

GO WITH THE FLOW: LEVERAGING THE ELECTRONIC MEDICAL RECORD TO ENHANCE CONTRAST SAFETY

Travis Browning, MD

Julie Champine, MD

Kristen Bishop, MD

Jason Wachsmann, MD

UT Southwestern Medical Center at Dallas



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Disclosures

- Travis Browning, MD
 - Physician Advisory Council
 - Hewlett-Packard through VisionIT
 - Clinical Advisor
 - McKesson Enterprise Medical Imaging Group
- Julie Champine, MD
 - None
- Kristen Bishop, MD
 - None
- Jason Wachsmann, MD
 - None

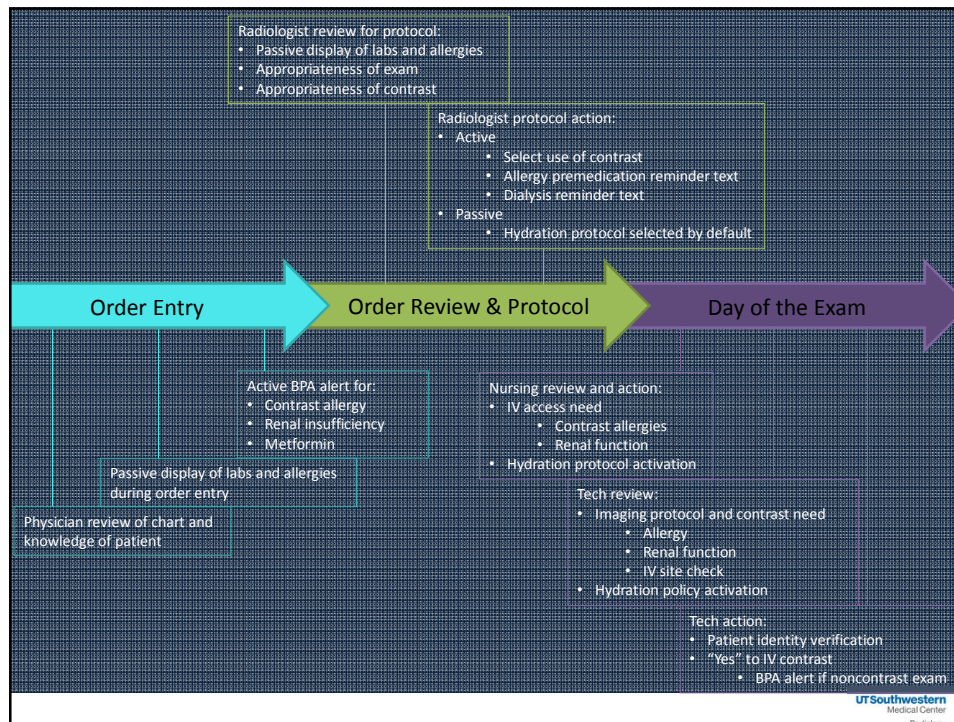
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Background

- Imaging contrast agents are the most commonly used medications in radiology departments
 - Enhance visualization of anatomic structures
 - Provide perfusion characteristics of tissue
- Iodinated contrast is one of the most common contrast agents used
 - Useful for CT, fluoroscopy, and invasive intravascular imaging
 - Critical to be administered safely
 - Contrast induced nephrotoxicity (CIN)
 - Contrast allergies
 - Metformin
 - Administered only when indicated

Purpose

- Leverage the tools within the Electronic Medical Record (EMR) to facilitate identification of patients at risk for adverse events related to iodinated contrast and embed clinical decision support
 - At order entry
 - At order review and protocol
 - At exam preparation and performance
 - Using
 - Information displays and print groups
 - Order sets
 - Best Practice Alerts (BPA)
 - Workflow processes – protocoling, technologist navigators



"Grouper" Build

- Our EMR (Epic Systems, Verona, WI) includes a "Grouper" functionality
 - Allows for custom grouping of orders, medications, other elements
 - Separate from other categories like modality, anatomy, location, class, etc....
 - Used to facilitate clinical decision support
 - We developed 2 groupers for our use:
 - Contrast Grouper – included all types of iodinated contrast
 - Contrast Exam Grouper – included all exams that use iodinated contrast

Display of Information

- Simply displaying needed information at the time of decision making aids in clinical decision support
 - We utilized the two basic paradigms of clinical decision support workflow:
 - Passive – no action required to have information display
 - Does not interrupt workflow
 - Interruptive – based on an action taken
 - Display of information interrupts the user workflow
 - Forces action, acknowledgement

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Passive – Renal Status Labs at Order Entry

Unsigned Orders new orders, reorders, and modifications [Next](#)

After visit Procedures (1 Order)

CT Abdomen W & W/O IV Contrast Accept Cancel Remove

Priority: Routine Routine

Class: OP Appt

Status: Future Expected:

Last Resulted:

Lab Test Results

Component	Time Elapsed	Value	Range	Status
CREATININE	6 days (08/07/15 1454)	1.36 (H)	0.51 - 0.95 mg/dL	Final result
eGFR NON-AFRICAN AMERICAN	6 days (08/07/15 1454)	40	mL/min/1.73m2	Final result
eGFR African American	6 days (08/07/15 1454)	49	mL/min/1.73m2	Final result

Questions:

1. Reason for exam: Abdominal Pain

2. Modify procedure in the interest of radiological appropriateness? Yes No

Single response

Process Inst:

Pelvic anatomical region will NOT be included. Structures including from the level of the umbilicus/iliac crests and below will NOT be imaged. Please order "CT Abdomen/Pelvis" if imaging of both regions is desired.

Comments (F6): [Click to add text](#)

Accept Cancel Remove

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Interruptive – Allergy Alert at Order Validation

Order Validation

The following information is missing or may need your attention

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug Ingredient): DIATRIZOATE SODIUM
Allergy: Iodine(Drug Ingredient)

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug Ingredient): IODINE
Allergy: Iodine(Drug Ingredient)

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug Ingredient): IOHEXOL
Allergy: Iodine(Drug Ingredient)

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug Ingredient): IODIXANOL
Allergy: Iodine(Drug Ingredient)

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug): DIATRIZOATE MEGLUMINE-D.SODIUM
Allergy: Iodine(Drug Ingredient)

Order-Allergy Interaction
Order: CT Abdomen W IV Contrast
Allergen in order(Drug Class): IODINATED CONTRAST MEDIA - IV DYE
Allergy: Iodine(Drug Ingredient) (Cross-sensitive)

Medication allergy alert firing at signing of order. Provides no further support, but requires acknowledgement to proceed.

☒ Accept ☐ Cancel

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Electronic Protocols

- Electronic protocoling allows protocol selection to be discretely captured in the EMR
 - Can be made visible in other electronic workflows as information display
 - Allows for auditable timestamp and provider identification
 - Mimics those elements of Computerize Provider Order Entry
 - Can be considered the radiologist's "orders"
 - Initiate non-provider workflows and care protocols
 - Contrast administration
 - Lab draws
 - Renal prophylaxis regimes

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Electronic Protocols

Common contrast alterations can be entered by radio button or free text. Will display for the scheduler and performing technologist.

Allergies: Penicillins, Mycins [Other]

Passive display of renal

Protocol regarding hydration

Entry of passive text reminder to display for performing technologist regarding contrast allergy prophylaxis.

Order Sets

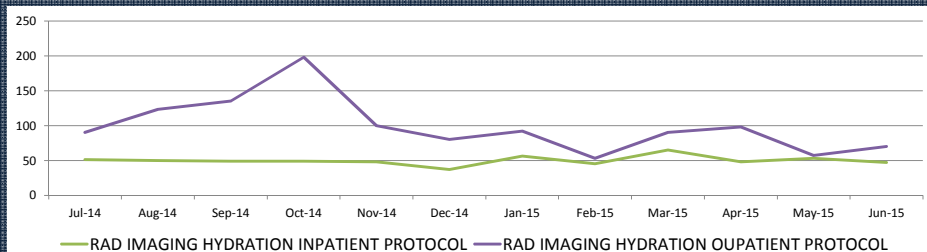
- Preprogrammed groups of orders utilized in specific clinical situations
 - Reduce time and error in order entry
 - Within our EMR, order set have a unique identifier allowing for track of usage
 - Who, when, where
 - Measure, evaluate, monitor
 - Our order sets for contrast safety
 - Contrast allergy prophylaxis
 - Renal nephrotoxicity prophylaxis – hydration protocol
 - Inpatient
 - Outpatient

Order Sets – Hydration

- IV hydration prophylaxis protocol
 - Initiated by radiologist protocoling step
 - Nursing Cr/eGFR testing if patient meets specified criteria and no result within 30 days
 - Or otherwise specified in radiologist entered protocol
 - Initiation of IV hydration if eGFR 30-59
 - Performed by radiology for outpatients
 - Suggested to treatment teams for inpatients
 - Outpatient to return in 48 hours for repeat Cr check in radiology
 - If worsened, radiologist is notified for further instructions

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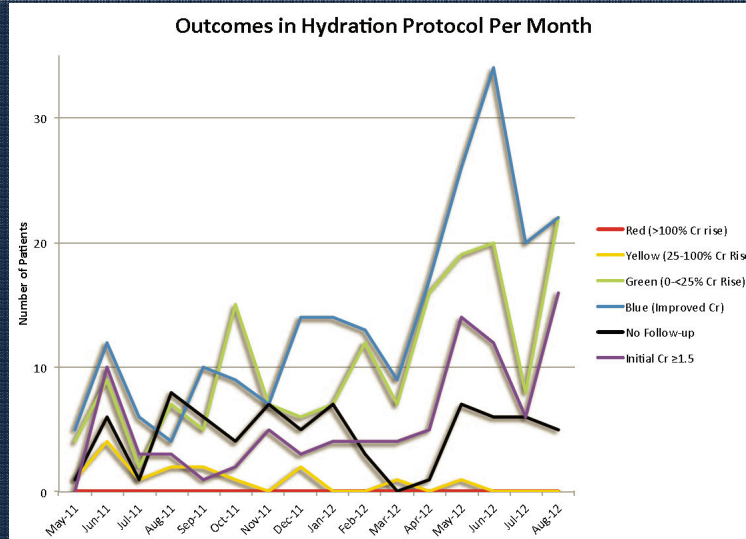
Hydration Prophylaxis Order Set



	2014-07	2014-08	2014-09	2014-10	2014-11	2014-12	2015-01	2015-02	2015-03	2015-04	2015-05	2015-06
AMBULATORY RENAL INSUFFICIENCY BPA ALERT	158	210	176	176	208	141	163	164	169	184	195	220
--	107	155	115	125	144	84	119	113	104	113	124	141
I will Remove the Order	1	4	5	1	1	3	1	1	4	3	2	5
Not Done-Medical Reason	5	1	5	5	4	2	1	4	3	7	6	5
Other	15	14	26	21	23	17	17	16	18	24	22	20
Patient has Tolerated Therapy Previously	30	36	25	24	36	35	25	30	40	37	41	49
INPATIENT RENAL INSUFFICIENCY BPA ALERT	294	348	327	316	281	320	325	303	393	342	330	358
--	218	253	229	223	196	211	233	219	269	234	216	257
I will Remove the Order	4	5	3	4	2	6	12	7	2	3	3	4
Not Done-Medical Reason	6	16	11	11	21	17	22	16	17	22	22	17
Other	44	53	58	49	37	53	30	42	72	48	58	48
Patient has Tolerated Therapy Previously	22	21	26	29	25	33	28	19	33	35	31	32
Grand Total	452	558	503	492	489	461	488	467	562	526	525	578

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Outpatient Hydration Order Set – 48 Hour Outcomes



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Best Practice Alerts (BPA)

- BPAs are an interruptive form of clinical decision support
 - Displays patient specific data
 - Offers recommendations or guidelines on actions to take
 - Can facilitate taking those actions
 - Embedded hyperlink to recommended orders or order sets
 - Track acknowledgement and justification responses
- System logic created to determine when BPAs “pop-up” to alert
 - EMR “Groupers” facilitate this workflow
 - For example, if ordering an exam in the “Contrast Exam Grouper” and patient has an allergy to a medication in the “Contrast Grouper”, then trigger Contrast Allergy BPA

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BPA – Renal Insufficiency

BestPractice Advisory -

⚠ Use of iodinated IV contrast is strongly discouraged in patients with significant renal impairment. Please take appropriate actions. **For eGFR between 30 and 60, consider using IV hydration (order set below)**

Last CREATININE=1.36 mg/dL on 8/7/2015
 Prev CREATININE=1.33 mg/dL on 6/15/2015
 Last EGFRNAA=40 mL/min/1.73m2 on 8/7/2015
 Last EGFRAA=49 mL/min/1.73m2 on 8/7/2015

☒ Open Order Set: Rad Imaging Hydration Inpatient Protocol [preview](#)

Renal insufficiency BPA triggers when ordering Contrast Exam Grouper test with last eGFR <60. The inpatient version includes hyperlink to inpatient hydration order set for consideration. Outpatient is only informative, as hydration is directed by the radiology department.

BestPractice Advisory -

⚠ Use of iodinated IV contrast is strongly discouraged in patients with significant renal impairment. Please take appropriate actions.

Last CREATININE=1.36 mg/dL on 8/7/2015
 Prev CREATININE=1.33 mg/dL on 6/15/2015
 Last EGFRNAA=40 mL/min/1.73m2 on 8/7/2015
 Last EGFRAA=49 mL/min/1.73m2 on 8/7/2015

[Accept](#) [Cancel](#)

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BPA – Contrast Allergy, BPA – Metformin

BestPractice Advisory - NpcRoundEight,Pavarotti

⚠ You have ordered a test that contains IV contrast on this patient taking Metformin. Please discontinue Metformin for the 48 hours AFTER the test to avoid risk of lactic acidosis.

⚠ You have ordered an imaging test with iodinated contrast. Patient has an allergy as listed below.

- If reaction is nausea or vomiting, no prophylaxis necessary.
- If reaction is swelling, hives or itching consider prophylaxis (orderset below)
- If reaction is anaphylaxis or airway compromise consider different test or contact radiology at 2-XRAY

Allergies as of 8/13/2015 Reviewed On: 8/13/2015 By: Wyatt, Christopher, RH

Allergen	Noted	Reaction Type	Reactions
Iodine	08/13/2015		
Peanut	05/12/2015		Anaphylaxis

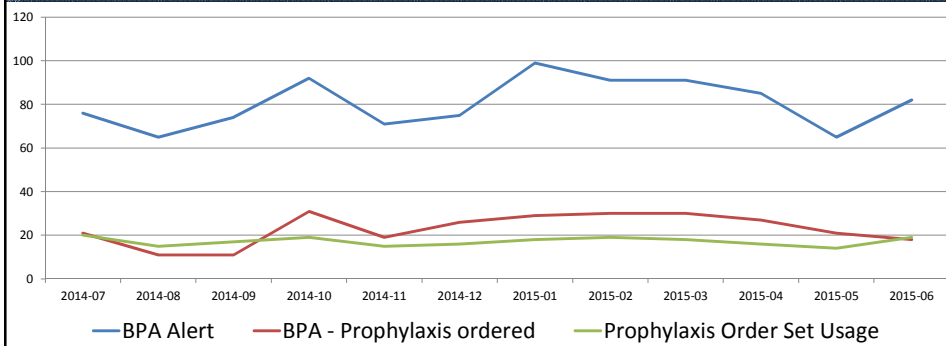
☒ Open Order Set: Rad Iodine Contrast Allergy Prophylaxis [preview](#)

[Accept](#) [Cancel](#)

Contrast Allergy BPA displays the type of allergen and type of reaction. Also used to facilitate proper prophylaxis orders when appropriate.

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BPA – Allergy Alerts, Prophylaxis Order Set Usage



	2014-07	2014-08	2014-09	2014-10	2014-11	2014-12	2015-01	2015-02	2015-03	2015-04	2015-05	2015-06
PKMOD CT W/CONTRAST AND ALLERGY	76	65	74	92	71	75	99	91	91	85	65	82
--	36	36	40	43	38	40	45	43	40	42	26	46
Not a true allergy	8	10	10	6	5	3	7	4	8	4	5	6
Order will be removed	11	8	13	12	9	6	18	14	13	12	13	12
Prophylaxis ordered	21	11	11	31	19	26	29	30	30	27	21	18
Grand Total	76	65	74	92	71	75	99	91	91	85	65	82

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BPA – Metformin Alerts

- This BPA is primarily for information display
 - Remind inpatient provider patient is on metformin and will need to hold for contrast imaging
 - Remind inpatient provider ordering metformin patient has recently had contrast imaging and need to check renal status

	2014-07	2014-08	2014-09	2014-10	2014-11	2014-12	2015-01	2015-02	2015-03	2015-04	2015-05	2015-06
Inpatient BPA – Ordering iodinated contrast imaging on patient with metformin	420	413	424	461	384	379	458	469	451	505	502	445
--	351	356	338	346	291	293	350	358	359	394	370	347
Declined: Provider Preference	47	44	62	88	58	66	88	73	70	75	97	68
Does not meet criteria	22	13	24	27	35	20	20	38	22	36	35	30
Inpatient BPA – Ordering metformin on patient with iodinated contrast within 48 hours	59	66	55	85	45	43	72	50	63	42	73	65
--	59	66	55	85	45	43	72	50	63	42	73	65
Grand Total	479	479	479	546	429	422	530	519	514	547	575	510

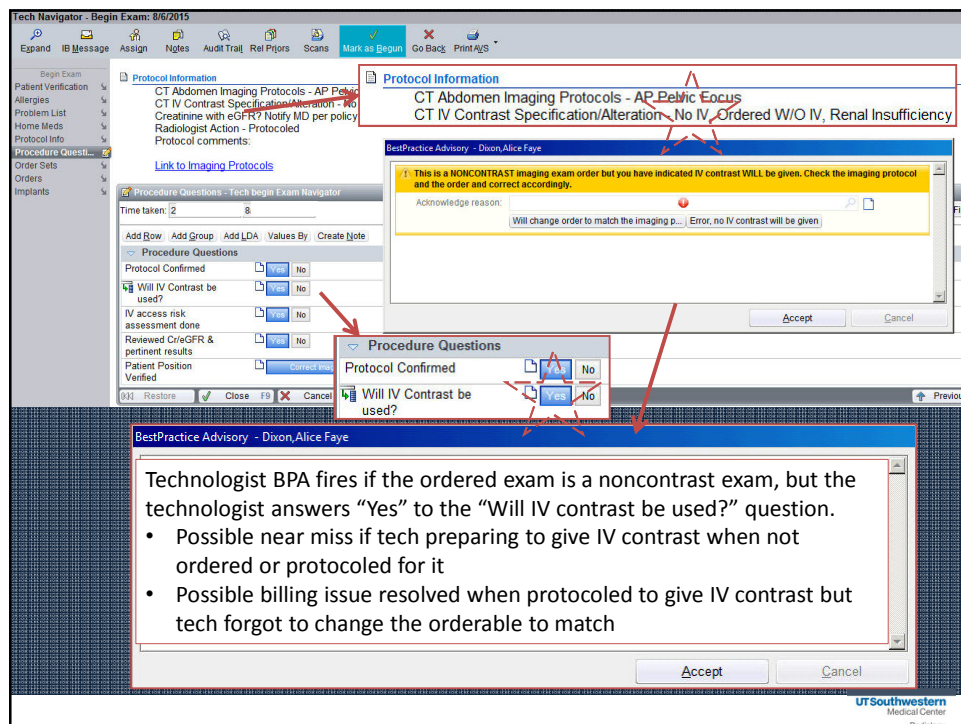
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Technologist Exam Begin Navigator

- Workflow Navigators are used in the EMR to facilitate proper completion of certain tasks
 - Organized as a sequential series of steps
 - Differing elements can display based on patient characteristics
 - Gender, age, other data elements
 - Captures answers/acknowledgement entries
 - Supports cascades of additional questions based on earlier answers
 - Displays information
 - Reminders to perform IV assessment and review renal labs
 - Auditable

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The screenshot displays the 'Tech Navigator - Begin Exam' window. The left sidebar lists various exam steps: Begin Exam, Patient Verification, Allergies, Problem List, Home Meds, Protocol Info, Procedure Questions, Order Sets, Orders, and Implants. The main window is divided into two panes. The top pane, titled 'Protocol Information', shows details for 'CT Abdomen Imaging Protocols - AP 1', including 'Creatinine with eGFR? Notify MD per policy - Cr & Hydration by policy', 'Radiologist Action - Protocolized', and 'Protocol comments:'. A red box highlights this section, with an arrow pointing to a text box stating 'Radiologist entered protocol details from electronic protocoling step.' The bottom pane, titled 'Procedure Questions - Tech begin Exam Navigator', contains a 'Time taken' field, 'Add Row', 'Add Group', 'Add LDA', and 'Values By' buttons. Below these are 'Procedure Questions' with 'Yes/No' checkboxes. A red box highlights the question 'Will IV Contrast be used?' with a 'Yes' selection. An arrow points from this question to a text box stating 'Cascade question displays based on preceding answer become interruptive reminders to perform IV safety checks.' Below this question are two more questions: 'IV access risk assessment done' and 'Reviewed Cr/eGFR & pertinent results', both with 'Yes' selections. At the bottom of the window are buttons for 'Restore', 'Close', 'F9', and 'Cancel'.

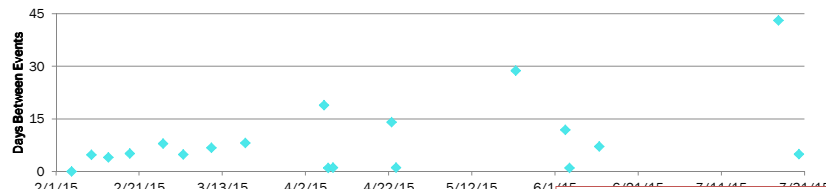


Exam Begin Navigator BPA – Outcomes

- BPA Alert activated February 2015
 - Fired 36 times between February 1st and July 31st, 2015
 - 19 possible near miss IV contrast administration
 - 12 different technologists
 - 9 reminder to change orderable to match protocol
 - Ordered as W/O IV contrast, protocolled with IV contrast
 - 7 different technologists
 - 5 workflow issues
 - Noncontrast exam processed in Epic AFTER contrast exam
 - 4 different technologists
 - 3 unclear how triggered
 - 2 exams ordered and protocolled with IV contrast, but changed to noncontrast due to day of exam eGFR
 - 1 exam ordered with IV contrast, protocolled without contrast, and technologist appropriately handled

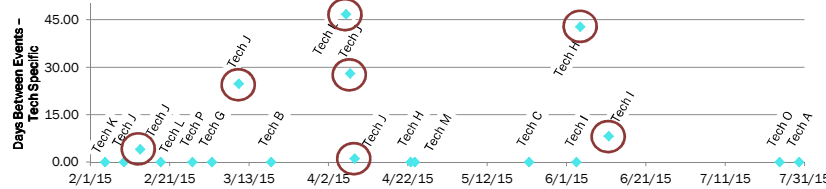
Exam Begin Navigator – Outcomes

Possible Near-Miss IV Contrast Administration Prevented by BPA (19)
Average Days Between = 9.7; Median Days Between = 6.0



Circles indicate recurrence by the same tech, helping to identify when an intervention is needed.

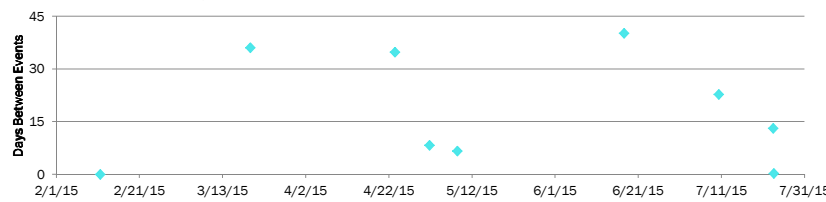
Possible Near-Miss IV Contrast Administration Prevented by BPA (19) – Technologist Specific



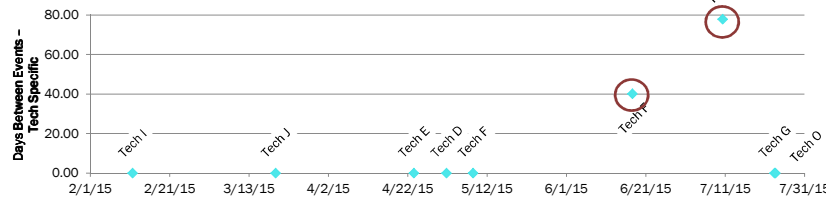
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Exam Begin Navigator – Outcomes

Exam Type Changes for Proper Coding Aided by BPA (9)
Average Days Between = 20.3; Median Days Between = 17.9



Exam Type Changes for Proper Coding Aided by BPA (9) – Technologist Specific



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Conclusions

- Leveraging tools and workflows within the EMR can facilitate identification and management of patients at risk from allergies or nephrotoxicity related to iodinated contrast
- Embedding contrast related workflow tools at exam order entry, exam protocoling, and Exam Begin processes can produce a multilayer system of safety