



# Distributed learning: predictive models based on data from multiple hospitals without data leaving the hospital

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# Distributed learning



Best treatment against cancer is a personalized treatment



Knowledge for what is the optimal personalized treatment is missing



Data to bridge the knowledge gap is available



But... Administrative, ethical, legal and political boundaries!

# Distributed learning

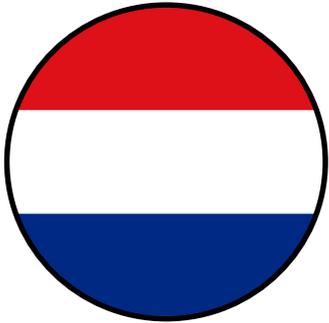


Distributed learning:  
learning from data without  
data leaving the hospital



Train a Bayesian network  
in a distributed manner, to  
predict dyspnea

# Distributed learning



Maastricht

• 123 patients



Eindhoven

• 58 patients



Aachen

• 48 patients



Hasselt

• 24 patients



Liège

• 34 patients



MAASTRO  
UNIVERSITY



MAASTRO  
INNOVATIONS



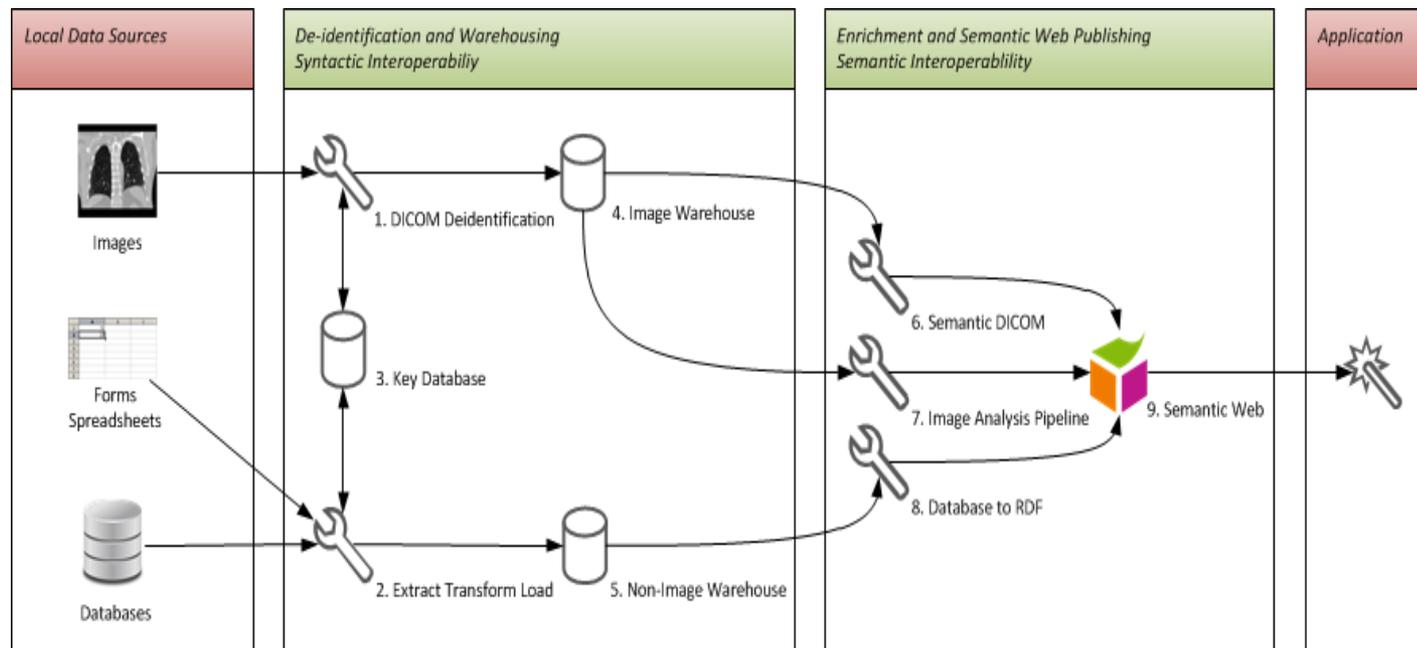
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# Distributed learning



CAT infrastructure installed on each site



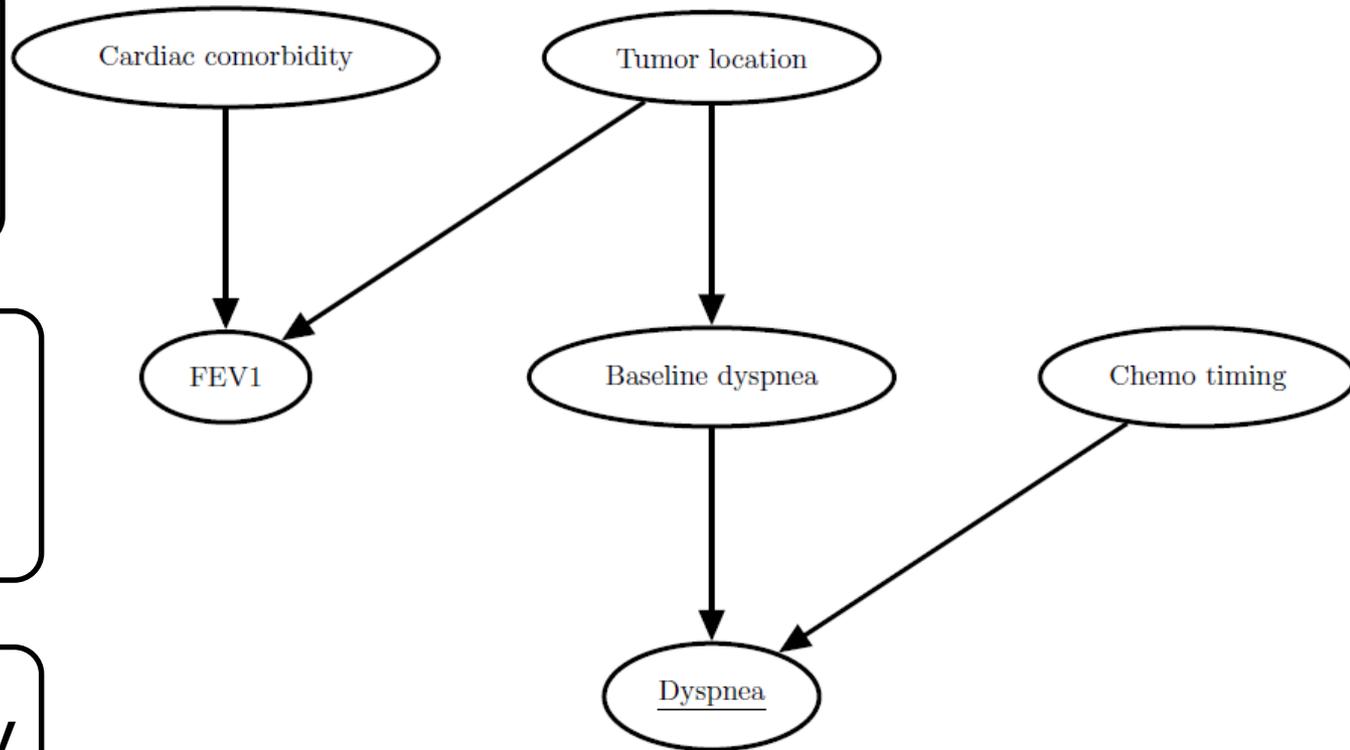
# Distributed learning



**Bayesian  
networks**

*Network  
structure*

**Probability  
tables**



# Distributed learning



Bayesian networks

Network structure

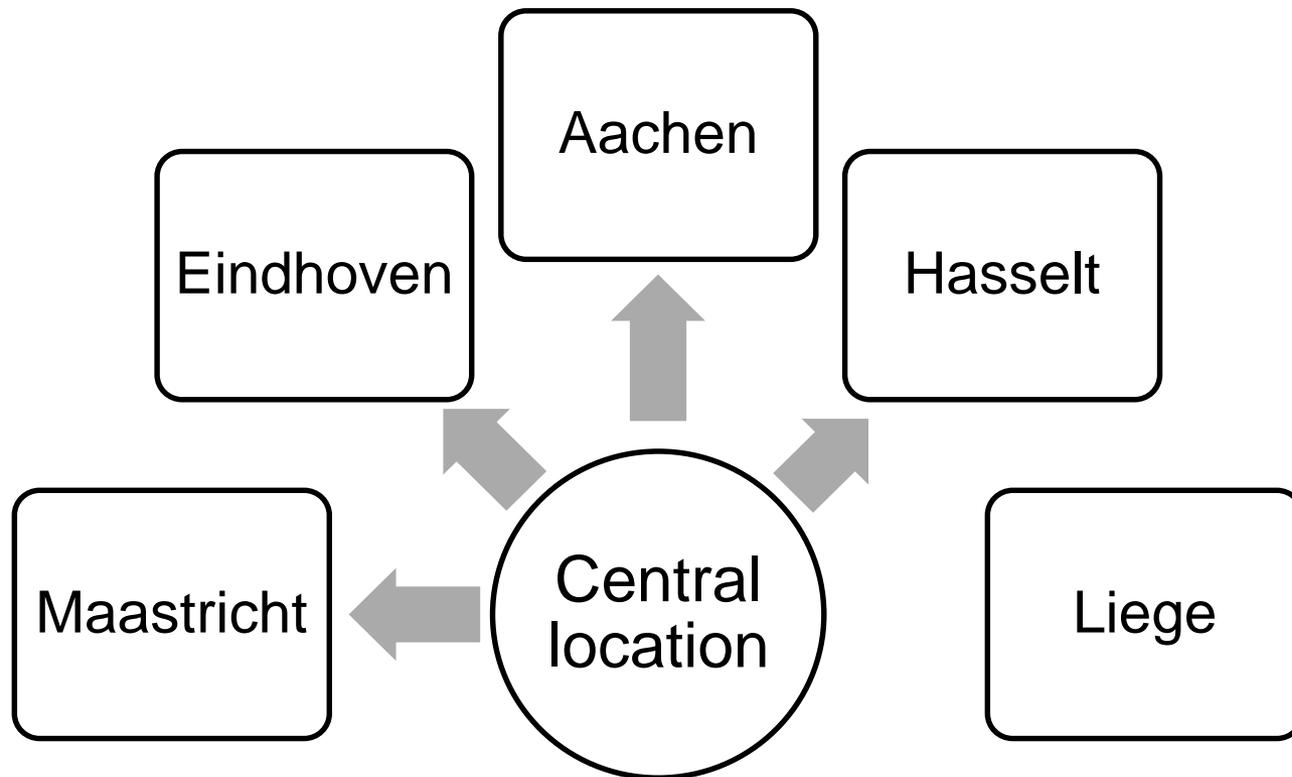
*Probability tables*

Baseline dyspnea	<2	<2	≥ 2	≥ 2
Chemo timing	sequential	concurrent	sequential	concurrent
Dyspnea < 2	0.8	0.7	0.85	0.6
Dyspnea ≥ 2	0.2	0.3	0.15	0.4

# Distributed learning



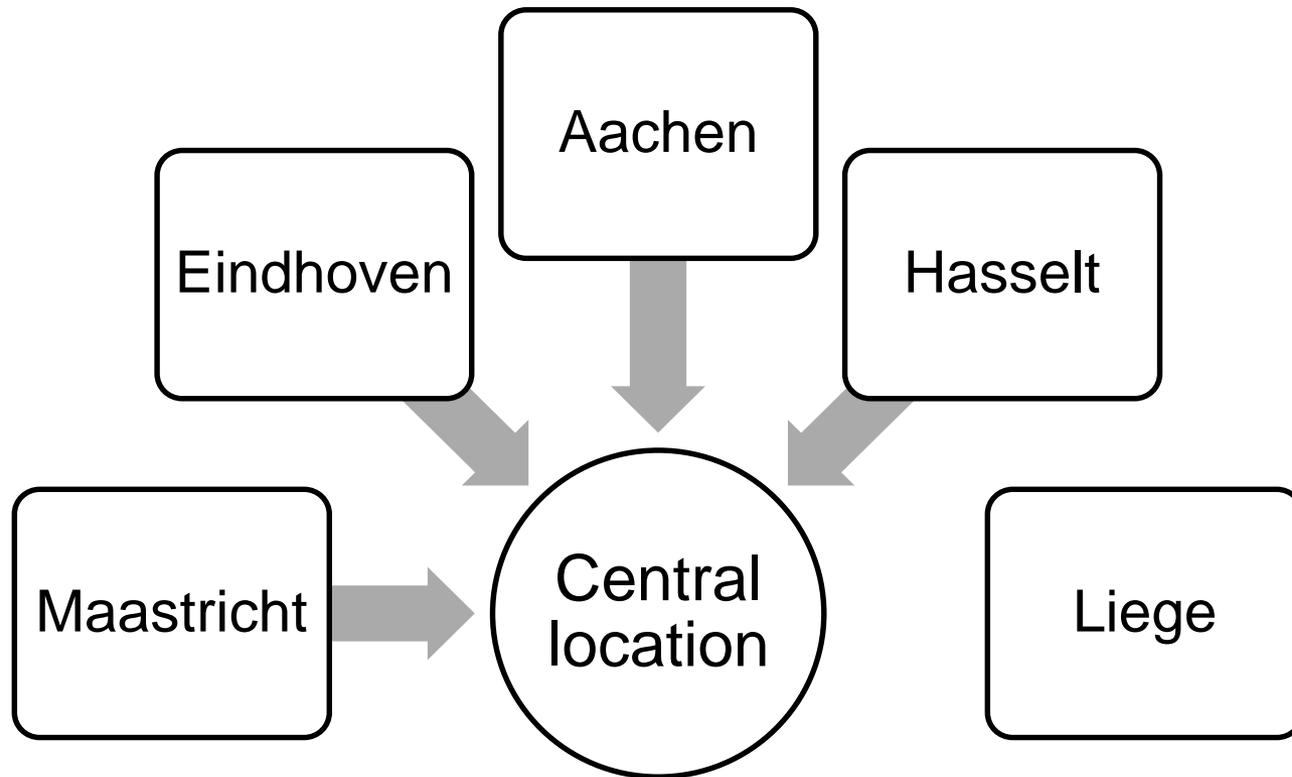
- Step 1: local learning



# Distributed learning



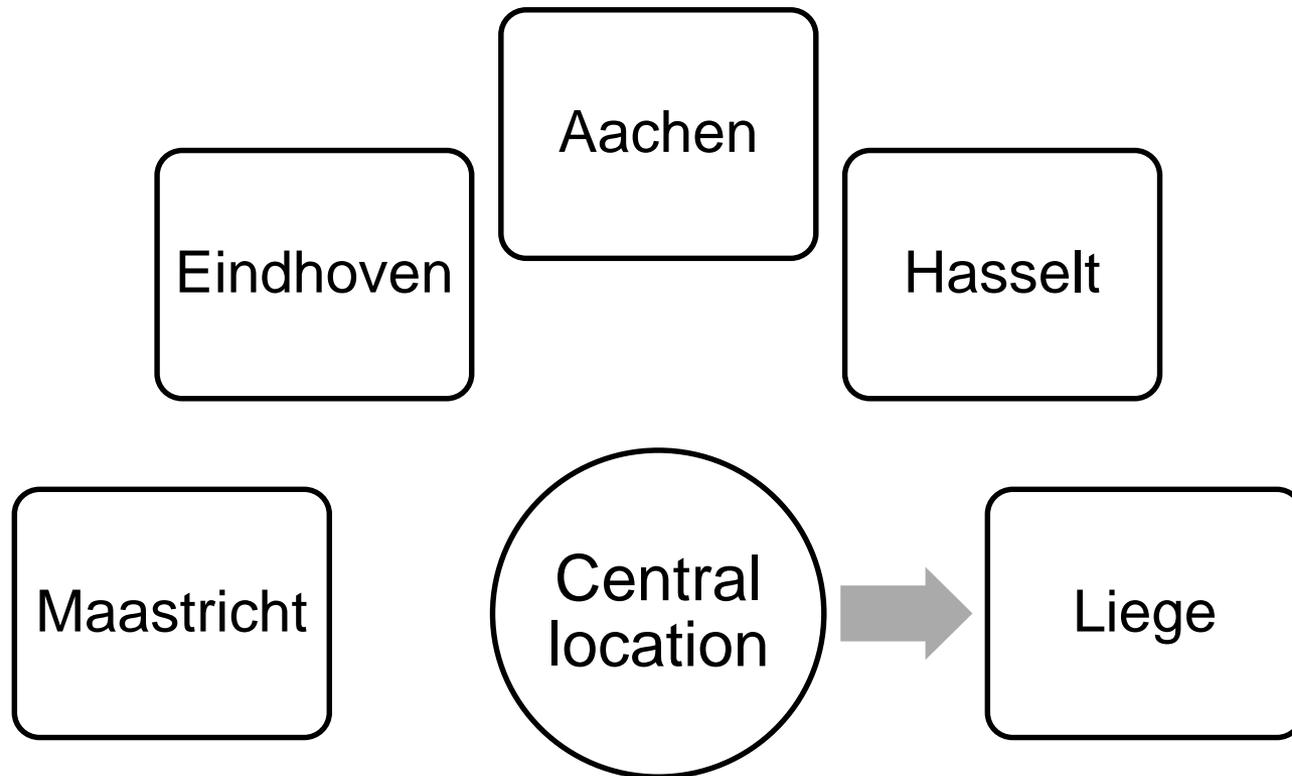
- Step 2: global learning



# Distributed learning



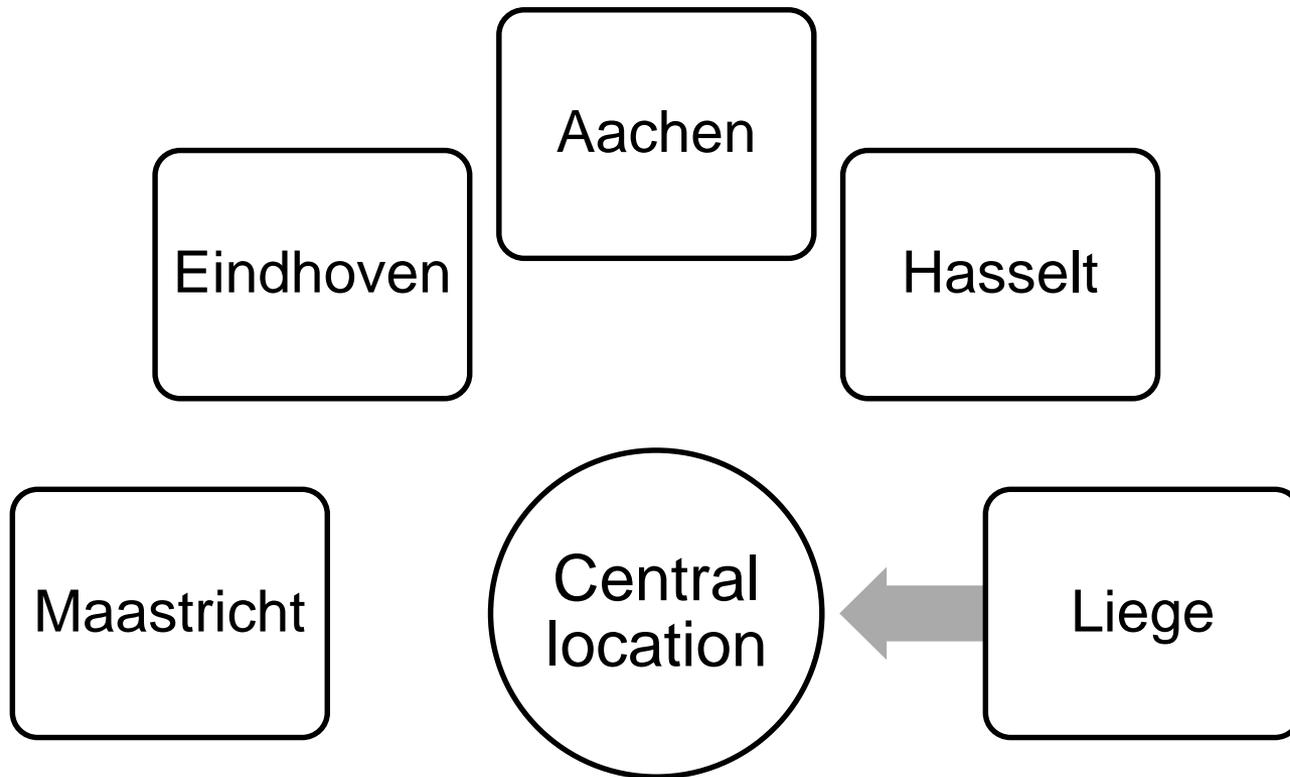
- Step 3: local validation



# Distributed learning



- Step 2: global validation



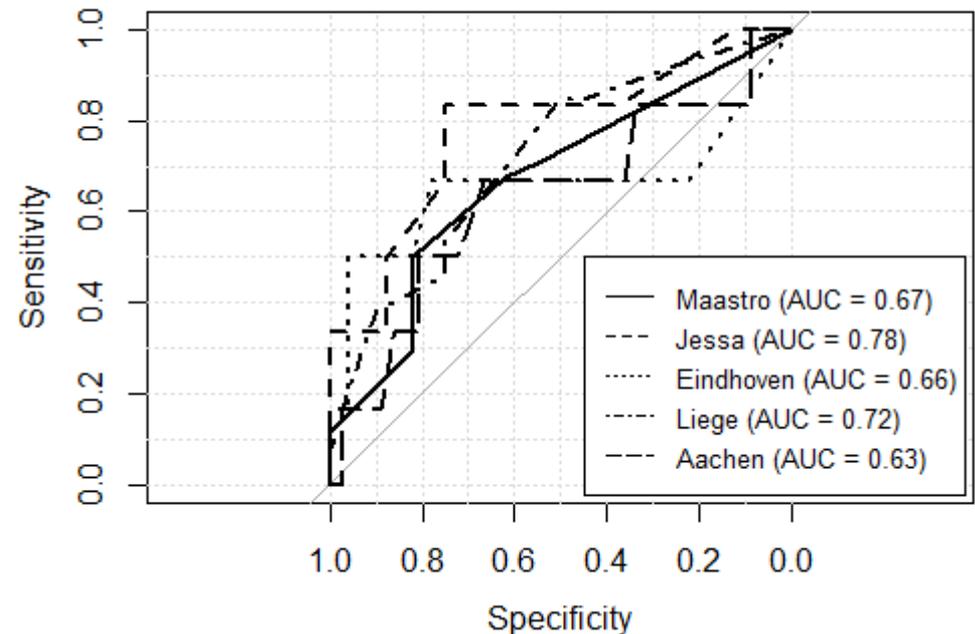
# Distributed learning



## Results

Training on 4 hospitals,  
validation on 1 hospital

AUCs from  
0.63 to 0.78



## Conclusion

- Results are promising
- Future work:
  - more models (survival, esophagitis, radiation-induced lung damage)
  - more data
  - better results

# Distributed learning



## Acknowledgements

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- Uniklinik Aachen (Aachen)
  - Michael Eble
- Chulg (Liege)
  - Philippe Coucke



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# Distributed learning



	Hasselt	Aachen	Liege	Eindhoven	Maastricht
Number of patients	24	48	34	58	123
Neoplasm					
-Lung Carcinoma	10 (42%)	2 (4%)	0(0%)	1 (2%)	6 (5%)
-Non-Small Cell Lung Carcinoma	9 (37%)	30 (63%)	27 (80%)	40 (69%)	91 (74%)
-Small Cell Lung Carcinoma	5 (21%)	16 (33%)	7 (20%)	17 (29%)	26 (21%)
-Missing	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Dyspnea score					
-CTCAE Grade < 2	8 (33%)	36(76%)	20 (59%)	50 (86%)	89(72%)
-CTCAE Grade ≥ 2	6 (25%)	6(12%)	13 (38%)	6 (10%)	34(28%)
-Missing	10(42%)	6(12%)	1 (3%)	2 (3%)	0(0%)
Gender					
-Female	6 (25%)	14 (29.2%)	13 (38%)	25 (43%)	46 (37%)
-Male	18 (75%)	34 (70.8%)	21 (62%)	33 (57%)	77 (63%)
-Missing	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
FEV1Percentage					
	82 (±22)	68 (±20)	72 (±22)	81 (±25)	78 (±22)
-Missing	4 (16%)	23(48%)	0(0%)	21(37%)	0(0%)
ECOG performance status					
-1	7 (29%)	0(0%)	9 (26%)	23 (40%)	34 (28%)
-2	10 (42%)	0(0%)	22 (65%)	29 (50%)	68 (55%)
-3	1 (4%)	0(0%)	2 (6%)	6 (10%)	16 (13%)
-4	0(0%)	0(0%)	0(0%)	0(0%)	4 (3%)
-5	0(0%)	0(0%)	0(0%)	0(0%)	1 (1%)
-Missing	6(25%)	48(100%)	1(3%)	0(0%)	0(0%)

