Supervision of Artificial Ventilation: A Clinical Study using the NéoGanesh System

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Abstract. *Objective*: Systems for automatic supervision of artificial ventilation must combine two main components: a *tactical component* that continuously adjusts the mechanical assistance in function of the patient's state evolution; and a *strategic component* that influences the behaviour of the tactical component in order to follow specific therapeutic plans. Such systems associate low-level control and high-level planning capabilities[1]. Depending on their goals, techniques and models they use (based on AI or control theory), systems proposed in the literature are mainly designed for solving either planning or control problems. To improve the weaning process, several automatic systems control the parameters of the respirator via low-level control loops integrating[2] or not[3,4] specific weaning protocols. They are reactive, efficient in their narrow domain of application and can be validated in clinical environments; but are unable to modify dynamically their initial strategy and to anticipate clinical events. At the opposite, general architectures for intelligent monitoring such as[5,6] integrate sophisticated techniques for planning and reasoning under real-time constraints, but many work and tests should be performed before envisaging their clinical use. The NéoGanesh system lies at an intermediate position between the two quoted categories. Our goal was to design a system 1) efficient for solving a precise clinical problem, the automatic control of mechanical support, 2) extendable to gradually improve its reasoning and planning capabilities and 3) testable at the patient's bedside to measure at each step its performance. A first clinical study evaluated the ability of NéoGanesh to predict the right time for extubation[7]. The present study reports new clinical evidences on the interest of such a system.

Methods: NéoGanesh is based on current AI techniques: knowledge representation mixing objects and rules and temporal abstractions in a distributed architecture[8]. Because of the extreme difficulty for designing and validating a patient's model, we modelled and represented the intensivist's decision-making process to predict the ventilation, to adapt the actions and the global weaning strategy. The controller in NéoGanesh uses three physiological parameters to modify the assistance in PS mode and to maintain the patient with an acceptable ventilation (12<RR<28cycles/min,Vt<250ml, $PetCO_2$<55mmHg). 10 patients were randomly ventilated during 2 periods of 24 hours with NéoGanesh or with physician-controlled PSV.

Results: Patients spent less time in critical zones of ventilation (5% versus 24% of the total duration of the ventilation) and with an occlusion pressure > 4cmH_2O (11±17 versus 34±35) when ventilated with NéoGanesh than without it.

Conclusion: NéoGanesh allows patients to spend more time within physician predefined limits and could reduce periods of excessive workload. Similarly to[9], it is based on a pragmatic bottom-up approach guided by a tight collaboration with intensivists and a continuous clinical evaluation. NéoGanesh system is a useful closed-loop system and must be evaluated and enriched through a large multicentre study.

References: **1**- TL Dean and MP Wellman, Planning and Control, Morgan Kaufmann, San Mateo CA, 1991. **2**- JH Strickland and JH Hasson, Chest, 103 (1993) 1220-1226. **3**- C Chopin and MC Chambrin, in: Yearbook of Intensive Care and Emergency Medicine (Springer-Verlag, 1994) 499-507. **4**- TP Laubscher et al., IEEE Trans. Bio. Eng., 41 (1994) 51-58. **5**- B Hayes-Roth et al. AIM 4 (1992) 165-185. **6**- GW Rutledge et al. AIM, 5 (1993) 67-82. **7**- M Dojat et al. Am. J. Respir. Crit. Care Med., 153 (1996) 997-1004. **8**- M Dojat, et al. AIM 11 (1997) 97-117. **9**- S Miksch, et al. AIM 8 (1997) 543-576.