

# Interprofessional Simulation in Hospital Leadership Training: Its Role in Improving Participants' Self-Efficacy

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**Purpose:** Training health services administration (HSA) professionals is essential for the effective functioning of hospitals. Evidence suggests that training should emphasize social and decision-making competencies, as HSA professionals collaborate in an interprofessional environment. Simulation training (ST) for HSA in an interprofessional context is a promising approach. This study evaluated the effectiveness of such a training program on leadership self-efficacy, examined differences across professions and tested whether there was an interaction between profession and training effects.

**Participants and Methods:** This retrospective study was conducted at the simulation center of Metropole Savoie Hospital in France. The 3-day program was mandatory for all HSA professionals, and included customized simulation scenarios, interprofessional collaboration and integration of aviation sector for their expertise in leadership skills employed in crisis management. Self-efficacy was measured by a specifically constructed questionnaire administered at baseline (T0), post training (T1) and 4 months post-training (T2).

**Results:** The ST program significantly increased leadership self-efficacy. Self-efficacy improved post-training ( $p < 0.001$ , mean change = 31.67, 95% CI [28.06, 35.28],  $d = 1.75$ ) and increased self-efficacy was maintained for 4 months ( $p < 0.001$ ,  $\eta^2 p = 0.70$ , T0-T1  $\Delta = 32.05$  [26.71–37.39], T0-T2  $\Delta = 2.43$  [-7.77–2.90],  $\eta^2 p = 0.70$ ). There was a significant main effect of profession with executive physicians reporting lower self-efficacy than other professionals combined ( $p < 0.001$ , mean difference = -22.56, 95% CI [14.83–30.30],  $\eta^2 p = 0.66$ ). No significant interaction between profession and program was observed ( $p > 0.05$ ).

**Conclusion:** ST shows promise for enhancing leadership skills in HSA, particularly in an interprofessional context. Executive physicians remain a key group for targeted training, as their lower self-efficacy suggests, they may benefit from interventions aimed at strengthening leadership skills. Advancing in this direction will reinforce the findings.

**Keywords:** interprofessional relations, longitudinal, simulation training, hospital administration

## Introduction

The role of health services administration (HSA) has become more salient over the years.<sup>1</sup> The need for training HSA is a challenge shared by several health systems.<sup>2,3</sup> This could be due to the lack of formal leadership training in the medical curriculum.<sup>4</sup> In France, there appears to be no formal training concerning the administration and organization of hospital units.<sup>5</sup> A physician becomes a physician executive based on their clinical expertise, irrelevant of their leadership skills, which is an issue observed worldwide.<sup>3,6–9</sup> A well-functioning HSA position requires the mastery of technical or hard skills that are domain specific (eg traumatology), as well as leadership skills (eg effective communication, teamwork, decision making) the latter being equally needed. Throughout this paper, we use “leadership skills” as a comprehensive term to refer to soft skills, interpersonal skills, social skills, decision-making skills and/or non-technical skills.<sup>1,3,9–11</sup>

Despite this, the existing training programs have proven to be more effective for training technical skills rather leadership skills.<sup>3</sup> To focus on the latter, action-based learning methods, such as simulation training (ST) is a promising technique.<sup>6,12–14</sup> This type of training aims to engage participants in realistic scenarios in which they practice their skills with the opportunity to reflect on afterwards, without the risk of consequential error.<sup>15–17</sup> Moreover, literature attests for ST's effects on self-efficacy



in various contexts (eg leadership, interprofessional, social skills, clinical training).<sup>14,18–20</sup> It is theorized by Bandura as the belief in one's own capabilities to accomplish a given task.<sup>21,22</sup> ST can be expected to influence self-efficacy by acting on 3 out of 4 of its determinants: performance accomplishments, vicarious learning and verbal persuasion.<sup>21</sup>

Specifically, the use of ST for practicing leadership skills in HSA has shown its effectiveness, especially in training physician executives.<sup>13</sup> However, some of these programs train HSA professionals as individuals, rather than members of a team, who need to collaborate with colleagues from the same occupational group but different professional backgrounds.<sup>3,13</sup> This can be seen as a weakness to be addressed, particularly in view of the specificity of the targeted skill set.<sup>10</sup>

Interprofessional health leadership programs exist. However, only a few makes use of ST.<sup>23</sup> Those that did, concerned undergraduate and graduate medical and paramedical students or postgraduates in their early years of practice.<sup>12,14,24,25</sup> Active HSA professionals are a harder population to reach, although continuing education in France is compulsory.<sup>26</sup> This occupational group could certainly benefit from rigorous ST on leadership skills, but evidence is currently lacking as most training programs do not target active HSA professionals.<sup>12,14,24,25</sup> Given this evidence, employing ST for leadership skills and targeting active HSA professionals is a promising approach.

## Materials and Methods

### Study Objectives

The present research aimed to address this matter by testing the effectiveness of an interprofessional hospital leadership training program with ST. This program was developed by the simulation center of Métropole Savoie Hospital in France and was designed to be provided for all active HSA professionals of the organization. The primary criterion for assessing the effectiveness of this simulation-based intervention was the improvement in self-efficacy scores. The second concerned the maintenance of this effect over time. Finally, in an exploratory way, we tested whether there was an effect of profession and whether there was an interaction between profession and program.

Thus, we hypothesized that:

- Primarily, self-efficacy scores will be higher after the training.
- Secondly, the increase of self-efficacy scores after training will persist over time (4 months).

And, on an exploratory note we hypothesized:

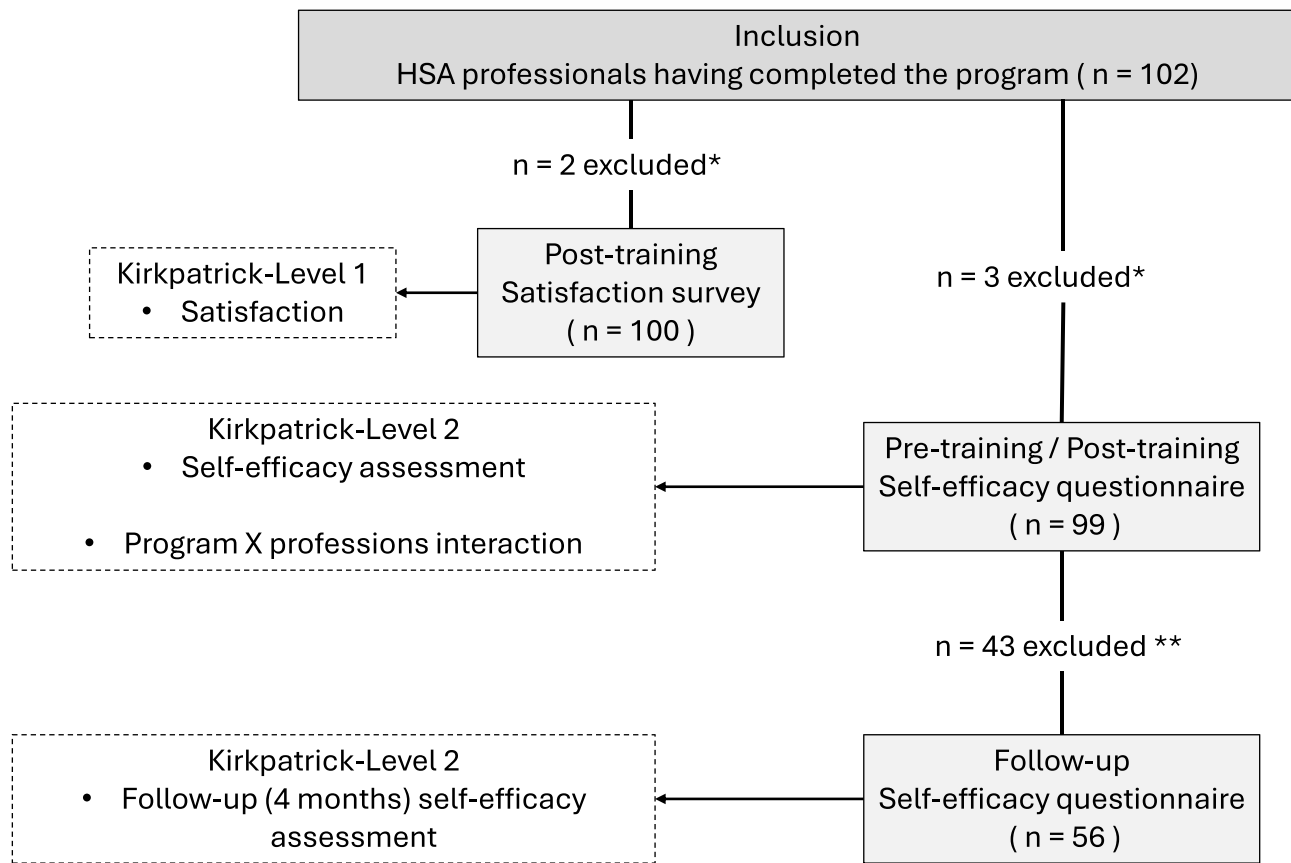
- Self-efficacy will differ across professions.
- Training impact on self-efficacy will vary across professions.

### Study Design

The study design was mixed with Time (ie T0, T1, T2) as the within-subjects variable, Profession (ie hospital administrator, department executives, executive nurse administrators, physician executives, nurse administrators and support services executives) as the between-subjects variable and leadership self-efficacy as the dependent variable. This study did not employ a control group as it benefited from a within-subjects design with participants as their own control and longitudinal measurement (T2).

Training was mandatory for all HSA professionals, but participants could choose when to participate according to their availability and profession to form diverse groups that encompass inter-professional occupations.

As the training was mandatory the program concerned all HSA professionals. The inclusion criteria for the study, were being an HSA professional at Métropole Savoie Hospital, having completed the program and relevant questionnaires. Participants who failed to complete the questionnaire were excluded from the statistical analyses ( $n = 3$ ) (Figure 1). There were no further exclusion criteria apart from the non-completion of the questionnaires. Participants with incomplete questionnaires or missing responses were excluded from analyses. No imputation was performed for the missing data. Participants provided consent for the use of collected data in this study.



**Figure 1** Flow chart. \*Participants were excluded due to the incompleteness of the questionnaires \*\*Participants did not provide a response for the follow-up assessment.

## Sample

The sample consisted of all types of HSA professionals employed by the Métropole Savoie Hospital. An HSA professional can be defined as a professional who is in charge of a system in a hospital, may it be from a purely medical, allied health, administrative or logistics background.<sup>10,27</sup> This included a combination of senior executive, middle and front-line hospital administrators being: hospital administrator (n = 8), department executives (n = 7), executive nurse administrators (n = 5), physician executives (n = 24), nurse administrators (n = 29) and support services executives (ie administrative, technical, logistics, materials management) (n = 26), respectively. So far, 102 participants have completed the program and 99 of them were eligible for the study.

In the French hospital system, the hospital is constituted of several departments, and each department contains several units (eg geriatrics department, cognitive-behavioral unit). A physician executive oversees a unit and manages it in collaboration with the executive nurse administrator. A department executive is a former physician executive who oversees a department and works in collaboration with the executive nurse administrator who is a former nurse administrator. A hospital administrator or chief executive works in collaboration with support services executives. Therefore, multiple functional dyads exist across multiple levels in this type of system.

## The Training Program

The training program was created with the aim to better equip HSA professionals for their administration and organizational roles. One of the authors, an executive nurse administrator, perceived the need to improve certain leadership skills. This initiative aligned with the agenda of the institution. The skills targeted by the program were based on a needs assessment by what was observed on the field and institutional priorities.

The program was endorsed by the hospital's top administrators with the objective to train all HSA professionals. To this end, training was conducted during working hours. It consisted of 3 days: two consecutive days and one a month

later. This allowed participants to put their training from the first 2 days into work and share their impressions on the last day. The trainers were an expert in pedagogy and simulation, an expert executive nurse administrator and an aviation training expert, who were also the authors of the program. The aerospace industry is one of the safest due to their expertise in leadership skills and use of ST to prepare for crisis scenarios.<sup>15</sup> Therefore, the conception of the program benefited from aviation expertise in combination with pedagogy and leadership concepts.

Each session was composed of 12 participants: 8 from medical and allied health, 4 from top hospital administration (eg chief executive officer), regular administrative, technical and logistics professionals. HSA professionals from distinct backgrounds and departments were convened to discuss and work on common issues. However, functional dyads were maintained (eg Physician executives and nurse administrators who worked together were incited to participate in the training together). This allowed them to train as a team while collaborating with colleagues from distinct backgrounds. Proposing the program to the entirety of the HSA professionals makes way for the creation of a common leadership culture hospital wide.<sup>28</sup>

The training was assembled by the authors by combining certain pedagogical theories. This included a combination based on the principles of constructivism of Piaget and socio-constructivism of Vygotsky.<sup>29,30</sup> Along with theories issued from psychology such as social cognitive theory, theory of planned behavior and cognitive load theory.<sup>31–33</sup> Participants were asked about their expectations regarding the program, and these were addressed at the end of the program also.

Training for the required leadership skills resides on a tool-based approach. Each tool is relevant to a leadership skill pertaining thus to: teamwork, communication, decision-making and problem-solving skills and the pedagogical context was relevant to self-awareness. This allows participants to easily transfer skills into practice. Leadership situations will generate goals which can be attained by the correct application of a tool. For example, if an employee behaves in a dysfunctional manner, the HSA professional will aim to rectify the situation. To do so, they could employ the DESC (Describe, Express, Specify, Consequences) method/tool to engage in non-violent and comprehensive communication, used to resolve tense conversations more effectively.<sup>34</sup> Details regarding this tool are available (see [Supplementary File 1](#)). The idea of a “tool” is to simplify the use and accessibility of a technique. These tools were assembled from various leadership models (eg Lean, Aviation training). A total of 16 tools were first employed in pedagogical contexts (ie activities and brief lectures). Participants were also given a small, easy to carry booklet with all these tools and the steps needed to apply them. For example, the participants were demonstrated how a board with multiple sections could be arranged. Then they were asked to do it themselves in smaller groups and later present it to the main group. The boards they made were then paired with Stand Up Meetings during simulation sessions in the afternoon. Details regarding the board with sections and Stand Up Meeting are available (see [Supplementary File 1](#)). A full list of the tools used is made available (see [Supplementary File 2](#)).

Later, in full-scale simulation, these tools were used to practice application and to be reflected upon during the debriefing that followed. Simulation was at the heart of the training as a quintessential part of the learning process that underlies its effectiveness. Practicing these tools and associated skills in a safe environment allows the participants to see its effects and gain confidence in their capacity all the while detecting potential points of improvement. The idea behind this is bridging that gap between theory (eg healthy and effective communication) and practice (eg the act) so that the participants may employ these tools with more ease when they really need it. Participants were put in bespoke scenarios according to their functions, allowing them to be fully immersed. The situations participants were put in contained elements familiar to their day-to-day lives in the hospital and content of the scenarios varied regarding the affiliation of the participants. For instance, if a physician executive from obstetrics was to partake, then the scenario was constructed via past incidents that took place in the obstetrics unit. In addition, the room was arranged so that it replicated the office of a physician executive from obstetrics. Thus, the construction of each scenario required prior research and meticulous preparation as ecological validity is a success factor for full-scale simulation training.<sup>35</sup> Simulation exercises included a simulated actor.

Pre-simulation briefing is an important element not only to indicate the setting and context of the exercise but also to regulate anxiety. At first, the idea of performing a task while being watched by peers can be daunting, especially for professionals holding a leadership position due to their status. During this phase, we aim to construct a sense of psychological safety for the participants by insisting on common values of goodwill and assuring confidentiality.<sup>36</sup> Debriefings consisted of 4 Phases: Reaction, Description, Analysis, Summary according to the specific model of PEARLS.<sup>37</sup> This model was paired with

explicit description and analysis techniques. During the debriefing, the trainer provided additional information, made summaries and elicited thoughts on real-life implications of the experience.<sup>38</sup>

The third day of training was different, as the focus was on human factors and leadership tools used in aviation. With respect to differences that exist between aviation and healthcare frequent parallels were made between the two sectors concerning the similar set of leadership skills needed.<sup>39,40</sup> The aim was to show HSA professionals that tools that underlie safety culture in the cockpit could also work in healthcare settings. This idea was delivered to the participants by one of the authors who is a pilot and frequently uses these techniques. A total of 3 tools (eg FORDEC) relating to decision making and effective briefing were picked as compatible with healthcare situations. Details regarding this tool are available (see [Supplementary File 1](#)). In the morning, there were interactive lectures regarding cognitive bias avoidance. As for the simulation exercises, participants were put in situations related to aviation. They were asked to role-play airline pilots and co-pilots according to their functions (eg physician executive as a pilot, nurse administrator as a co-pilot). This type of simulated role-playing made participants employ the same tool and skills in a different context.

## Assessment Method

We relied on the Kirkpatrick Model, as did most studies testing training effectiveness.<sup>3,13,16,41,42</sup> According to this model, a training's effectiveness is evaluated on four levels: reaction, learning, behavior and results.<sup>43</sup> In this study, we opted for measuring the first 2 levels of the model while tangentially relating to the third. Measuring reactions is possible through program satisfaction assessment. Self-efficacy is used as proxy measure for the learning level of evaluation in the Kirkpatrick Model in ST.<sup>23</sup> A training program can be considered as effective if it modifies the perception of its participants for the better regarding the trained skills. Hence, it is used for assessing the second level because it measures the extent to which participants have appropriated the training and how it impacts the perception of their capabilities when they project themselves in the future. Moreover, self-efficacy is a valid predictor of behavior. Therefore, assessing it also provides information on the third (ie behavioral) level.<sup>44,45</sup>

The first level was evaluated with a post-training satisfaction survey with an overall satisfaction score. Participants were asked to indicate their satisfaction on a Likert scale of 0–5. The survey was developed for this study; an English language version is available as a [supplementary file](#) (see [Supplementary Figure 1](#)).

Following Bandura's guidelines for constructing self-efficacy scales, a specific questionnaire was made relating to leadership skills practiced throughout the program (ie teamwork, communication, decision-making, problem-solving).<sup>46</sup> “I feel capable of setting clear and intelligible objectives for everyone” and “I feel capable of making a decision using a structured analysis method” are examples of items pertaining to communication and decision-making skills, respectively. The self-reported questionnaire was in French and consisted of 15 items presented in a visual analogue format.<sup>47</sup> Participants were asked to rate to what extent they felt capable of performing the leadership skill described in each item. For the analyses, the scores for each item (0–10) were summed giving a total score representing leadership self-efficacy (0–150). The questionnaire's reliability was verified via McDonald's Omega, which yielded a high internal consistency ( $\omega = 0.93$ ).

The questionnaire was administered 3 times: pre-training (T0), immediately after the training as post-training (T1) and 4 months after the training as a follow-up measure (T2). This is a retrospective study, and there were no control groups. The leadership self-efficacy questionnaire was developed for this study, English language versions are available as [supplementary files](#) for each assessment (see [Supplementary Figures 2–4](#)).

## Statistical Analysis

Statistical analyses were conducted with JASP.

Normality assumptions were violated, Shapiro–Wilk test was significant ( $W = 0.96$ ,  $p < 0.003$ ). Nevertheless, the QQ plot reveals that the distribution is normal, and the test is influenced by outliers. Therefore, leadership self-efficacy scores (primary outcome) were tested with a paired samples *t*-test. This pertained to the comparison between T0 and T1 measures.

Sphericity assumptions were violated, Mauchly's test was significant ( $W = 0.66$ ,  $p < 0.001$ ).

Thus, the follow-up of leadership self-efficacy scores (secondary outcome) were tested with repeated measures ANOVA with a Greenhouse–Geisser correction (as the estimated epsilon was 0.74). This pertained to the comparison between T0, T1 and T2 measures.

Levene's test shows that the variances are homogenous for both Pre-training ( $F(5,93) = 1.06, p = 0.389$ ) and Post-training ( $F(5,93) = 1.11, p = 0.359$ ) data. Interaction between program and profession (exploratory analysis) was tested with mixed design ANOVA. This pertained to the differences according to professions in comparison with T0 and T1 measures. A value of  $p < 0.05$  was considered significant with an alpha risk = 5% and confidence intervals = 95%.

## Results

### Response Rates

Out of the 102 participants, 100 completed the post-training satisfaction survey, 99 completed the pre-training (T0) and post-training (T1) self-efficacy questionnaires and 56 completed the follow-up questionnaire (T2) (Figure 1 and Table 1).

The program was reported as highly satisfactory ( $M = 4.6, SD = 0.4$ ).

### Socio-Demographic Data

Age, gender and years occupied in a leadership position were collected (Table 2). Those who did not provide the years occupied in their leadership position were excluded from the sample (regarding socio-demographic data).

### Primary Outcome

The primary outcome concerned the initial sample ( $n = 99$ ). Immediately after the program, difference of total leadership self-efficacy scores between pre-training (T0) ( $M = 89.1, SD = 23.5$ ) and post-training (T1) measures ( $M = 120.77, SD = 15.6$ ) was statistically significant ( $t(98) = 17.4, p < 0.001$ , mean change = 31.67, 95% CI [28.06, 35.28],  $d = 1.75$ ). Post-training scores were higher than pre-training scores (Figure 2).

### Secondary Outcome

The secondary outcome concerned the follow-up sample ( $n = 56$ ). Four months later, total leadership self-efficacy scores between T0 ( $M = 89.1, SD = 21.0$ ), T1 ( $M = 121.1, SD = 14.4$ ) and T2 ( $M = 118.7, SD = 17.8$ ) measures were significantly different ( $F(1,483,55) = 132.1, p < 0.001$ ,  $T0-T1 \Delta = 32.05 [26.71-37.39]$ ,  $T0-T2 \Delta = 2.43 [-7.77-2.90]$ ,  $\eta^2 p = 0.70$ ) (Figure 3). Post-hoc contrasts revealed that the difference between T1 and T2 measures was not statistically significant ( $t(110) = -1.1, p = 0.270$ ) whereas the differences between both measures and T0 were [ $t(110) = 14.6, p < 0.001$ ], [ $t(110) = 13.5, p < 0.001$ ], respectively]. Post-training and follow-up scores remained the same and both were higher than pre-training scores.

### Exploratory Outcome(s)

The exploratory outcome(s) concerned the initial sample ( $n = 99$ ). There was a significant effect of profession on self-efficacy ( $F(5,93) = 7.31, p < 0.001, \eta^2 p = 0.66$ ). Physician executives' self-efficacy is lower than other professions'

**Table 1** Initial Distribution of Professions in Comparison to the Follow-Up Distribution

Profession	Pre/Post-Training	Follow-Up
	n	n
Hospital administrator	8	5
Support services executive	26	10
Executive nurse administrator	5	3
Physician executive	24	19
Nurse administrator	29	16
Department executive	7	3
Total	99	56

**Table 2** Age, Years in a Leadership Role and Gender According to Professions

	Pre-Post Assessment				Follow-Up Assessment			
	Average Age	Average Years in a Leadership Role	Gender		Average Age	Average Years in a Leadership Role	Gender	
			N				N	
			M	F			M	F
Hospital administrator	45.5	19.3	2	6	44.6	17.7	1	4
Support services executive	45.7	8.7	8	16	45.1	7.8	3	6
Executive nurse administrator	49.4	13.2	1	4	52	13.3	0	3
Physician executive	47.5	6.3	11	11	46.8	5.8	9	9
Nurse administrator	48.1	10.2	5	22	47.5	10.4	3	12
Department executive	51.6	9.9	4	3	46.6	4.8	1	2
Total	47.4	9.8	31	62	46.8	8.9	17	36
			Out of 93*				Out of 53*	

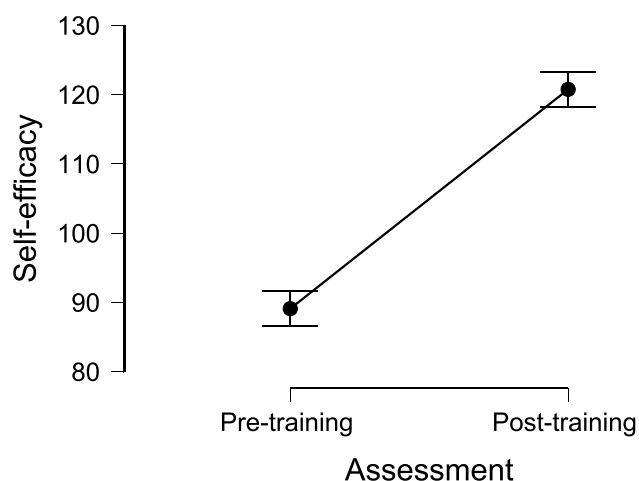
**Notes:** \*Exclusions were made due to incomplete questionnaires (regarding years in HSA role).

despite the increase ( $t(93) = 5.8, p < 0.001$ , mean difference =  $-22.56$ , 95% CI [14.83–30.30]) (Figure 4 and Table 3). This difference concerned both pre-training and post-training scores ( $t(93) = 5.3, p < 0.001$ ), ( $t(93) = 4.9, p < 0.001$ ). The interaction effect between the program and profession was not significant ( $F(5,93) = 2.22, p = 0.058, \eta^2 p = 0.10$ ).

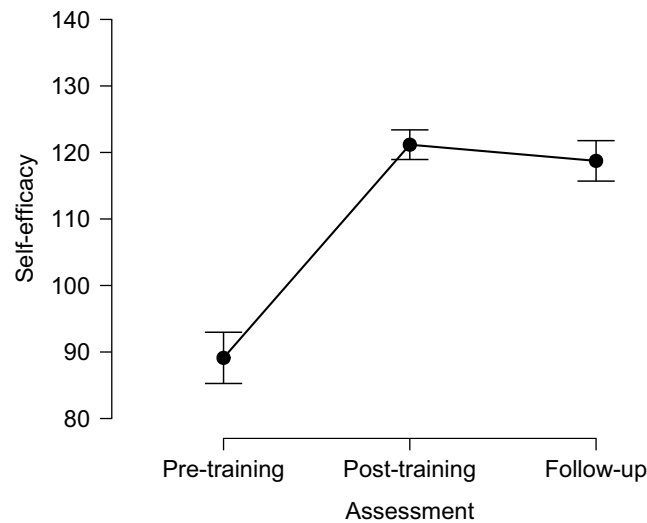
## Discussion

This study's main objective was to test the effectiveness of an interprofessional hospital leadership training program, which was evaluated through its effect on participants' leadership self-efficacy.

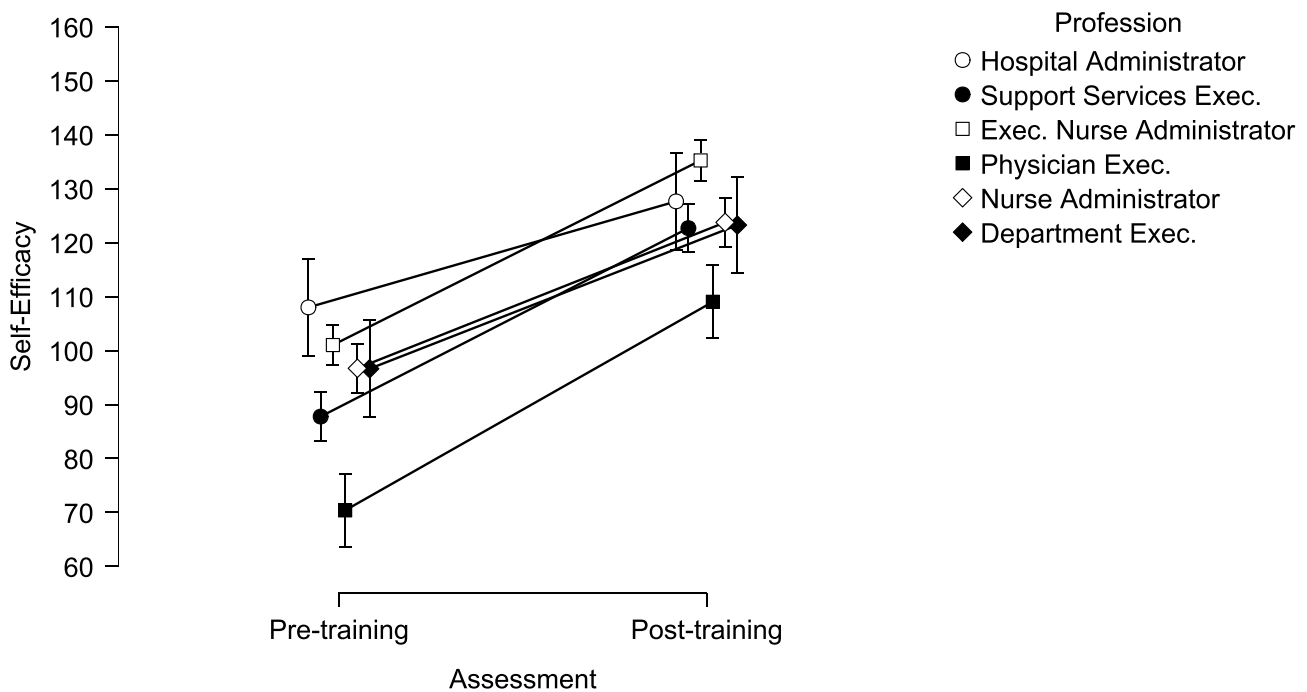
The primary outcome attests that leadership self-efficacy increased post-program. This study suggests that simulation-based interprofessional hospital leadership training allows participants to improve their perceptions of their leadership skills which in turn is a valid predictor of their behavior. Meaning that there is a greater chance for an HSA professional with a higher self-efficacy to put these tools and skills to use rather than one who has a lower self-efficacy. These results allowed us to consider the program as effective for training leadership skills in HSA in an interprofessional context.



**Figure 2** Primary outcome's descriptive plot: program's effect on leadership self-efficacy. Points represent group means; error bars indicate 95% confidence intervals.



**Figure 3** Secondary outcome's descriptive plot: program's effect on leadership self-efficacy in follow-up measures. Points represent group means; error bars indicate 95% confidence intervals.



**Figure 4** Program's effect on leadership self-efficacy according to different professions. Points represent group means; error bars indicate 95% confidence intervals.

Participants had a better perception of their teamwork, communication, decision-making and problem-solving skills in relation to leadership situations.

The secondary outcome attests that the increase of leadership self-efficacy was maintained over 4 months. Participants' perception of their leadership skills was stable over time after being improved post-program. As it takes time for learned skills to be applied in quotidian life, long-term follow-up is required for evaluating the sustainability of the training's effects.<sup>3,43</sup> These results allowed us to consider the program's effectiveness as maintaining overtime for 4 months.

**Table 3** Leadership Self-Efficacy Means in Pre-Training and Post-Training Assessments According to Professions

Profession	Pre-Training		Post-Training	
	M	SD	M	SD
Hospital administrator	108	11.1	127.7	12.4
Support services executive	87.8	18.3	122.7	14.7
Executive nurse administrator	101	9.9	135.2	6.9
Physician executive	70.4	23.3	109	12.6
Nurse administrator	96.7	21.8	123.8	15.1
Department executive	96.6	28.1	123.3	18.6

However, the exploratory outcome shows that leadership self-efficacy is not the same for every profession. Physician executives appear to have a worse perception of their leadership skills when compared to other HSA professionals before and even after the program despite the improvement.

These results are not surprising in the sense that physician executives, among HSA professionals are traditionally the least trained for leadership.<sup>3,6-9</sup> With respect to other professions, physician executives have a lower average of years in a leadership role (Table 2). As the measured variable is self-efficacy, we could assume that this difference between years of experience would have an impact on performance experiences which is a determinant of self-efficacy. To put it simply, lower self-efficacy of physician executives could be a result of them having less experience in leadership practices. Their direct supervisors (department executives) who followed the same curricula, did not share their lower self-efficacy pre-program. A potential explanation could be that department executives' confidence in their skills can be related to their profession and status. More years of experience and a sense of legitimacy generated by higher status could explain stronger confidence in their skills.

There are some contradictory findings in literature as studies report a decrease in self-efficacy due to ST.<sup>48,49</sup> This trend is observed especially for participants who are not accustomed to ST. Studies document apprehension and a tense emotional climate for simulation novices which could explain the phenomenon.<sup>24,50</sup> As our study contained a population for which ST is novel (eg hospital administrators, support services executives, etc), there was a risk of observing a similar trend, however, self-efficacy increased for all the distinct populations regardless of their familiarity with ST. Additionally, the aforementioned studies rely on a student population which differs from ours in both age and experience and might explain why self-efficacy was not affected in the same way.

## ST and Self-Efficacy

ST's effect on self-efficacy determinants (ie performance accomplishments, vicarious learning, verbal persuasion) can be explained through several mechanisms. Performance accomplishments refer to one's prior experiences of success for a given task. Simulation exercises specifically aim to recreate a plausible situation in which participants employ their skills without the risk of consequential error. Verbal persuasion refers to external or internal encouragement regarding a person's capacity to accomplish a task. Self-efficacy can be influenced through verbal persuasion during debriefings, as participants are commended and given feedback for their performance.<sup>35</sup> Vicarious learning refers to impressions on how one might perform on a task based on others' success. During simulation exercises, some participants watched while others performed, seeing how it is possible to make use of a "tool" to efficiently manage a team.

## Future Perspectives and Limitations

Limitations should be considered when interpreting the results of this study. The lack of a control group and the use of a non-randomized convenience sample limit the attribution of observed changes in leadership self-efficacy exclusively to

the training program. Furthermore, no a priori sample size calculation was performed. However, we also conducted a sensitivity analysis with G\*Power for the primary outcome (T0-T1) and the initial sample size ( $n = 99$ ). Given the within-participants design (paired  $t$ -test), with a power of 90% and an alpha level of  $\alpha = 0.05$ , this sensitivity analysis indicates that our initial sample size of  $n = 99$  allows to detect any effect size above  $d = 0.3$ . The observed effect size for this effect - the difference in leadership self-efficacy scores between pre-training (T0) and post-training (T1) measures - was of  $d = 1.75$ . The heterogeneity of the follow-up sample sizes for distinct professions might explain the obtained results. Our low statistical power increases the beta risk and could explain the non-significance of the interaction effect.

Our study suffered experimental attrition on T2 measures. Only 57% of the initial sample completed the follow-up questionnaire. This amount of attrition may produce a risk of attrition bias as participants who completed the follow-up measures may differ from those who did not despite the distribution of professions being similar across samples (Table 1).

Participation in the training was mandatory, which may have contributed to a potential response bias. Mandatory participation could have prompted socially desirable responses, especially in an organizational context. A potential risk of bias could be that only the participants who were motivated by the training responded to the follow-up measures. Therefore, the observed leadership self-efficacy scores could be high for that reason. A similar study reports that self-rated questionnaires can have a response bias risk albeit being valid measures of self-efficacy.<sup>24</sup>

Assessment of the training program only consisted of self-rated self-efficacy which is relevant to the second level of the Kirkpatrick Model and a predictor of the third level (ie behavior).<sup>44,45</sup> Similar studies opted for evaluating their programs on the second level while very few evaluated on the highest levels.<sup>13,41,42</sup> Self-efficacy refers to a degree of belief in perceived capability rather than objectively observed performance, and increases in perceived competence may not necessarily translate into behavioral change. However, all levels must be considered for a more reliable evaluation with an emphasis on objective performance indicators and organizational outcomes.<sup>3</sup> Additionally, the questionnaire was constructed specifically for this study and beyond testing its internal consistency it did not undergo formal psychometric validation. Although being constructed relying on Bandura's guidelines<sup>46</sup> it is uncertain whether the scale fully captures leadership self-efficacy and the interpretation of the findings warrant for caution.

Another element that could potentially bias results is prior leadership training. Indeed, most of the HSA professionals that participated in the program had prior training and recognized some of the leadership tools. This may not have been the case - or to a lesser extent - among physician executives explaining their lower levels of self-efficacy, particularly at pre-training. However, without data on prior training rates among targeted professions, this explanation remains speculative and should be investigated in future research.

This program is characterized by its interprofessional and hospital-wide application elements. Therefore, promising results can be expected for different measures of the 3rd and the 4th level of the Kirkpatrick Model which are behavioral change and results, respectively. We can surmise that the higher levels would be more affected by interpersonal and environmental factors on which an interprofessional hospital-wide program aims to have an impact.

Self-evaluation is a reliable indicator, but it cannot always capture the whole picture. In this sense, qualitative analyses would provide a better understanding of the implications for participants' day-to-day practices. The inclusion of the teams with whom HSA professionals work is an important element of this survey, as practices are bound to have a direct impact on them.

In addition, a multi-level evaluation including both individual and organizational changes (effects of leadership quality, occupational health indicators) would further define the impact of this ST-based intervention. This would be consistent with a medico-economic study measuring the impact of innovation. Longer follow-up measures (12 months) are needed to assess the extent of the program's effectiveness' perpetuation. Prior leadership training should be considered in future studies as a variable to avoid a potential risk of bias.

Prior simulation experience is a similar factor to consider. Professionals affiliated to medical professions had previously done ST, whereas hospital administrator and support services executives did not systematically have any experience. Apprehension of the exercises is very common among simulation training novices.<sup>24,50</sup> These anticipatory thoughts could engender negative emotions and stress during the exercise which may impede the skill acquisition process.<sup>51,52</sup> Participants familiar with simulation training would be less inclined to have apprehensions and experience negative emotions during the exercises. Hence, prior simulation training experience should be considered as a variable in future studies. This study

concerned active HSA professionals already employed at the hospital rather than novice professionals. Testing the effectiveness of this program on novices could prove to be a potential ground for future research.

ST's effects on stress, anxiety, burnout and psychosocial risks have been demonstrated.<sup>53,54</sup> A possible trajectory for future evaluation of this program could include mental health indicators particularly positive mental health indicators apart from self-efficacy such as social support.<sup>55–58</sup> This program convened HSA professionals from distinct backgrounds to work on common skills and problems. These types of interventions that include uniting professionals to encourage sharing and working together for a common goal can have beneficial social effects. We surmise that a sense of belonging is engendered by this type of program.<sup>59,60</sup> Testing this hypothesis might bring some clarity on the social effects of simulation training.

## Conclusion

ST shows promise for enhancing leadership skills in HSA, particularly in an interprofessional context. This study suggests that such a training program increases the leadership self-efficacy of its participants post-training and that this perception persists over time. Furthermore, physician executives report lower self-efficacy than other professions and might be a key group for targeted training. These findings reflect perceived capability rather than objective assessment of leadership performance and interpretation of these findings warrant for caution due to design limitations. Future research in this direction would result in a better understanding of ST's effectiveness and how to improve leadership practices.

## Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Ethics Approval

The study was conducted in accordance with the principles of the Declaration of Helsinki. The study is in compliance with the recommendations of the CNIL (French National Commission for Information Technology and Civil Liberties) and the General Data Protection Regulation (GDPR), particularly in terms of data storage and accessibility. No ethical review and approval were required for the study of human participants in accordance with local legislation and institutional requirements. The study is based on the evaluation of a training course and corresponds to a mandatory certification process for training organizations (The national certification process Qualiopi). Participants have been individually informed and do not object to the use of the data. Data from questionnaires are de-identified.

## Acknowledgments

We would like to acknowledge the authors of this program: C Secheresse, executive nurse administrator and training manager of the program, P Vincent, captain pilot at Air France Airways and TS. The board of directors, notably A Gallet, F Chambaz and Dr L Amico medical director, for their support and endorsement. All the simulated actors for their implication: C Amador, M Berbel, A Villar. C Buret for administrative organization. All the HSA professionals who participated at the program. A Carré and A Smeding (as researchers) and A Le Bellour (as student) acknowledge the Federative Health Research Structure of the Univ. Savoie Mont Blanc ("SFRI Santé Prévention Qualité de Vie"). They also acknowledge the mental health and well-being research program called "Chaire BEST" sustained by the *Fondation Université Savoie Mont Blanc*.

## Disclosure

Arman Le Bellour was employed by Centre Hospitalier Métropole Savoie throughout the study duration and paper writing. Léo Blervaque is employed by CHMS: Centre Hospitalier Métropole Savoie as scientific officer in the clinical research unit. Dr Thierry Secheresse is employed by the CHMS: Centre Hospitalier Métropole Savoie as director of the simulation center. In addition, he reports that M2S: Management Santé Simulation is a registered name but it does not provide any funds. The authors report no other conflicts of interest in this work.

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