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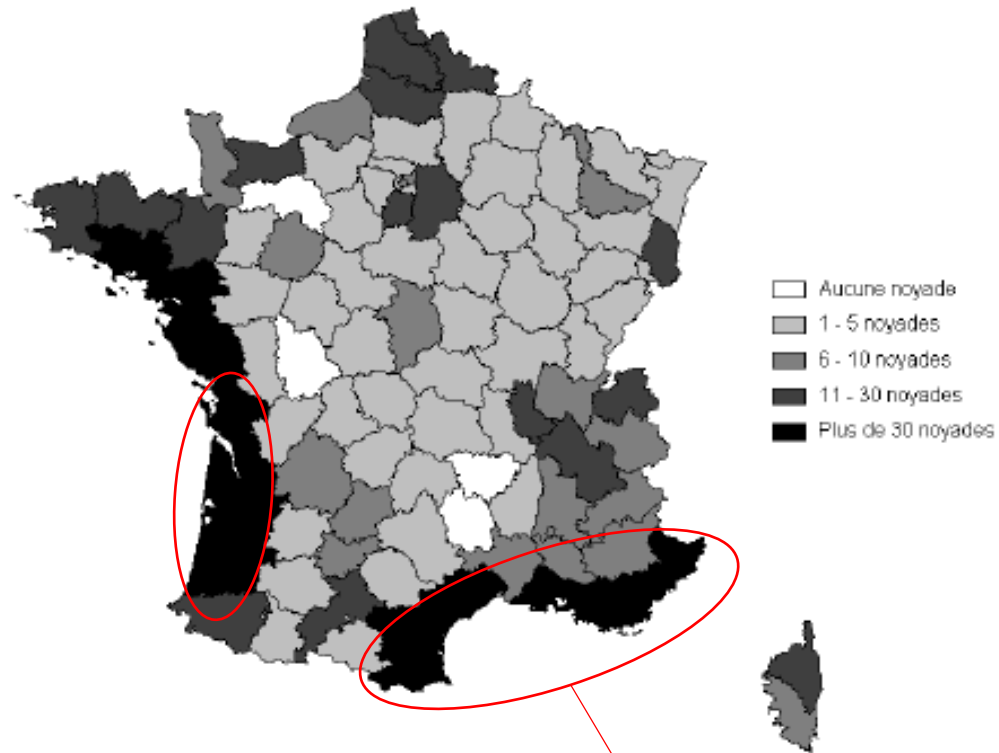
Noyades : vers un recentrage de la problématique
P Michelet – Urgences Timone 2

La situation française

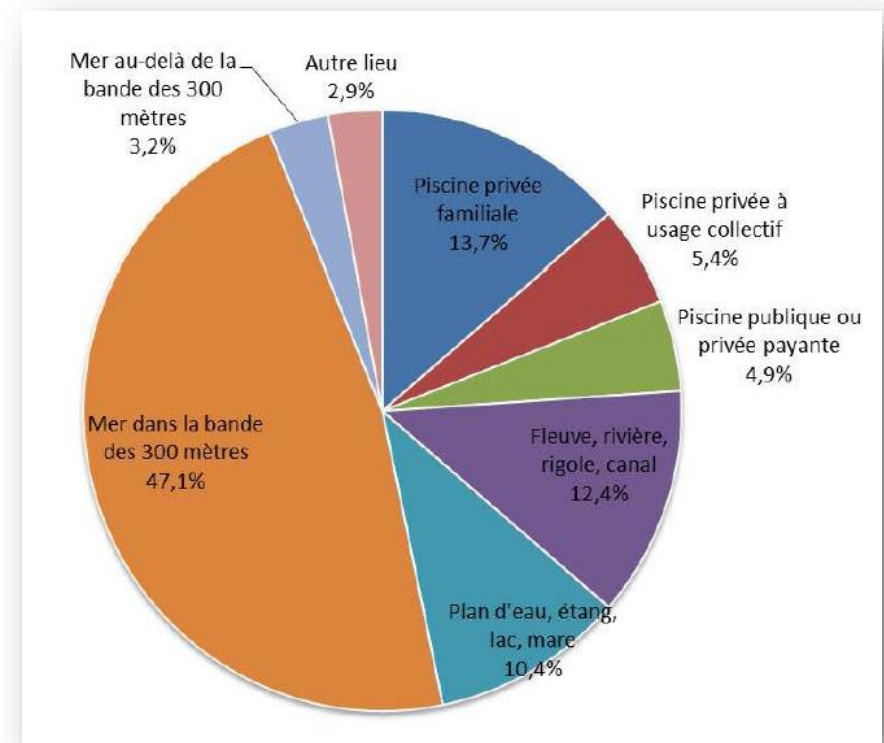


- Une évaluation épidémiologique bien menée par l'INVES
 - Évaluations en 2015, 2012, 2009, 2006, 2003, 2004
- Un **nombre de noyade stable**
 - 1226 noyades accidentelles en 2015
 - 1366 en 2009; 1207 en 2006
- Un **taux de mortalité qui ne diminue pas**
 - 436 décès (soit 34%) en 2015
 - 34% en 2009 contre 33% en 2006
- Mais aucune donnée médicale précise

La situation française



440 noyades chaque année, 23% de mortalité



Source : INVS 2009, 2015

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De la définition à la
physiopathologie

Définition – vers la simplification

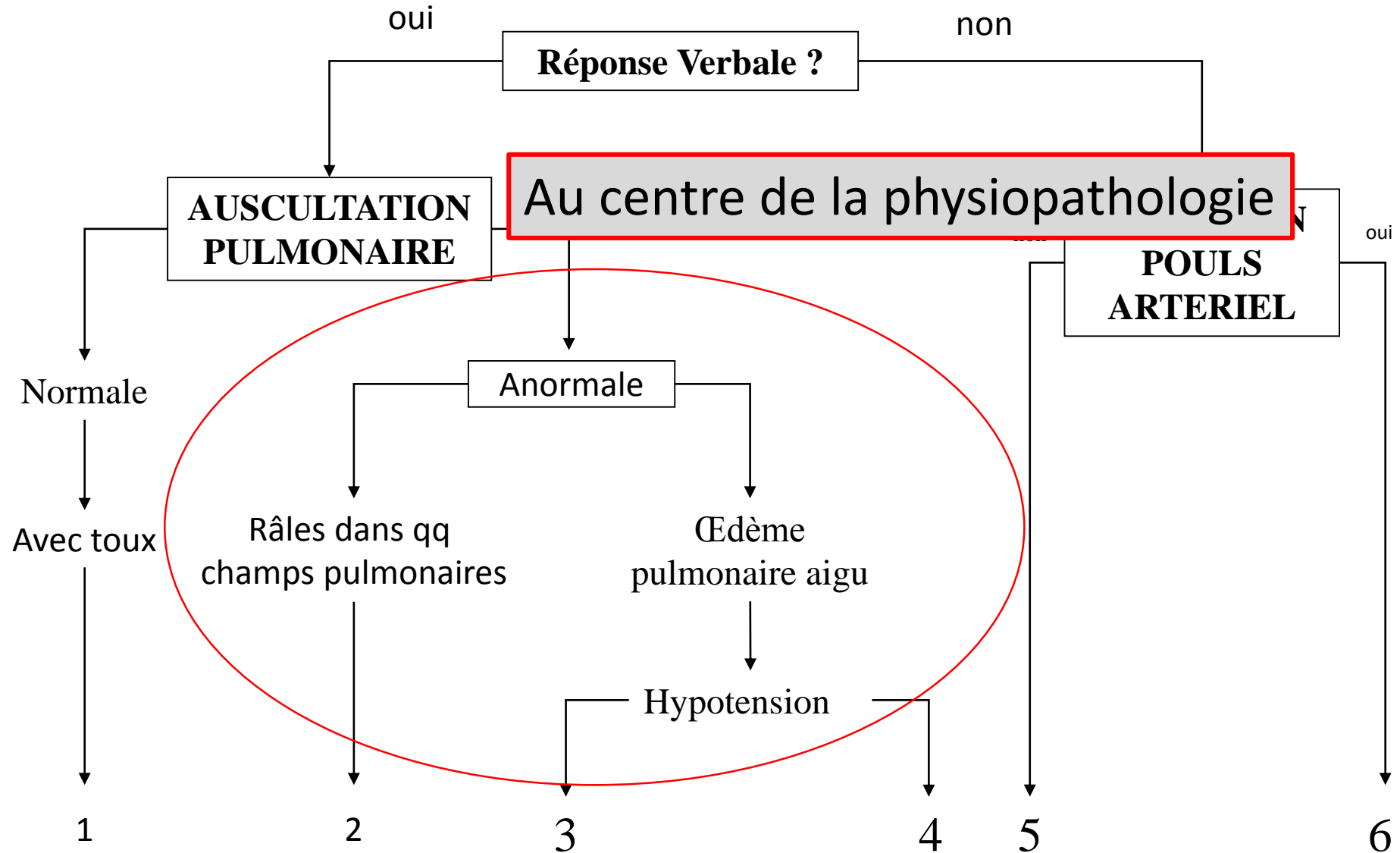
- La noyade:

Etat résultant d'une insuffisance respiratoire provoquée par la submersion ou l'immersion en milieu liquide

- Défaillance respiratoire aiguë

- Élément physiopathologique majeur responsable d'une hypoxémie
- Défaillances viscérales secondaires à l'hypoxémie
 - Arrêt cardiaque
 - Coma et encéphalopathie post-anoxique
 - Défaillance rénale
 - Défaillance hématologique (CIVD)

Algorithme de Szpilman



Physiopathologie – encore méconnue

- Insuffisance respiratoire aiguë : OK
 - Ingestion >> Inhalation
- Insuffisance cardio circulatoire
 - Finalité = Arrêt Cardiaque Hypoxique
 - Mais avant ??
 - Tachycardie : OK
 - Décharge catécholaminergique ??

Résolutivité rapide de l'IRA



OAP ??

Physiopathologie – encore méconnue

- Insuffisance respiratoire aiguë : OK
 - Ingestion >> Inhalation
- Insuffisance cardio circulatoire
 - Finalité = Arrêt Cardiaque Hypoxique
 - Mais avant ??
 - Tachycardie : OK
 - Décharge catécholaminergique ??
- Participation métabolique ?

Drowning, haemodilution, haemolysis and staining of the intima of the aortic root – preliminary observations

Roger W. Byard ^{a,b,*}, Glenda Cains ^a, Ellie Simpson ^a, David Eitzen ^a, Michael Tsokos ^c

JOURNAL OF
CLINICAL
FORENSIC
MEDICINE

- Etude observationnelle
 - 74 victimes :
 - 44 en eau douce (age = 43,4 ans)
 - 30 en eau de mer (age = 60.5 ans)
 - Mesure du Na dans le ventricule gauche (**post mortem**)
- Résultats (p=0,001)
 - Eau douce : 117 ± 14.2 mmol/l
 - Eau de mer : 153 ± 14.4 mmol/l

	Na	K	pH	
Eau de mer	145 ± 5	4 ± 0.6	7,23 ± 0,13	NS
Eau douce	132 ± 4	4,3 ± 0,6	7,13 ± 0,19	

Drowning



Plus d'allusion précise

David Szpilman, M.D., Joost J.L.M. Bierens, M.D., Ph.D.,
Anthony J. Handley, M.D., and James P. Orlowski, M.D.

N Engl J Med 2012;366:2102-10.

Drowning in fresh and saltwater has the same respiratory and metabolic course in a matched cohort study

Pierre MICHELET¹, Marion DUSART¹, Laurence BOIRON¹, Julien MARMIN¹, Tarak MOKNI³, Anderson LOUNDOU², Mathieu COULANGE⁴, Thibaut MARKARIAN¹.

Eur J Emerg Med 2018 en Révision

	Fresh Water Group	Sea Water Group	p
Respiratory parameters			
PEEP (cmH ₂ O) *	7 ± 4	5 ± 4	0.11
Inspiratory pressure (cmH ₂ O) §	12 ± 4	10 ± 4	0.46
pH 0H	7.18 ± 0.24	7.25 ± 0.14	0.610
PaFiO ₂ 0H	141 ± 76	220 ± 122	0.023
PaFiO ₂ 12H	229 ± 105	202 ± 73	0.386
pCO ₂ 0H (mmHg)	48 ± 13	47 ± 11	0.952
pCO ₂ 12H (mmHg)	38 ± 8	43 ± 6	0.069
NIV length of use (day)	1.4 ± 2	1.2 ± 7	0.638
MV length of use (day)	7 ± 17	9 ± 15	0.394
Metabolic parameters			
Sodium 0H (mmol/l)	140 ± 5.2	144 ± 6.8	0.004
Potassium 0H (mmol/l)	4.12 ± 0.8	4.32 ± 0.9	0.323
Lactates 0H (mmol/l)	4.2 [1.5-14.4]	2.5 [1.4-3.9]	0.127
Protein 0H (g/l)	63 ± 13	70 ± 9	0.026

Conclusions: Despite initial differences in respiratory function, the type of water did not influence the clinical outcomes for patients admitted to ICU after drowning

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Pronostic de l'AC sur Noyade

Pronostic des patients

- **Fonction de la durée d'immersion**

Quan L et al. Predicting outcome of drowning at the scene: A systematic review and meta-analyses. Resuscitation 2016;104:63–75

- **Fonction de la rapidité d'intervention des secours**

Jeong J et al. Relationship between drowning location and outcome after drowning-associated out-of-hospital cardiac arrest:nationwide study. Am J Emerg Med. 2016;34(9):1799–803

- **Fonction du stade de gravité lors de la prise en charge**

Prognostic factors and outcome after drowning in an adult population

M. A. BALLESTEROS et al. Acta Anaesthesiol Scand 2009; 53: 935–940

Results: There were 43 patients (five children and 38 adults), with male predominance. Fifteen patients, all adults (34.9%), died

Table 3

Univariate analysis of the main variables.

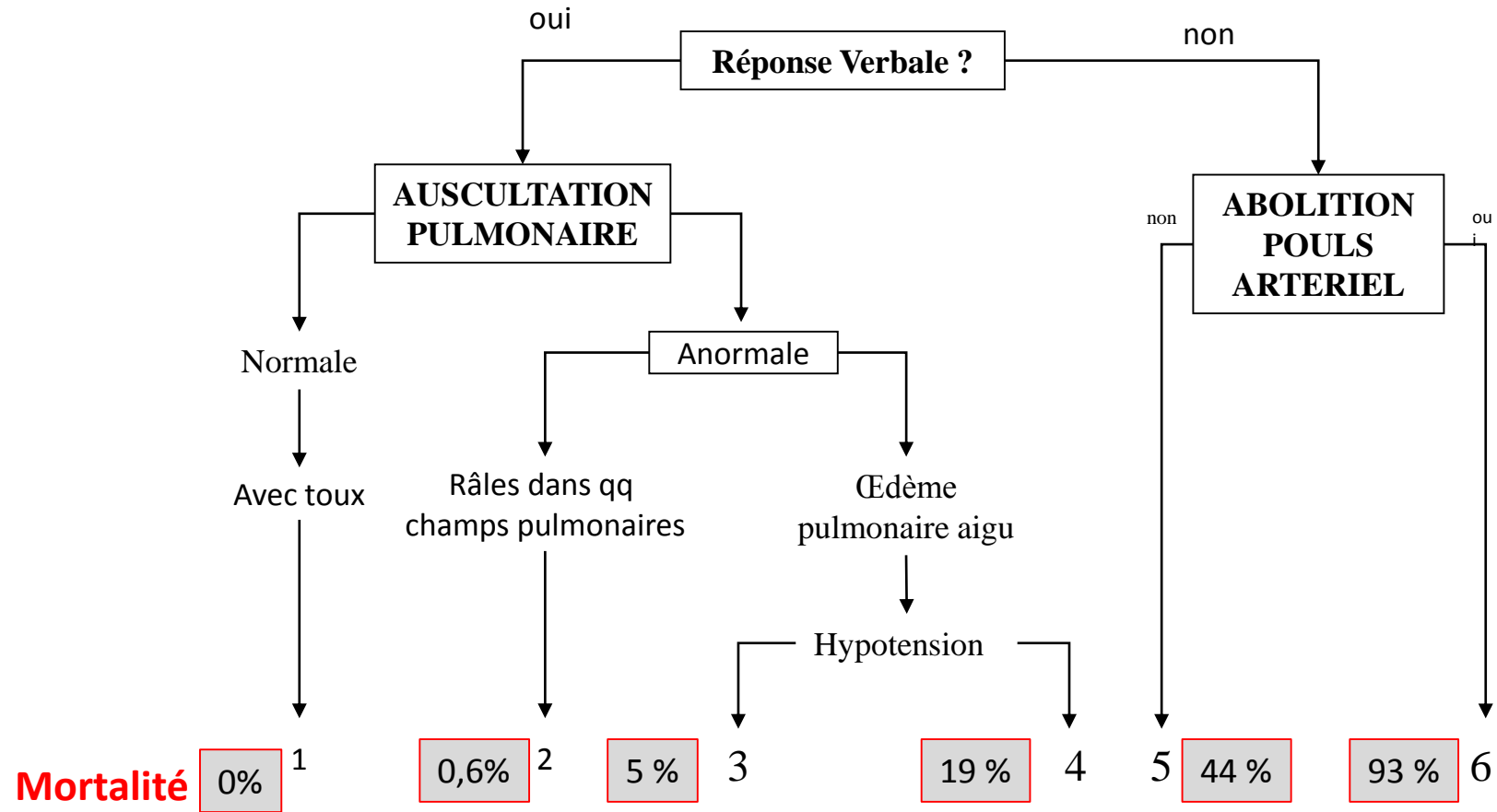
	<i>N</i>	β	SE	OR (95% CI)	<i>P</i>
Constant			0.320		
Age (years)	43	0.041	0.017	1.04 (1.01–1.08)	0.018
Submersion time (minutes)	30	0.350	0.138	1.42 (1.08–1.86)	0.011
Water temperature (°C)	22		0.253	0.61 (0.37–0.99)	0.047
Glycaemia (mg/dl)	34	0.014	0.006	1.01 (1.00–1.03)	0.013
GCS (points)	42		0.113	0.641 (0.51–0.80)	<0.005
No pupillary reactivity	41	3.376	0.948	29.25 (4.56–187.70)	<0.005
APACHE II score (points)	34	0.296	0.091	1.34 (1.13–1.61)	0.001

OR is expressed with respect to each increase or decrease in the unit of measurement in which the variable is expressed. APACHE II, acute physiology and chronic health evaluation; GCS, Glasgow Coma Score; β , logistic regression coefficient; SE, standard error; OR, odds ratio.

Lavelle JM et al. CCM 1993

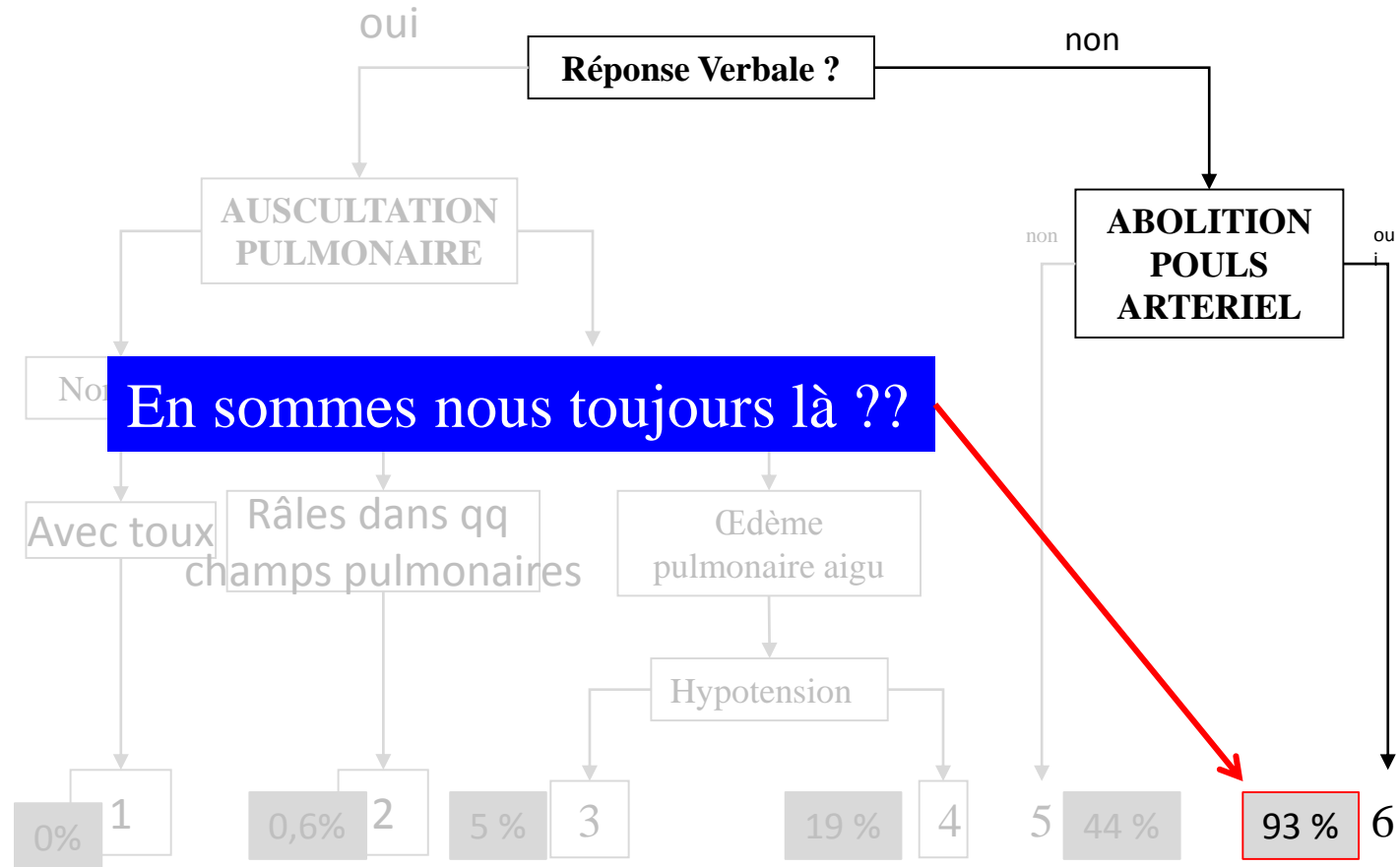
Algorithme de Szpilman

Szpilman D. et al Chest 1997; 112 : 660-665



Algorithme de Szpilman

Szpilman D. et al Chest 1997; 112 : 660-665



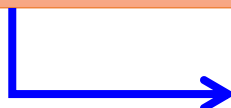
S Grmec et al. Int J Emerg Med 2009; 2: 7-12 = 44% de survie !!
Mais qu'auprès des patients vivants à l'arrivée à l'H.

Étude rétrospective sur 3 ans
7 réanimations de la côte
méditerranéenne

Michelet P et al. Eur J Emerg Med, 2015

Détresse Respiratoire Aigue Post Noyade (n=126)

38 patients en ACR médicalisé



40% de survie à 28 jours

> 15 % de survie globale en incluant les ACR non récupérés sur place

VS

93 % de mortalité dans la série de Szpilman

Can we identify termination of resuscitation criteria in cardiac arrest due to drowning: results from the French national out- of-hospital cardiac arrest registry

Hubert H, Escutnaire J, Michelet P, et al

Journal of Evaluation in Clinical Practice. 2016 17(8):712:20



Registre RéAC.

- Amélioration de la survie si :
 - Rapidité d'intervention des secours OR: 0.960[0.925; 0.996]
 - Réduction de la période de no flow OR: 0.535[0.313; 0.913]
 - Association avec la ventilation OR: 6.742[2.043; 22.250]

AC et Noyade :
Toujours MCE « ET » VA

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Prise en Charge Thérapeutique

Creating a drowning chain of survival David

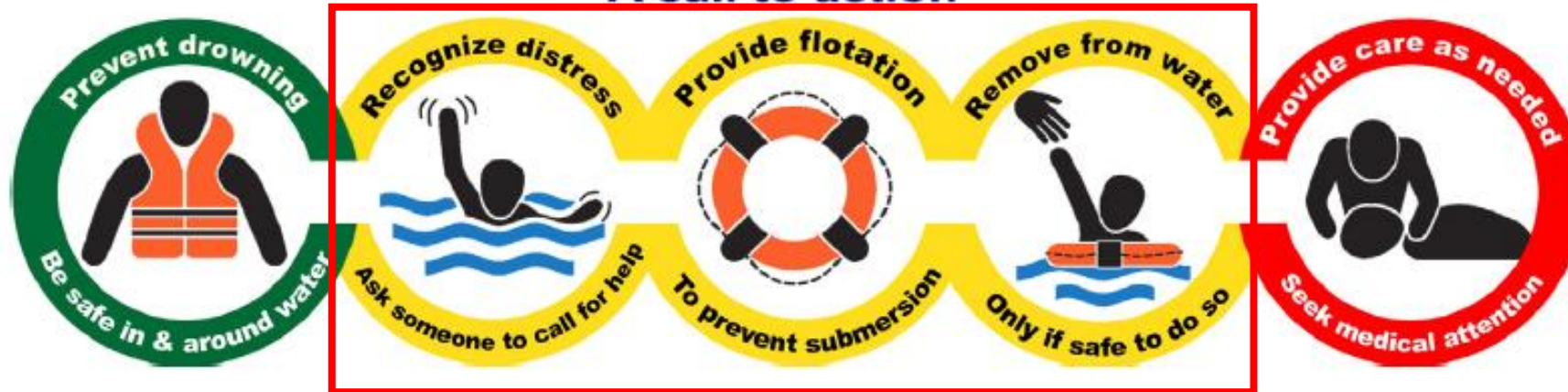
Szpilman^{a,*}, Jonathon Webber^b, Linda Quan^c, Joost Bierens^d, Luiz Morizot-Leite^e,
Stephen John Langendorfer^{f,g}, Steve Beerman^h, Bo Løfgrenⁱ



Resuscitation 85 (2014) 1149–1152

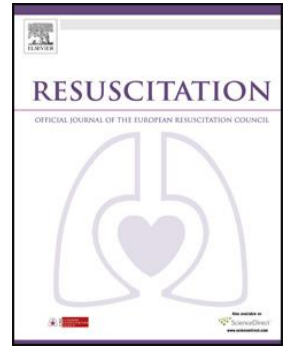
DROWNING CHAIN OF SURVIVAL

A call to action



Association of water temperature and submersion duration and drowning outcome

Linda Quan, Christopher D. Mack, Melissa A. Schiff.



Resuscitation 85 (2014) 790–794

Multivariate predictors for good outcome in open water drowning victims.

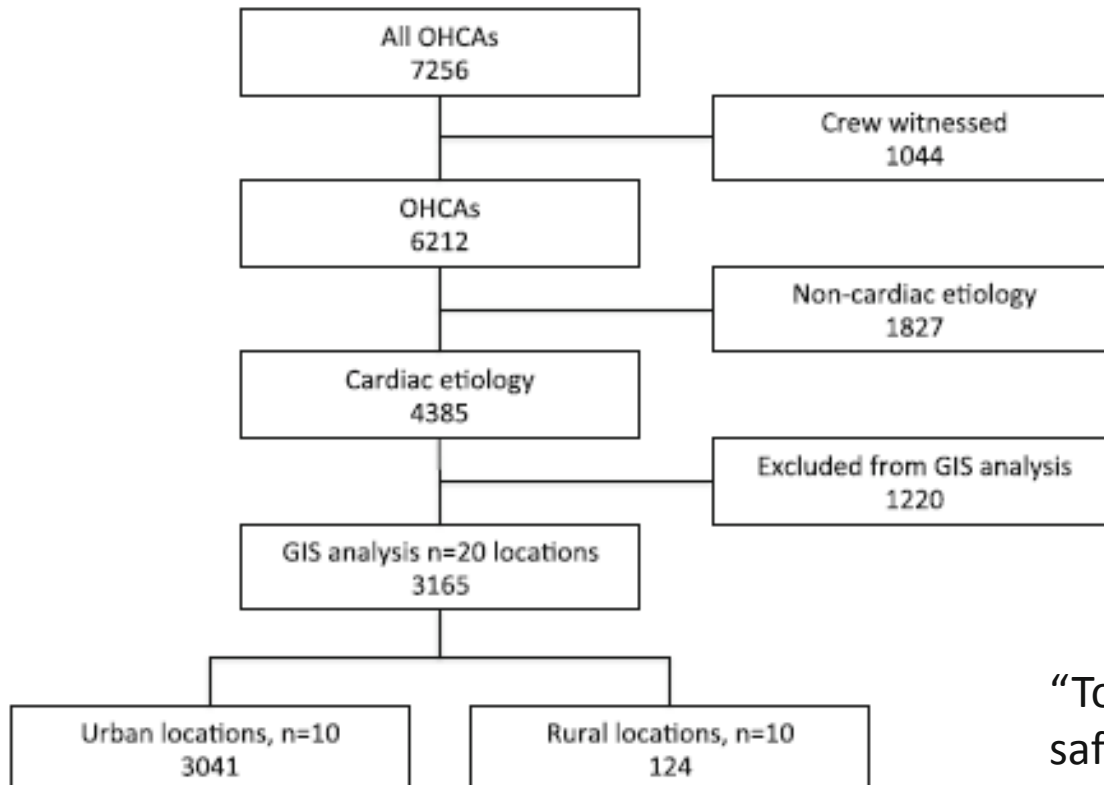
Characteristics	Adjusted RR (95% CI)
Age (years)	
0–4	1.34 (1.01, 1.79)
5–14	1.33 (0.96, 1.85)
15+	1.0
Submersion duration (minutes)	
<6	1.0
6–10	0.39 (0.23, 0.65)
11+	0.02 (0.01, 0.04)
Water temperature (°C)	
<6	1.0
6–16	1.13 (0.84, 1.52)
17+	0.97 (0.71, 1.33)



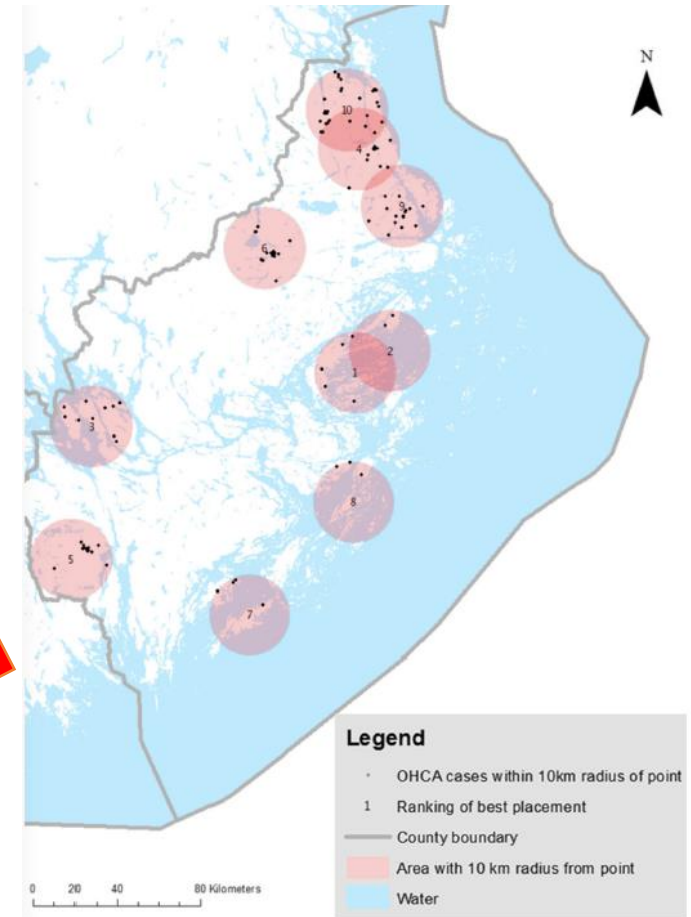
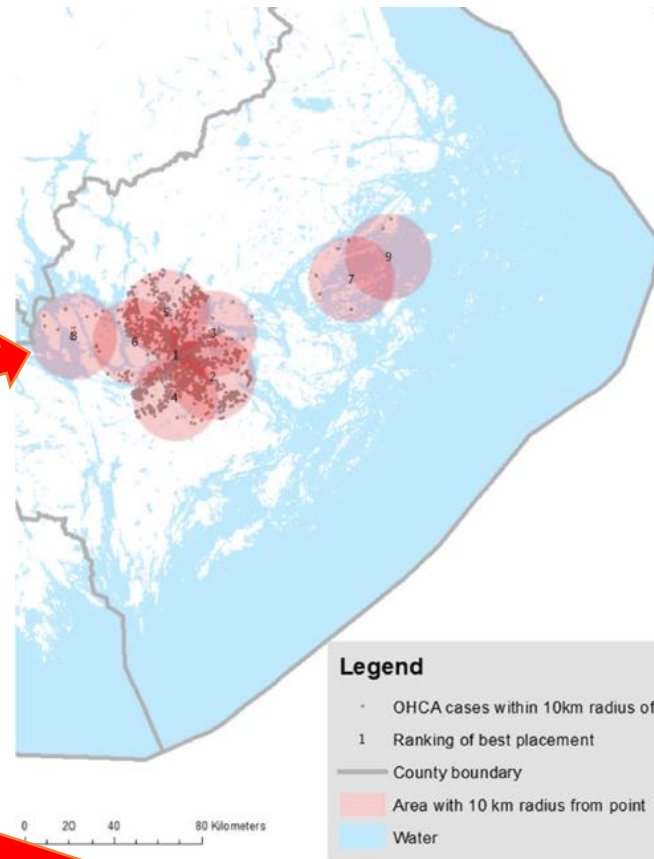
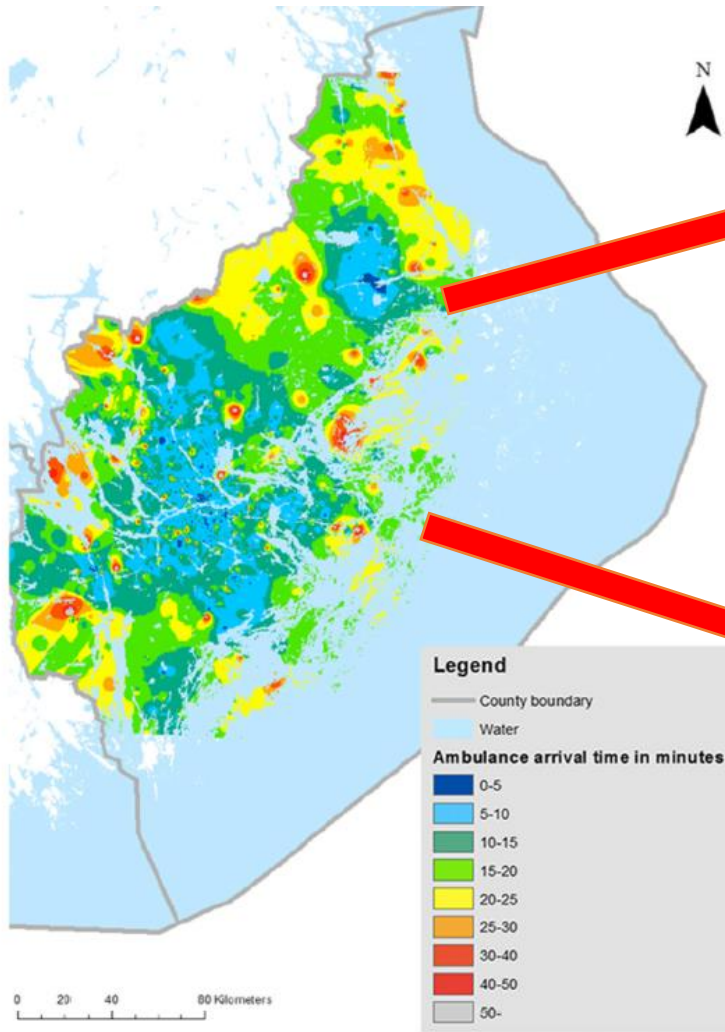
“estimated submersion duration was the most powerful predictor of outcome. Recommendations for initiation of rescue and resuscitation efforts should be revised to reflect the very low likelihood of good outcome following submersion greater than 10 min.”

Unmanned aerial vehicles (drones) in out of-hospital-cardiac-arrest

A. Claesson¹, D. Fredman¹, L. Svensson¹, M. Ringh¹, J. Hollenberg¹, P. Nordberg¹, M. Rosenqvist², T. Djarv¹, S. Österberg¹, J. Lennartsson³ and Y. Ban³



“To use drones in rural areas to deliver an AED in OHCA may be safe and feasible. Suitable placement of drone systems can be designed by using Geographic Information System models. The use of an AED equipped drone may have the potential to reduce time to defibrillation in OHCA.”



Drones may be used to save lives in out of hospital cardiac arrest due to drowning

A. Claesson^{a,*}, L. Svensson^a, P. Nordberg^a, M. Ringh^a, M. Rosenqvist^a, T. Djarv^a, J. Samuelsson^b, O. Hernborg^c, P. Dahlbom^d, A. Jansson^d, J. Hollenberg^a

Method:

Randomized simulation study used a submerged manikin placed in a shallow (<2 m) 100 × 100-m area at Tylösand beach, Sweden.

A search party of 14 surf-lifeguards (control) was compared to a drone transmitting video to a tablet (intervention).

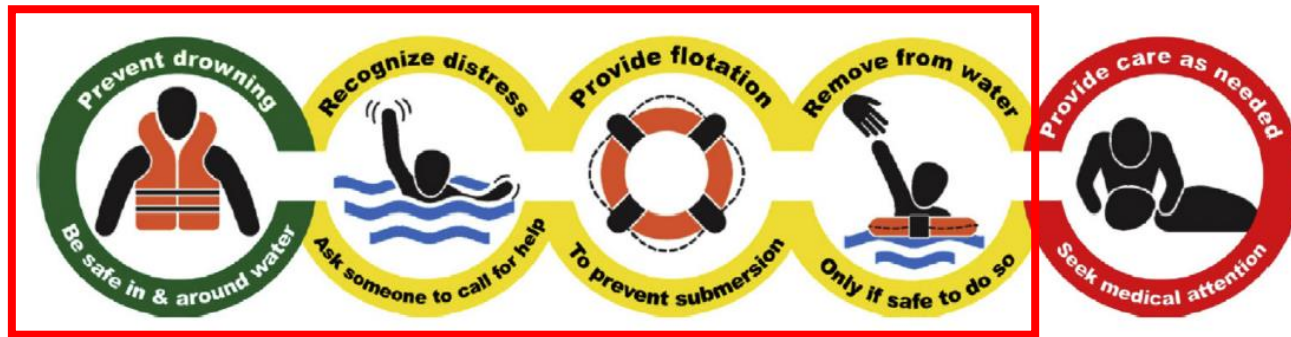
Time from start to contact with the manikin was the primary endpoint.

Results:

- Twenty searches were performed in total, 10 for each group.
- The median time from start to contact with the manikin was 4:34 min (IQR 2:56–7:48) for the search party (control) and 0:47 min (IQR 0:38–0:58) for the drone-system (intervention) respectively ($p < 0.001$).
- The median time saved by using the drone was 3:38 min (IQR 2:02–6:38).



Chaine de survie de la noyade



Beaucoup d'éléments en rapport avec le secourisme



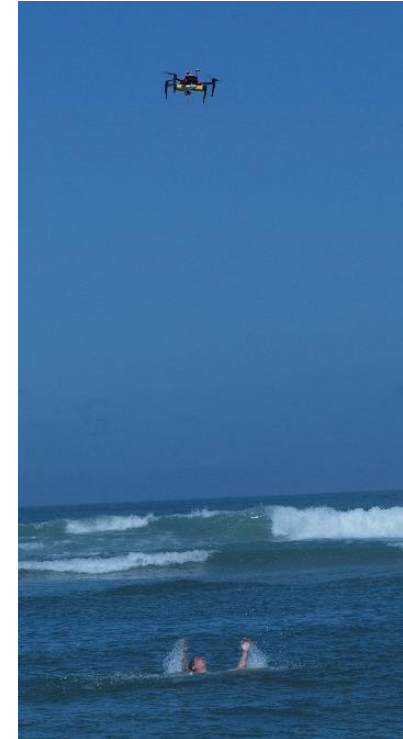
« Helper Drone »

En soumission

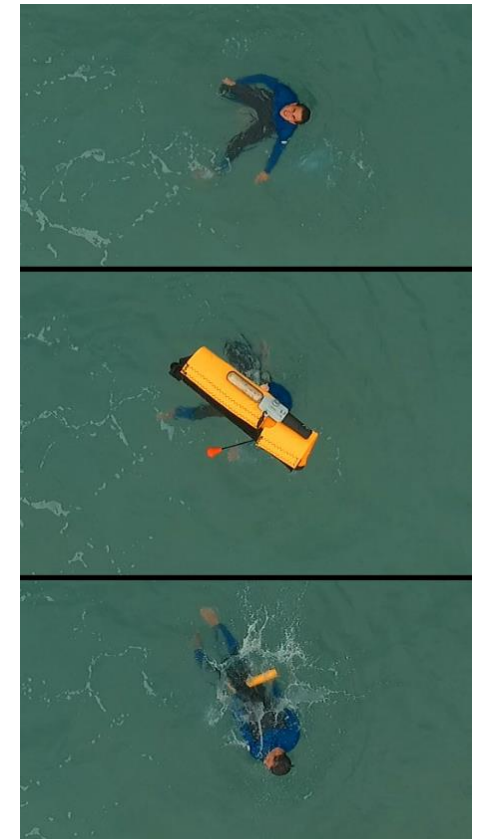
Unmanned aerial vehicles (drones) to prevent drowning

Celia Seguin¹, Gilles Blaquière¹, Anderson Loundou², Pierre Michelet³, Thibaut Markarian³

	Calm conditions N rescues = 8	Moderate conditions N rescues = 13	Rough conditions N rescues = 7
UAV Time	64 ± 25	68 ± 41	84 ± 34
Life Buoy grab	10.5±4	13 ± 5	15 ± 8
SRO Time	93±47 *	179 ± 78 *	198 ± 130 *
Jet-Ski Time	105±25 §	178 ± 25 §	142 ± 39 §

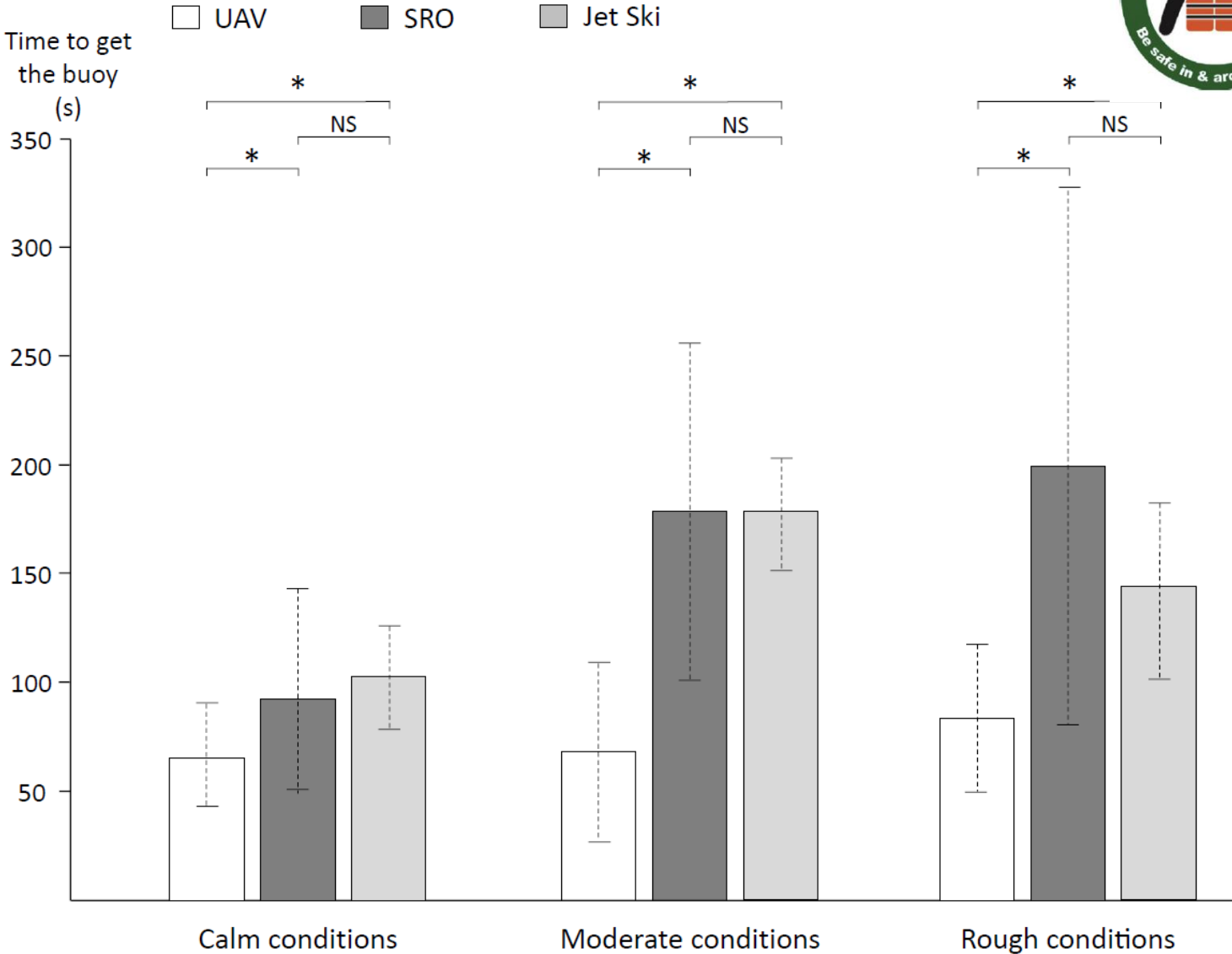


SAMU 40



Unmanned aerial vehicles (drones) to prevent drowning

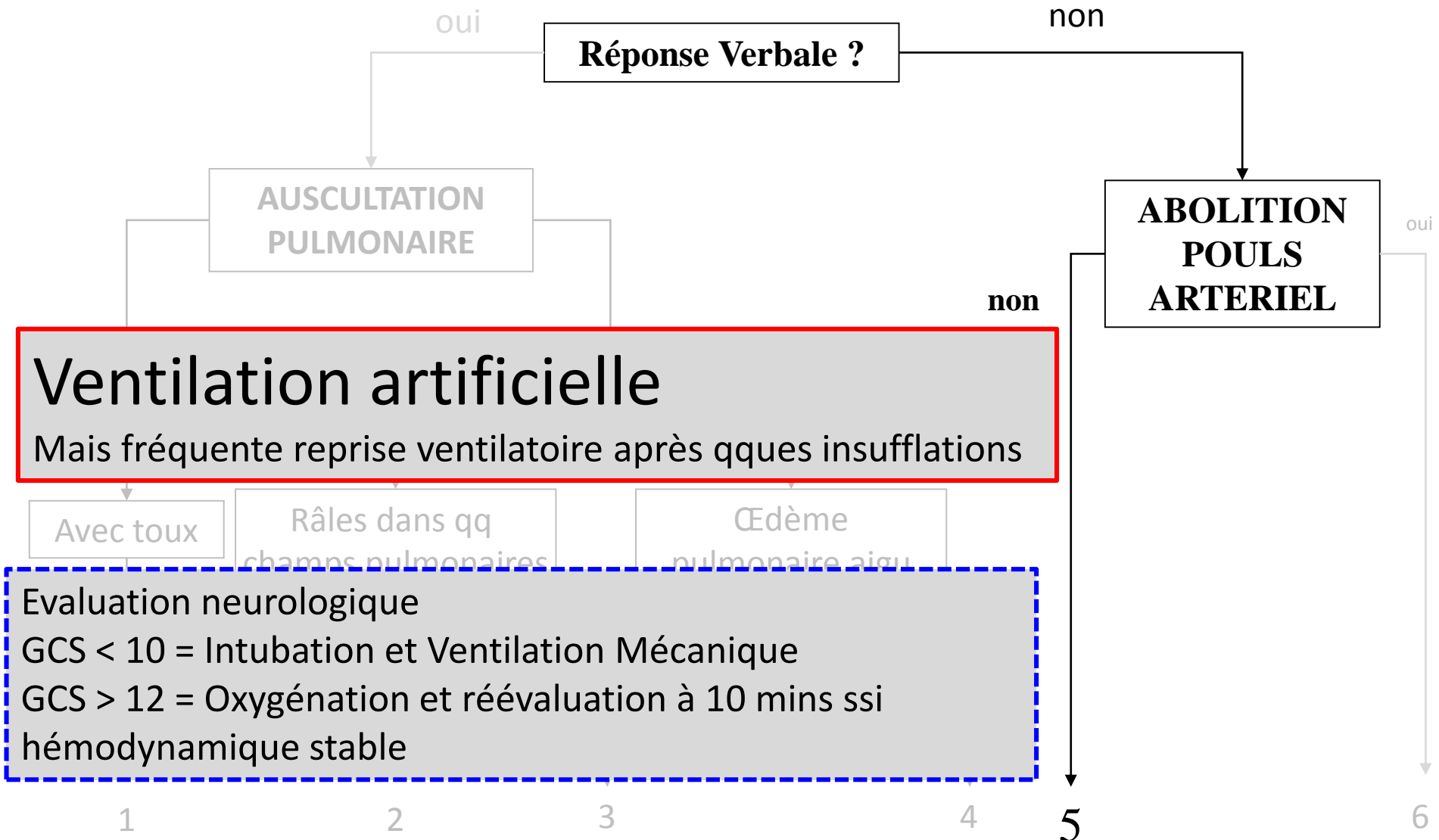
Celia Seguin¹, Gilles Blaquière¹, Anderson Loundou², Pierre Michelet³, Thibaut Markarian³



Drowning

N Engl J Med 2012;366:2102-10.

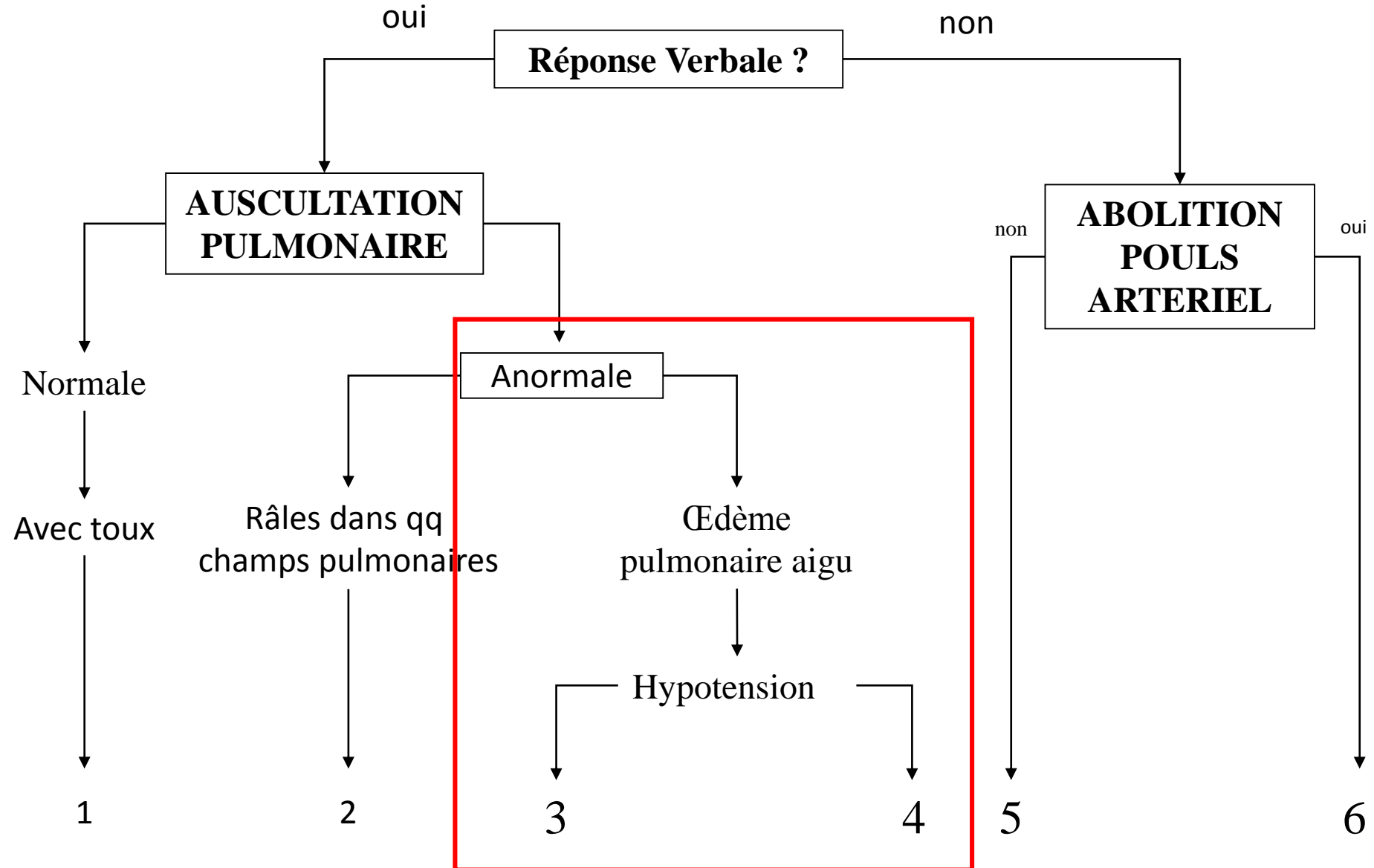
David Szpilman, M.D., Joost J.L.M. Bierens, M.D., Ph.D.,
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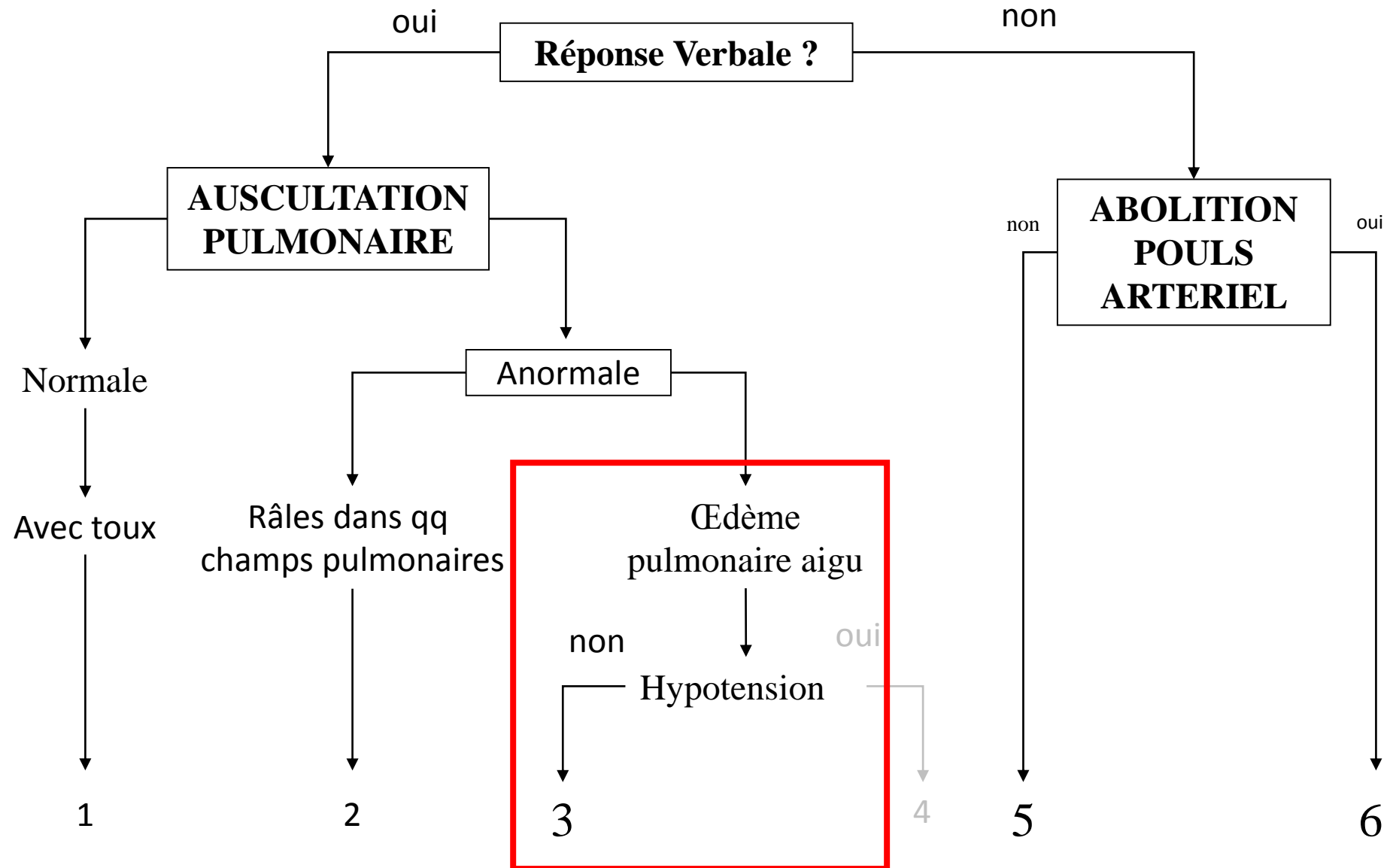
	ACR	Pas d'ACR	P
pH initial	7.11	7.27	<0.001
PaCO2 initiale (mmol/L)	49	46	NS
PaO2/FiO2	217	155	0.052
Température corporelle initiale (°C)	34.6	36.6	<0.001
PAM HO (mmHg)	84	90	NS
Fréquence cardiaque HO (/min)	91	93	NS
Remplissage vasculaire 24h (litre)	2.5	0.7	<0.001
Jours avec amines	3	0.3	<0.001
Défaillance cardiaque	40 %	3 %	<0.001
Glycémie (mmol/L)	14.3	8	<0.001
Lactatémie (mmol/L)	8.6	3.5	<0.001
Protidémie (g/L)	64	71	<0.05
Diurèse (mL)	2030	1550	<0.05
SAPS2	65	33	<0.05
SOFA	11	4	<0.05
Durée de séjour en réanimation (jour)	12	3	<0.05
Mortalité à 28 jours	60 %	0 %	<0.05

Principaux paramètres comparatifs entre le groupe ACR et le groupe n'ayant pas présenté d'ACR (moyenne)

Drowning

N Engl J Med 2012;366:2102-10.

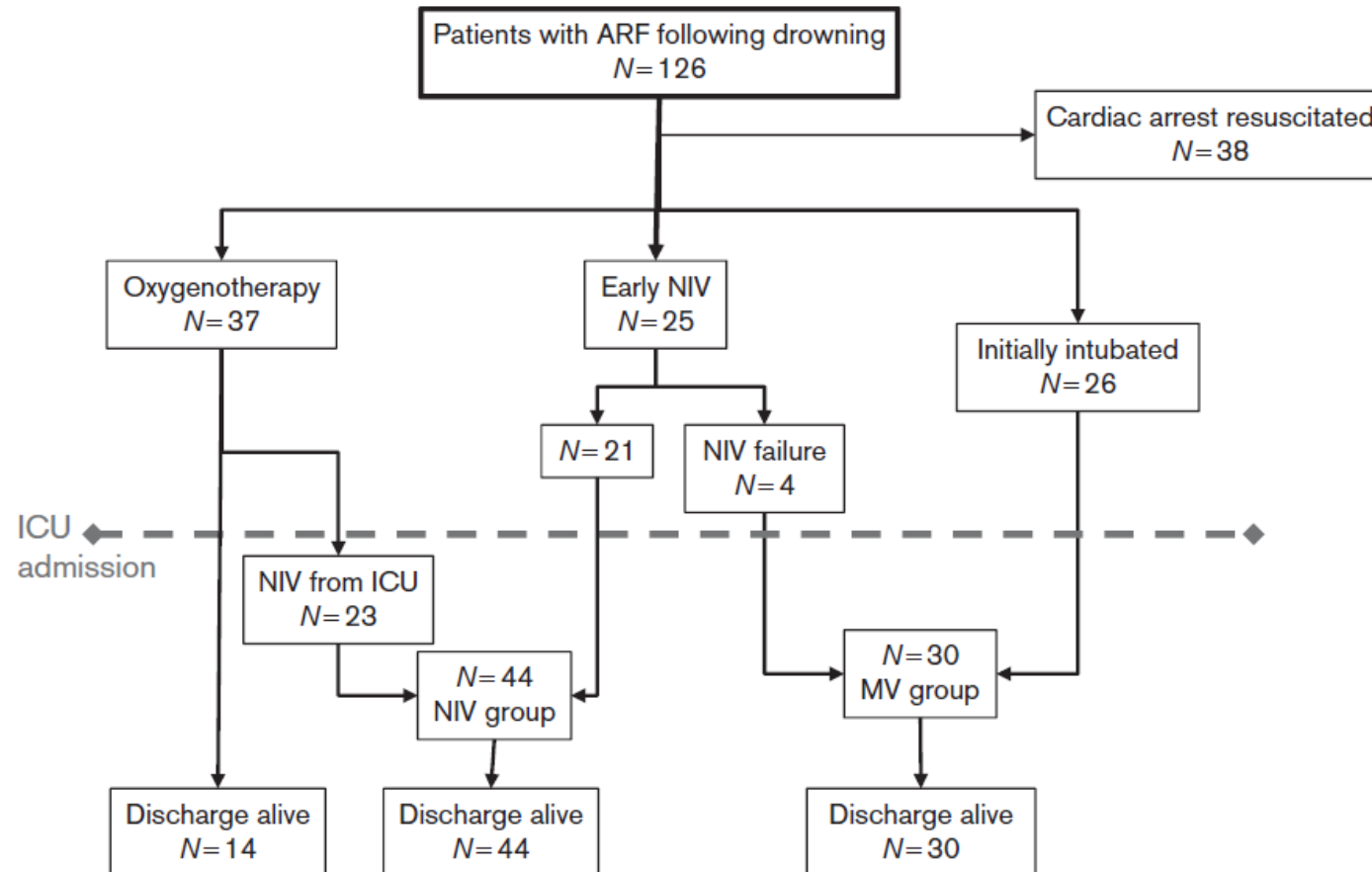
David Szpilman, M.D., Joost J.L.M. Bierens, M.D., Ph.D.,
Anthony J. Handley, M.D., and James P. Orłowski, M.D.



Acute respiratory failure after drowning: a retrospective multicenter survey

Pierre Michelet^a, Fouad Bouzana^a, Olivia Charmensat^a, Fabrice Tiger^b, Jacques Durand-Gasselín^c, Sami Hraiech^d, Samir Jaber^e, Jean Dellamonica^f and Carole Ichaí^g

European Journal of Emergency Medicine 2015



Étude rétrospective sur 3 ans

7 réanimations de la côte méditerranéenne

Détresse Respiratoire Aigue Post Noyade (n=126)

GCS global de 8 ± 5

38 patients en ACR

26 avec GCS de 7 ± 2

48 patients ont amélioré leur GCS
 12 ± 3 à 14 ± 1 en moins de 15 mins

14 patients avec GCS de 14-15

Table 1 Utstein style for drowning parameters

	Oxygen group (N= 14)	NIV group (N= 44)	MV group (N= 30)
Age (years)	56±21	65± 14	58± 23
Sex (male/female)	9/5	23/21	7/23
Cardiovascular disease (%)	2 (14)	20 (45)	8 (25)
Respiratory disease (%)	1(7)	3 (6.5)	5 (18)
Neurological disease (%)	1 (7)	6 (14)	8 (27)
Loss of consciousness [n (%)]	2 (10)	18 (36)	21 (26)
Glasgow Coma Scale	13±2 ^a	14±1 ^a	7±2
Corporeal temperature (H0) (°C)	36.2±1	36.7±1.4	36.2±1.2
Mean arterial pressure (H0) (mmHg) ^a	90±22	96± 18	77± 18
Heart rate (H0) (beats/min) ^a	91±25	92± 24	87±26
pH (H0) ^a	7.33±0.06	7.31±0.08	7.23±0.09
PaFiO ₂ (H0) (mmHg) ^a	243±154 ^b	156±92	149±95
PaCO ₂ (H0) (mmHg) ^a	43±8	44±8	52±11
HCO ₃ ⁻ (mmol/l) ^a	22±2	22±3	22±4
Lactate (H0) (mmol/l) ^a	2.0±0.6	2.9±1.9	3.4±2
SAPS 2 score	24±8	28±8	50±19
SOFA score	1.7±1	2.4±2	6.5±4
Incidence of infectious pneumonia [n (%)]	0	1 (2)	6 (20)
Length of ventilator support	–	1.4±0.7	3±2
ICU length of stay	1.4±0.5	2 (1–7)	3 (1–14)

MV, mechanical ventilation; NIV, noninvasive ventilation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; H0, intensive care first assessment.

^aData recorded at the ICU admission.

^bFor PaFiO₂ ratio calculation, the measured PaO₂ on blood gas analysis was divided by 80% FiO₂ as oxygen concentration in the heavy oxygen supply mask.

Acute respiratory failure after drowning: a retrospective multicenter survey

Pierre Michelet^a, Fouad Bouzana^a, Olivia Charmensat^a, Fabrice Tiger^b, Jacques Durand-Gasselín^c, Sami Hraiech^d, Samir Jaber^e, Jean Dellamonica^f and Carole Ichaï^g

VNI possible et safe
Patients en amélioration
neurologique ou à statut
neurologique OK

Perspectives

- Physiopathologie
 - Place du cœur dans la physiopathologie ?
 - Sidération myocardique ?
 - Incompétence VD ?
- Thérapeutique
 - Projet de PHRC National sur CPAP et DRA post Noyade
- Prévention
 - Amélioration de la rapidité de mise à disposition de moyens de flottabilité

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Merci de votre écoute