Criteria for placing extravasation sensor devices on patients to prevent massive extravasation of contrast material at contrast enhanced CT

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Introduction

- Massive contrast material (CM) extravasation at contrast enhanced CT (CECT) leads to serious complications such as compartment syndrome [1].
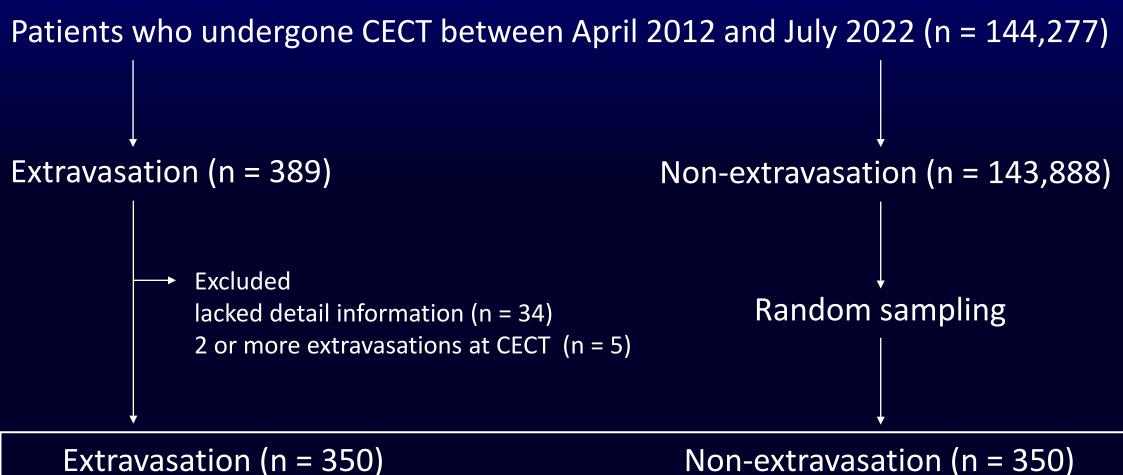
  1. Roditi G, et al. Eur Radiol. 2022.

- While extravasation sensors may be highly sensitive for the detection of extravasation and may prevent serious complications [2], in terms of time and cost they are not practical for all patients [3].

  2. Birnbaum BA, et al. Radiology. 1999.
  3. Rupp JD, et al. Acad Emerg Med. 2016.

- The purpose of this study was to identify risk factors for extravasations during CECT in a large population and to establish criteria for placing the sensor device on patients.

Study population

Patients who undergone CECT between April 2012 and July 2022 (n = 144,277)

Extravasation (n = 389)

Non-extravasation (n = 143,888)

Excluded
lacked detail information (n = 34)
2 or more extravasations at CECT (n = 5)

Random sampling

Extravasation (n = 350)

Non-extravasation (n = 350)

Methods

- We performed multivariate logistic regression analysis between patients with- (n = 350) and randomly-selected patients without CM extravasation (n = 350).

- The outcome variable was the presence or absence of extravasation; the explanatory variables were the age, sex, BMI, hospitalization status, hemodialysis and diabetes mellitus, the use of anticancer drugs, total serum protein, the injection rate, catheter gauge, catheter location, use of existing catheters, and the years of nurse CT experience.

- We examined how the sensitivity to detect CM extravasation changes when the proportion of patients wearing sensor device is changed using results of a receiver operating characteristics (ROC) curve analysis.

Results 1. Frequency of extravasation

- Extravasation occurred in 389 out of 144,277 CECT examinations (0.27%).

- The median estimated extravasation volume was 10 ml (range, 1-40 ml).

Results 2. Multivariate logistic regression with stepwise (AIC)

Predictor	OR	95% CI	p
Injection rate	1.61	1.33 - 1.95	<0.001
Smaller catheter gauge (22–24G)	3.86	1.92 - 7.76	<0.001
Use of anticancer drugs	1.81	1.32 - 2.50	<0.001
Use of existing catheters	1.52	1.10 - 2.11	0.009
Hemodialysis	2.47	0.85 - 7.16	0.094
Diabetes mellitus	0.74	0.52 - 1.06	0.107

AIC: Akaike's information criterion
OR: odds ratio
CI: confidence interval

Results 3. Relationship between sensor sensitivity and percentage of patients placing on sensor devices (%)

Sensitivity (%)	Specificity (%)	Percentage of patients placing on sensor devices (%)
100.0	0.86	99.1
90.0	19.7	80.3
80.0	34.9	65.2
70.0	49.7	50.3
60.6	60.3	39.8
50.3	72.6	27.5

Discussion 1

- Consistent with earlier reports, risk factors for extravasation were the injection rate [1, 4-6], catheter gauge [7-9], and the use of anticancer drugs [8, 10] and of existing catheters [4, 11-14].

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Discussion 2

- The sensitivity for detecting extravasation decreased as the proportion of patients with sensors decreased.

- The percentage of patients appropriately fit with sensors must consider the time required for their placement, their cost, and their sensitivity for detecting extravasation.

- We think that placing a sensor on 40% of patients, and a sensor sensitivity of 60% are reasonable in clinical practice.

Conclusion

Our findings suggest that risk factors for extravasation at CECT are injection rate, catheter gauge, use of anticancer drugs, and use of existing catheters.

These findings may help for adaptation criteria for extravasation sensor devices.