



HAL
open science

Implementation of a systematic comprehensive geriatric assessment for elderly patients suspected of pulmonary hypertension

C. Duvillard, L. Lafaie, É. de Magalhaes, S. Bezzeghoud, S. Accassat, P.B. Poble, P.B. Bonnefoy, C. Tulane, T. Célarier, L. Bertoletti

► To cite this version:

C. Duvillard, L. Lafaie, É. de Magalhaes, S. Bezzeghoud, S. Accassat, et al.. Implementation of a systematic comprehensive geriatric assessment for elderly patients suspected of pulmonary hypertension. *Respiratory Medicine and Research*, 2020, 78, pp.100785 -. 10.1016/j.resmer.2020.100785 . hal-03492278

HAL Id: hal-03492278

<https://hal.science/hal-03492278v1>

Submitted on 14 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

1 **Title: Implementation of a systematic comprehensive geriatric assessment for elderly patients**
2 **suspected of pulmonary hypertension.**

3 **Short title:** CGA in pulmonary hypertension

4 **Authors:** C. Duvillard¹, L. Lafaie², É. De Magalhaes^{1,3,9}, S. Bezzeghoud^{1,9}, S. Accassat^{1,3,9}, PB. Poble⁴, PB.
5 Bonnefoy⁵, C. Tulane⁶, T. Célarier^{2,7,8}, L. Bertoletti^{1,3,9,10}.

6 **Affiliations :**

7 ¹Service de Médecine Vasculaire et Thérapeutique, CHU de Saint-Etienne, Saint-Etienne, France ;

8 ²Département de Gériatrie clinique, CHU de Saint-Étienne, Saint-Etienne, France ;

9 ³INSERM, UMR1059, Equipe Dysfonction Vasculaire et Hémostase, Université Jean-Monnet, F-42055,
10 Saint-Etienne, France ;

11 ⁴Service d'Explorations Fonctionnelles, CHU de St-Etienne, Saint-Etienne, France ;

12 ⁵Service de Médecine Nucléaire, CHU de St-Etienne, Saint-Etienne, France ;

13 ⁶Département de cardiologie, CHU de Saint-Etienne, Saint-Etienne, France ;

14 ⁷Gérontopôle Auvergne Rhône-Alpes, Saint-Etienne, France ;

15 ⁸Chaire santé des Aînés, Université Jean Monnet, Saint-Etienne, France ;

16 ⁹INSERM, CIC-1408, CHU Saint-Etienne, F-42055, Saint-Etienne, France ;

17 ¹⁰F-CRIN INNOVTE network, Saint-Etienne, France.

18 **Corresponding author:**

19 Ludovic LAF AIE, Département de gériatrie clinique CHU de Saint-Etienne, France

20 **Highlights :**

- 21 - Pulmonary hypertension (PH) is incrementally suspected in elderly patients
- 22 - With advanced age, low prevalence of PAH as increased prevalence of Chronic
- 23 thromboembolic PH make more complex the management of PH suspicion in the elderly
- 24 - Implementation of a Comprehensive geriatric assessment in elderly patients referred for a
- 25 PH suspicion is possible, and lead to stop PH diagnostic work-up in a third of cases
- 26 - Among patients with pulmonary hypertension, precapillary pulmonary hypertension was the
- 27 most common group, with a high proportion of Chronic thromboembolic PH

28 **Abstract:** 239/250 words

29 *Background:* The phenotype of patients seen for a suspicion of pulmonary hypertension has changed,
30 with an increasing age and frequency of comorbidities. Selection of elderly patients in whom a
31 classical work-up is mandatory is challenging. Comprehensive geriatric assessment (CGA) has
32 modified the management of elderly patients with cancer. Pulmonary hypertension (PH) shares with
33 cancer a functional impact and may evolve rapidly, depending with group of PH. We assessed the
34 impact of a systematic CGA in patient over 70 year-old referred for a suspicion of PH.

35 *Methods:* A standardized CGA was performed for every patient older than 70 years old, referred for a
36 PH suspicion, before considering invasive tests for diagnosis and treatment, between July 2014 and
37 May 2019. Our primary aim was to describe the impact of CGA on the decision to stop or pursue the
38 recommended diagnostic work-up for PH.

39 *Results:* Among the thirty-one patients evaluated (mean age 81,5 [72-91] years), a negative CGA lead
40 to stop the diagnostic work-up in eleven patients. Among the nineteen remaining patients, sixteen
41 had confirmed PH, with half being chronic thromboembolic pulmonary hypertension.

42 *Conclusions:* Our study indicates that comprehensive geriatric assessment could be an excellent first
43 screen for elderly patients referred for a PH suspicion. Involving a geriatric physician stopped the
44 investigations in one third of patients. In patients with a favorable CGA, PH was confirmed in most of
45 the cases, with chronic thromboembolic pulmonary hypertension being the first cause of PH.

46

47 **Keys Words:** geriatric assessment; pulmonary hypertension; elderly

- 48 **Abbreviations:**
- 49 ADL: Activities of Daily Living
- 50 BMI: Body mass index
- 51 CGA: Comprehensive Geriatric Assessment
- 52 CTEPH: Chronic Thromboembolic Pulmonary Hypertension
- 53 ECOG: Eastern Cooperative Oncology Group
- 54 GDS: Geriatric Depression Scale
- 55 IADL: Instrumental Activities of Daily Living
- 56 LVEF: Left ventricular ejection fraction
- 57 MMS: Mini Mental State
- 58 MNA: Mini Nutritional Assessment
- 59 NYHA: New York Heart Association
- 60 PAH: Pulmonary Arterial Hypertension
- 61 PH: Pulmonary Hypertension
- 62 sPAP: systolic pulmonary artery pressure
- 63 TTE: Transthoracic Echocardiogram
- 64 V/Q lung scan: Ventilation/Perfusion lung scan

66 **1. Introduction**

67 Pulmonary hypertension (PH) is a severe condition, linked to an increase in pulmonary vascular
68 resistances, which can lead to right heart failure and death. On the functional level, the impact on
69 daily life and autonomy is important, with dyspnea limiting the activities of daily life. The etiologies of
70 PH are diverse and classified into several major groups: related to chronic respiratory (group 3) or
71 cardiac (group 2), chronic thromboembolic (group 4), and pulmonary arterial hypertension (group
72 1)(1) . Therapeutic management varies according to these etiologies. For group 1 and group 4,
73 specific drug treatments were developed. For group 4, it is also recommended to be treated by
74 pulmonary endarterectomy and balloon pulmonary angioplasty (1). Without treatment, the median
75 survival rate is less than 3 years for pulmonary arterial hypertension (2–4).

76 These specific PAH drug treatments have on the one hand, potential side effects (hypotension,
77 headache, digestive disorders for the most frequent) with on the other hand, potentially serious drug
78 interactions (bleeding accident with oral anticoagulants for example (5)). Regarding to thrombo-
79 endarterectomy, the only curative treatment for chronic thromboembolic pulmonary hypertension
80 (CTEPH) (6), a significant mortality rate (between 2 and 4% perihospital) was observed (6). Thus, it is
81 crucial to concentrate and improve management of these vulnerable PH patients in a specialized PH
82 center.

83 It is well recognized that medical advances contributed to an increase in life expectancy. For
84 instance, the proportion of patients over 75 years of age rose from 6.3% (3.7 million) in 1996 to 9.1%
85 (6.1 million) in 2016 (7). In the same time, the epidemiology of patients with PH has moved from
86 young female to older patients in their 6th decade (8,9). This phenotype's modification is marked in
87 patients seen for a suspicion of pulmonary hypertension, with an increasing age and high frequency
88 of comorbidities. The development of transthoracic echocardiogram (TTE) has increased the number
89 of patients suspected of being diagnosed with elevated right pressures. However, the sensitivity and

90 specificity of this examination remains modest (10). This is one problem in elderly patients with
91 associated comorbidities, causing frequent false positives when the patient is brought to right
92 cardiac catheterization.

93 In the elderly patient, the most frequent causes of PH are groups 2 or 3 (cardiac or respiratory
94 pathology) (11). CTEPH (group 4) and PAH (group 1) are not known to be one of the most common
95 causes, but management and prognosis may be different, as it is potentially curable for CTEPH
96 patients. In fact, in the case of individual comorbidities, a precise diagnostic procedure must be
97 carried out in the event of suspected PH (12). Regardless the etiology, the confirmation of the
98 diagnosis of hypertension requires the realization of a right cardiac catheterization, an invasive
99 examination. The pertinence of this exam can be discussed if it does not lead to the initiation of a
100 dedicated therapy. Selection of elderly patients, in whom a classical work-up is mandatory, is
101 challenging. In this population, there is a balance between futility (because most suspect PH is
102 assumed to be post-capillary PH, with no need for introduction of specific therapy), and loss of
103 chance (some patients may have pre-capillary PH that can be effectively improved by dedicated
104 therapy).

105 The Comprehensive Geriatric Assessment (CGA) is a multidimensional diagnostic process and an
106 interdisciplinary approach to the frail elderly subject. It provides an complete assessment of medical
107 issues, as psychosocial and functional capacities for each patient.

108 Its development has deeply proven track in elderly patients with cancer, where, it is important to
109 differentiate between what results from the determinants of fragility and/or co-morbidities and what
110 results from cancer pathology. In cancer, CGA provides a better approach to physiological age and
111 comorbidities (13). Moreover, knowledge of side effects of specific treatments (chemotherapy,
112 radiotherapy) can be used to estimate a patient's ability to tolerate them, as well as the impact on his
113 quality of life.

114 For this frail population with a PH and other comorbidities, no specific guidelines about how identify
115 and manage them is available. An invasive test must not be automatic (compared with younger
116 patients), particularly because they have a systemic and pulmonary vasculature less responsive to
117 vasodilation (14). So, it is unlikely to give them a profit with a PAH treatment (15). It is first necessary
118 to understand their life expectancy and their quality of life, because expectations of each patient for
119 any therapy should always be considered and a case by case assessment is recommended.

120 Based on this point of view, we decided to evaluate the impacts of a systematic CGA in consecutive
121 patients 70 years of age and older referred for suspected pulmonary hypertension.

122 **2. Materials and Methods**

123 This study was mono-centric, prospective and descriptive, carried out in the Pulmonary Hypertension
124 Centre of Saint Etienne University Hospital, between July 2014 and May 2019.

125 All consecutive patients over 70 years of age, referred for suspected PH, were seen in consultation or
126 hospitalization before considering invasive tests for a diagnosis of PH. At the time of this
127 consultation, the evaluating physician had a complete clinical examination (including an assessment
128 of dyspnea according to the NYHA functional class modified by WHO), history and available
129 paraclinical data (transthoracic echocardiogram).

130 The comprehensive geriatric evaluation was standardized, carried out by a specialized doctor during
131 a dedicated consultation. The assessment was made using the following scales: Katz ADL autonomy
132 scale, Lawten IADL scale, Mini MNA (Mini Nutritional Assessment), monopod support, walking speed,
133 mini GDS (Geriatric Depression Scale), MMS (Mini Mental State), 5 word test. The CGA also included
134 an analysis of comorbidities, socio-economic data (lifestyle, environment, and resources) and
135 capacities to adapt to possible specific therapies. These scales are presented in the appendix.

136 The complete evaluation was notified to the referring doctor, including the conclusion of the CGA
137 (positive evaluation, negative evaluation).

138 In the case of a positive evaluation, the patient pursued the recommended diagnostic work-up with
139 an initial assessment in hospitalization: right cardiac catheterization (including a fluid challenge in
140 patients with pulmonary hypertension and wedge pressure superior between 12 and 16 mmHg),
141 6min walking test, pulmonary function tests, blood gas analysis, thoracic iconography (V/Q lung scan,
142 thoracic CT). Additional advice from the national PH center was taken any time required. Adaptation
143 of therapies were made during the initial hospitalization.

144 The management of patients with confirmed precapillary PH was realized in accordance with the
145 international recommendations (1).

146 In case of a negative CGA evaluation, no more tests were realized, and symptomatic treatments were
147 proposed.

148 **3. Results**

149 3.1 Population

150 From July 2014 to May 2019, 31 elderly patients were referred for a suspicion of PH. The median age
151 was 81 [72-91] years. Twenty (64,5%) of these patients had a comprehensive geriatric evaluation
152 favorable to further investigations, one of them refused to continue the examinations. Thus, 19
153 patients (61,3%) received additional examinations for diagnosis and 11 (35,5%) were rejected on the
154 basis of the geriatric assessment.

155 In the patients with a CGA favorable to further investigations, all patients were still alive 12 months
156 after the PH suspicion. Regarding the 11 patients not evaluated after CGA, 1 died at 6 months, and
157 remaining 10 were alive at 12 months.

158 The population is described in Table 1.

159 3.2 Clinical profile of PH

160 Of the 19 patients with complementary assessment for suspected PH, more than two-thirds were
161 female, and the median age was 81 [72-91]. For 3 patients (15,8%) the diagnosis of PH was refuted
162 by a right cardiac catheterization.

163 Of the 16 patients with confirmed PH (Table 2), eight had Chronic thromboembolic pulmonary
164 hypertension, three PAH (precapillary pulmonary hypertension with both negative fluid challenge
165 and etiological assessment), two group 2 PH (PH due to heart failure with preserved LVEF) and three
166 had Group 3 PH (2 restrictive and 1 obstructive lung diseases). Two patients combined a group 1 (1
167 anorexigenic intake and 1 scleroderma) and group 4 PH. The NYHA functional class was between II
168 and III for all patients. The median cardiac index was 1,75 l/min/m² [1,3-3,3], the PAPm (median) was
169 36 mmHg [25-47], the right atrium pressure (median) was 9,5 mmHg [2-16], the 6-minute walk test
170 (median) was 264 meters [104-444]. The median PaO₂ was 58,5mmHg in room air [44-93].

171 3.3 Additional treatment

172 Specific treatment of PH has been initiated for 13 of the 16 patients. 3 patients did not receive
173 specific treatment.

174 3 patients in group 1 received a phosphodiesterase 5 inhibitor and 1 of them received an endothelin
175 receptor inhibitor in addition.

176 In group 2 PH, 1 patient has benefited from an improvement in his diuretic treatment.

177 1 patient in group 3 benefited from the introduction of non-invasive ventilation in the context of
178 advanced Obstructive Sleep Apnea Syndrome.

179 Finally, all patients with group 4 PH were eligible for specific invasive treatment (pulmonary
180 endarterectomy or balloon pulmonary angioplasty). Two of them refused invasive treatment and
181 stayed on with drug treatment. For the two patients with mixed group 1 and group 4 PH, both were
182 treated as group 4 PH, one by balloon pulmonary angioplasty twice and the other with Riociguat.

183 All the information concerning diagnosis and treatment are summarized in Table 2.

184 **4. Discussion**

185 In our monocenter prospective study, the implementation of a dedicated Comprehensive Geriatric
186 Assessment in elderly patients referred for a suspicion of PH lead to stop the investigation in one
187 third of patients. In the remaining patients, precapillary PH was confirmed in most of them, with
188 CTEPH representing half of the patients.

189 CGA was initially developed in oncology and is an integral part of international recommendations
190 (16). By specifying what is related to the clinical manifestations of fragility by what is related to
191 cancer pathology, CGA predicts treatment tolerance, hospitalization times, dependence and survival
192 (17–19). An approach which is increasingly validated for areas other than cancer, such as post-hip
193 fractures (20). A literature review of 10 recent studies found a change in initial oncologic treatment
194 after a CGA for 39% of patients (21), and 2/3 of patients had a less intensive treatment. Our results
195 suggest that implementation of a systematic CGA in patients admitted for PH suspicion was possible,
196 and had a similar impact in the field of PH than in oncology, since 35% of patients did not have a
197 favorable CGA and therefore did not have additional investigations. One has to remember that right
198 heart catheterization is an invasive procedure, exposing the patients to the risk of complications as
199 Haematoma at puncture sites, pneumothoraces, arrhythmias, vasovagal episodes, hypotensive
200 episodes, and pulmonary haemorrhage (22). If these risks are acceptable in a patient with a high
201 likelihood of PAH, it is most debatable in elderly patients with a lower likelihood.

202 Our suspected PH patients with more often functionally dependent (ADL and low IADL and high
203 ECOG Performans Status), more isolated, having more polydrug therapy and having a lower BMI
204 were not examined. Interestingly, all these factors (included patient functional status (ADL),
205 undernutrition (17), and number of co-morbidities (23)) are statistically significant to modify
206 oncology treatment in patient with cancer. Results which supported well our investigation.

207 Currently, two major cohorts are underway in oncogeriatric to clarify how the CGA affects the
208 initiation of specific treatment. The GERICO cohort (24), evaluates the benefit of the CGA in terms of

209 chemotherapy, morbidity and mortality versus conventional treatment in colorectal cancer in the
210 elderly; and the EGeSOR cohort (25) evaluates the impact of a CGA in survival, functional status and
211 nutrition for elderly patients with head and neck cancer. To our knowledge, there are no ongoing
212 studies in the field of PH. Moreover, some concerns have been raised about a potential under-
213 screening of PH after pulmonary embolism in patients with cancer (26).

214 Concerning our PH older patients detected, the etiologies of the PH found were mainly from group 4,
215 which is inconsistent because the main causes of PH after 65 years are rather from group 2, group 3
216 or mixed (11). This can be explained by the selection of patients and the monocentric nature of the
217 study.

218 However, in another French monocenter cohort, nearly a quarter of patients with 75 years and more
219 had a CTEPH (27). The increasing risk of pulmonary embolism with age (28) may explain these results.
220 Larger multicenter cohorts are needed.

221 The only curable cause of PH was that of group 4, thanks to a surgical procedure: pulmonary
222 endarterectomy. According to the European CTEPH register, survival at 3 years was better for
223 operated patients than for non-operated patients (89% versus 70%) (29). This management improve
224 survival, but also functional abilities and dyspnea (30). Most sick patients in our study were therefore
225 eligible for curable treatment. However, among these patients, two refused invasive management,
226 but all were able to receive specific treatment, which is known to improve exercise capacity and
227 reduce dyspnea, despite few elderly patients were included (31).

228 Our included population had severe PHs. Regarding functional impact: the average walking distance
229 for 6 minutes was 250m, all patients were with a function class III according to the NYHA functional
230 class and the average cardiac index was less than 2l/min/m². These investigations were useful
231 because they allowed the initiation of a specific treatment, offered to 13 out of 16 patients. The main
232 outcome of most targeted therapies is the functional improvement (increase in 6-minute walk

233 distance) on elderly patients, while the effect on survival may be more debatable than in younger
234 population.

235 Finally, PH group 1 in our study was as frequent as PH group 2 or 3, which is inconsistent with data
236 from other studies (11). This may be explained by the under-representation of group 2 and group 3
237 PAHs in our series, probably due to a recruitment bias.

238 Nevertheless, our work has many limits. This mono-centric study is representative of patients
239 referred to the unit, such as its endogenous recruitment. However, the patients referred in the PH
240 center came from several diverse situations, in a metropolitan area of 1 million of inhabitants. Our
241 department is also specialized in thromboembolic venous disease, so a recruitment bias is possible:
242 half of the patients were carriers of chronic thromboembolic pulmonary hypertension. Nevertheless,
243 the prospective nature of the collection has limited the number of lost views and follow-up is still
244 ongoing.

245 CGA could not be multidisciplinary. Due to the limited resources of the unit, we could not have a
246 dedicated physiotherapist, occupational therapist or neuropsychologist time. The assessment was
247 based on subjective statements; no assessment of the patient in his or her environment was
248 possible. The caregivers' appreciation was collected if possible but not systematically. The collection
249 was standardized for all patients, which limited the missing information.

250 PH has a significant impact on patient autonomy through the dyspnea it causes. The functional
251 capacity assessment may have been biased by this confounding factor. The assessment was as
252 exhaustive as possible, also based on other functional reserves, such as mental reserves, and
253 integrating, if possible, the assessment of those around them. However, it should be noted that the
254 distance covered by the walking test (in patients with a positive opinion) was low, objectifying the
255 handicap felt by the patients.

256 **5. Conclusion**

257 Our study suggests that the implementation of CGA in patients admitted for a PH suspicion is feasible
258 and may lead to stop the investigation in one third of patients. Most of the remaining patients had
259 PH, with CTEPH being the main cause of PH. Further research are needed to assess the efficacy on
260 such implementation in the clinical practice, as the evolution of patients according to CGA
261 conclusion.

262 Table 1: Population

	Patients evaluated after CGA n=19	Patients not evaluated after CGA n=11	Total population n=31*
Age (in years) (median [Boundaries])	81 [72-91]	82 [74-90]	81 [72-91]
Female sex	14 (73,7%)	6 (54,5%)	20 (64,5%)
Poly medication	10 (52,6%)	9 (81,8%)	19 (61,3%)
Anticoagulant treatment	13 (68,4%)	7 (63,6%)	21 (67,7%)
Isolation	2 (10,5%)	7 (63,6%)	9 (29%)
Performans status:			
- PS0	3 (15,8%)	0 (0%)	4 (12,9%)
- PS1	9 (47,4%)	4 (36,4%)	13 (41,9%)
- PS2	5 (26,3%)	2 (18,2%)	7 (22,5%)
- PS3	2 (10,5%)	3 (27,3%)	5 (16,1%)
- PS4	0 (0%)	2 (18,2%)	2 (6,4%)
Institutionalization	0 (0%)	3 (27,3%)	3 (9,6%)
Risk factor for PH:			
- Group 1	6 (31,6%)	2 (18,2%)	9 (29%)
- Group 2	4 (21,1%)	7 (63,6%)	11 (35,5%)
- Group 3	6 (31,6%)	5 (45,5%)	11 (35,5%)
- Group 4	11 (57,9%)	1 (9,1%)	13 (41,9%)
NYHA Functional class:			
- I / II	5 (26,3%)	(n=8) 2 (25%)	(n=28) 8 (28,6%)
- III	14 (73,7%)	2 (25%)	16 (57,1%)
- IV	0 (0%)	4 (50%)	4 (14,3%)
sPAP / TTE (mmHg) (median [Boundaries])	60 [43-100]	67,5 [45-90] (n=10)	62,5 [43-100] (n=30)
Sensory disorders:			
- Visual	3 (15,8%)	2 (18,2%)	5 (16,1%)
- Auditive	3 (15,8%)	3 (27,3%)	7 (22,6%)
Functional evaluation (median [Boundaries]):			
- ADL/6	6 [5-6]	5 [1-6]	6 [1-6]
- IADL/4	4 [2-4]	2 [0-4]	3 [0-4]
Nutrition (median [Boundaries]):			
- Mini MNA/14	14[6-14] (n=15)	10 [9-11] (n=2)	14 [6-14] (n=18)
- BMI kg/m ²	26,8 [16,5-43] (n=17)	25,7 [20,6-49] (n=7)	26,7 [16,5-49] (n=25)
- Albumin g/l	35 [29,1-43] (n=14)	36,5 [36-37] (n=2)	35,5 [29,1-43,0] (n=16)
Cognition (median [Boundaries]):			
- MMS/30	29 [26-29] (n=18)	25 [13-29] (n=7)	28 [13-29] (n=27)
- 5 words/10	10 [9-10] (n=18)	9 [9-10] (n=4)	10 [9-10] (n= 23)
Mini GDS/4 (median [Boundaries])	0 [0-3] (n=17)	1 [0-4] (n=7)	0 [0-4] (n=25)
Sleeping disorder	11 (68,8%) (n=16)	3 (42,9%) (n=7)	15 (62,5%) (n=24)
Risk of falling:			
- Fall history <1 year	4 (21,1%)	1 (11,1%) (n=9)	5 (17,2%) (n=29)
- Positive orthostatic	6 (35,3%) (n=17)	2 (40%) (n=5)	9 (39,1%) (n=23)

hypotension test			
- Monopodal support < 5sec	6 (26,7%) (n=15)	2 (66,7%) (n=3)	8 (42,1%) (n=19)
- Walking test < 1m/sec	4 (26,7%) (n=15)	1 (25%) (n=4)	5 (25%) (n=20)
Survival rate:			
- At 6 months	19 (100%)	10 (90,9%) (n=11)	29 (96,7%) (n=30)
- At 1 year	19 (100%)	10 (90,9%) (n=11)	29 (96,7%) (n=30)

263 *one patient refused explorations despite a favorable CGA

264 Table 2: PH diagnosis and treatment

	Total PH n=16	PH group 1 n=3	PH group 2 n=2	PH group 3 n=3	PH group 4 n=8
Age (median [Boundaries])	81 [72-91]	81 [72-82]	78 [78]	76 [76-85]	82,5 [77-91]
Female sex	12 (75%)	1 (33,3%)	2 (100%)	3 (100%)	6 (75%)
NYHA (median [Boundaries])	3 [2-3]	3 [2-3]	3 [3]	3 [2-3]	3 [2-3]
sPAP / TTE (median [Boundaries])	70 [43-100]	80 [70-83]	65 [60-70]	50[48-75]	65 [43-100]
Risk factor:					
- Group 1	6 (37,5%)	1 (33,3%)	1 (50%)	2 (66,7%)	2 (25%)
- Group 2	3 (18,8%)	2 (66,7%)	1 (50%)	0	0
- Group 3	6 (37,5%)	2 (66,7%)	0	3 (100%)	1 (12,5%)
- Group 4	10 (62,5%)	0	1 (50%)	1 (33,3%)	8 (100%)
Walking test / 6 min (median [Boundaries])	264 [104-444]	272 [143-341]	263 [224-302]	224 [200-282]	288 [104-444]
mPAP/ mmHg (median [Boundaries])	36 [25-47]	42 [40-47]	33,5 [31-36]	32 [25-51]	35,5 [28-46]
Cardiac index/L/mn (median [Boundaries])	1,75 [1,3-3,3]	1,7 [1,7]	2 [1.9-2.1]	3,1 [2,4-3,3]	1,55 [1,3-1,9]
Right atrium pressure / mmHg (median [Boundaries])	9,5 [2-16]	10 [6-16]	9,5 [9-10]	9 [2-11]	8 [3-16]
PaO2 / mmHg (median [Boundaries])	58,5 [44-93]	46 [44-51]	84 [75-93]	52 [46-61]	61 [56-65,4]
Introduction of specific treatment after evaluation		1 Sildenafil 1 Tadalafil 1 Sildenafil + Ambrisentan	1 Diuretics	1 Non invasive ventilation	1 Surgery 2 balloon pulmonary angioplasty 5 Riociguat

265

266 **Bibliography:**

- 267 1. Galie N, Humbert M, Vachiery J-L, Gibbs S, Lang I, Torbicki A, et al. 2015 ESC/ERS Guidelines
268 for the diagnosis and treatment of pulmonary hypertension: The Joint Task Force for the Diagnosis
269 and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the
270 European Respiratory Society (ERS): Endorsed by: Association for European Paediatric and Congenital
271 Cardiology (AEPC), International Society for Heart and Lung Transplantation (ISHLT). *Eur Heart J.* 1
272 *janv 2016;37(1):67-119.*
- 273 2. Humbert M, Sitbon O, Chaouat A, Bertocchi M, Habib G, Gressin V, et al. Survival in patients
274 with idiopathic, familial, and anorexigen-associated pulmonary arterial hypertension in the modern
275 management era. *Circulation.* 13 juill 2010;122(2):156-63.
- 276 3. Olsson KM, Delcroix M, Ghofrani HA, Tiede H, Huscher D, Speich R, et al. Anticoagulation and
277 survival in pulmonary arterial hypertension: results from the Comparative, Prospective Registry of
278 Newly Initiated Therapies for Pulmonary Hypertension (COMPERA). *Circulation.* 7 janv
279 2014;129(1):57-65.
- 280 4. Mueller-Mottet S, Stricker H, Domenighetti G, Domenighetti G, Azzola A, Geiser T, et al.
281 Long-term data from the Swiss pulmonary hypertension registry. *Respir Int Rev Thorac Dis.*
282 2015;89(2):127-40.
- 283 5. Margelidon-Cozzolino V, Delavenne X, Catella-Chatron J, De Magalhaes E, Bezzeghoud S,
284 Humbert M, et al. Indications and potential pitfalls of anticoagulants in pulmonary hypertension:
285 Would DOACs become a better option than VKAs? *Blood Rev.* 2019;37:100579.
- 286 6. Kim NH, Delcroix M, Jais X, Madani MM, Matsubara H, Mayer E, et al. Chronic
287 thromboembolic pulmonary hypertension. *Eur Respir J.* *janv 2019;53(1).*
- 288 7. INSEE, Pyramide des âges. Disponible sur <https://www.insee.fr/fr/statistiques/2418114>
- 289 8. Ling Y, Johnson MK, Kiely DG, Condliffe R, Elliot CA, Gibbs JSR, et al. Changing demographics,
290 epidemiology, and survival of incident pulmonary arterial hypertension: results from the pulmonary
291 hypertension registry of the United Kingdom and Ireland. *Am J Respir Crit Care Med.* 15 oct
292 2012;186(8):790-6.
- 293 9. Poms AD, Turner M, Farber HW, Meltzer LA, McGoan MD. Comorbid conditions and
294 outcomes in patients with pulmonary arterial hypertension: a REVEAL registry analysis. *Chest.* juill
295 2013;144(1):169-76.

- 296 10. Rich JD, Shah SJ, Swamy RS, Kamp A, Rich S. Inaccuracy of Doppler echocardiographic
297 estimates of pulmonary artery pressures in patients with pulmonary hypertension: implications for
298 clinical practice. *Chest*. mai 2011;139(5):988-93.
- 299 11. Pugh ME, Sivarajan L, Wang L, Robbins IM, Newman JH, Hemnes AR. Causes of Pulmonary
300 Hypertension in the Elderly. *Chest*. juill 2014;146(1):159-66.
- 301 12. Bertoletti L, Bertoletti G, Magalhaes ÉD, Merah A, Gaultier J-B, Gate-Martinet A, et al.
302 Hypertension pulmonaire chez la personne âgée. *Gériatrie Psychol Neuropsychiatr Vieil*. 1 mars
303 2015;13(1):8-14.
- 304 13. Brunello A, Fontana A, Zafferri V, Panza F, Fiduccia P, Basso U, et al. Development of an
305 oncological-multidimensional prognostic index (Onco-MPI) for mortality prediction in older cancer
306 patients. *J Cancer Res Clin Oncol*. 2016;142:1069-77.
- 307 14. Shapiro BP, McGoon MD, Redfield MM. Unexplained pulmonary hypertension in elderly
308 patients. *Chest*. janv 2007;131(1):94-100.
- 309 15. Hoeper MM, Huscher D, Ghofrani HA, Delcroix M, Distler O, Schweiger C, et al. Elderly
310 patients diagnosed with idiopathic pulmonary arterial hypertension: results from the COMPERA
311 registry. *Int J Cardiol*. 30 sept 2013;168(2):871-80.
- 312 16. Extermann M, Aapro M, Bernabei R, Cohen HJ, Droz J-P, Lichtman S, et al. Use of
313 comprehensive geriatric assessment in older cancer patients: recommendations from the task force
314 on CGA of the International Society of Geriatric Oncology (SIOG). *Crit Rev Oncol Hematol*. sept
315 2005;55(3):241-52.
- 316 17. Caillet P, Canoui-Poitaine F, Vouriot J, Berle M, Reinald N, Krypciak S, et al. Comprehensive
317 geriatric assessment in the decision-making process in elderly patients with cancer: ELCAPA study. *J*
318 *Clin Oncol Off J Am Soc Clin Oncol*. 20 sept 2011;29(27):3636-42.
- 319 18. O'Connell Francischetto E, Damery S, Davies S, Combes G. Discharge interventions for older
320 patients leaving hospital: protocol for a systematic meta-review. *Syst Rev*. 16 mars 2016;5:46.
- 321 19. Ekerstad N, Karlson BW, Dahlin Ivanoff S, Landahl S, Andersson D, Heintz E, et al. Is the acute
322 care of frail elderly patients in a comprehensive geriatric assessment unit superior to conventional
323 acute medical care? *Clin Interv Aging*. 2017;12:1-9.

- 324 20. Prestmo A, Hagen G, Sletvold O, Helbostad JL, Thingstad P, Taraldsen K, et al. Comprehensive
325 geriatric care for patients with hip fractures: a prospective, randomised, controlled trial. *Lancet Lond*
326 *Engl.* 25 avr 2015;385(9978):1623-33.
- 327 21. Hamaker ME, Te Molder M, Thielen N, van Munster BC, Schiphorst AH, van Huis LH. The
328 effect of a geriatric evaluation on treatment decisions and outcome for older cancer patients - A
329 systematic review. *J Geriatr Oncol.* 2018;9(5):430-40.
- 330 22. Hoepfer MM, Lee SH, Voswinckel R, Palazzini M, Jais X, Marinelli A, et al. Complications of
331 right heart catheterization procedures in patients with pulmonary hypertension in experienced
332 centers. *J Am Coll Cardiol.* 19 déc 2006;48(12):2546-52.
- 333 23. Chaïbi P, Magné N, Breton S, Chebib A, Watson S, Duron J-J, et al. Influence of geriatric
334 consultation with comprehensive geriatric assessment on final therapeutic decision in elderly cancer
335 patients. *Crit Rev Oncol Hematol.* sept 2011;79(3):302-7.
- 336 24. Lund CM, Vistisen KK, Dehlendorff C, Rønholt F, Johansen JS, Nielsen DL. The effect of
337 geriatric intervention in frail elderly patients receiving chemotherapy for colorectal cancer: a
338 randomized trial (GERICO). *BMC Cancer.* 28 juin 2017;17(1):448.
- 339 25. Brugel L, Laurent M, Caillet P, Radenne A, Durand-Zaleski I, Martin M, et al. Impact of
340 comprehensive geriatric assessment on survival, function, and nutritional status in elderly patients
341 with head and neck cancer: protocol for a multicentre randomised controlled trial (EGeSOR). *BMC*
342 *Cancer.* 13 juin 2014;14:427.
- 343 26. Catella-Chatron J, Merah A, De Magalhaes E, Moulin N, Accassat S, Duvillard C, et al. Chronic
344 thromboembolic pulmonary hypertension suspicion after pulmonary embolism in cancer patients.
345 *Respir Med Res.* nov 2019;76:34-7.
- 346 27. Ginoux M, Turquier S, Chebib N, Glerant J-C, Traclet J, Philit F, et al. Impact of comorbidities
347 and delay in diagnosis in elderly patients with pulmonary hypertension. *ERJ Open Res.* oct 2018;4(4).
- 348 28. Delluc A, Tromeur C, Le Ven F, Gouillou M, Paleiron N, Bressollette L, et al. Current incidence
349 of venous thromboembolism and comparison with 1998: a community-based study in Western
350 France. *Thromb Haemost.* 28 oct 2016;116(5):967-74.
- 351 29. Delcroix M, Lang I, Pepke-Zaba J, Jansa P, D'Armini AM, Snijder R, et al. Long-Term Outcome
352 of Patients With Chronic Thromboembolic Pulmonary Hypertension: Results From an International
353 Prospective Registry. *Circulation.* 1 mars 2016;133(9):859-71.

- 354 30. Mayer E, Jenkins D, Lindner J, D'Armini A, Kloek J, Meyns B, et al. Surgical management and
355 outcome of patients with chronic thromboembolic pulmonary hypertension: results from an
356 international prospective registry. *J Thorac Cardiovasc Surg.* mars 2011;141(3):702-10.
- 357 31. Ghofrani H-A, D'Armini AM, Grimminger F, Hoeper MM, Jansa P, Kim NH, et al. Riociguat for
358 the treatment of chronic thromboembolic pulmonary hypertension. *N Engl J Med.* 25 juill
359 2013;369(4):319-29.