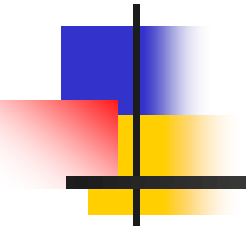


Pianificazione Centri Trapianto

Un Modello di Localizzazione e Allocazione

Modello TRALOC
(Transplant Location Allocation Model)

Formulazione di TRALOC

- Dati
- Obiettivo
- Decisioni
- Vincoli
- Formulazione come problema di PLI binario

Formulazione del Modello

Modello TRALOC
(Transplant Location Allocation Model)

$$\min \sum_{i=1}^{M} \sum_{j=1}^{N} a_{ij}\, x_{ij} + \sum_{l=1}^{P} \sum_{j \in T_l}^{J} h_l\, d_{lj}\, y_{lj} + E$$

$$\sum_{j=1}^{N} x_{ij} = 1, \quad i = 1, \ldots M;$$

$$\sum_{j \in T_l} y_{lj} = 1, \quad l = 1, \ldots P;$$

$$y_{lj} \leq z_j, \quad i = 1, \ldots M, \quad l = 1, \ldots P;$$

$$x_{ij} \leq z_j, \quad i = 1, \ldots M, \quad j = 1, \ldots N;$$

$$\sum_{j=1}^{N} z_j = p,$$

$$E \geq \sum_{l=1}^{P} h_l y_{lj}, \quad j = 1, \ldots N;$$

$$x_{ij} \in \{0, 1\}, \quad i = 1, \ldots M, \quad j = 1, \ldots N;$$

$$y_{lj} \in \{0, 1\}, \quad l = 1, \ldots P, \quad j = 1, \ldots N;$$

$$z_j \in \{0, 1\}, \quad j = 1, \ldots N.$$

Modello TRALOC
(Transplant Location Allocation Model)

Esperimenti e Validazione del Modello

Dati

- Territorio di riferimento: Italia
- Insieme CE: le 105 province
- Insieme PR: le 105 province
- Insieme CIR/CT: 52 province
- Domanda di organi: liste d'attesa al 31/12/2003

Modello TRALOC
(Transplant Location Allocation Model)

Number of Transplant Centers actually active in Italy

	ORGAN					
	HEART	KIDNEY	LIVER	LUNG	PANCREAS	INTESTINE
Number of actual TRANSPLANT CENTERS	24	44	21	11	13	1

- Table 1 -

Modello TRALOC
(Transplant Location Allocation Model)

The 52 chosen potential locations
- J definition -

AGRIGENTO	FIRENZE	NOVARA	SIENA
ANCONA	FOGGIA	PADOVA	SIRACUSA
BARI	GENOVA	PALERMO	TARANTO
BERGAMO	GROSSETO	PARMA	TORINO
BOLOGNA	IMPERIA	PAVIA	TRAPANI
BOLZANO	L'AQUILA	PERUGIA	TRENTO
BRESCIA	LECCE	PISA	TREVISO
CAGLIARI	MASSA C.	POTENZA	UDINE
CAMPOBASSO	MATERA	RAGUSA	VARESE
CATANIA	MILANO	REGGIO C.	VENEZIA
CATANZARO	MODENA	ROMA	VERONA
CHIETI	NAPOLI	SALERNO	VICENZA
COSENZA	NUORO	SASSARI	VITERBO

- Table 2 -

Modello TRALOC
(Transplant Location Allocation Model)

Covering distances (δ) for different values of covering time (τ)

COVERING MATRIX (Speed=90 km/h) τ = cold ischemia time					
	KIDNEY	HEART	LIVER	LUNG	PANCREAS
τ (h)	18	5	12	5	12
δ (km)	1620	450	1080	450	1080

COVERING MATRIX (Speed=90 km/h) $\tau/2$ = (cold ischemia time)/2					
	KIDNEY	HEART	LIVER	LUNG	PANCREAS
τ (h)	9	2,5	6	2,5	6
δ (km)	810	225	540	225	540

COVERING MATRIX (Speed=90 km/h) $\tau/3$ = (cold ischemia time)/3					
	KIDNEY	HEART	LIVER	LUNG	PANCREAS
τ (h)	6	1,7	4	1,7	4
δ (km)	540	153	360	153	360

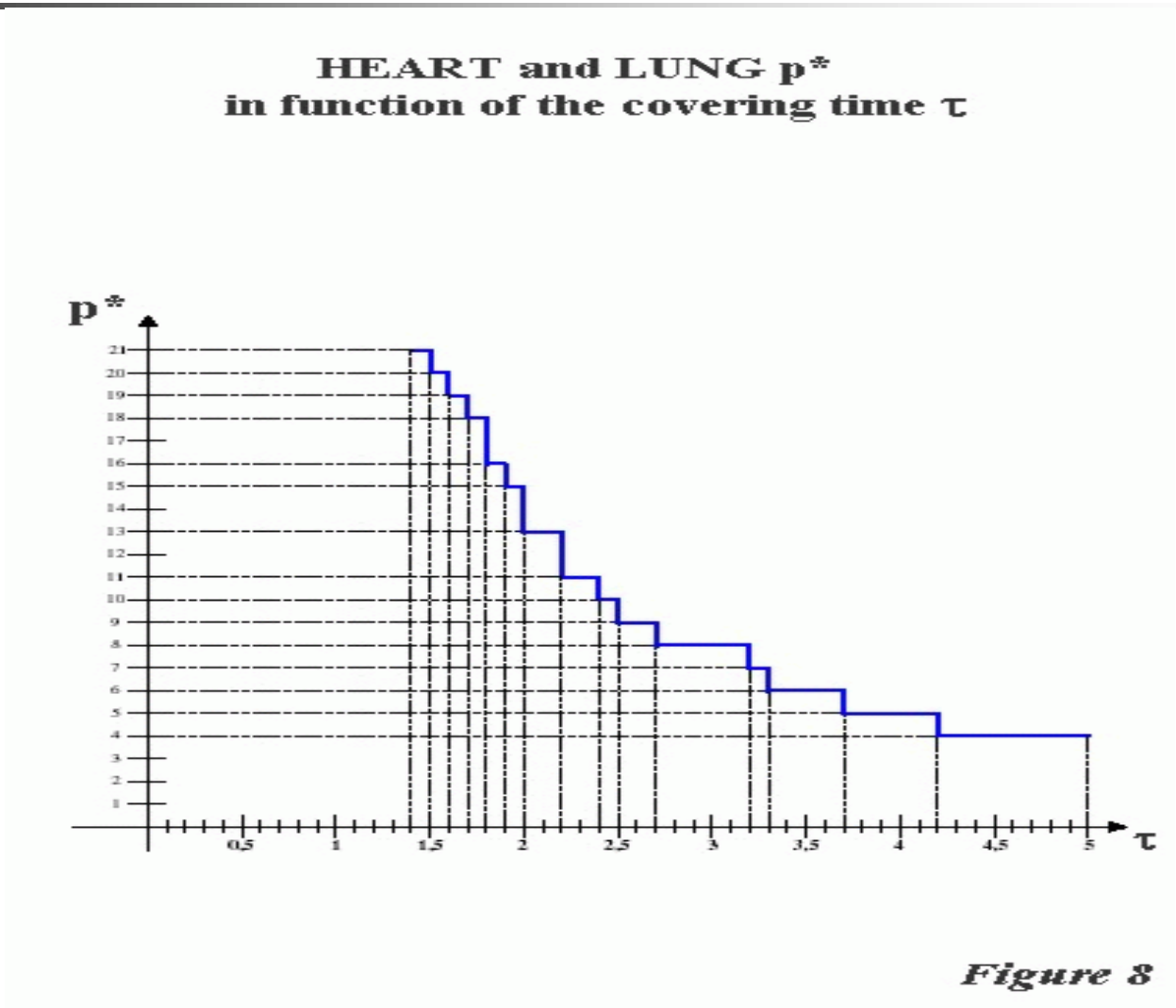
- Table 3 -

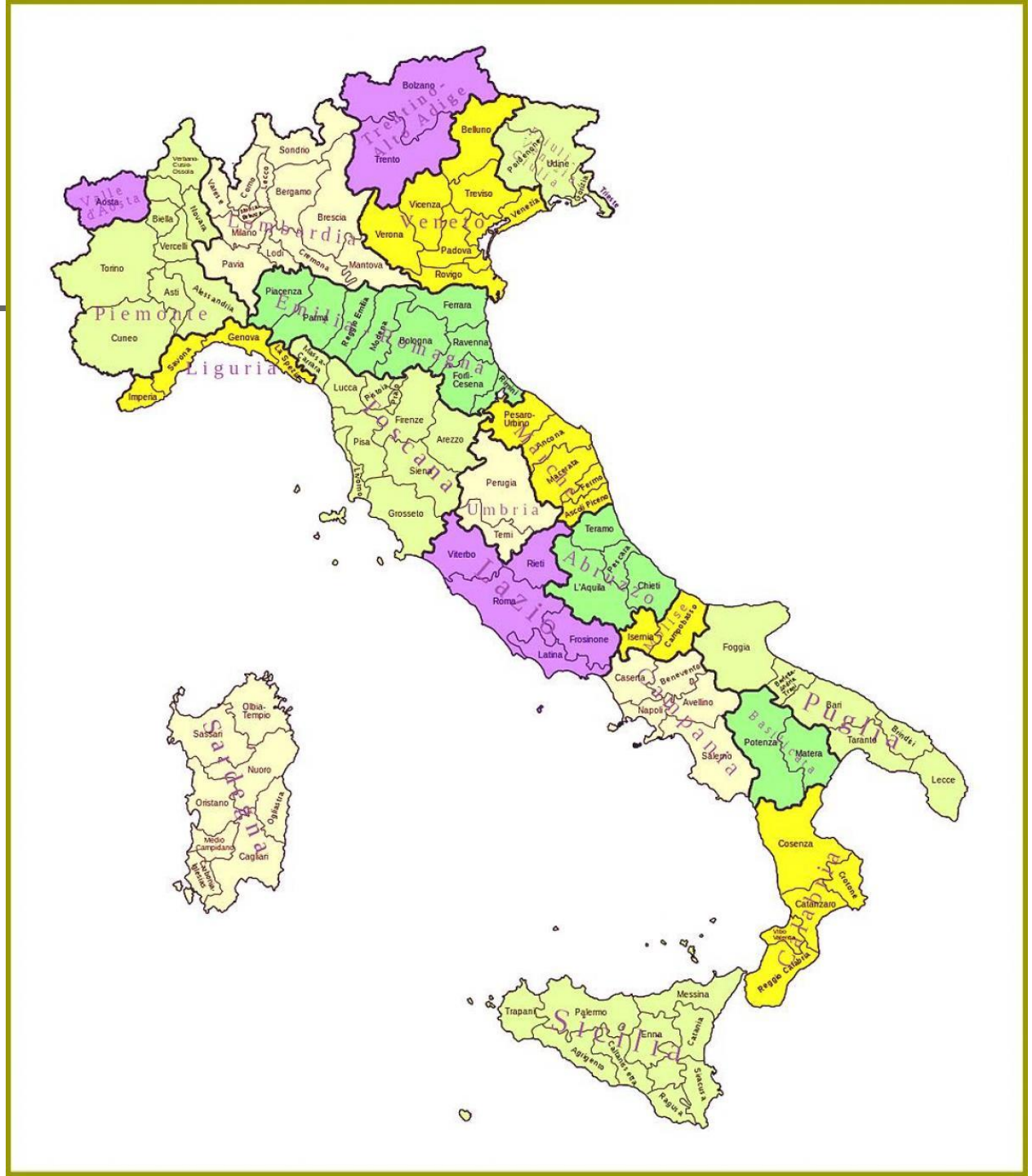
Modello TRALOC
(Transplant Location Allocation Model)

Table 4 Values of p

	KIDNEY	HEART	LIVER	LUNG	PANCREAS
$p^*(\tau)$	1	4	1	4	1
$p^*(\tau/2)$	2	9	3	9	3
$p^*(\tau/3)$	3	18	5	13	5
p_{act}	44	24	21	11	13
p'	20	15	10	10	8
p''	30	30	16	15	18

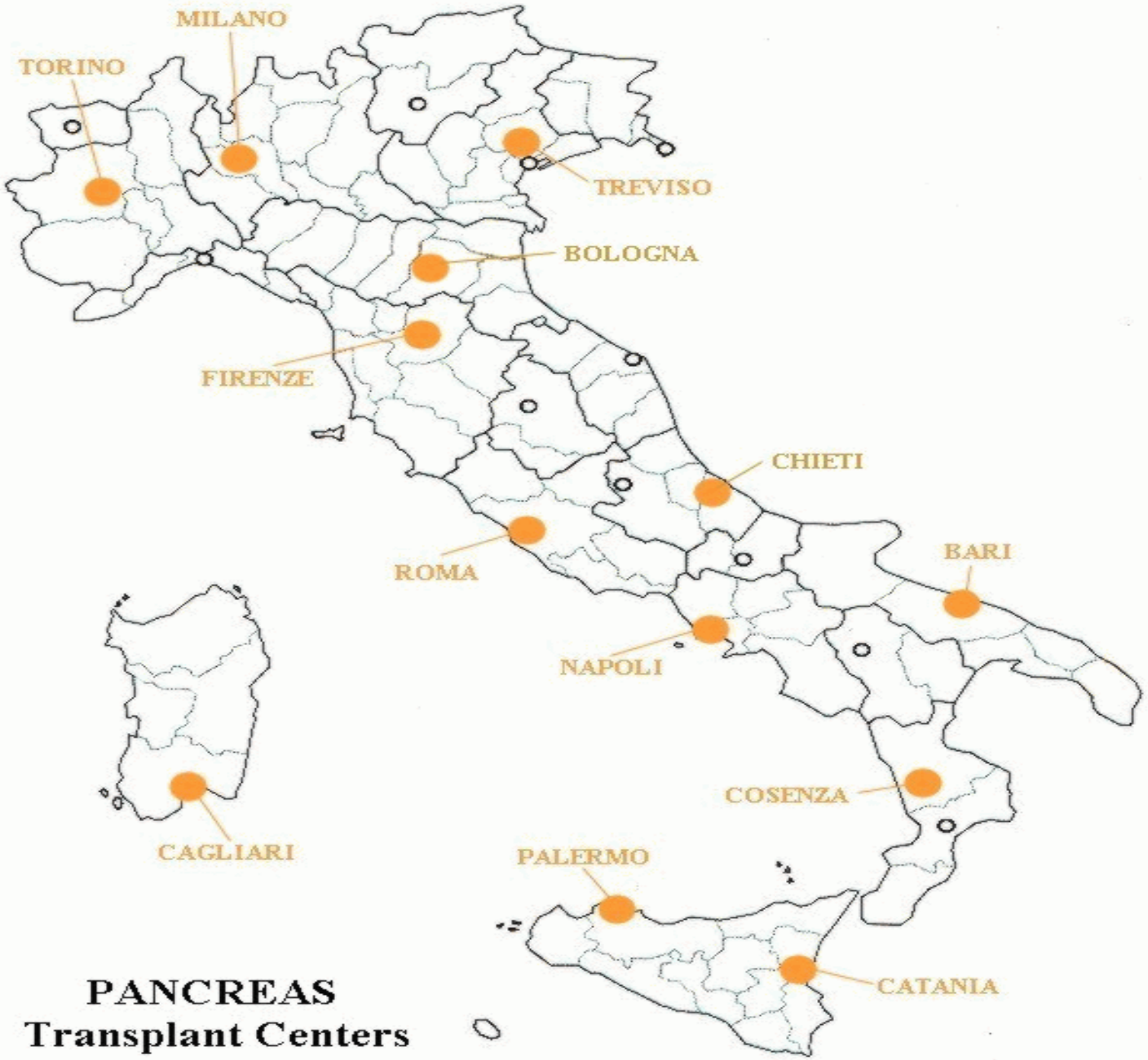
Modello TRALOC
(Transplant Location Allocation Model)




Bolzano-Trentino-Alto Adige
Trento
Belluno
Udine
Friuli-Venezia Giulia
Vicenza
Treviso
Venezia
Verona
Padova
Rovigo
Veneto
Sondrio
Bergamo
Brescia
Milano
Lodi
Cremona
Mantova
Lombardia
Valle d'Aosta
Aosta
Biella
Vercelli
Torino
Pavia
Asti
Alessandria
Piacenza
Parma
Reggio Emilia
Modena
Ferrara
Bologna
Ravenna
Forlì-Cesena
Rimini
Emilia-Romagna
Piemonte
Cuneo
Genova
Savona
Imperia
Liguria
Massa-Carrara
Lucca
Pistoia
Prato
Firenze
Pisa
Arezzo
Siena
Livorno
Grosseto
Toscana
Pesaro-Urbino
Ancona
Macerata
Fermo
Ascoli Piceno
Perugia
Umbria
Temi
Viterbo
Rieti
Roma
Lazio
Teramo
Pescara
Chieti
L'Aquila
Abruzzo
Isernia
Campobasso
Molise
Foggia
Caserta
Benevento
Avellino
Napoli
Salerno
Campania
Barletta-Andria-Trani
Bari
Taranto
Brindisi
Lecce
Puglia
Potenza
Matera
Basilicata
Olbia-Tempio
Sassari
Nuoro
Oristano
Ogliastra
Medio Campidano
Cagliari
Carbonia-Iglesias
Sardegna
Cosenza
Crotone
Catanzaro
Vibo Valentia
Reggio Calabria
Calabria
Messina
Trapani
Palermo
Enna
Catania
Agrigento
Caltanissetta
Siracusa
Ragusa
Sicilia

PANCREAS
Transplant Centers
ACTUAL Location

Figure 4



PANCREAS
Transplant Centers
Location

Figure 9

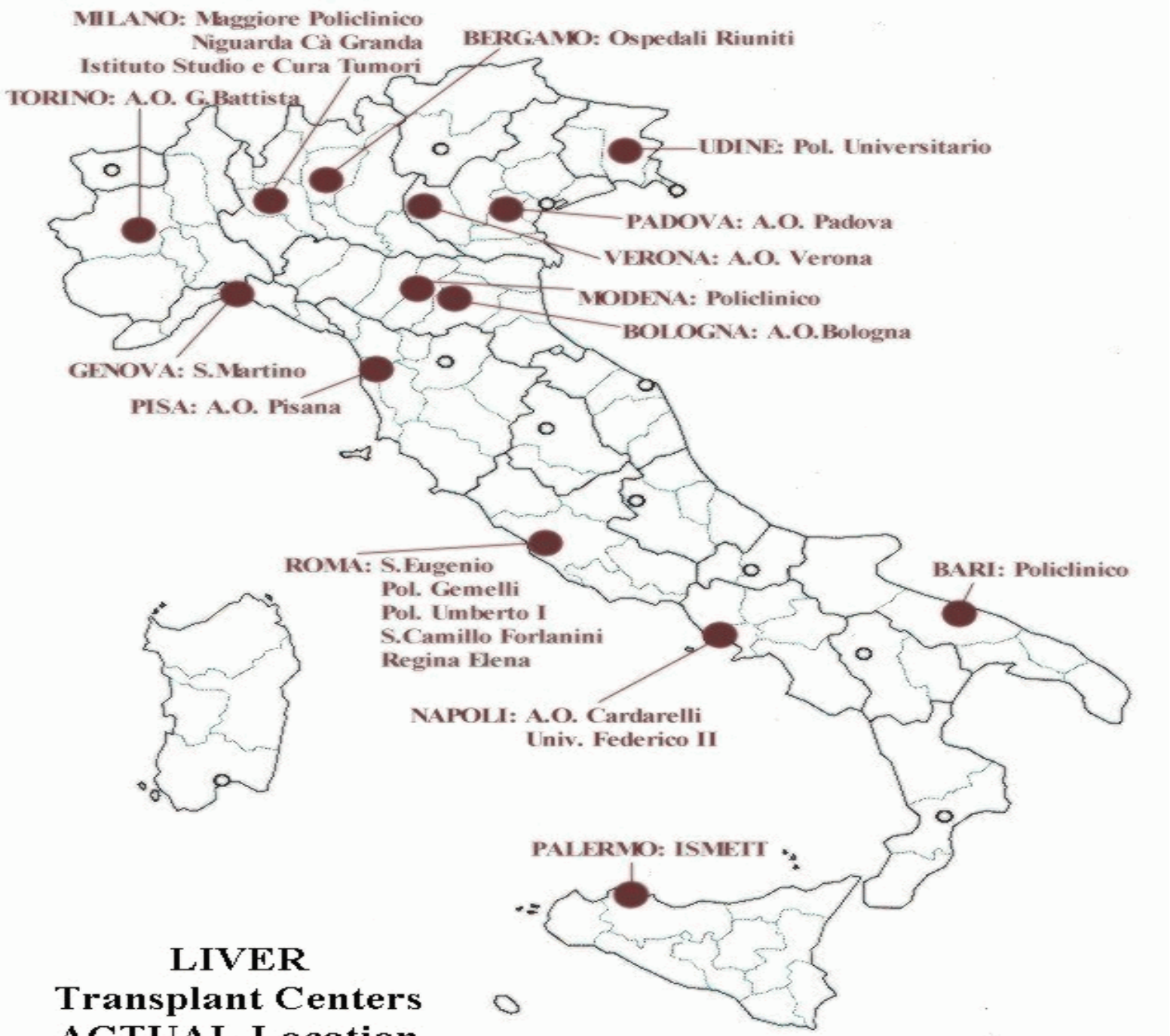
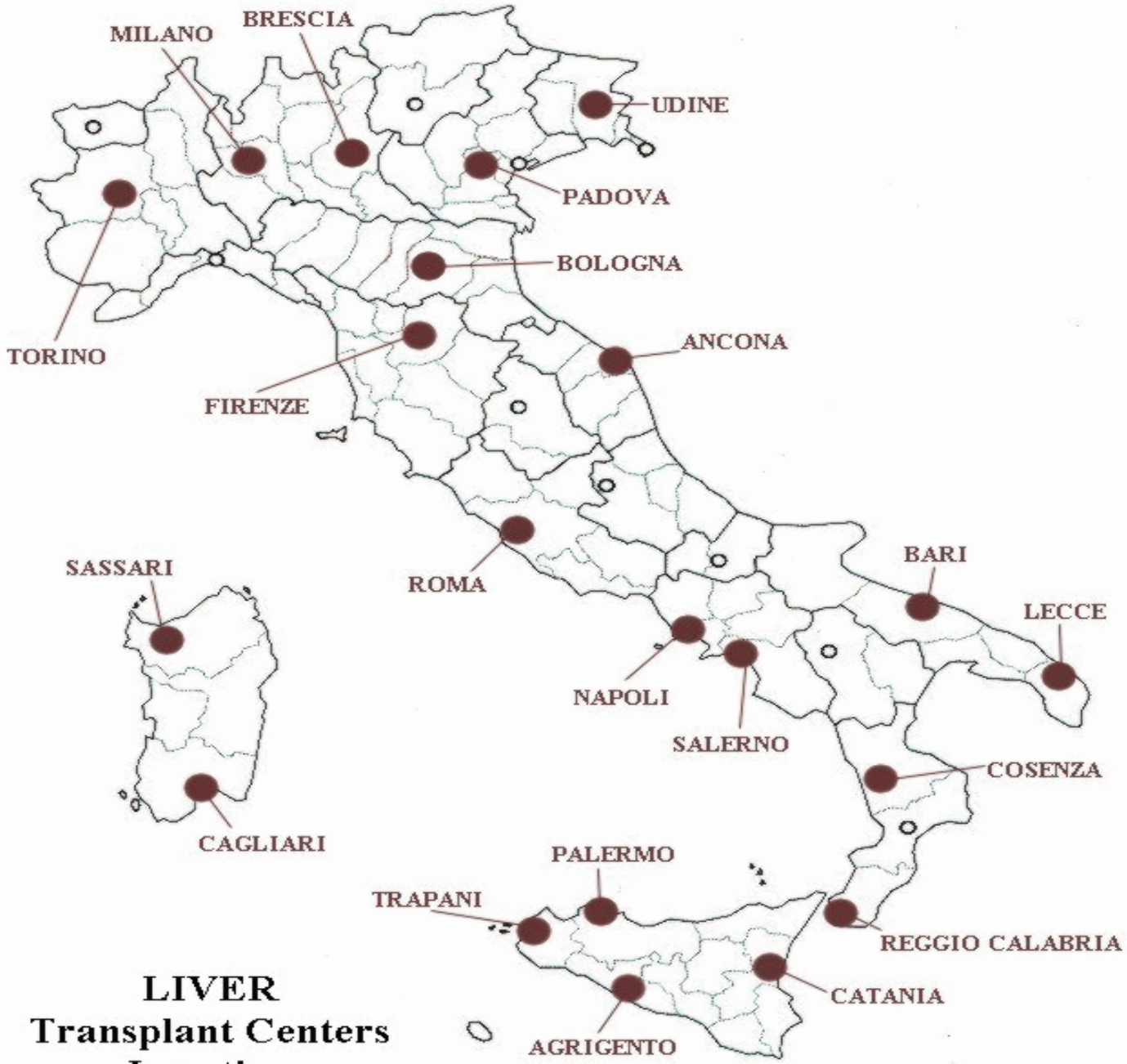

MILANO: Maggiore Policlinico
Niguarda Cà Granda
Istituto Studio e Cura Tumori
BERGAMO: Ospedali Riuniti
TORINO: A.O. G.Battista
UDINE: Pol. Universitario
PADOVA: A.O. Padova
VERONA: A.O. Verona
MODENA: Policlinico
BOLOGNA: A.O.Bologna
GENOVA: S.Martino
PISA: A.O. Pisana
ROMA: S.Eugenio
Pol. Gemelli
Pol. Umberto I
S.Camillo Forlanini
Regina Elena
BARI: Policlinico
NAPOLI: A.O. Cardarelli
Univ. Federico II
PALERMO: ISMETT
LIVER
Transplant Centers
ACTUAL Location

Figure 3



LIVER
Transplant Centers
Location

Figure 10

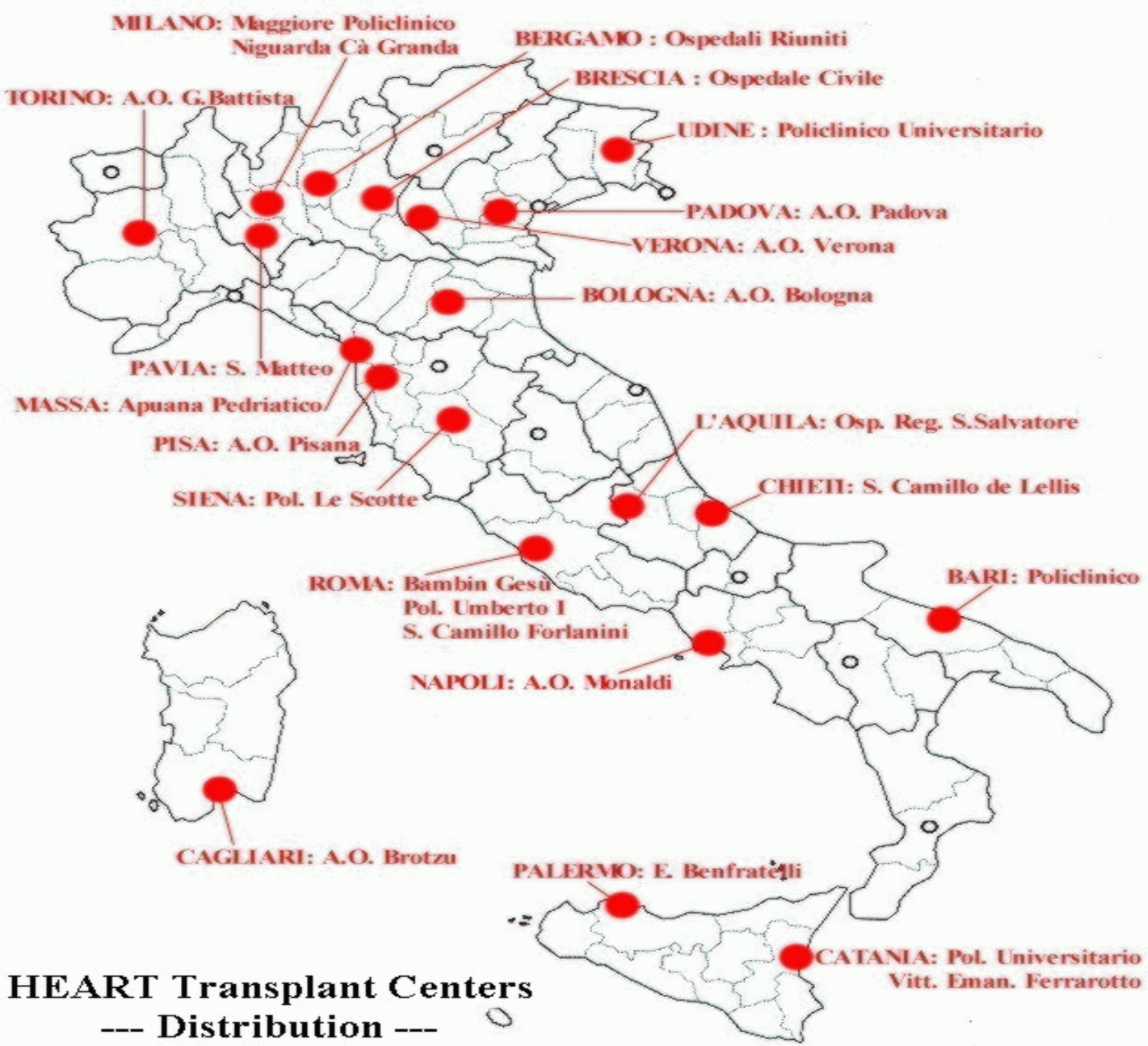

MILANO: Maggiore Policlinico
Niguarda Cà Granda
BERGAMO : Ospedali Riuniti
BRESCIA : Ospedale Civile
TORINO: A.O. G.Battista
UDINE : Policlinico Universitario
PADOVA: A.O. Padova
VERONA: A.O. Verona
BOLOGNA: A.O. Bologna
PAVIA: S. Matteo
MASSA: Apuana Pedriatico
PISA: A.O. Pisana
SIENA: Pol. Le Scotte
L'AQUILA: Osp. Reg. S.Salvatore
CHIETI: S. Camillo de Lellis
ROMA: Bambin Gesù
Pol. Umberto I
S. Camillo Forlanini
BARI: Policlinico
NAPOLI: A.O. Monaldi
CAGLIARI: A.O. Brotzu
PALERMO: E. Benfratelli
CATANIA: Pol. Universitario
Vitt. Eman. Ferrarotto
HEART Transplant Centers
--- Distribution ---

Figure 2

Fig. 5 Optimal distribution of the heart transplant centers with service areas

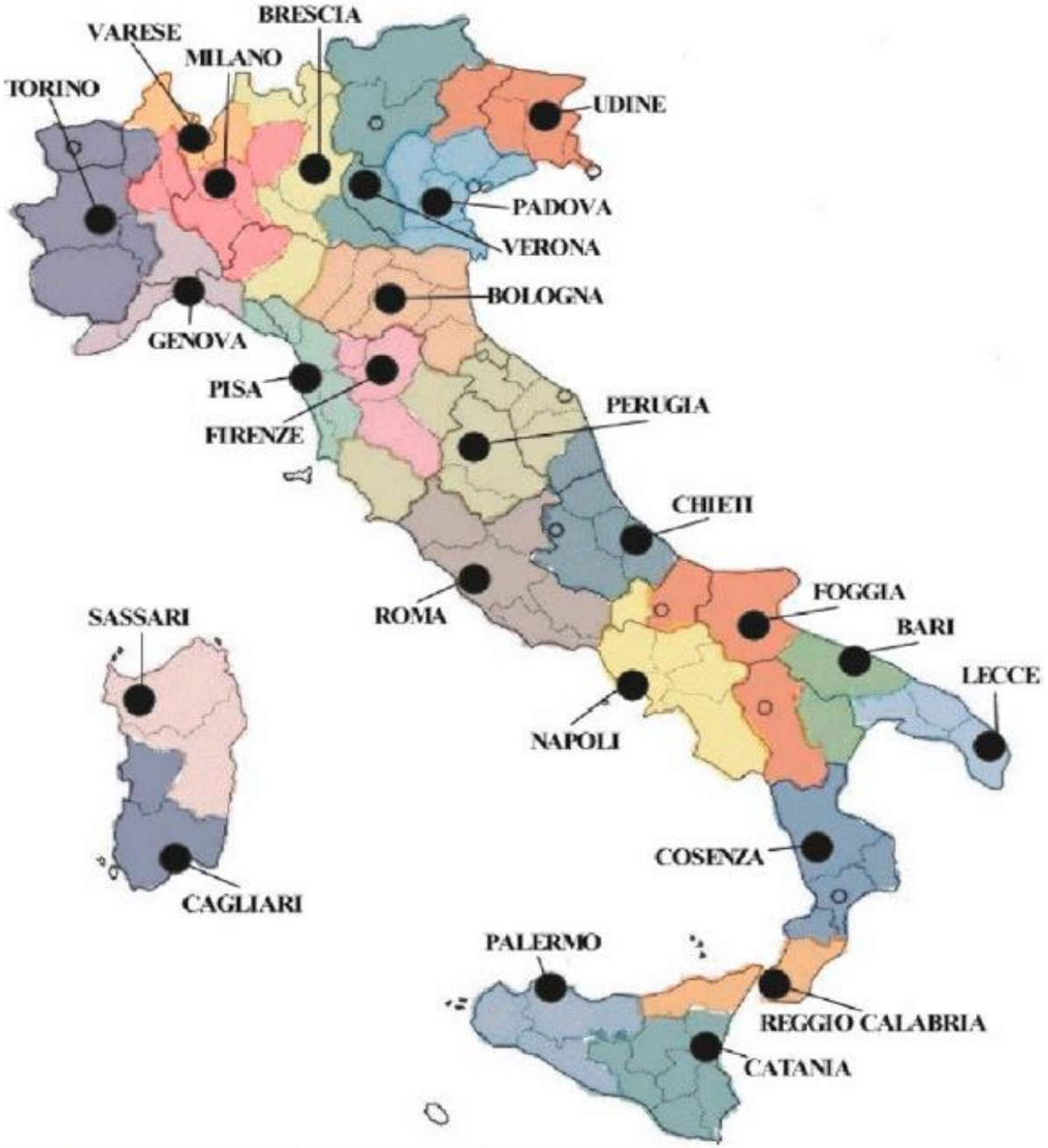
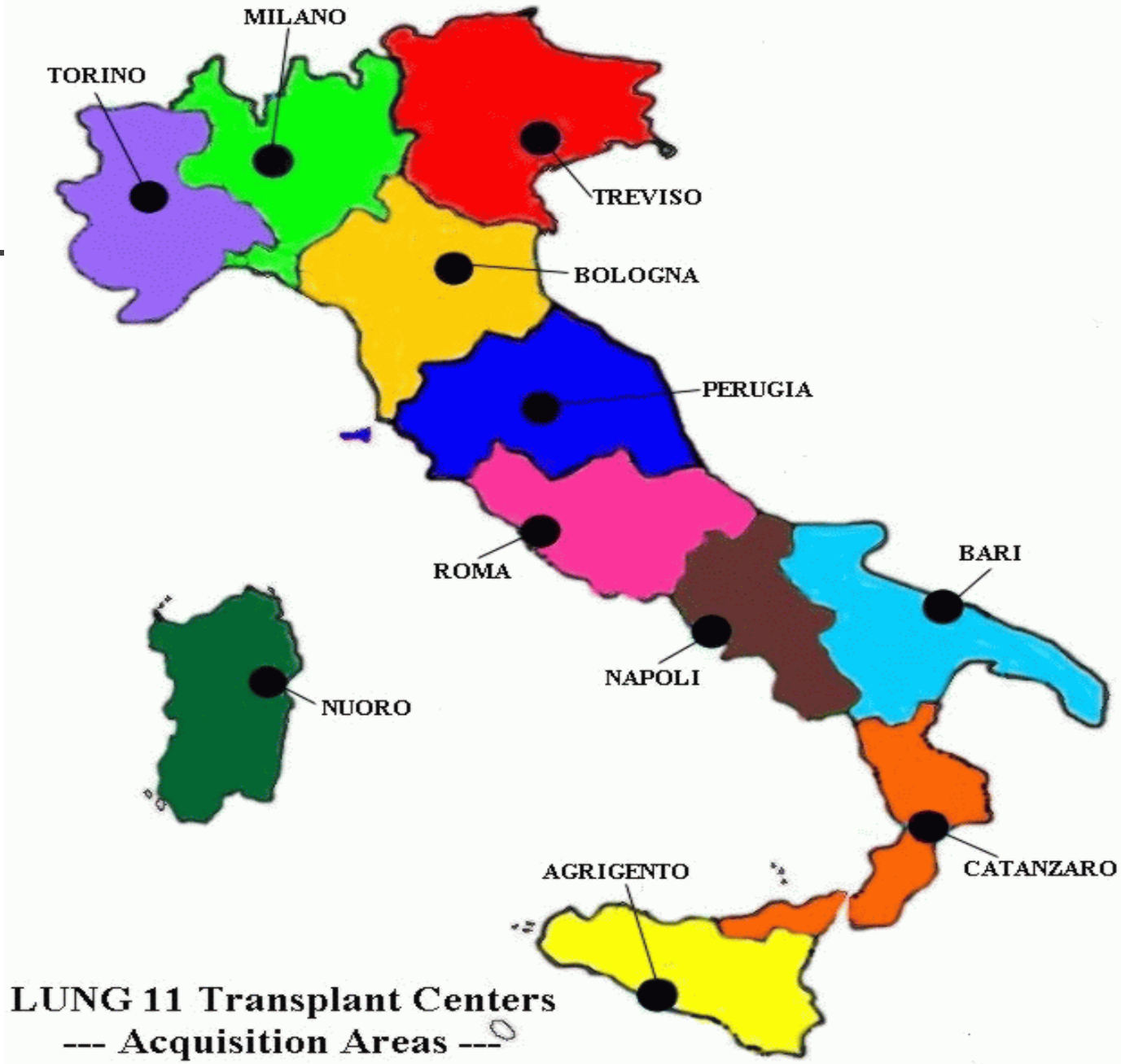


Fig. 8 Optimal distribution of the heart transplant centers with acquisition areas



LUNG 11 Transplant Centers
--- Acquisition Areas ---

Figure 11

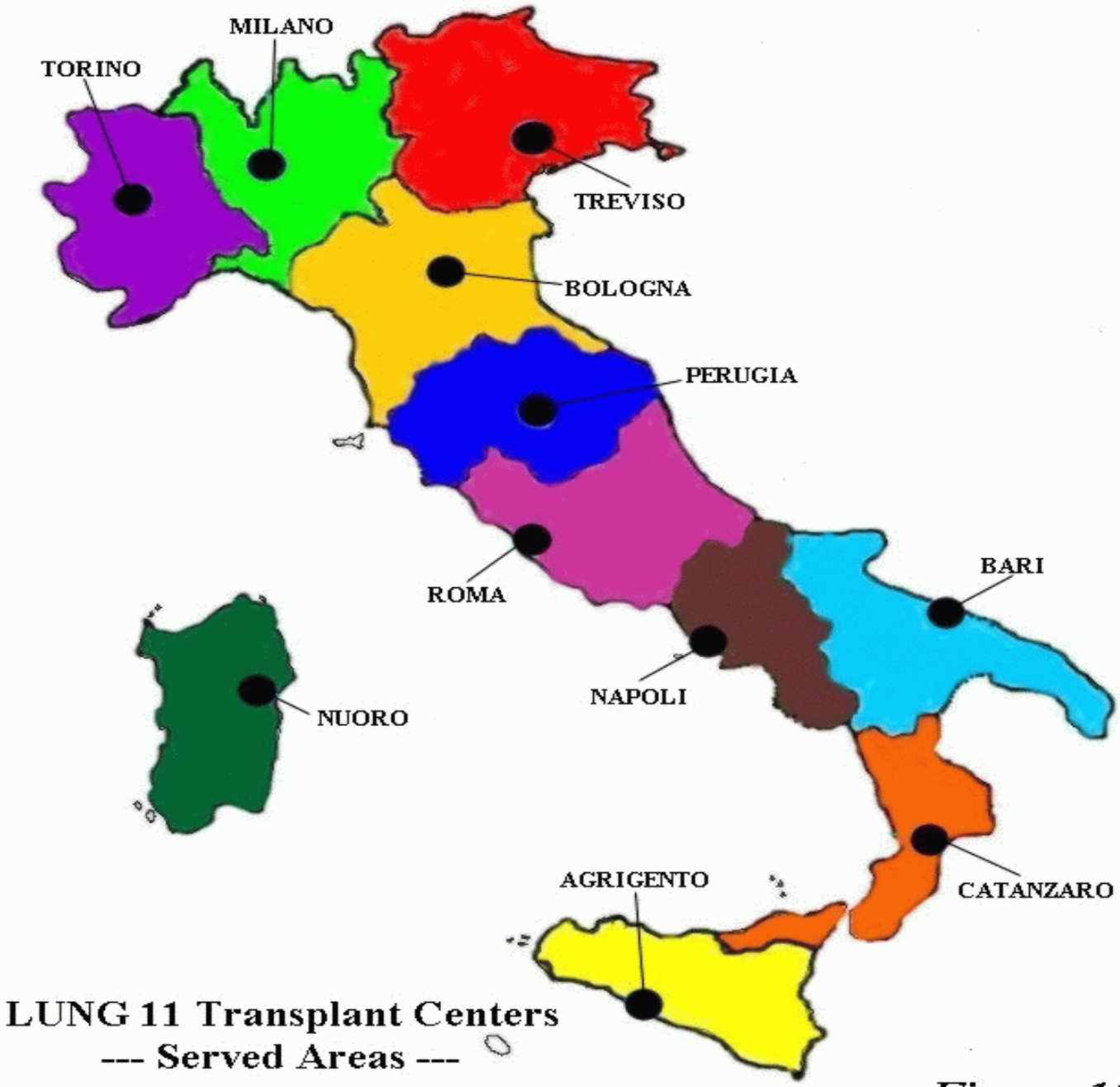

MILANO
TORINO
TREVISO
BOLOGNA
PERUGIA
ROMA
BARI
NAPOLI
NUORO
AGRIGENTO
CATANZARO
LUNG 11 Transplant Centers
--- Served Areas ---

Figure 12

PANCREAS 13 Transplant Centers
--- Acquisition Areas ---

Figure 13

PANCREAS 13 Transplant Centers
--- Served Areas ---

Figure 14

HEART E variation in function of the activated Transplant Centers for different values of τ

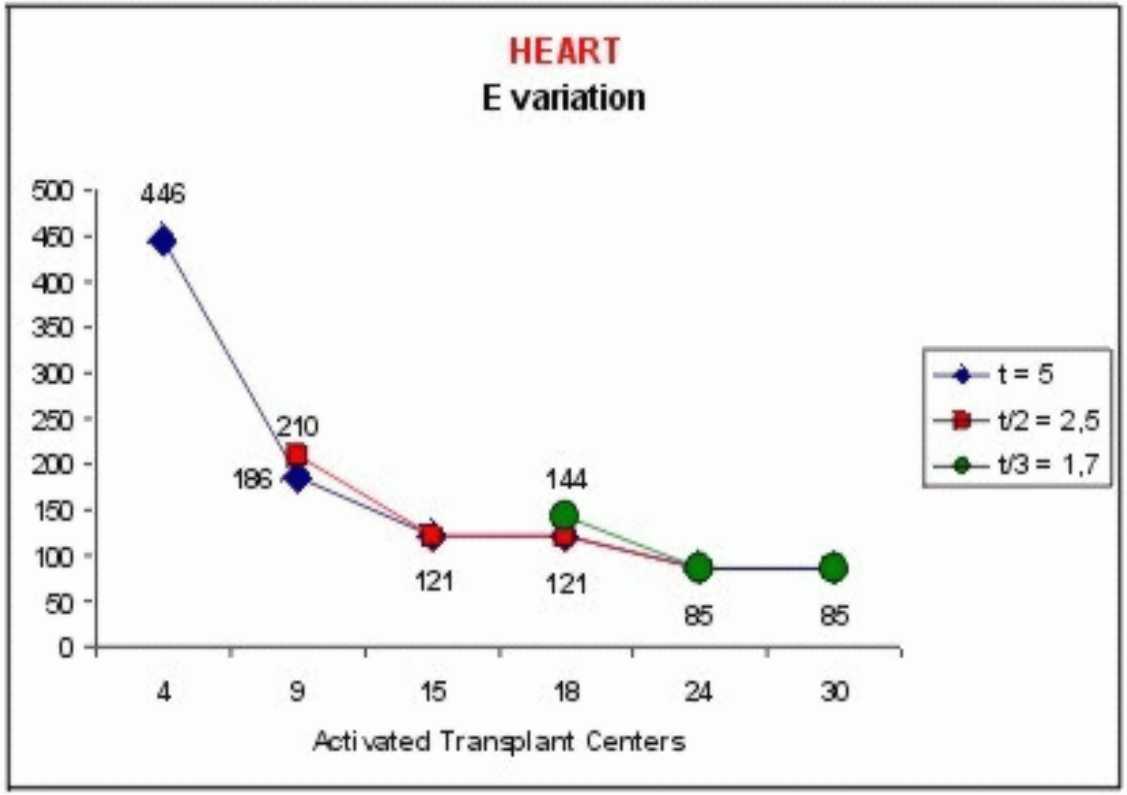


Figure 15

LUNG E variation in function of the activated Transplant Centers for different values of τ

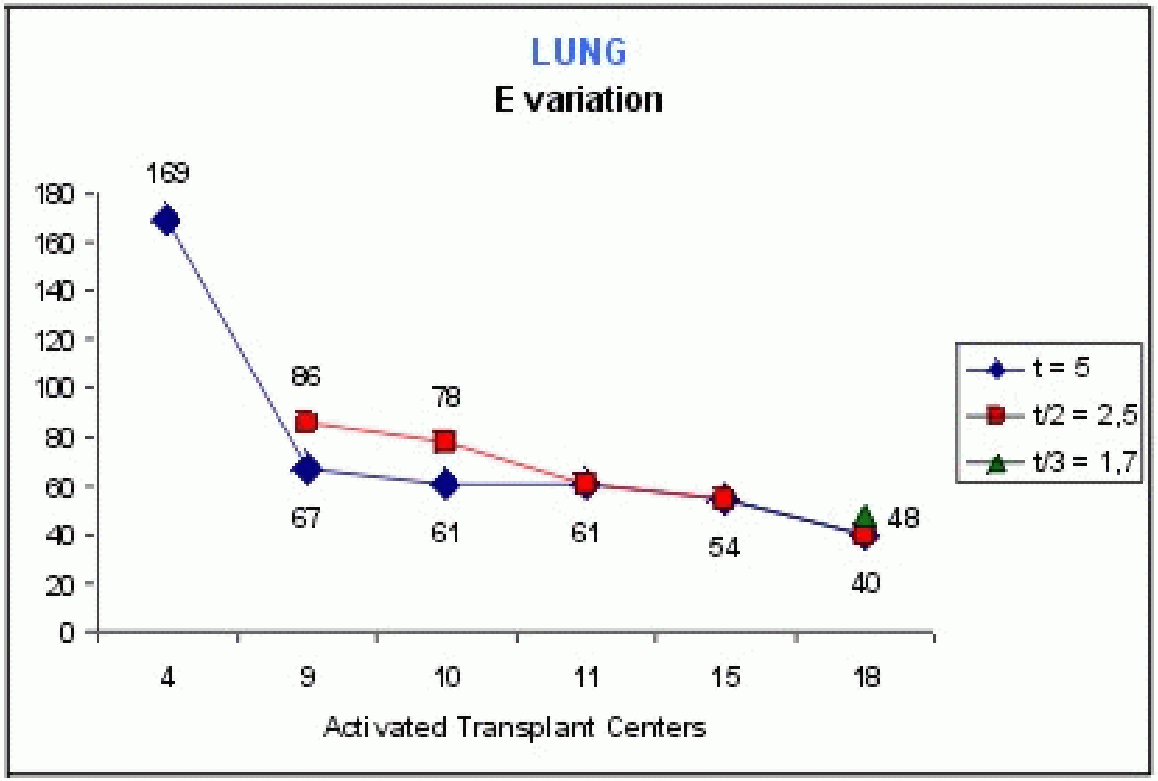


Figure 16

LIVER E variation in function of the activated Transplant Centers for different values of τ

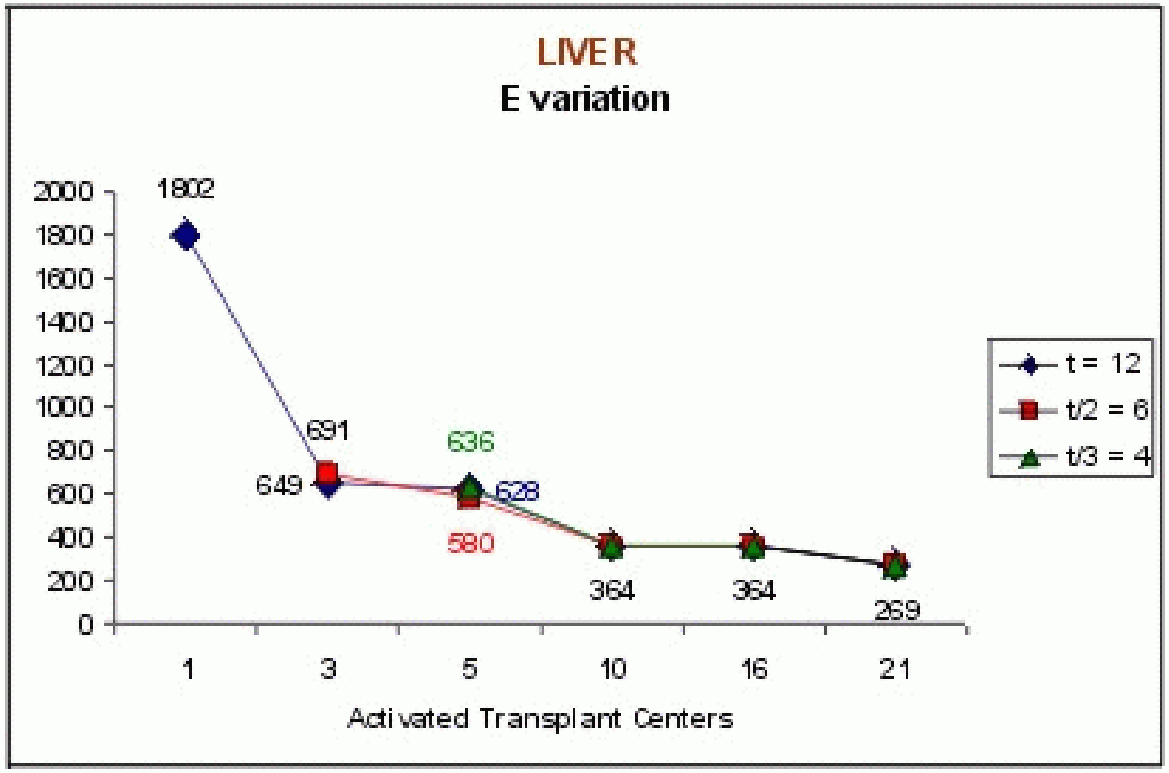


Figure 17

PANCREAS E variation in function of the activated Transplant Centers for different values of τ

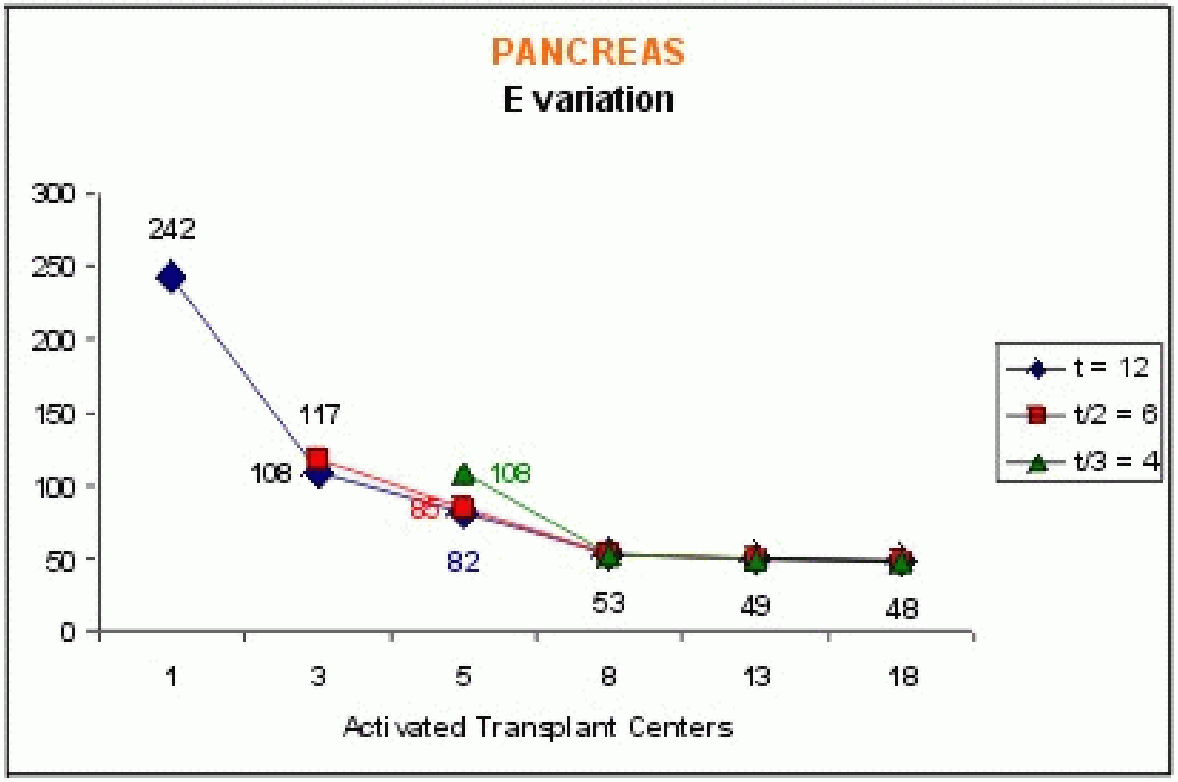


Figure 18

KIDNEY E variation in function of the activated Transplant Centers for different values of τ

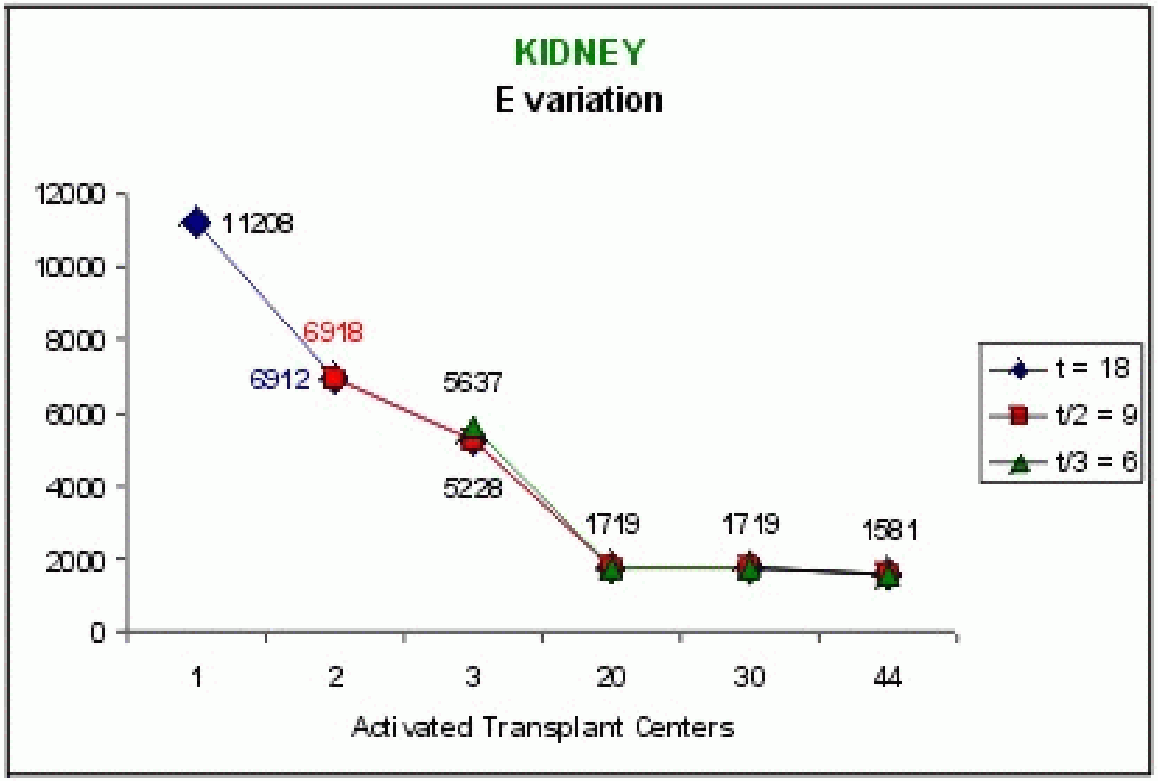


Figure 19