Online supplement

Evaluation of a multicomponent grading system (Baveno classification) for obstructive sleep apnoea

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Criteria for the Baveno classification

An *ad hoc working group* of the Sleep Disordered Breathing Group of the European Respiratory Society and the European Sleep Research Society developed this new approach to OSA beyond the AHI integrating symptoms and cardiometabolic comorbidities [1]. It grades OSA in a two-dimensional scheme into four groups on based the level of symptoms and the presence and severity of comorbidities. For the current analysis, we adapted the originally proposed classification criteria, partly owing to the limited availability of certain parameters in the data base. Symptoms include daytime sleepiness, insomnia, and hypersomnia. Comorbidities associated with OSA which were taken in account are atrial fibrillation, (uncontrolled) arterial hypertension, heart failure, stroke, and diabetes mellitus. Symptoms were classified according to their absence or presence and comprised the following: daytime sleepiness as defined by an ESS score ≥11, hypersomnia defined by subjective sleep length ≥11 hours, and diagnosis of insomnia. If at least one of these conditions was met, the patient was classified as having severe symptoms and thus allocated to the Baveno group B or D.

As distinguished from the Baveno paper we choose an ESS threshold of ≥11 according the general practice [1-2].

End-organ impact was classified considering the absence or presence of uncontrolled arterial hypertension, atrial fibrillation, heart failure, diabetes mellitus, and history of stroke. If at least one of these comorbidities was present, end-organ impact was deemed major calling for an allocation to Baveno group C or D. Uncontrolled hypertension was defined as a diagnosis of arterial hypertension accompanied by a systolic office blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg.

Selection

For this analysis we included all complete data sets for the following parameters: AHI≥5/h according to PSG or PG and baseline data needed for the allocation to the four Baveno groups including data on symptoms related to sleep-disordered breathing (ESS score, subjective sleep length, diagnosis of insomnia) and major end-organ impact (uncontrolled arterial hypertension, atrial fibrillation, heart failure, diabetes mellitus, and history of stroke).

8862 (61%) patients underwent full attended polysomnography, 128 (1%) unattended polysomnography, and 5509 (38%) cardiorespiratory polygraphy.

We decided for a strict inclusion management selecting only patients with complete data required for classification according to the Baveno system in order to minimize the limitations of a retrospective study. Daytime sleepiness as measured by ESS score and the diagnosis of insomnia were generally available symptoms.

The physician examined the health documents of each patient, including drug treatment. Data on arterial hypertension, atrial fibrillation, heart failure, diabetes and stroke, were also available in all included data sets and allowed for the description of comorbidities. Blood pressure ≥140/90 mmHg was used as a surrogate of uncontrolled hypertension.

The follow-up visits of the patients within a time window of 24 to 36 months after baseline were considered for the longitudinal analysis. Considering all participating clinical sites, the percentage of patients with follow-up varied between 0% and 50%. During follow-up, 1,042 patients were on positive airway pressure (PAP) therapy (474 APAP, 468 CPAP, 95 BPAP, 5 unspecified), 29 were treated with non-PAP therapies (10 mandibular advancement device, 1 surgery, 1 medical therapy, 27 unspecified).

Prevalence of comorbidities within Baveno groups

The Baveno classification differentiates the groups according to subjective symptoms and comorbidities. Regarding comorbidities, Groups C and D are characterized by severe (uncontrolled (e.g. hypertension) or recurrent (e.g. atrial fibrillation)) comorbidities. Minor (stable conditions and well-controlled) comorbidities are accepted for Groups A and B. Although hypertension is frequent in OSA, there are still substantial differences between the groups (Table e1).

Table e1: Prevalence of comorbidities according to the Baveno groups

	Group A	Group B	Group C	Group D
Systemic hypertension	33.5[*,§]	31.1[*,§]	55.2	56.6
Ischaemic heart disease	6.2[*,§]	6.1[*,§]	10.2	12.7
Left ventricular hypertrophy	0.9	0.8	1.8	1.9
Valvular heart disease	0.9[*]	0.9[*]	2.1	1.2
History of TIA or stroke	0.0	0.0	4.3	4.0
Atrial fibrillation	0.0	0.0	15.1[§]	10.1
Pulmonary hypertension	0.2[*,§]	0.4	1.0	0.9
History of myocardial infarction	1.1[*]	0.9[*]	2.3	1.8
Cardiac failure	0.0	0.0	5.9	7.4
Hyperlipidaemia	24.8[*,§]	21.8[*,§]	29.8	32.0
Diabetes mellitus	0.0	0.0	27.8[§]	32.5
Hyperuricaemia	2.9[*,§]	2.0[*,§]	4.6	4.7
Restrictive pulmonary disease	0.4	0.4	0.8	0.7
Respiratory failure	0.3[§]	0.4[§]	0.8	1.6
COPD	5.3[§]	6.6[§]	6.6[§]	10.4
Bronchial Asthma	4.4[§]	5.9	6.2	6.8
Neurological Disease	5.2	3.7	4.8	4.5

Psychiatric disease	8.1	10.3*	7.7	9.9
Inflammatory Disease	1.8	1.6	1.8	1.9
Gastrointestinal disease	7.7	9.3	8.2	9.7
Malignant disease	1.7	1.0	2.2	1.8

Data are given as within-group percentage.

TIA: transitory ischaemic attack, COPD: chronic obstructive pulmonary disease

* = p<0.001 vs. C, § = p<0.001 vs. D

Blood serum parameters

For subsets of patients results from clinical routine blood serum analysis regarding total cholesterol (n=9356), triglycerides (n=9248) and C-reactive protein (n=8220) were available at baseline (Table e2).

Table e2: Baseline parameters of lipid and inflammatory parameters according to the Baveno groups

	Group A	Group B	Group C	Group D	p
Total cholesterol (mg/dL)	199 [172;226]	200 [175;226]§	195 [167;224]	197 [168;226]	<0.001
Triglycerides (mg/dL)	136 [98;185]*	137 [99;195]*	145 [104;200]*	151 [110;206]	<0.001
CRP (mg/dL)	0.29 [0.12;0.50]*	0.29 [0.13;0.52]*	0.30 [0.14;0.57]*	0.33 [0.17;0.65]	<0.001

CRP: C-reactive protein

Values are given as median and quartile 1 and 3.

*p<0.001 vs. D

§p<0.001 vs. C

Comparison of patients with and without follow-up

To evaluate the representativeness of the subgroup of patients considered for follow-up analysis (n=943) they were compared to all other patients with prescription of CPAP or APAP at baseline, who did not return for a follow-up visit within the specified time window of 24 to 36 months (n=9926) (Table e3).

Table e3: Comparison of PAP-treated patients with vs. without follow-up

	CPAP/APAP patients without follow-up (n=9926)	CPAP/APAP patients with follow-up (n=943)	p
Age (years)	55 [47;64]	56 [48;64]	0.043
BMI (kg/m²)	32.6 [29.0;37.1]	31.2 [28.2;35.1]	<0.001
ESS	10 [6;14]	11[7;14]	0.002
AHI (/h)	38.0 [24.2;59.8]	38.0 [24.7;58.0]	0.588
ODI (/h)	35.0 [20.7;58.6]	27.6 [13.0;50.0]	<0.001
Mean SpO_2 (%)	93 [90;94]	93 [91;94]	<0.001
Minimum SpO_2 (%)	79 [71;83]	80 [76;84]	<0.001
T90 (min)	26.1 [4.9;83.0]	29.0 [5.1;82.0]	0.635
Total cholesterol (mg/dL)	196 [167;225]	199 [171;224]	0.127
Triglycerides (mg/dL)	142 [104;196]	153 [106;212]	0.002
HbA_{1c} (%)	5.7 [5.4;6.2]	5.7 [5.4;6.1]	0.086
CRP (mg/dL)	0.30 [0.15;0.60]	0.29 [0.20;0.50]	0.694
Systolic BP (mmHg)	130 [123;141]	130 [120;140]	0.235

Diastolic BP (mmHg)	80 [73;90]	80 [76;90]	0.087
Females (%)	26.5	23.3	0.033
Group A	23	19	0.003
Group B	20	25	<0.001
Group C	29	28	0.348
Group D	28	29	0.551

BMI: body mass index, ESS: Epworth Sleepiness Scale, AHI: apnoea-hypopnoea index, ODI: oxygen desaturation index, SpO_2: oxygen saturation as measured by pulse oximetry, T90: percentage of sleep time with a SpO_2 below 90%, HbA_{1c}: glycated haemoglobin, CRP: C-reactive protein, BP: blood pressure

Values are given as median and quartile 1 and 3 or percentage.

Treatment compliance

The median compliance was 6.0 [5.2;7.0] h/day and did not differ significantly according to Baveno groups, BMI quartiles, age or sex (Table e4).

Table e4: Comparison of treatment compliance between Baveno groups, BMI and age quartiles as well as between sexes

Baveno group	A	B	C	D	p
	6.0 [5.4;7.0]	6.0 [6.0;7.0]	6.0 [5.0;7.0]	6.0 [5.5;7.0]	0.416
BMI (kg/m²) quartiles	<28.0	28.0-31.6	31.7-36.2	>36.2	-
	6.0 [5.0;7.0]	6.0 [5.3;7.0]	6.0 [5.4;7.0]	6.0 [5.3;7.0]	0.825
Age (years) quartiles	<46	46-55	56-63	>63	-
	6.0 [5.0;7.0]	6.0 [5.0;7.0]	6.0 [6.0;7.0]	6.0 [6.0;7.0]	0.063
Sex	female		male		-
	6.0 [5.5;7.0]		6.0 [5.2;7.0]		0.081

BMI: body mass index

Values are given as median and quartile 1 and 3

References

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