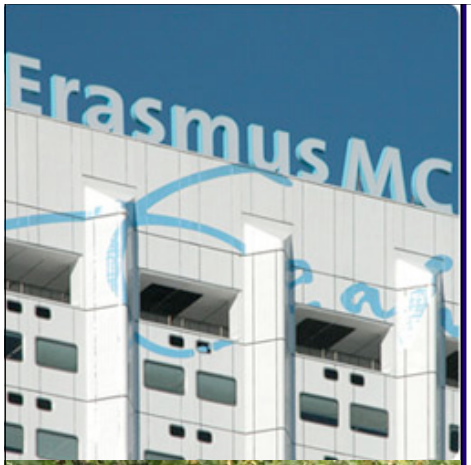

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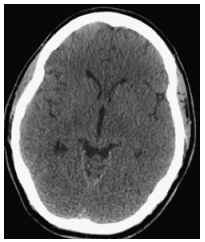

Imminent Brain Death and the DCD-N Score

Tools for potential organ donor recognition

dr Erwin J.O. Kompanje

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Department of Intensive Care

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Organ transplantation

Problems in 1950-1970

1. Warm ischemia of the dead donor
2. Rejection of the transplanted organ

Problems nowadays

1. Low availability of donor organs (more patients on the waiting lists than donor-organs available)
2. Long term co-morbidity (malignancies) after transplantation

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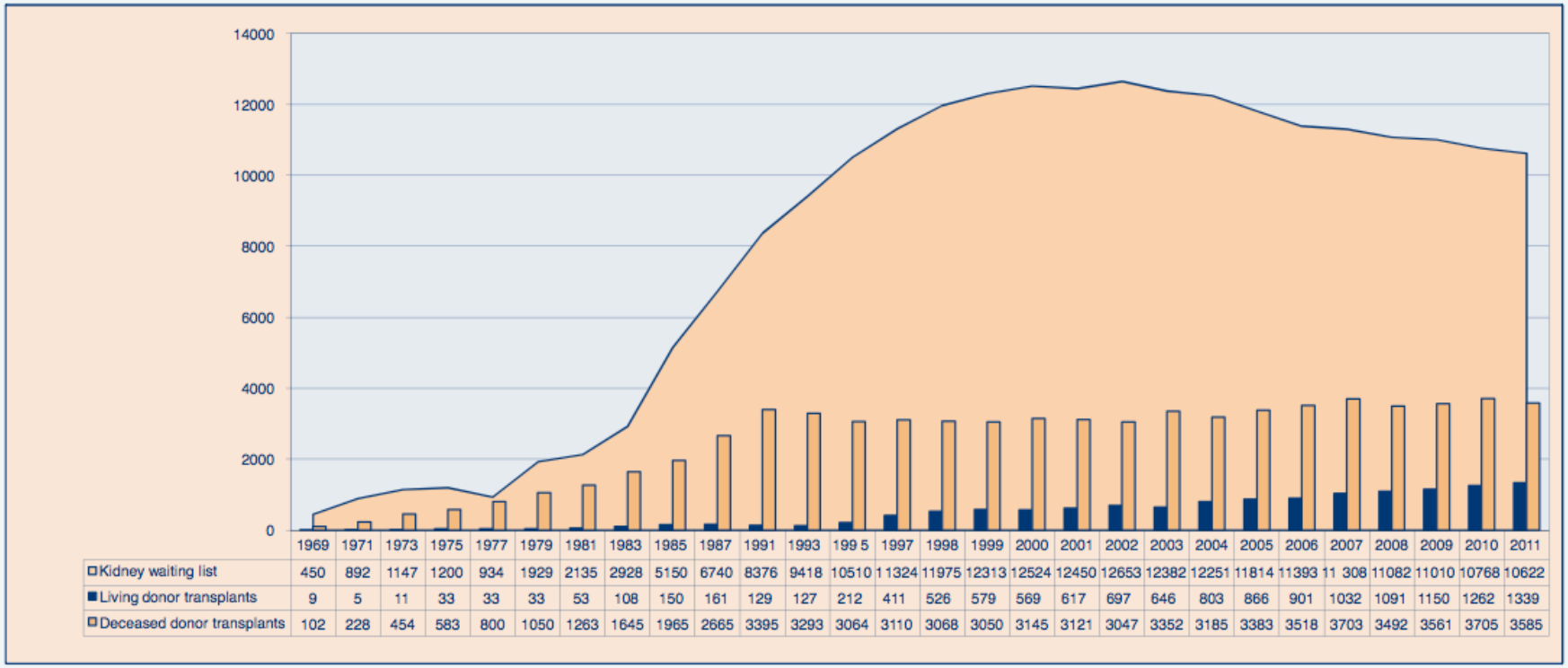
Waiting list and supply of kidneys

EUROTRANSPLANT

Figure 4.5 Dynamics of the Eurotransplant kidney transplant waiting list and transplants between 1969 and 2011



	1969	1971	1973	1975	1977	1979	1981	1983	1985	1987	1991	1993	199 5	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Kidney waiting list	450	892	1147	1200	934	1929	2135	2928	5150	6740	8376	9418	10510	11324	11975	12313	12524	12450	12653	12382	12251	11814	11393	11 308	11082	11010	10768	10622
Living donor transplants	9	5	11	33	33	33	53	108	150	161	129	127	212	411	526	579	569	617	697	646	803	866	901	1032	1091	1150	1262	1339
Deceased donor transplants	102	228	454	583	800	1050	1263	1645	1965	2665	3395	3293	3064	3110	3068	3050	3145	3121	3047	3352	3185	3383	3518	3703	3492	3561	3705	3585

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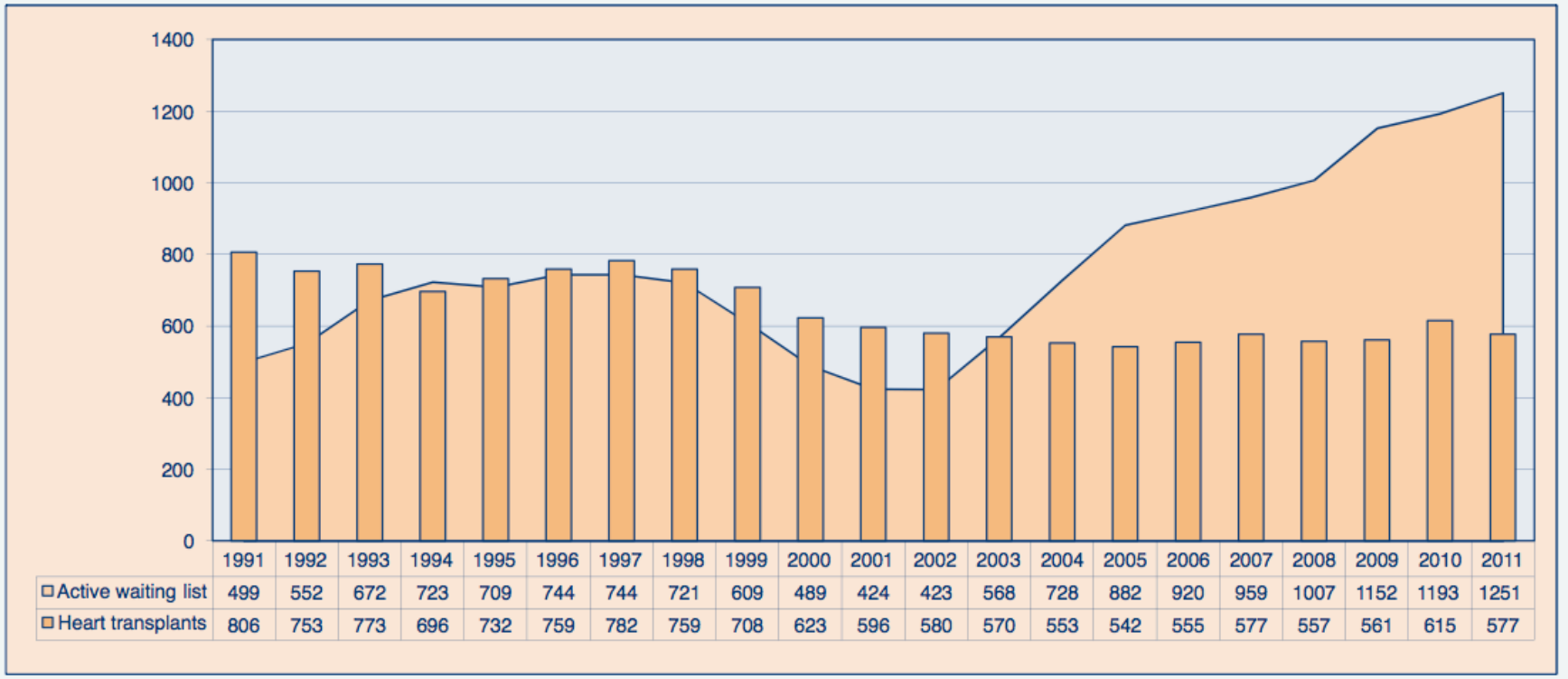
Waiting list and supply of hearts

EUROTRANSPLANT

Figure 5.9 Dynamics of the Eurotransplant heart waiting list and transplants between 1991 and 2011



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Active waiting list	499	552	672	723	709	744	744	721	609	489	424	423	568	728	882	920	959	1007	1152	1193	1251
Heart transplants	806	753	773	696	732	759	782	759	708	623	596	580	570	553	542	555	577	557	561	615	577

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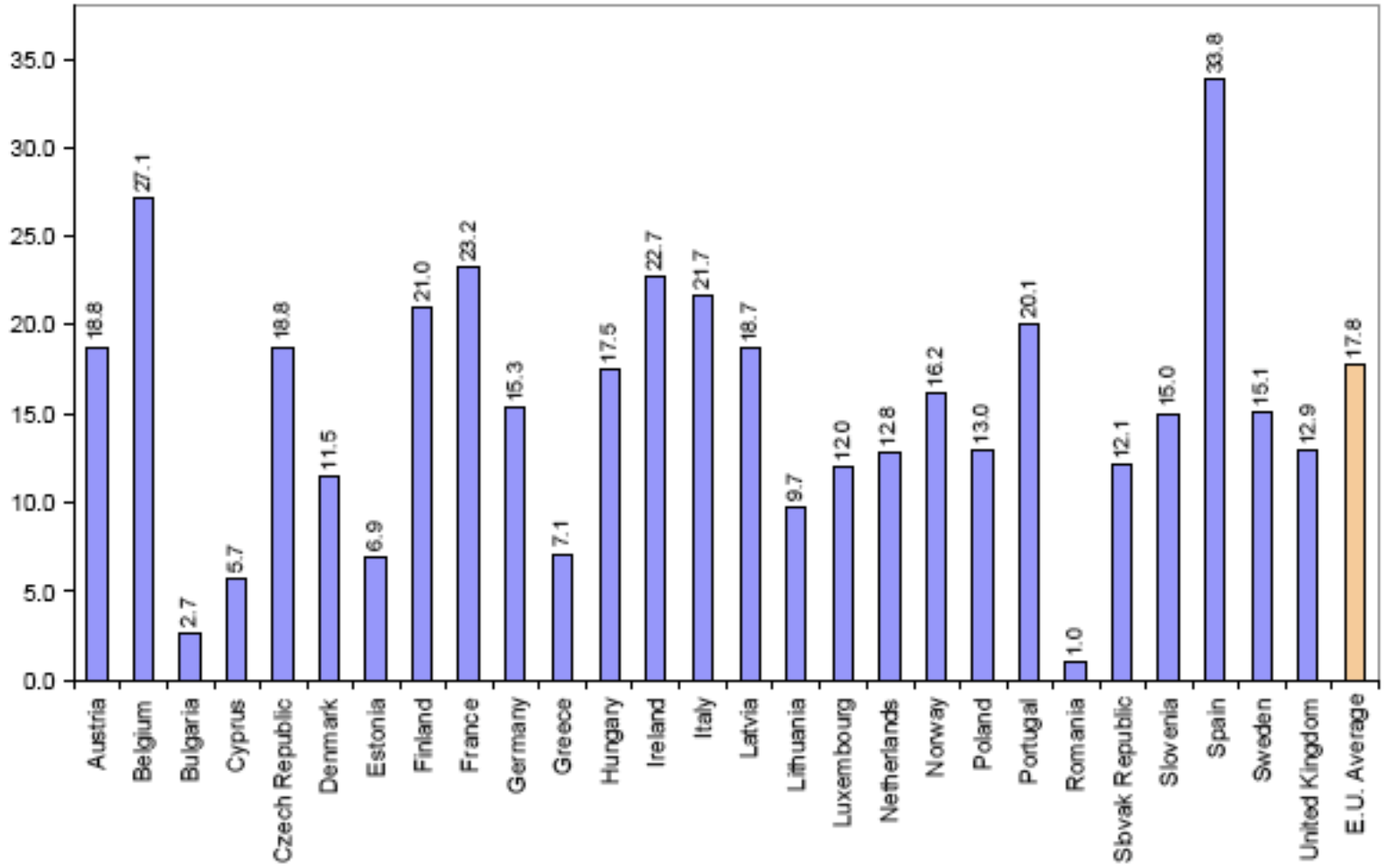
Donation rates (per million/population) in the European Union (2007)



SOURCE: Council of Europe (2007) Deceased organ donors in the European Union

Most important reasons for low number of donor organs

1. Progress in effective *prevention* and effective *treatment* of acute neurological conditions

2. Refusal to donate organs of a deceased relative

3. Non-recognition of a potential organ donor by professionals

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Brain death is, and has always been, a rare outcome of neuro-critical care in a selected cohort of patients

c. 3% of all patients who die on a neurocritical care unit die from brain death. Less than 1% on general ICUs.

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Brain death, underlying conditions

Analysis of 71 series (1968-2008)
N= 6317 [83% SAH, TBI, ICH]

60% SAH, 8% ICH

15% TBI

Kompanje, 2009

Is Organ Donation From Brain Dead Donors Reaching an Inescapable and Desirable Nadir?

Erwin J.O. Kompanje, Yorick J. de Groot, and Jan Bakker

Department of Intensive Care Adults
Erasmus MC University Medical Center Rotterdam

TABLE 1. Comparing effectuated DCD and DBD in different eras in The Netherlands over the past 15 yr

	Era 1 (1995–1999)	Era 2 (2000–2004)	Era 3 (2005–2009)	P^a
No. of donors	1033	1042	1090	0.695
DBD (% of total number of donors)	915 (88.6)	697 (66.9)	637 (58.4)	0.008
DCD (% of total number of donors)	118 (11.4)	345 (33.1)	453 (41.6)	<0.0001

(*Transplantation* 2011;91: 1177–1180)

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Time trends in outcome of subarachnoid hemorrhage

Population-based study and systematic review

Conclusion: Mortality due to subarachnoid hemorrhage fell by about 50% in our study population over the last 2 decades, due mainly to improved outcomes in cases surviving to reach hospital. This improvement is consistent with a significant decrease in case-fatality over the last 25 years in our pooled analysis of other similar population-based studies. *Neurology*® 2010;74:1–1

Neurology 74 May 11, 2010

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Why Have Traffic Fatalities Declined in Industrialised Countries?

Implications for Pedestrians and Vehicle Occupants

Elizabeth Kopits and Maureen Cropper

'Between 1970 and 1999, total traffic fatalities declined, on average by 35% in 32 European countries and USA, while total vehicle kilometres driven increased by over 250%'

Journal of Transport Economics and Policy, Volume 42, Part 1, January 2008, pp. 129–154

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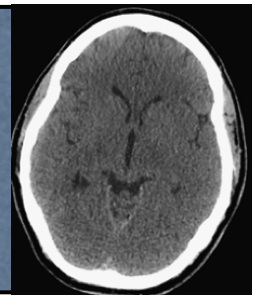
How to increase the number of donor organs?



EULOD
LIVING ORGAN DONATION IN EUROPE

1. Increase living organ donation
2. Lowering family refusal
3. Better potential organ donor recognition leading to a better Donor Conversion Rate

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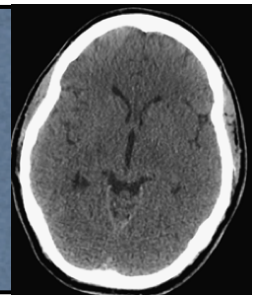
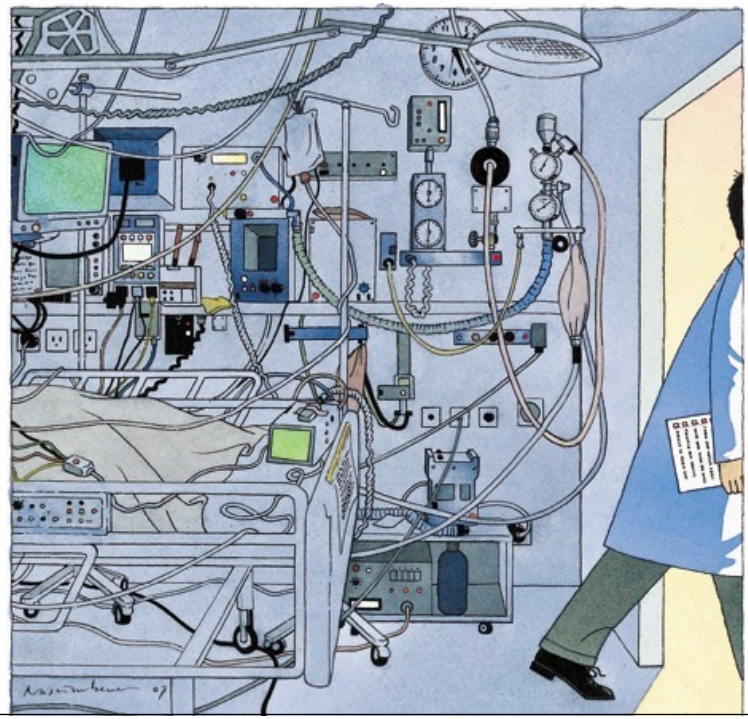
Organ donor recognition

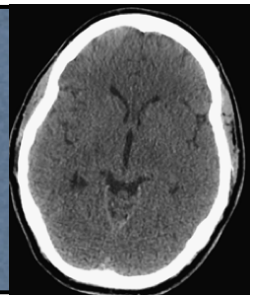


1. Recognition of the potential brain-dead organ donor

2. Recognition of the potential circulatory death donor



OPTN Organization Procurement and Transplantation Network



Imminent neurological death (IND) as defined by the Organ Procurement Transplantation Network (OPTN) in the USA and published on their website (see http://optn.transplant.hrsa.gov). The OPTN defined imminent neurological death as "a patient … with severe neurological injury and requiring ventilator support, who upon clinical evaluation … has an absence of at least three brain stem reflexes". Age, which is part of this definition, is excluded from our statistical analysis to prevent its influence on the comparison.

Intensive Care Med (2010) 36:1488–1494
DOI 10.1007/s00134-010-1848-y

ORIGINAL

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Imminent brain death: point of departure for potential heart-beating organ donor recognition

As a definition for imminent brain death we propose:

'A mechanically ventilated, deeply comatose patient, admitted to an ICU, with irreversible catastrophic brain damage of known origin (e.g. TBI, SAH, ICH). A condition of imminent brain death requires either a GCS of 3 and the progressive absence of at least three out of six brainstem reflexes, or a FOUR score of $E_0M_0B_0R_0$'.

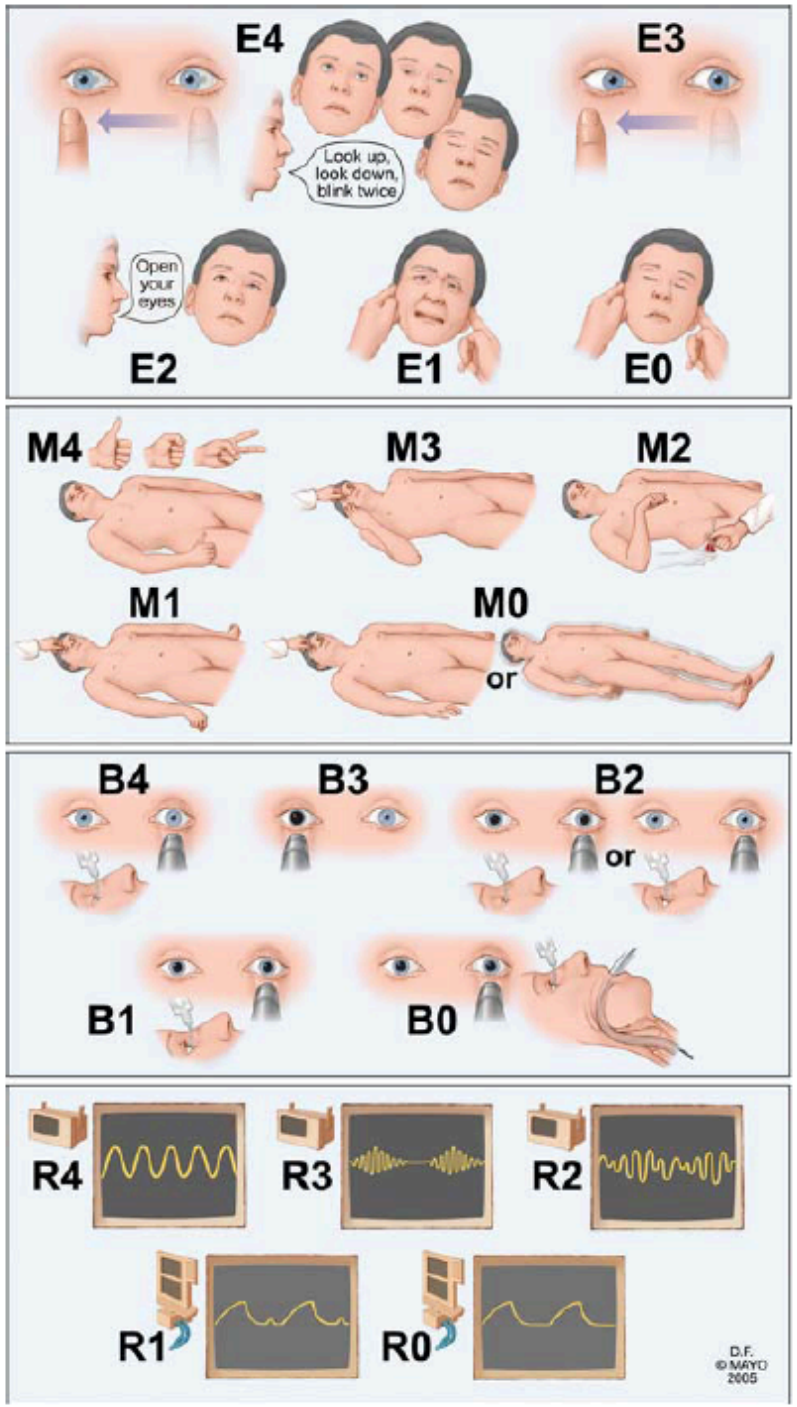

Fig. 1 Description of Full Outline of UnResponsivenes (FOUR) score. Eye response: *E4* eyelids open or opened, tracking or blinking to command; *E3* eyelids open but not tracking; *E2* eyelids closed but open to loud voice; *E1* eyelids closed but open to pain; *E0* eyelids remain closed with pain. Motor response: *M4* thumbs-up, fist or peace sign; *M3* localising to pain; *M2* flexion response to pain; *M1* extension response to pain; *M0* no response to pain or generalised myoclonus status. Brainstem reflexes: *B4* pupil and corneal reflexes present; *B3* one pupil wide and fixed; *B2* pupil or corneal reflexes absent; *B1* pupil and corneal reflexes absent; *B0* absent pupil, corneal and cough reflex. Respiration pattern: *R4* not intubated, regular breathing pattern; *R3* not intubated, Cheyne-Stokes breathing pattern; *R2* not intubated, irregular breathing; *R1* breathes above ventilatory rate; *R0* breathes at ventilator rate or apnea

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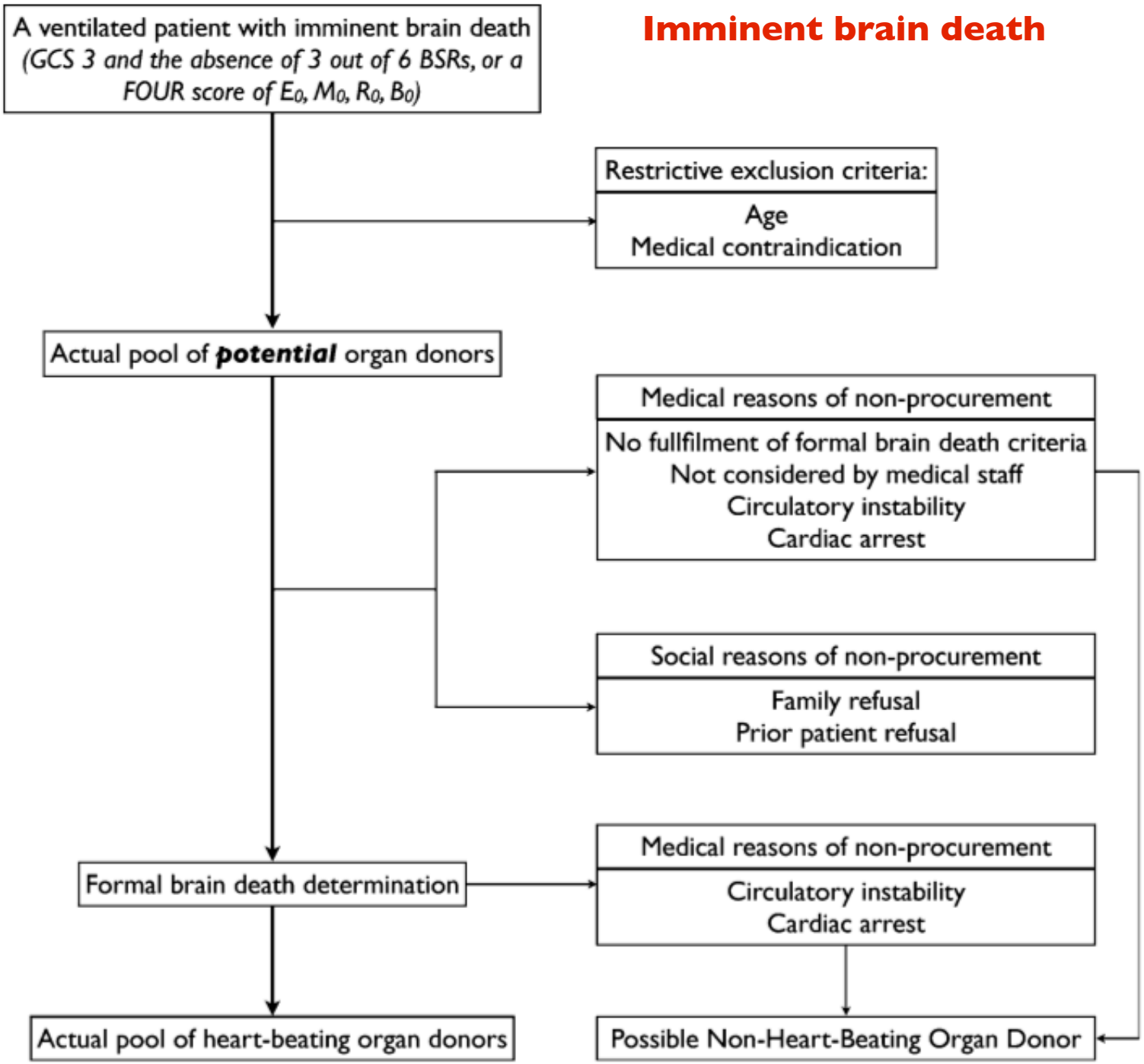
Imminent brain death



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Intensive Care Med (2011) 37:665–670
DOI 10.1007/s00134-011-2131-6

ORIGINAL

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Donor conversion rates depend on the assessment tools used in the evaluation of potential organ donors

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Imminent brain death

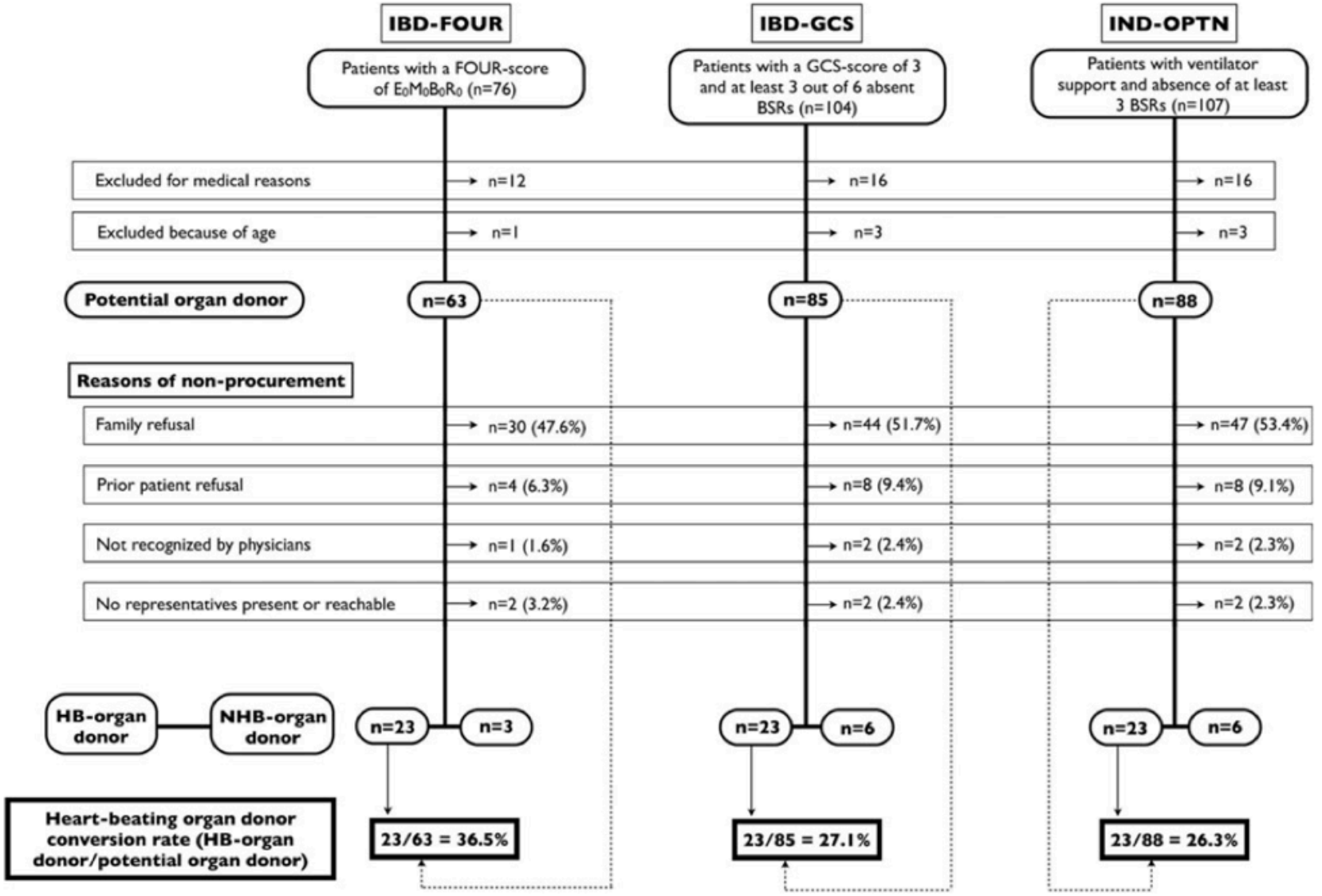

Fig. 1 Flowchart of the assessment tools. *IBD-FOUR* imminent brain death based on FOUR criteria, *IBD-GCS* imminent brain death based on GCS criteria, *IND-OPTN* imminent neurological death used by the OPTN, *BSRs* brain stem reflexes, *HB-organ donor* heart-beating organ donor, *NHB-donor* non-heart-beating organ donor

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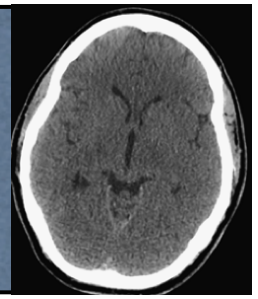
Organ donor recognition



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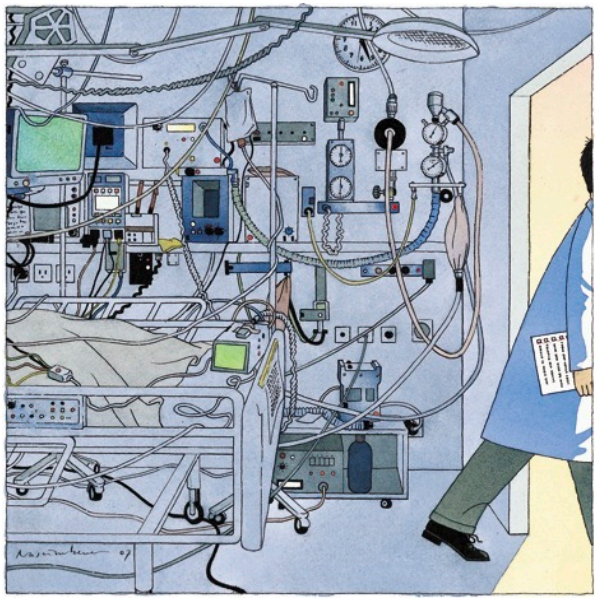

Is Organ Donation From Brain Dead Donors Reaching an Inescapable and Desirable Nadir?

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(*Transplantation* 2011;91: 1177–1180)

American Journal of Transplantation 2009; 9: 2157–2165
Wiley Periodicals Inc.

doi: 10.1111/j.1600-6143.2009.02758.x

Time to Cardiac Death After Withdrawal of Life-Sustaining Treatment in Potential Organ Donors

C. Suntharalingam[a], L. Sharples[b], C. Dudley[c], J. A. Bradley[a] and C. J. E. Watson[a,*]

Time to death

All patients died following treatment withdrawal. The time to death ranged from 5 min to 3.3 days (4779 min) (Figure 1). Most patients died soon after treatment withdrawal, with a median time to death of 36 min. The proportions of patients still alive at 1, 2, 3, 4 and 12 h were 43.5%, 36.1%, 30.9%, 28.3% and 14.1%, respectively. Fewer than 10% remained alive for more than 24 h following treatment withdrawal.

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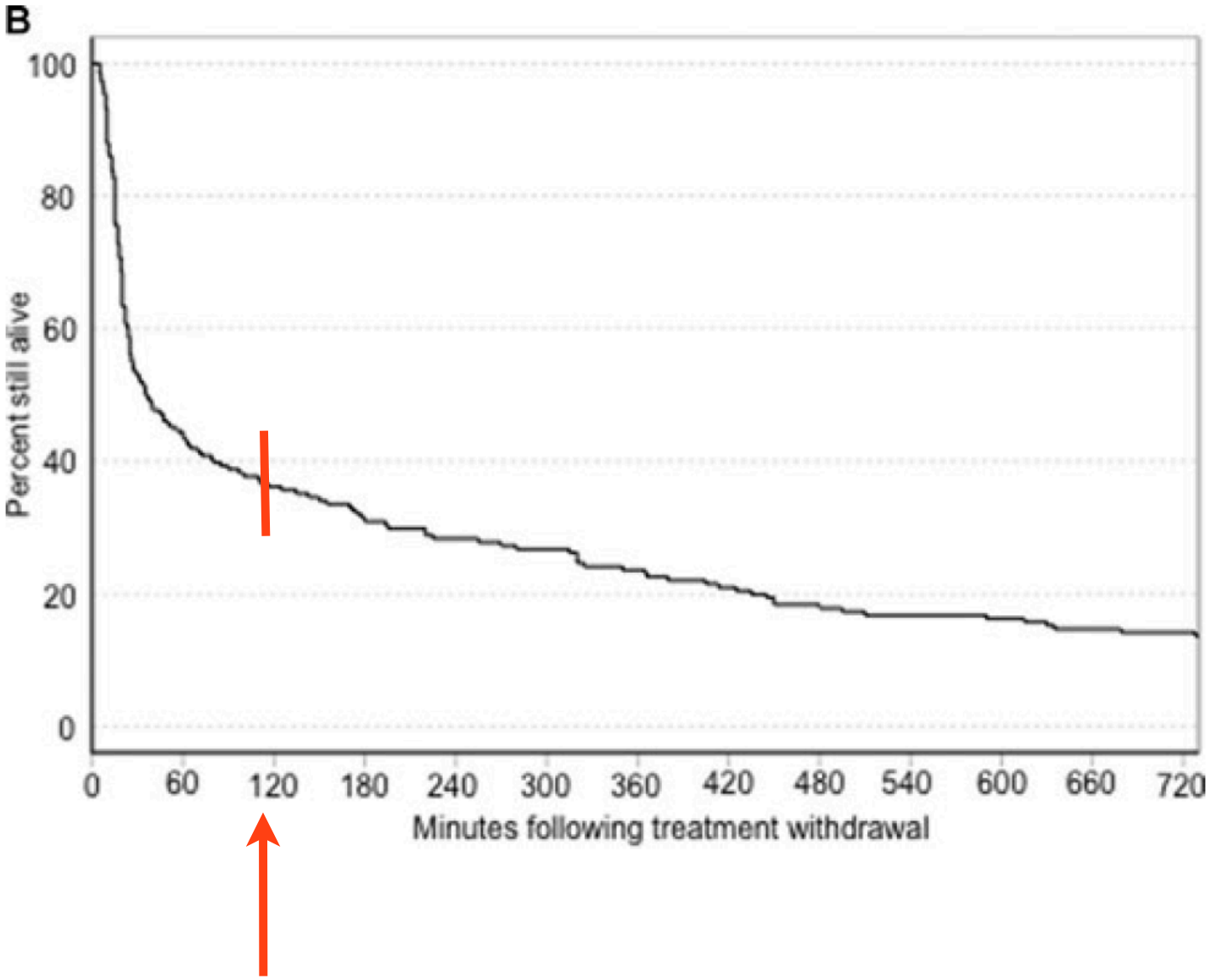

C. Suntharalingam[a], L. Sharples[b], C. Dudley[c],
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Factors influencing time to death after withdrawal of life support in neurocritical patients

A.H. Yee, DO
A.A. Rabinstein, MD
P. Thapa, MS
J. Mandrekar, PhD
E.F.M. Wijdicks, MD, PhD

Neurology® 2010;74:1380-1385

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Figure 1 **Probability of death within 60 minutes after cessation of life-sustaining therapy**

Absent corneal reflex	Absent cough reflex	Extensor/absent motor response	Oxygenation index >4.2	Probability
■				0.677
	■			0.762
		■		0.653
			■	0.667
■	■			0.825
■		■		0.715
■			■	0.812
	■	■		0.827
	■		■	0.842
		■	■	0.833
■	■	■		0.849
■	■		■	0.894
■		■	■	0.865
	■	■	■	0.916
■	■	■	■	0.929

■ = Presence of variable

Neurology® 2010;74:1380-1385

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External validation of a prognostic model predicting time of death after withdrawal of life support in neurocritical patients*

Yorick J. de Groot, MD; Hester F. Lingsma, PhD; Jan Bakker, MD, PhD; Diederik A. Gommers, MD, PhD; Ewout Steyerberg, PhD; Erwin J. O. Kompanje, PhD

Objective: The ability to predict the time of death after withdrawal of life support is of specific interest for organ donation after cardiac death. We aimed to externally validate a previously developed model to predict the probability of death within the time constraint of 60 mins after withdrawal of life-sustaining measures.

Design: The probability to die within 60 mins for each patient in this validation sample was calculated based on the model developed by Yee et al, which includes four variables (absent corneal reflex, absent cough reflex, extensor or absent motor response, and an oxygenation index >4.2). Analyses included logistic regression modeling with bootstrapping to adjust for overoptimism. Performance was assessed by calibration (agreement between observed and predicted outcomes) and discrimination (distinction of those patients who die within 60 mins from those who do not, expressed by the area under the receiver operating characteristic curve).

Setting: Mixed intensive care unit in The Netherlands.

Patients: We analyzed data from 152 patients who died as a result of a neurologic condition between 2007 and 2009.

Interventions: None.

Measurements and Main Results: A total of 82 patients had sufficient data. Fifty (61%) died within 60 mins. Univariable and multivariable odds ratios of the predictors were very similar between the development and validation sample. The prediction model showed good discrimination with an area under the receiver operating characteristic curve of 0.75 (95% confidence interval [CI] 0.63–0.87) but calibration was modest. The mean predicted probability was 80%, overestimating the 61% overall observed risk of death within 60 mins. Modeling oxygenation index as a linear term led to an improved version of the Mayo NICU model. (area under the receiver operating characteristic curve [95% CI] = 0.774 [0.69–0.90], bootstrap-validated area under the receiver operating characteristic curve [95% CI] = 0.74 [0.66–0.87]).

Conclusions: The model discriminated well between patients who died within 60 mins after withdrawal of life support and those who did not. Further prospective validation is needed. (Crit Care Med 2012; 40:233–238)

KEY WORDS: organ donation; validation studies; withdrawing treatment

External validation of a prognostic model predicting time of death after withdrawal of life support in neurocritical patients

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Table 2. Factors predicting dead within 60 mins from withdrawal of life-sustaining measures included in the final model of Yee et al

	Yee et al (3)		Present Study	
Variable	Patients Dying <60 Mins (Total n = 75), No. (%)	Patients Dying >60 Mins (Total n = 74), No. (%)	Patients Dying <60 Mins (Total n = 50), No. (%)	Patients Dying >60 Mins (Total n = 32), No. (%)
Absent corneal reflex	65 (87)	32 (43)	42 (84)	14 (44)
Absent cough reflex	45 (64)	15 (20)	26 (52)	5 (16)
Extensor/absent motor response	64 (85)	34 (46)	48 (96)	22 (69)
Oxygenation index >4.2	34 (45)	17 (23)	23 (46)	10 (31)

This table is partly reproduced from Yee AH, Rabinstein AA, Thapa P, et al: Factors influencing time to death after withdrawal of life support in neurocritical patients. *Neurology* 2010; 74:1380–1385, with permission from the copyright holder.

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Articles

Prediction of potential for organ donation after cardiac death in patients in neurocritical state: a prospective observational study

Alejandro A Rabinstein, Alan H Yee, Jay Mandrekar, Jennifer E Fugate, Yorick J de Groot, Erwin J O Kompanje, Lori A Shutter, W David Freeman, Michael A Rubin, Eelco F M Wijdicks

Lancet Neurol 2012; 11: 414–19

Absent corneal reflex	Absent cough reflex	Extensor or absent motor response	Oxygenation index >3·0	Score	Probability
No	No	No	No	0	0·08
No	No	No	Yes	1	0·16
Yes	No	No	No	1	0·18
No	No	Yes	No	1	0·20
No	Yes	No	No	2	0·26
Yes	No	No	Yes	2	0·34
No	No	Yes	Yes	2	0·37
Yes	No	Yes	No	2	0·40
No	Yes	No	Yes	3	0·45
Yes	Yes	No	No	3	0·48
No	Yes	Yes	No	3	0·51
Yes	No	Yes	Yes	3	0·61
Yes	Yes	No	Yes	4	0·68
No	Yes	Yes	Yes	4	0·71
Yes	Yes	Yes	No	4	0·74
Yes	Yes	Yes	Yes	5	0·87

1 point was assigned for each of absent corneal reflex, absent or extensor motor response to pain, and oxygenation index of more than 3·0. 2 points were assigned for an absent cough reflex.

Table 4: **Probabilities of death within 60 min according to the combinations of predictive variables**

	Death within 60 min	Death after 60 min
0	0	14 (100%)
1	6 (12%)	21 (78%)
2	8 (30%)	19 (70%)
3	18 (62%)	11 (38%)
4	15 (71%)	6 (29%)
5	28 (90%)	3 (10%)
Overall	75 (50%)	74 (50%)

Table 5: **Frequency of death after withdrawal of life-sustaining measures according to donation after cardiac death in patients in a neurocritical state (DCD-N) score in the retrospective cohort of 149 patients[6]**

1 point was assigned for each of absent corneal reflex, absent or extensor motor response to pain, and oxygenation index of more than 3·0. 2 points were assigned for an absent cough reflex.

The DCD-N score provides a readily accessible estimate of the likelihood of death within 60 min of WLST in patients with critical brain injury who are dependent on artificial life support. The score needs to be tested in patients for whom consent of DCD has been obtained. If the reliability of its performance is confirmed, this scoring technique could help guide resource allocation without compromising the availability of viable DCD donors.

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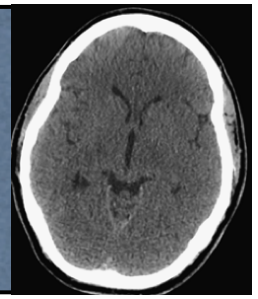
Conclusions



1. Uniform definition of a potential brain dead organ donor (imminent brain death) will lead to higher donor conversion rate and allows better comparison between countries and hospitals

2. Using the DCD-N score will predict death within 60 minutes after withdrawal of life support which will lead to a higher donor conversion rate, less burden for relatives and better use of resources

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