UTILIZATION OF RADIATION-SAVING PRACTICES WITH MYOCARDIAL PERFUSION IMAGING: TEMPORAL TRENDS AND IMPACT ON RADIATION DOSE

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BACKGROUND

- Emphasis on reducing the radiation burden with myocardial perfusion imaging (MPI) has increased in recent years
- As a result, several radiation-sparing practices (RSP) have been described for incorporation with MPI, aiming to enhance patients' safety through reducing radiation dose
- However, RSP adoption at nuclear laboratories remains limited with significant variability among sites
- Effective dose (ED) with MPI at national and international sites continues to be above recommended goals
- Objective assessment of the impact of RSP implementation on ED will support efforts to broaden RSP adoption

OBJECTIVE

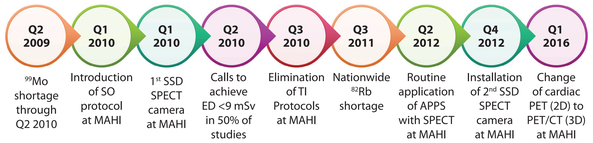
- Examine changes in ED of MPI following the introduction of different levels of RSP at a group of nuclear laboratories

METHODS

- MPI studies performed at Saint Luke's Mid America Heart Institute (Kansas City, MO) between 1/2010 and 12/2016 were identified
- For each study, data on injected radiopharmaceutical dose, stress and imaging protocol followed and camera system used were recorded at the time of study performance
- Utilization of RSP was defined by the elimination of Thallium-based studies, use of PET, stress-only (SO), solid state detector (SSD) SPECT cameras and advanced post-processing software (APPS)
- Participating sites were divided into those with full and limited RSP capabilities, depending on whether or not at least RSP was consistently used
- Effective dose (ED), in mSv, for every study was estimated using standard formulae
- Timeline for introduction of RSP at all sites during study period is summarized in Figure 1

METHODS

FIGURE 1: TIMELINE FOR INTRODUCTION OF RSP AT ALL SITES



STATISTICAL ANAYLYSIS

- Characteristics of patients who underwent MPI at sites with full and limited RSP capabilities were compared using appropriate tests
- hange in mean ED and RSP utilization over time was compared between sites with full and limited RSP capabilities
- Achieved reduction in ED with each RSP modality was compared, relative to no RSP use, between modalities after adjusting for confounders using multiple linear regression

RESULTS

- Total of 56075 patients underwent an MPI during the study period (94.3% at sites with full RSP capabilities)
- RSP was utilized in 72% of studies from sites with full RSP capabilities and in 10% of those from sites with limited capabilities (p <0.001)
- Table 1 shows differences in patient characteristics between sites with full and limited RSP capabilities

TABLE 1: PATIENT CHARACTERISTICS

	Before Match		After 5:1 Match	
	Full RSP	Limited RSP	Full RSP	Limited RSP
Number of studies	52880	3195	15065	3013
Age (years)	65.5 ± 12.2	62.9 ± 12.9	63.7 ±12.1	63.7 ±12.2
Men (%)	55.7	45.9	46.8	46.8
BMI (kg/m²)	30.5 ± 7.2	33 ± 8.9	33 ± 7.3	33.1 ± 7.4
ED (mSv)	6.3 ± 7.9	17.7 ± 9.5	7 ± 5.9	16.3 ± 8.5

- Utilization of RSP increased between 2010 and 2016 at sites with limited and full RSP capabilities (Figure 2, Table 2)

RESULTS

FIGURE 2: UTILIZATION OF RSP

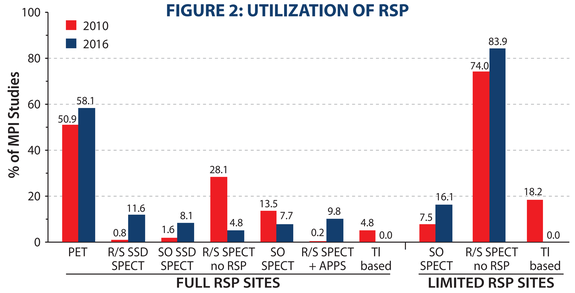


TABLE 2: UTILIZATION OF RSP

	Full RSP Capabilities		Limited RSP Capabilities	
	2010	2016	2010	2016
Number of studies	8561	7644	505	517
ED (mSv)	9 ±15.3	4.7 ± 4.2	18.5 ±7.9	13.8 ± 5
Any RSP use (%)	5741 (67)	7279 (95.2)	38 (7.5)	83 (16.1)
Tl-based (%)	415 (4.8)	0	92 (18.2)	0
Mean ^{201}Tl dose	4.1 ± 1.3	0	4.3 ± 1	0
Median ^{201}Tl dose	4.5 (3.6-4.6)	0	4.5 (4-4.6)	0
R/S SPECT (%)	2405 (28.1)	365 (4.8)	375 (74.3)	434 (83.9)
Mean ^{99m}Tc dose	44.5 ± 13.5	57.4 ± 10.1	60.8 ± 10.6	51.3 ± 13.8
Median ^{99m}Tc dose	41.8 (39.8-44)	61.5 (58-63.4)	61.9 (59.7-64)	60.3 (37.3-62.7)
SO SPECT (%)	1159 (13.5)	588 (7.7)	38 (7.5)	83 (16.1)
Mean ^{99m}Tc dose	27.6 ± 8.8	15.3 ± 10.1	28.3 ± 3.9	22.6 ± 7.9
Median ^{99m}Tc dose	32 (25-33)	9.5 (9-29.2)	29 (25.3-31.7)	20.5 (16.1-32)
R/S SPECT +APPS (%)	21 (0.2)	747 (9.8)	-	-
Mean ^{99m}Tc dose	25.2 ± 5.7	39.5 ± 8.7	-	-
Median ^{99m}Tc dose	27.5 (23.9-28.9)	39.6 (37.1-39.6)	-	-
SO SSD SPECT (%)	135 (1.6)	620 (8.1)	-	-
Mean ^{99m}Tc dose	3.7 ± 2.9	5.1 ±2.6	-	-
Median ^{99m}Tc dose	3.5 (3-3.8)	4.7 (4.3-5.3)	-	-
R/S SSD SPECT (%)	66 (0.8)	883 (11.6)	-	-
Mean ^{99m}Tc dose	31 ± 13.3	20.4 ± 6.3	-	-
Median ^{99m}Tc dose	38.7 (16.7-41.9)	20 (16.9-21.6)	-	-
R/S PET (%)	4360 (50.9)	4441 (58.1)	-	-
Mean ^{82}Rb dose	130 ± 34	68.1 ± 15.6	-	-
Median ^{82}Rb dose	124	70.1	-	-

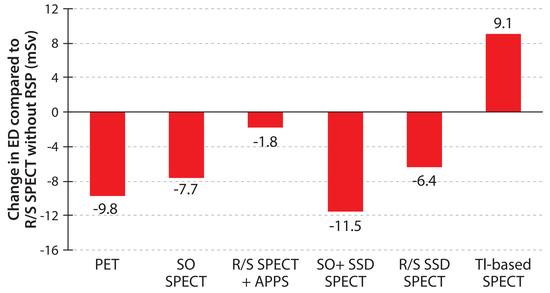
- During the same period, ED decreased significantly at sites with full and limited RSP capabilities, mean difference of 3.3 mSv (95% CI [2.98 – 3.62], p<0.001) and 4.5 mSv (95% CI [3.59 – 5.41], p<0.001), respectively

RESULTS

- Sites with full RSP capabilities had consistently lower ED during the study period compared to sites with limited such capabilities, mean between-group difference of 10.8 ± 8.2 mSv (unadjusted) and 9.5 ± 11.2 mSv (adjusted for age, gender, and BMI)

At sites with full RSP capabilities, use of SO with SSD SPECT camera was the most effective in lowering ED (mean reduction of 11.5 mSv, 95%CI [11.2 -11.7], p<0.001), followed by PET MPI (mean reduction= 9.8 mSv, 95%CI [9.6 -9.9], p<0.001), elimination of Tl-based protocols (mean reduction= 9.1 mSv, 95%CI [8.6 -9.7], p<0.001), and least with SPECT +APPS (mean reduction= 1.8, 95%CI [1.6 -2.1], p<0.001), (Figure 3)

FIGURE 3: RELATIVE EFFICACY OF DIFFERENT RSP APPROACHES IN LOWERING ED AT RSP-CAPABLE SITES



CONCLUSION

- Incorporation of any level of RSP results in significant reduction in ED
- Additionally, access to full RSP capabilities lowers ED to a greater extent and allows reaching recommended radiation targets
- Elimination of Tl-based protocols, use of SO in combination with SSD cameras and utilization of PET MPI are most effective in lowering ED compared to other RSP approaches

DISCLOSURES

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