient Dose	200
Appendix 1.3.11: Over-Beaming	201
Appendix 1.3.12: Over-Ranging in Helical Scanning	202
Appendix 1.3.13: Automatic Tube Current Control in CT	203
Appendix 1.3.14: Cardiac Scanning	203
Appendix 1.4: Installation	204
Appendix 1.4.1: Scanner Location	204
Appendix 1.4.2: Room Requirements	204
Appendix 1.4.3: Ancillary Equipment	205
Appendix 1.4.4: Patient Workflow	205

Appendix 1.4.5: Staffing	206
Appendix 1.4.6: Cardiac Procedures	207
Appendix 1.4.7: Information Workflow	207
Appendix 2: A Buyer's Guide for MRI	209
Appendix 2.1: Key Purchasing Factors to be Considered	209
Appendix 2.1.1: Technical Features	209
Appendix 2.1.1.1: Strength of the Main Magnetic Field	209
Appendix 2.1.1.2: Signal-to-Noise Ratio (SNR)	209
Appendix 2.1.1.3: Field Uniformity and Stability	209
Appendix 2.1.1.4: Shim Coils	210
Appendix 2.1.1.5: Radiofrequency System	210
Appendix 2.1.1.6: Gradient Coil Systems	210
Appendix 2.1.1.7: Parallel Imaging Techniques	210
Appendix 2.1.2: Ease of Use and Safety	210
Appendix 2.1.2.1: Patient Comfort	210
Appendix 2.1.2.2: Safety	210
Appendix 2.1.2.3: Costs	211
Appendix 2.1.2.4: Accessories	211
Appendix 2.1.2.5: Maintenance	211
Appendix 3: X-Ray Usage and Safety	212
Appendix 3.1: Radiation	212
Appendix 3.1.1: Radiation in Medical Imaging	213
Appendix 3.2: Ionizing Radiation: Basic Concepts	216
Appendix 3.2.1: Action of Ionizing Radiation	216
Appendix 3.2.2: Regulatory Agencies	216
Appendix 3.2.3: Ionizing Radiation: Quantification, Exposure and Risk	217
Appendix 3.2.4: Proper Protection from Ionizing Radiation	218
Appendix 3.2.5: Effect of Ionizing Radiation on Pregnant Women	219
Appendix 3.3: Alternative Non-Radiation Imaging Modalities	221
Appendix 3.3.1: Ultrasound Imaging	221
Appendix 3.3.2: Magnetic Resonance Imaging	222

## INDEX OF FIGURES

Figure 2.1: Percent Application of X-Rays by Indication	23
Figure 2.2: DR and CR Fixed General X-Ray Systems Installed in U.S. Hospitals, 2010-2016	24
Figure 3.1: Relative Use of Imaging Modalities in Oncology	53
Figure 3.2: Relative Use of Imaging Modalities in Cardiology	54
Figure 3.3: Relative Use of Imaging Modalities in Neurology	55
Figure 3.4: Relative Use of Imaging Modalities in Musculoskeletal Disorders	56
Figure 4.1: Percent Share of Medical Imaging Market by Imaging Modalities, 2016	58
Figure 4.2: Global Market for Medical Imaging Equipment, 2016-2022	59
Figure 4.3: Percent Share of Medical Imaging Market by Geography, 2016	60
Figure 4.4: Top Ten Companies based on Diagnostic Imaging Market Share (%), 2016-2022	62
Figure 4.5: Global Market for X-Ray Systems, 2016-2022	63
Figure 4.6: Percent Share of X-Ray by Product Type, 2016	64
Figure 4.7: Geographical Share of X-Ray Market, 2016	65
Figure 4.8: Global Market for Ultrasound Systems, 2016-2022	66
Figure 4.9: Global Market for Diagnostic Ultrasound by Geography, 2016	67
Figure 4.10: Percent Share of Ultrasound Market by Application, 2016	68
Figure 4.11: Global Market for MRI Systems, 2016-2022	69
Figure 4.12: Global Market for MRI by Geography, 2016	70
Figure 4.13: Percent Share of MRI Procedures by Application, 2016	71
Figure 4.14: Market Leaders in MRI	72
Figure 4.15: Global CT Scanners Market, 2016-2022	73
Figure 4.16: Geographical Share of CT Scanners Market, 2016	74

Figure 4.17: Global Market for Nuclear Imaging Equipment (SPECT & PET), 2016-2022	75
Figure 4.18: Nuclear Imaging Equipment Market Share by Geography, 2016	76
Figure 4.19: Market Leaders in Nuclear Imaging Equipment, 2016	77
Figure 4.20: Percent Share of Global SPECT Market by Indication, 2016	77
Figure 4.21: Percent Share of Worldwide PET Market by Indication, 2016	78
Figure 4.22: Global Market for Breast Imaging Equipment, 2016-2022	79
Figure 4.23: Market Leaders in Full-Field Digital Mammography Systems	80
Figure 4.24: Market Leaders in DBT Systems, 2016	81
Figure 4.25: Global Market for Fluoroscopy and Mobile C-Arms, 2016-2022	82
Figure 4.26: Market Leaders in Mobile C-Arm, 2016	83
Figure 4.27: Global Market for Medical Imaging Software, 2016-2022	84
Figure 4.28: Global Market for PACS, 2016-2012	85
Figure 4.29: PACS Market Share by Company, 2016	86
Figure 4.30: Global Market for Bone Densitometers, 2016-2022	87
Figure 4.31: Percent Share of Bone Densitometer Market by Technology, 2016	87
Figure 4.32: Global Market for Bone Densitometers by Geography, 2016	88
Figure 4.33: Global Market for Refurbished Imaging Equipment, 2016-2022	89
Figure 4.34: Percent Share of Refurbished Imaging Equipment Market by Technology, 2016	91
Figure 5.1: U.S. Market for Medical Imaging Equipment, 2016-2022	92
Figure 5.2: Average Expenses per Procedure by Modality in the U.S. Hospital Setting	93
Figure 5.3: Average Expenses per Procedure by Modality in the U.S. Free-Standing Imaging Centers	94
Figure 5.4: CT Procedure Volumes in the U.S. Hospital and Non-Hospital Sites, 2005-2015	95
Figure 5.5: Distribution of CT Sites and Procedures by Site Type, 2015	96
Figure 5.6: Distribution of CT Scanners in the U.S. by Number of Slices as of 2015	97
Figure 5.7: Distribution of CT Procedures in the U.S. and Sites, by Procedure Category, 2015	100
Figure 5.8: Type of Mammography Units Installed in the U.S. as of 2015	101
Figure 5.9: Total MRI Procedure Volume in the U.S., 2005-2015	102
Figure 5.10: MRI Procedure Mix in the U.S., 2015	103
Figure 5.11: Distribution of Installed Base of MRI Systems by Bore Type, by Site Type, 2015	104
Figure 5.12: Distribution of Installed Base of MRI Systems by Magnet Field Strength in the U.S., 2015	105
Figure 5.13: MRI Installed Base in the U.S. by Field Strength as of 2015	107
Figure 5.14: Distribution of PET Imaging Sites and PET Scans by Site Type in the U.S., 2015	108
Figure 5.15: Estimated Clinical PET Scans by Site Type, 2005-2015	109
Figure 5.16: Clinical Application Mix for PET/CT and PET Scans in the U.S., 2015	110
Figure 5.17: Distribution of PET Oncology Scans by Cancer Type in the U.S., 2015	111
Figure 5.18: Percent Distribution of PET/CT Installed Base by Number of CT slices, 2015	112
Figure 5.19: Canadian Medical Imaging Market Share by Company, 2016	115
Figure 5.20: Canadian Medical Imaging Growth Rate by Segment, 2016	116
Figure 5.21: Canadian Market Share for Major Imaging Equipment, 2016	118
Figure 5.22: European Market for Medical Imaging in Select Countries, 2016-2022	119
Figure 5.23: Installed Bases of Major Medical Imaging Modalities in Europe	120
Figure 5.24: Age Profile of CT Scanners in Major European Healthcare Markets as of 2015	121
Figure 5.25: Age Profiles of CT Scanners in Select Region/Country, 2015	122
Figure 5.26: Upgraded and Replaced CT Units in Europe as of 2015	123
Figure 5.27: Density of CT Units in Select Region/Country as of 2015	124
Figure 5.28: Age Profile of MRI in Europe as of 2015	125
Figure 5.29: Density of MRI Units in Select Region/Country as of 2015	126
Figure 5.30: Age Profile of X-Ray Angiography Units in Major European Healthcare Markets as of 2015	127
Figure 5.31: Age Profile of X-Ray Angiography in Select Region/Country as of 2015	128
Figure 5.32: Density of X-Ray Angiography Units in Select Region/Country as of 2015	129
Figure 5.33: Age Profile of PET Units in Major European Healthcare Markets as of 2015	130
Figure 5.34: Age Profile of PET in Select Region/Country as of 2015	131
Figure 5.35: Density of PET Units by Select Region/Country as of 2015	132
Figure 5.36: Chinese Medical Imaging Equipment Market by Technology, 2016-2022	133
Figure 5.37: Indian X-Ray Market, 2016	134
Figure 5.38: Indian Digital Radiography (DR) Market, 2016	135

Figure 5.39: Indian Ultrasound Market by Volume and Value, 2015 136

Figure 5.40: Indian Color Doppler Equipment Market, 2015 137

Figure 5.41: Indian Color Ultrasound Equipment Market, 2016 138

Figure 5.42: Indian CT Scanners Market, 2015 139

Figure 5.43: Indian Diagnostic MRI Market, 2015 140

Figure 5.44: Indian SPECT & PET Market, 2016 141

Figure A. 1.1: Schematic Diagram of CT Scanner “End View” 188

Figure A. 1.2: Schematic Diagram of CT Scanner “Side View” in Helical Acquisition Mode 188

Figure A. 1.3: Multi-slice CT Scanner X-Ray Beam and Detectors Approximately to Scale 189

Figure A. 1.4: Multi-slice CT Scanner X-Ray Beam and Detectors, Schematic 189

Figure A. 1.5: Technical Advances in CT Scanner Technology 190

Figure A. 1.6: Effect of Detector Array on Number of Rotations and Scan Time 192

Figure A. 1.7: Example of 16 Slice Detector with Reduced Coverage for Fine Slices 192

Figure A. 1.8: Examples of Fixed and Variable Z-Axis Detector Arrays 193

Figure A. 1.9: CT Perfusion with “Jog” or “Shuttle” Scan 194

Figure A. 1.10: Test Objects with Line Pairs of Varying Frequencies for Assessment of Scan Plane Spatial Resolution 195

Figure A. 1.11: Diagram of Methods for Improving Sampling Density (a) Quarter Detector Shift, (b) Flying Focal Spot 196

Figure A. 1.12: Reduction of Effective Detector Size with Attenuating Grid 196

Figure A. 1.13: Test Object for Contrast Resolution Measurements 197

Figure A. 1.14: Principle of Multi-Segment Reconstruction in Retrospectively Gated CCTA 198

Figure A. 1.15: Schematic Diagram of a Dual Source CT Scanner 198

Figure A. 1.16: CT Scan Through Shoulders, Demonstrating Photon Starvation Artifacts 199

Figure A. 1.18: PMMA Body Phantom used for Measurement of CT Doses 200

Figure A. 1.18: Illustration of CTDI<sub>vol</sub> Representing Average Dose at Central Slice Position of 100 mm Irradiation Length 201

Figure A. 1.19: Reduced Influence of Over-Beaming for Larger Z-Axis Beam Collimations 201

Figure A. 1.20: Increased Contribution from Over-Ranging with Wider X-Ray Collimation 202

Figure A. 1.21: Dynamic Collimation to Reduce Dose at the Extremities of a Scan 202

Figure A. 1.22: Automatic Tube Current Control in CT 203

Figure A. 1.23: EEG-Gated Tube Current Modulation 203

Figure A. 1.24: The Stages of a CT Scan 206

Figure A. 1.25: Examples of Allocations of Specific Roles to Assist Patient Workflow 206

Figure A. 1.26: Information and Image Flow 207

**INDEX OF TABLES**

Table 2.1: Important Features of Different Imaging Modalities 22

Table 2.2: Percent Applications of X-Rays by Indication 23

Table 2.3: Medicare Reimbursement Cuts to X-Ray by Technology 24

Table 2.4: Features of Some of the Largest Selling CR Systems 26

Table 2.5: DR Systems in the Market 26

Table 2.6: Detector Types in Selected DR Systems 28

Table 2.7: Features of Cassette-Based DR Solutions from Different Vendors 29

Table 2.8: Select DR Systems 30

Table 2.9: 16 Slice CT Scanners 38

Table 2.10: 32 to 40 Slice CT Scanners 38

Table 2.11: 64 Slice CT Scanners 39

Table 2.12: Wide Bore CT Scanners 39

Table 2.13: Greater Than 64 Slice CT Scanners 40

Table 2.14: Examples of SPECT/CT Systems 47

Table 2.15: Select PET/CT Systems 49

Table 2.16: Select PACS Systems 49

Table 4.1: Global Medical Imaging Equipment Market by Technologies, 2016-2022 58

Table 4.2: Medical Imaging Equipment Market by Geography, 2016-2022 59

Table 4.3: Top Ten Companies based on Diagnostic Imaging Market Share (%), 2016 and 2022	62
Table 4.4: Global Market for X-Ray Systems by Technology, 2016-2022	63
Table 4.5: Global Market for Ultrasound by Technology, 2016-2022	66
Table 4.6: Global Market for MRI by Technology, 2016-2022	69
Table 4.7: Global CT Scanners Market by Technology, 2016-2022	73
Table 4.8: Global CT Scanners Market by Geography, 2016-2022	74
Table 4.9: Global Market for Nuclear Imaging Equipment (SPECT & PET), 2016-2022	75
Table 4.10: Global Market for Breast Imaging Equipment, 2016-2022	79
Table 4.11: Global Market for Fluoroscopy and Mobile C-Arms, 2016-2022	82
Table 4.12: Global Market for Medical Imaging Software, 2016-2022	83
Table 4.13: Global Market for PACS by Imaging Modality, 2016-2022	84
Table 4.14: Global Market for Bone Densitometers by Technology, 2016-2022	86
Table 4.15: Global Market for Bone Densitometers by Geography, 2016-2022	88
Table 4.16: Global Market for Refurbished Diagnostic Imaging Equipment Market by Geography, 2016-2022	89
Table 4.17: Global Market for Refurbished Medical Imaging Equipment by Technology, 2016-2022	91
Table 5.1: U.S. Market for Medical Imaging by Technology, 2016-2022	92
Table 5.2: Average Expenses per Procedure by Modality in the U.S. Hospital Setting	93
Table 5.3: Average Expenses per Procedure by Modality in the U.S. Free-Standing Imaging Centers	94
Table 5.4: CT Procedure Volumes in the U.S. Hospital and Non-Hospital Sites, 2005-2015	95
Table 5.5: Distribution of CT Sites and Procedures by Site Type, 2015	96
Table 5.6: Distribution of CT Scanners in the U.S. by Number of Slices as of 2015	97
Table 5.7: Distribution of CT Procedures in the U.S. and Sites, by Procedure Category, 2015	98
Table 5.8: Type of Mammography Unit Installed in the U.S. as of 2015	100
Table 5.9: Total MRI Procedure Volume in the U.S., 2005-2015	102
Table 5.10: MRI Procedure Mix in the U.S., 2015	103
Table 5.11: Distribution of Installed Base of MRI Systems by Bore Type, by Site Type, 2015	104
Table 5.12: Distribution of Installed Base of MRI Systems by Magnet Field Strength in the U.S., 2015	105
Table 5.13: MRI Installed Base in the U.S. by Field Strength as of 2015	107
Table 5.14: Distribution of PET Imaging Sites and PET Scans by Site Type in the U.S., 2015	108
Table 5.15: Estimated Clinical PET Scans by Site Type, 2005-2015	109
Table 5.16: Clinical Application Mix for PET/CT and PET Scans in the U.S., 2015	110
Table 5.17: Distribution of PET Oncology Scans by Cancer Type in the U.S., 2015	111
Table 5.18: Percent Distribution of PET/CT Installed Base by Number of CT slices, 2015	112
Table 5.19: Canadian Medical Imaging Market Share by Company, 2016	115
Table 5.20: Canadian Medical Imaging Growth Rate by Segment, 2016	116
Table 5.21: Canadian Market Share for Major Imaging Equipment, 2016	118
Table 5.22: European Market for Medical Imaging in Select Countries, 2016-2022	118
Table 5.23: Installed Bases of Major Medical Imaging Modalities in Europe	119
Table 5.24: Age Profile of CT Scanners in Major European Healthcare Markets as of 2015	121
Table 5.25: Age Profiles of CT Scanners in Select Region/Country, 2015	122
Table 5.26: Upgraded and Replaced CT Units in Europe as of 2015	123
Table 5.27: Density of CT Units in Select Region/Country as of 2015	124
Table 5.28: Age Profile of MRI in Europe as of 2015	125
Table 5.29: Density of MRI Units in Select Region/Country as of 2015	126
Table 5.30: Age Profile of X-Ray Angiography Units in Major European Healthcare Markets as of 2015	127
Table 5.31: Age Profile of X-Ray Angiography in Select Region/Country as of 2015	128
Table 5.32: Density of X-Ray Angiography Units in Select Region/Country as of 2015	129
Table 5.33: Age Profile of PET Modalities in E.U. as of 2015	130
Table 5.34: Age Profile of PET in Select Region/Country as of 2015	131
Table 5.35: Density of PET Units by Select Region/Country as of 2015	132
Table 5.36: Chinese Market for Medical Imaging, 2016-2022	133
Table 5.37: Indian X-Ray Market, 2016	134
Table 5.38: Indian Digital Radiography (DR) Market, 2016	135
Table 5.39: Indian Ultrasound Market by Volume and Value, 2015	136
Table 5.40: Indian Color Doppler Equipment Market, 2015	137

Table 5.41: Leading Vendors in Indian Ultrasound Market, 2015 138  
 Table 5.42: Indian Color Ultrasound Equipment Market, 2016 138  
 Table 5.43: Indian CT Scanners Market, 2015 139  
 Table 5.44: Indian Diagnostic MRI Market, 2015 140  
 Table 5.45: Indian SPECT & PET Market, 2016 141  
 Table A. 2.1: i.5 T and 3.0 T Models Evaluated by PASA 209  
 Table A. 2.2: Key Technical Specifications for 1.5 T Equipment 211  
 Table A. 2.3: Key Technical Specifications for 3 T Equipment 211  
 Table A. 3.1: Ionizing and Non-Ionizing Sources of Radiation 212  
 Table A. 3.2: Common Sources of Radiation 217  
 Table A. 3.3: Radiation Dose for Various Imaging Procedures Compared to Natural Radiation 218  
 Table A. 3.4: Proper Protection from Ionizing Radiation 218  
 Table A. 3.5: Radiation-Induced Malformations from Fetal Exposure 220  
 Table A. 3.6: Estimated Radiation Dose Received by Fetus during Imaging Procedures 220

SAMPLE

## 1. Overview

### 1.1 Statement of This Report

The purpose of this TriMark Publications report is to describe the specific market segment of the diagnostics market sector called medical imaging. Medical imaging can be categorized into nine main modalities: X-ray, ultrasound, computed tomography (CT), positron emission tomography (PET), single photon emission computed tomography (SPECT), magnetic resonance imaging (MRI), nuclear medicine (NM), mammography, and fluoroscopy. Globally, the X-ray is the most frequently used imaging procedure with more than [REDACTED] X-ray exams per year. MRIs are second with [REDACTED] examinations per year. PET, SPECT, CT and nuclear medicine rank third with [REDACTED] examinations per year. Picture archiving and communication systems (PACS) and contrast agents are the sub-segments in medical imaging market that have gained significant growth in recent years. As a result of these medical imaging advancements, the multi-slice systems are generating large volumes of data, and this creates demand for data storage, three-dimensional (3-D) visualization and analysis. As such, the global medical imaging industry is primed to experience significant growth through the next decade. This report surveys almost all of the companies known to be marketing, manufacturing or developing medical imaging equipment and supplies in the world. Each company is discussed in extensive depth with a section on its history, product line, business and marketing analysis, and a subjective commentary of the company's market position. Detailed tables and charts with sales forecasts and market data are also included.

The huge revenue earning potential of the medical imaging industry is primarily due to the general cost of most imaging equipment and its functional benefits. The value of the global imaging industry has grown from \$ [REDACTED] in [REDACTED] to \$ [REDACTED] in [REDACTED]. The U.S. and Europe are the most mature markets for the medical imaging products, and they show a compounded annual growth rate (CAGR) hovering around [REDACTED]% growth. Product innovations will play a key role in further progression of the medical imaging in these two mature markets. For the existing medical imaging products, the vendors are now focusing on the regional markets such as China and India, which have shown to experience a CAGR of [REDACTED]% to [REDACTED]%. China's healthcare sector has witnessed a robust growth assisted by growing demand and government support. The medical devices market in India is anticipated to register an annual growth rate in the high double digits in the coming years and the medical imaging market will form a major part of it. Public hospitals in the Eastern European region are also seeking assistance from private finance companies to invest in the latest medical imaging modalities. The overall analysis of the growth pattern indicates that the private imaging centers are gaining momentum and most public sector healthcare services are focusing on outsourcing imaging diagnostics.

### 1.2 Scope of This Report

The main objectives of this analysis are:

- Estimate the current and future U.S. and global markets for medical imaging modalities.
- Assess market opportunities and the potential market for medical imaging products.
- Discuss the shift in trends towards portable devices in medical imaging.
- Analyze the need for medical imaging for the different disease indications.
- Examine the current utilization and future demand for radiopharmaceuticals used in nuclear imaging procedures.
- Review the impact of healthcare reforms on medical imaging procedures and the reimbursement rates available in the U.S. for the different imaging procedures.
- Identify the key players in medical imaging industry and their contribution to the continuing innovations in the development of new modalities.

Key questions answered in this study are:

- What disease conditions offer the greatest potential for medical imaging?
- What market drivers are responsible for the growth of medical imaging products?
- Which healthcare segments contribute more to the growth of medical imaging industry?
- What regulatory and technical challenges is the medical imaging industry confronting?



- How far has the industry progressed in developing portable imaging equipment?
- What is the reimbursement rate for the different imaging procedures in the U.S.?
- What impacts have U.S. healthcare reforms made on the growth of medical imaging industry?

This report contains:

- A brief introduction to the various medical imaging modalities, the market leading brands in each modality and the medical applications for each.
- Global, U.S., European, Chinese and Indian markets for medical imaging modalities.
- Estimated market for medical imaging products at the global and the U.S. level.
- The current status of the isotope supply to the global radiology market.
- One section of the appendix gives a detailed account of the global and regional markets for refurbished imaging modalities such as CT, MRI and ultrasound.

For more information on the U.S. and global markets for medical imaging equipment, please visit <http://www.trimarkpublications.com> to find this study's companion report called *European Medical Imaging Markets*. Other TriMark reports cover the specific sectors within the medical imaging market include: *Mammography World Markets*, *Nuclear Cardiology Markets*, *Picture Archiving and Communications Systems (PACS)*, *Positron Emission Tomography (PET) Markets* and *Ultrasound Markets*.

### 1.3 Methodology

The author of this report is a Ph.D. in biochemistry from the University of Minnesota with many decades of experience in science writing and as a medical industry analyst. He has been a senior director of several large regional and national healthcare laboratories. The editor of this report is a retired college professor with three decades of experience in teaching biochemistry, biotechnology, pharmacology, environmental biology and horticulture. Additionally, important data sources include the American Hospital Association (AHA), American College of Radiology (ACR), World Health Organization (WHO), National Cancer Institute, American Cancer Society (ACS) and Medical Imaging & Technology Alliance (MITA). Where possible and practicable, the most recent data available have been used.

Some of the statistical information was taken from Biotechnology Associates' databases and from TriMark's private data stores. The information in this study was obtained from sources that TriMark believes to be reliable, but TriMark does not guarantee the accuracy, adequacy or completeness of any information or omission or for the results obtained by the use of such information. Key information from the business literature was used as a basis to conduct dialogue with and obtain expert opinion from market professionals regarding commercial potential and market sizes.

#### *Primary Sources*

TriMark collects information from hundreds of database tables and many comprehensive multi-client research projects and Sector Snapshots published annually. TriMark extracts relevant data and analytics from its research in the past three years as part of this data collection. TriMark also extracts qualified data feeds from e-questionnaire responses and primary research responses for this compilation.

#### *Secondary Sources*

TriMark uses research publications, journals, magazines, newspapers, newsletters, industry reports, investment research reports, trade and industry association reports, government affiliated trade releases, and other published information as part of its secondary research materials. The information is then analyzed and translated by the Industry Research Group into a TriMark study. The Editorial Group reviews the complete package with product and market forecasts, critical industry trends, threats and opportunities, competitive strategies and market share

determinations. The report conclusions are verified through intensive interviewing of the top-ranking companies in the industry.

### ***TriMark Publications Report, Research and Data Acquisition Structure***

The general sequence of research and analysis activity prior to the publication of every report in TriMark Publications includes the following items:

- Completing an extensive secondary research effort on an important market sector, including gathering all relevant information from corporate reporting, publicly-available data and proprietary databases.
- Formulating a study outline with the assigned writer, including important items, as follows:
  - Market and product segment grouping, including evaluating their relative significance.
  - Evaluation of key competitors, including their relative positions in the business and other relevant facts to prioritize diligence levels and assist in designing a primary research strategy.
  - End-user research to evaluate analytical significance in market estimation.
  - Supply chain research and analysis to identify any factors affecting the market.
  - New technology platforms and cutting-edge applications.
- Identifying the key technology and market trends that drive or affect these markets.
- Assessing the regional significance for each product and market segment for proper emphasis of further regional/national primary and secondary research.
- Completing a confirmatory primary research assessment of the report's findings with the assistance of expert panel partners.

#### **1.4 Executive Summary**

The medical imaging industry is on the brink of a major new phase of growth. The growth in the market will be propelled by the availability of new technology coming from the digital information segment and by the aging population. Equipment vendors are being forced to design smaller and lower cost modalities. Recent innovations in the continued integration of technologies are showing much promise. Advances in PET/CT systems enable images to be seen that have never been seen before simultaneously. Another area showing promise is functional MRI (fMRI), which can enable advances in diagnostics for diseases such as Alzheimer's and other diseases that are becoming more prevalent with an aging population. The global market for medical imaging is worth about \$ [REDACTED] in [REDACTED], and is expected to grow to \$ [REDACTED] by [REDACTED]. Currently, Asia/Pacific is the largest market that is worth about \$ [REDACTED] and it is followed by North America and Europe with shares of \$ [REDACTED] and \$ [REDACTED] respectively.

CT continues to be a much sought after equipment in both inpatient and outpatient care. In mature markets, such as the U.S. and Europe, the purchase of new equipment is driven by an additional need for capacity. One week's backlog justifies the investment in another unit for CT because the facilities do not want their clients to go to their competitors. Another factor is obsolescence. Some clinicians still use a one-slice CT and manage to perform well. Some think that they need to have a 16-slice CT to do a good job. This perception of obsolescence varies among the institutions. The global CT market is controlled mainly by five major players, namely GE Healthcare, Hitachi Medical Systems, Philips Medical Systems, Siemens Medical Solutions, and Toshiba Medical Systems. The global CT scanners market was valued at \$ [REDACTED] in [REDACTED] with a potential to reach \$ [REDACTED] in [REDACTED].

MRI is the ideal system for imaging soft tissues. Yet, for several years, the small bore had been a disadvantage for both obese and claustrophobic patients. In [REDACTED], many MRI vendors launched systems with a wide bore. Hitachi received FDA approval for its Echelon Oval 1.5T wide-bore system in [REDACTED] and it is the only system in the industry to provide a 74 cm bore. Nearly two-thirds of the customers are likely to opt for wide bore units. Another boon for the MRI market is the advent of MRI-compatible pacemakers and other devices. Technological advances such as ultra-high-field MRI, innovative software applications, and novel detection of multiple sclerosis and breast cancer also contribute to boost the MRI market.

In the U.S., the MRI utilization rate has increased and yet there is revenue drop because of reimbursement cuts. Much of the procedure growth has been due to growth in lower and upper extremity procedure growth. According to

AllTech Medical Systems, there are approximately [REDACTED] fixed MRI systems in operation in the U.S. and scanning is performed in more than [REDACTED] hospitals, [REDACTED] hospital-owned outpatient locations and nearly [REDACTED] freestanding imaging centers. Over [REDACTED] MRI scans are performed in the U.S. each year, with increased applications in chest, vascular, breast and cardiac imaging procedures. The global market for MRI systems in [REDACTED] was valued at \$ [REDACTED] and it has the potential to reach \$ [REDACTED] in [REDACTED].

PET scanners are used to assess cancers and neurological and cardiovascular disorders. These scanning systems are capable of revealing changes in metabolism and thus different types of cancers can be detected using PET before they can be detected by other imaging techniques. PET can scan the entire body and thus it can be used to show whether cancer is spreading to other parts of the body. PET is a more advanced and accurate technology for cardiac perfusion imaging and it has been shown to provide a [REDACTED]% reduction in invasive coronary arteriography and coronary artery bypass grafting, resulting in [REDACTED]% cost savings and superior clinical outcomes. New procedures combine PET with computed X-ray tomography (CT) scans to give co-registration of the two images (PETCT) result in better diagnosis than with a traditional gamma camera alone. It is a very powerful and significant tool which provides unique information on a wide variety of diseases from dementia to cardiovascular disease and oncology.

Single Photon Emission Computed Tomography (SPECT) is a tomographic technique. Radioactive gamma rays are emitted from the human body by the injected radiopharmaceuticals. A gamma ray detection camera captures two-dimensional images from more than one angle. The tomographic reconstruction algorithm is applied to the two-dimensional images to form a three-dimensional image. The final image is manipulated to view images of the human body along a desired axis. The majority of SPECT usage in the U.S. is for cardiac imaging. The global market for nuclear imaging, which encompasses PET, PET/CT, and SPECT instruments, was worth \$ [REDACTED] in [REDACTED] and it is likely to have a value of \$ [REDACTED] in [REDACTED].

The ultrasound market has been a stable presence that continues to expand. While 2D ultrasounds have the largest market share due to its wide use in brain tumor and fetal screening and its low cost, 3D and 4D imaging has grown as new applications are developed. Traditionally, ultrasound is primarily used to capture images for gynecology, vascular, and cardiac care. However, its application has broadened into orthopedics, critical care, sports medicine, rheumatology, pain clinics and numerous other medical specialties and has contributed to market expansion. For instance, high-intensity focused ultrasound (HIFU) is being used for treating prostate cancer. The other therapeutic use of ultrasound is for treating kidney stones and gallstones using extracorporeal shockwave lithotripsy. Point of care ultrasound, which saw double-digit growth in [REDACTED], is another major driver. The global market for ultrasound systems in [REDACTED] was worth about \$ [REDACTED] and it has the potential to reach \$ [REDACTED] by [REDACTED].

Mammography has come a long way: from the first breast-specific X-ray unit (Sénographe), to the modern second-generation digital mammography systems such as the Mammomat Inspiration. The modern digital mammography systems can detect lesions as small as 0.2 cm in size allowing early treatment and improving overall breast cancer survival statistics substantially. Growth is being driven by the incidence of breast cancer as the population ages and the increase in early detection throughout the world. Technological advances contributing to growth include the greater use of 3D systems and advanced systems that can overcome issues of imaging dense breast tissue. The global market for breast imaging systems was valued at \$ [REDACTED] in [REDACTED], and it will be worth about \$ [REDACTED] in [REDACTED].

The worldwide market for mobile C-arms and fluoroscopy is to grow at slow but steady CAGR of [REDACTED]% during the forecast period. Increasing number of hospitals and diagnostic units are the important factors driving the demand for fluoroscopy and mobile C-arms. Rapidly growing aging population in almost all geographic regions has been the major cause of increased number of orthopedic surgeries. The introduction of innovative C-arms for multiple applications is expected to increase the demand for C-arms. Full mobile C-arms have a greater demand than the mini mobile C-arms. The global market for fluoroscopy and C-arm systems in [REDACTED] had a value of \$ [REDACTED] and this value is likely to reach \$ [REDACTED] in [REDACTED].