### CHART SMART: CONTRAST MEDIA DELIVERY SYSTEMS

#### Company info
- **ACIST Medical Systems Inc.**
  - Eden Prairie, MN
  - www.acist.com
- **E-Z-EM Inc.**
  - Lake Success, NY
  - www.ezem.com

#### Product name
- **ACIST CT® Contrast Delivery System**
  - ACIST Voyager and CMS 2000
- **EmpowerCT A Double Barrel CT Injector System**
- **EmpowerCT Injector System**
  - EmpowerMR (S10K pending)

#### List price
- **$39,995**
  - N/A
- **$19,500-25,000**
  - N/A

#### For use with
- **Cardiac, vascular angio**
  - N/A
- **CTA**
  - CT
  - MR

#### Syringe capacity (ml)
- **100 (up to 5 cases)**
  - N/A
  - 200 (2)
  - 200
  - 100 (2)

#### Syringe features
- **Multiuse (up to 5 cases; same contrast bottle usable for different cases)**
  - Automatic syringe refill/purge during case; user-initiated refill during case
  - Disposable, Y-connector (one-way valves)

#### Does your injector detect used syringes?
- **Yes; touchscreen and CTA 425-specified Can**
  - Software algorithms notify users of preused syringes

#### Bulk contrast container management
- **Multiuse syringe enables same contrast bottle to be used over different cases**
  - Sequential syringe auto initialization; empowering transfer set and IV pole accessory for auto fill of contrast/saline syringes
  - Sequential syringe auto initialization; empowering transfer set and IV pole accessory for auto fill of contrast/saline syringes

#### Saline delivery capabilities
- **Fixed-rate saline delivery**
  - KVO feature with 1 to 10 ml/min (20-minute timeout for maximum dispensed 200 ml saline)
  - Saline chasing contrast injection; intelligent ID reduces syringe content confusion
  - N/A
  - Saline chasing contrast; intelligent ID reduces syringe content confusion

#### MR injector power source
- **N/A**
  - N/A
  - Hydraulic cylinders use standard electric outlet power

#### Flow rate (ml/sec)
- **.8-.40 in increments of .1 for variable-fixed-rate modes**
  - N/A
  - 1-10 in increments of .1

#### Volume range (ml)
- **.8 to 99.9 in increments of .1 (for system with preset range limits); dependent on procedure type and user choice**
  - N/A
  - 1-200 in increments of 1
  - 1-100 in increments of 1

#### Delivery pressure range (psi); selectable pressure increments (psi); overpressure protection features
- **200 to 1,200 for system with preset limits; high-pressure limit alert, injection slow/stop**
  - N/A
  - 40-300 in increments of 1
  - 20-300 in increments of 1
  - 40-300 in increments of 1

#### Injector programming features
- **Cardiac/vascular modes**
  - Presets for flow rates, volumes and pressure limits throughout (diagnostic/interventional) case
  - Flow rate/volume inputted into color touchscreen graphical interface; remote control; stores up to 50 8-phase protocols; auto recall

#### Embolism detection
- **Air detection by sensor on side of disposable contrast tubing attached to patient catheter**
  - N/A
  - Tilts sensor minimizes air embolus by authorizing injection only when injector head tilts 20 degrees below horizontal, forcing air to rear of syringe

#### Extravasation detection
- **N/A**
  - Patch-based, patented extravasation detection system alerts user of possible extravasation; auto injection pauses before clinically significant problem (< 20 ml)
  - Not at this time

#### Describe your console controls
- **27 cm (10.5”) color touchscreen with flexible mounting options**
  - Yes; touchscreen and AngioTouch® variable-rate hand controller (for preprogrammed contrast delivery) provide input
  - Color touchscreen runs injector software; optional CT capability and contrast management/injector information system (with networked remote access)
  - 8 filling keys on injector head; 4 contrast keys/4 (corresponding) saline keys;
  - 2 color-coded key sets on injector base; injector indicator of ram movement;
  - Redundant sets for easy control

#### Do you have an air detector?
- **Yes; air-detection sensor on disposable contrast tubing attached to patient catheter (injection ceases if air detected)**
  - N/A
  - Not at this time

#### Key safety features
- **Overpressure protection**
  - Air detection
  - Extravasation detection, tilt sensor lockout, injector arming, on-the-spot flow rate control, pressure limiting, Y-connector (one-way valves), intelligent syringe ID, voice prompts

#### Adjustable rise time?
- **Yes; user-defined from 0 to 1 sec in .1 sec increments**
  - N/A
  - N/A

#### Adjustable time stop (by increments?)
- **.8-99.9 ml in .1 ml/sec increments (for system with preset range limits based on procedure type and user choice)**
  - N/A
  - N/A

#### Interface with an X-ray generator?
- **Yes, with major manufacturers (including Siemens, GE, Philips and Toshiba)**
  - N/A
  - N/A

### ANGIOGRAPHY FEATURES

#### Adjustable rise time?
- **Yes; user-defined from 0 to 1 sec in .1 sec increments**
  - N/A
  - N/A

#### Adjustable time stop (by increments?)
- **.8-99.9 ml in .1 ml/sec increments (for system with preset range limits based on procedure type and user choice)**
  - N/A
  - N/A

#### Interface with an X-ray generator?
- **Yes, with major manufacturers (including Siemens, GE, Philips and Toshiba)**
  - N/A
  - N/A
<table>
<thead>
<tr>
<th>Mallinckrodt</th>
<th>OptiVantage™ DH</th>
<th>Optistar® LE</th>
<th>CT 9000® ADV</th>
<th>Angiomat Illuмен®</th>
<th>OptiStat™</th>
<th>MEDRAD Avanta™ Fluid Management Injection System</th>
</tr>
</thead>
<tbody>
<tr>
<td>$33,500-39,500</td>
<td>$39,500</td>
<td>$18,800-27,000</td>
<td>$21,900-32,860</td>
<td>$8,000-9,500</td>
<td>$42,000-45,000</td>
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<tr>
<td>CT</td>
<td>MRI</td>
<td>CT</td>
<td>Angio, cath lab</td>
<td>CT</td>
<td>CCL, angio</td>
<td></td>
</tr>
<tr>
<td>200 (disposable frontload); 50, 75, 100, 125 (prefilled)</td>
<td>200 (disposable frontload); 50, 75, 100, 125 (prefilled)</td>
<td>10, 15, 20 and 30 (prefilled compatibility)</td>
<td>150, 200 (disposable); 50, 75, 100, 125 (prefilled); 150 (prefilled)</td>
<td>130 (disposable, Liebel Flarsheim); 50, 75, 100, 125 (prefilled)</td>
<td>150</td>
<td></td>
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<tr>
<td>Disposable, prefilled, single/ Y-tubing (0, 1, 2 check valves)</td>
<td>Disposable, prefilled</td>
<td>Disposable, prefilled, reusable</td>
<td>Disposable, prefilled</td>
<td>Disposable, prefilled</td>
<td>Disposable, prefilled</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Auto fill sequence allows repeated filling with user-set volumes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Saline precedes or succeeds contrast</td>
<td>No</td>
<td>Yes</td>
<td>Saline follows contrast</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>AC power (no batteries required)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>1-10</td>
<td>1-9.9</td>
<td>.01-40</td>
<td>1-6</td>
<td>1-10 in increments of .1 (contrast variable flow); 1-45 in increments of 1 (contrast fixed flow); 1.25 (saline fixed flow)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-200</td>
<td>1-120</td>
<td>1-200</td>
<td>.5-150</td>
<td>1-130</td>
<td>1-150 in increments of 1 (refillable from attached bulk source to connected contrast bottle)</td>
<td></td>
</tr>
<tr>
<td>25-325</td>
<td>20-200</td>
<td>25-300</td>
<td>75-1,200 (angle)</td>
<td>Dependent on flow rate up to 225</td>
<td>300-1,200 in increments of 1, electro-mechanical/software overpressure protection</td>
<td></td>
</tr>
<tr>
<td>Powerhead touchscreen (at patient side) or remote console entry of injection protocols</td>
<td>Remote console interface for quick protocol entry</td>
<td>Flow/volume entered via handheld unit</td>
<td>Up to 40 customizable protocols including variable fixed-flow mode, volumes, rate, pressure limit, rise time, inject/scan delay, auto/manual syringe fill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual</td>
<td>Manual, used syringe indicator</td>
<td>Built-in optional air-detection warning system, used syringe indicator</td>
<td>Manual, used syringe indicator</td>
<td>2 separate infrared sensors for saline/contrast fluid level; saline/contrast injection stop/warning message if level drops below sensors and ultrasound gross air detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>Patented pre-injection extravasation check</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color touchscreen (in control room), integrated powerhead console (at patient’s side)</td>
<td>Color touchscreen</td>
<td>Touchscreen</td>
<td>Handheld injector with digital display (ml/sec and syringe volume during injection); rate/volume adjustment arrow buttons</td>
<td>Color touchscreen setup memory for programming, arming, filling, auto priming; syringe volume remaining, peak/accumulated volume, flow rate, pressure, case number, alerts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual</td>
<td>Yes, built-in optional air-detection warning system</td>
<td>Manual</td>
<td>Yes, 2 separate ultrasound gross air detectors for saline/contrast lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OptiVantage DH Powerhead touchscreen enables more clinician time at patient side; preinjection extravasation check</td>
<td>No</td>
<td>Yes; built-in optional air-detection warning system</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OptiVantage DH Powerhead touchscreen</td>
<td>Ultratrace prefilled syringes minimize air introduction risk during filling sequence; powerhead recessed start button eliminates inadvertent injections; technologist starts injection at patient side to check IV site</td>
<td>Ultratrace prefilled syringes minimize air introduction risk during filling sequence; injector software algorithms notify users of prused syringes</td>
<td>Ultratrace prefilled syringes minimize air introduction risk during filling sequence; patented Air Detection Aide/Warning System, bubble resistance, disposable syringes</td>
<td>Ultratrace prefilled syringes minimize air introduction risk during fill sequence; automatic pressure adjustment based upon programmed flow rate</td>
<td>Gross air detection, fluid-level sensor, pressure control, high-pressure tubing, syringe backlighting, injector armed light, contamination/radiation exposure risk reduction</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Yes; 1-10 sec</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>0-9.9 sec (fixed flow)</td>
<td></td>
</tr>
<tr>
<td>Automatic electronic, 1 ml</td>
<td>Automatic electronic, .5 ml</td>
<td>Automatic electronic, 1 ml</td>
<td>1 ml</td>
<td>1 ml</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PET/CT is the May Chart Smart focus. Contact Jill Hoffman, associate editor, at jhoffman@merion.com for more information.
<table>
<thead>
<tr>
<th>Company info</th>
<th>MEDRAD Inc. continued</th>
<th>Nemoto Kyorindo Co Ltd. Tokyo, Japan <a href="http://www.nemoto-do.co.jp">www.nemoto-do.co.jp</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>List price</td>
<td>N/A</td>
<td>N/A ($46,950)</td>
</tr>
<tr>
<td>For use with</td>
<td>Angio in cardiology, radiology and vascular surgery</td>
<td>Angio in cardiology, radiology and vascular surgery</td>
</tr>
<tr>
<td>Syringe capacity (ml)</td>
<td>60, 150, 200</td>
<td>60, 150, 200 (contrast), 115 (saline) 200</td>
</tr>
<tr>
<td>Syringe features</td>
<td>Disposable; FluiDots&lt;sup&gt;®&lt;/sup&gt; on pressure jacket for gross air detection</td>
<td>Disposable, FluiDots, one-time use, 9C°, low-pressure tubing</td>
</tr>
<tr>
<td>Saline delivery capabilities</td>
<td>N/A</td>
<td>Dual syringe injection components; FluiDots for maximum safety (also on Bracco prefilled syringes; compatible with GE prefilled syringes)</td>
</tr>
<tr>
<td>MR injector power source</td>
<td>N/A</td>
<td>Disposable, custom kits, dual syringe injection components (Bracco prefilled syringes available)</td>
</tr>
<tr>
<td>Flow range (ml/sec)</td>
<td>.1-10</td>
<td>Disposable, plunger-style, outside injector filling</td>
</tr>
<tr>
<td>Volume range (ml)</td>
<td>5-200</td>
<td>5-200 (2)</td>
</tr>
<tr>
<td>Delivery pressure range (psi); selectable pressure increments (psi); overpressure protection features</td>
<td>100-1,200 in increments of 1; overpressure controls set pressure limit</td>
<td>50-325 in increments of 50; real-time pressure monitor graph for comparing pressure vs. limit</td>
</tr>
<tr>
<td>Injector programming features</td>
<td>N/A</td>
<td>Stores 32 protocols (up to 6 phases each); protocol and user-configuration memory maintained when system power off</td>
</tr>
<tr>
<td>Embolism detection</td>
<td>N/A</td>
<td>Syringes equipped with FluiDots for easy air/fluid visualization</td>
</tr>
<tr>
<td>Extravasation detection</td>
<td>N/A</td>
<td>Uses patented FluiDots for easy air/fluid visualization</td>
</tr>
<tr>
<td>Describe your console controls</td>
<td>Easy to use</td>
<td>Manual</td>
</tr>
<tr>
<td>Key safety features</td>
<td>N/A</td>
<td>Color LCD touch screen with anatomical protocol selection; creation/ editing capabilities</td>
</tr>
<tr>
<td>Adjustable rise time?</td>
<td>Yes; 0-9.9 sec in .1 sec increments</td>
<td>Yes; can set with each protocol</td>
</tr>
<tr>
<td>Adjustable volume stop (by what increments?)</td>
<td>.1 ml Electronic</td>
<td>N/A</td>
</tr>
<tr>
<td>Interface with an X-ray generator?</td>
<td>Yes</td>
<td>Multiple scanner interface options N/A</td>
</tr>
</tbody>
</table>

**ANGIOGRAPHY FEATURES**

- KVO feature for .25 ml saline delivery at No; extravasation detection addressed at N/A
- CT
- N/A (low-end CT injector price)

**Syringe features**

- Disposable; FluiDots<sup>®</sup> on pressure jacket for gross air detection
- Disposable, FluiDots, one-time use, 9C°, low-pressure tubing
- Dual syringe injection components; FluiDots for maximum safety (also on Bracco prefilled syringes; compatible with GE prefilled syringes)
- Disposable, custom kits, dual syringe injection components (Bracco prefilled syringes available)

**MR injector power source**

- N/A
- Integrated Continuous Battery Charging system for continuous battery power
- N/A

**Flow range (ml/sec)**

- .1-10 in increments of .01 (from .01-3.1); increments of .1 (from 3.1-10)
- 1-10
- 1-9.9
- .1-10

**Volume range (ml)**

- 5-200 (Syringe A); 5 max in increments of .1 (from .5-31 and increments of 1 for 31+); (Syringe B) 1 max in increments of 1
- 1-200 (2)
- 1-200
- 1-200 (contrast); 1-100 (saline)

**Delivery pressure range (psi); selectable pressure increments (psi); overpressure protection features**

- Up to 325 (if injection system can maintain flow rate of 10% of programmed rate for 3 sec; system disarms with stall condition)
- Stores 32 protocols (up to 6 phases each); protocol and user-configuration memory maintained when system power off

**Injector programming features**

- Stores 32 protocols (up to 6 phases each); protocol and user-configuration memory maintained when system power off
- Stores 32 protocols (up to 6 phases/delays)
- Easy-to-use, multiphasic contrast injections

**Embolism detection**

- N/A
- Operator must answer questions prior to arming; warning label on injector head reminds user to check for disposables air; FluiDots indicators on Spectris storage
- Syringes equipped with FluiDots for easy air/fluid visualization
- Uses patented FluiDots for easy air/fluid visualization
- Manual

**Extravasation detection**

- N/A
- No; extravasation detection addressed at company application training
- Meets ACR guidelines (including saline test injection and injection site monitoring)
- Meets ACR guidelines (including injection site monitoring)
- Not at this time

**Describe your console controls**

- Easy to use
- Color touchscreen with few keystrokes; up to 6 programmable phases; pause/hold phases (programmable delay between timing and contrast rate); stopwatch, storage, protocol recall
- Easy-to-use color touchscreen; stopwatch for delayed sequence monitoring (pause in any order)
- FluiDots for air/fluid visualization
- No; air-check button on injector head confirms air expulsion from filled syringes

**Do you have an air detector?**

- Yes
- No; air-check button on injector head confirms air expulsion from filled syringes
- FluiDots for air/fluid visualization
- No

**Key safety features**

- N/A
- Air-check confirmation button, fiberoptic communication; pressure safety limit not to exceed 325 psi
- Saline test injection, real-time pressure monitor graph, syringe FluiDots, remote air check, remote arm, injector head display
- Syringe FluiDots and start/stop injector controls from scan room or control room
- Real-time graphical pressure monitoring, visual air-check reminder; injector self-test at startup and during injection

**ANGIOGRAPHY FEATURES continued**

- KVO feature for .25 ml saline delivery at No; extravasation detection addressed at N/A
- CT
- N/A (low-end CT injector price)
- Inquire with distributor

**Syringe features**

- Disposable; FluiDots<sup>®</sup> on pressure jacket for gross air detection
- Disposable, FluiDots, one-time use, 9C°, low-pressure tubing
- Dual syringe injection components; FluiDots for maximum safety (also on Bracco prefilled syringes; compatible with GE prefilled syringes)
- Disposable, custom kits, dual syringe injection components (Bracco prefilled syringes available)

**Does your injector detect used syringes?**

- N/A
- Recognizes plunger position in new, previously loaded or empty syringes
- No
- Not at this time

**Bulk contrast container management**

- N/A
- Yes
- Auto features for protocol-specific contrast/saline loading; virtually no contrast waste
- Compatible with MEDRAD SVTS transfer sets for non-bulk contrast loading
- Compatible with swabbable spike tubing; auto fill

**Saline delivery capabilities**

- N/A
- KVO feature for .25 ml saline delivery at selected timed intervals to maintain line patency (independent of injection profile)
- Exclusive dual-flow technology for triphasic injections (ideal for cardiac and “triple rule-out studies”); contrast saline delivery in any order; vein patency evaluation, custom protocols
- No saline
- Inquire with distributor

**MR injector power source**

- N/A
- Integrated Continuous Battery Charging system for continuous battery power
- N/A
- N/A

**Flow range (ml/sec)**

- .1-10 in increments of .01 (from .01-3.1); increments of .1 (from 3.1-10)
- 1-10
- 1-9.9
- .1-10

**Volume range (ml)**

- 5-200 (Syringe A); 5 max in increments of .1 (from .5-31 and increments of 1 for 31+); (Syringe B) 1 max in increments of 1
- 1-200 (2)
- 1-200
- 1-200 (contrast); 1-100 (saline)

**Delivery pressure range (psi); selectable pressure increments (psi); overpressure protection features**

- Up to 325 (if injection system can maintain flow rate of 10% of programmed rate for 3 sec; system disarms with stall condition)
- Stores 32 protocols (up to 6 phases each); protocol and user-configuration memory maintained when system power off
- Stores 32 protocols (up to 6 phases/delays)
- Easy-to-use, multiphasic contrast injections
- Injection protocols stored and selected based on anatomical region; up to 125 protocols can be created/naved with each Q-SELECT set; up to 5 Q-SELECT sets available with each Nemoto CF card

**Injector programming features**

- Stores 32 protocols (up to 6 phases each); protocol and user-configuration memory maintained when system power off
- Stores 32 protocols (up to 6 phases/delays)
- Easy-to-use, multiphasic contrast injections
- Injection protocols stored and selected based on anatomical region; up to 125 protocols can be created/naved with each Q-SELECT set; up to 5 Q-SELECT sets available with each Nemoto CF card

**Embolism detection**

- N/A
- Operator must answer questions prior to arming; warning label on injector head reminds user to check for disposables air; FluiDots indicators on Spectris storage
- Syringes equipped with FluiDots for easy air/fluid visualization
- Uses patented FluiDots for easy air/fluid visualization
- Manual

**Extravasation detection**

- N/A
- No; extravasation detection addressed at company application training
- Meets ACR guidelines (including saline test injection and injection site monitoring)
- Meets ACR guidelines (including injection site monitoring)
- Not at this time

**Describe your console controls**

- Easy to use
- Color touchscreen with few keystrokes; up to 6 programmable phases; pause/hold phases (programmable delay between timing and contrast rate); stopwatch, storage, protocol recall
- Easy-to-use color touchscreen; stopwatch for delayed sequence monitoring (pause in any order)
- All programming at injector head
- Color LCD touch screen with anatomical protocol selection; creation/ editing capabilities

**Do you have an air detector?**

- Yes
- No; air-check button on injector head confirms air expulsion from filled syringes
- FluiDots for air/fluid visualization
- No
- Injection stops if less than 4.3 psi detected continuously while 10 ml injected at 1.5 ml/sec or higher; caution message warns user of low pressure while injection continues at 1.4 ml/sec or lower

**Key safety features**

- N/A
- Air-check confirmation button, fiberoptic communication; pressure safety limit not to exceed 325 psi
- Saline test injection, real-time pressure monitor graph, syringe FluiDots, remote air check, remote arm, injector head display
- Syringe FluiDots and start/stop injector controls from scan room or control room
- Real-time graphical pressure monitoring, visual air-check reminder; injector self-test at startup and during injection