

## Promoting Behavioural Safety in Gas Manufacturing: Adaptation of the B-Safe Training Program

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In the industrial gas manufacturing sector, stringent safety protocols and proactive safety promotion are crucial to prevent hazardous incidents protect employees, customers, and the environment from the potential risks of handling and transporting these gases. Train The Trainer (TTT) programmes can be tailored to the organisation's needs and cover various topics, such as handling hazardous materials, emergency response procedures, equipment use and ergonomics, and managing emergency response procedures. The B-SAFE project, designed based on the 'Communities of Practice' theoretical framework and adopting the TTT approach, aims to provide workers with tools and resources to increase work safety and reduce accidents by acting on underlying cognitive behaviour and processes. The present case study aims to present the Italian adaptation of the B-SAFE training programme, incorporating specific revisions resulting from previous research. Twenty-five Health, Safety and Environment (HSE) top and middle managers from a leading gas manufacturing firm participated in the five-module training. At the conclusion of each B-SAFE module, they filled out a short questionnaire to report their satisfaction with the training methods and content. The answers were analysed to gather feedback on the course. In general, participants found the course to be useful, satisfying, fun and easy.

### 1. Introduction

In recent decades, the issue of safety in the workplace remains a significant challenge (Paolucci et al., 2020). As the ILO reports, every 15 seconds, at least one worker dies from a workplace accident or occupational disease (Pega et al., 2022). A report released by the National Institute for Insurance against Accidents at Work (INAIL) reveals that, from January to September 2023, there were 430,829 accident reports in Italy and 761 fatalities. Homecare has become a topic of attention within the occupational safety domain, as it is particularly vulnerable to occupational accidents and injuries (Hansell et al., 2018). Homecare operators routinely navigate a labyrinth of chemical hazards, each posing unique risks to their safety and wellbeing. In this context, ensuring the chemical safety of operators, especially during the handling and delivery of oxygen and other medical gases, is crucial. Homecare workers face risks related to safety, including exposure to accidents involving chemicals. The sector is, in fact, inherently high-risk due to the transportation of highly flammable substances like oxygen, which, in the event of a leak, can lead to significant fire hazards (Chen, 2016). However, the spectrum of chemical risks extends beyond this singular focus. For instance, homecare operators are frequently exposed to aggressive cleaning agents and disinfectants (Goodyear et al., 2018). The handling of medications, particularly those with potent or chemotherapeutic properties, presents another layer of risk, necessitating careful management to prevent accidental exposure. Moreover, volatile organic compounds (VOCs), further complicate the chemical risk landscape (Su et al., 2018).

#### 1.1 Role of Human Factors in Homecare Safety

The importance of addressing Human Factors for preventing or reducing accidents in the homecare sector is a critical aspect of occupational safety. Human factors in the homecare sector encompass a broad range of psychological, cognitive, and social elements that significantly influence worker behaviour and safety. Errors, a

central focus in human factors research, often result from complex interactions between individual capabilities, task demands, and environmental factors (Reason, 2000; Hollnagel, 2008; Rasmussen, 1990). For instance, time pressure and fatigue are common factors leading to lapses in attention and judgment, thereby increasing the likelihood of accidents (Reason, 2000). In addition to physical stressors, the emotional and psychological strain on homecare workers plays a significant role in their overall well-being. Negative interactions with patients and caregivers can act as catalysts for stress. A study by Karakaya et al. (2023) revealed that homecare workers experience heightened stress levels, social isolation, and adverse societal perceptions, suggesting that external factors may also impact stress levels. Psychosocial factors, including stress and job dissatisfaction, can detrimentally affect cognitive function and decision-making, leading to increased accident risks (Karakaya, 2023). These findings emphasise the necessity of addressing not only the tangible physical demands of the role but also the emotional and organisational challenges these professionals face. Consequently, it is imperative to adopt a holistic approach in evaluating and addressing the myriad factors influencing the health and safety of homecare workers. Developing a safety-conscious work culture, where safety protocols are respected and openly discussed, is another critical aspect of integrating human factors into safety management (Burke & Hutchins, 2007). Tailoring interventions targeting individual differences can help address context-specific vulnerabilities and needs. Homecare organisations have implemented policies and processes and personnel training programmes to handle safety-related issues. These results highlight the importance of addressing not only the job's physical demands but also the emotional and organisational challenges these professionals face. Therefore, it is crucial to take a comprehensive approach to assessing and addressing the various factors affecting homecare workers' health and safety.

### **1.2 Practical Training to Reduce Human Errors**

Effective training and skill development in homecare organisations are crucial for minimising hazards and ensuring the safe execution of tasks (Quinlan et al., 2015), including chemical hazards (Robson et al., 2012). Training could encompass practical demonstrations and usage of medical equipment, handling of hazardous materials, and emergency response protocols (Rydenfält et al., 2020). Regular and updated training sessions are vital to keep healthcare professionals abreast of new safety regulations and to maintain their skill proficiency. The Train-The-Trainer (TTT) technique, where a limited group of people receive training to train other collaborators later on, has been shown to be a practical approach for improving safety, particularly in industries with specific safety regulations and in large organisations (Pearce et al., 2012; Triplett et al., 2020).

These programs aim to enhance safety awareness and instill a sense of collective responsibility towards maintaining a safe working environment (Ree & Wiig, 2019; Sartori et al., 2023). As delineated by Yarber et al. (2015), TTT programs harness the expertise of a selected group of employees to disseminate safety knowledge and best practices across an organisation effectively. Moreover, in TTT programs, involving managers has proven to boost the effectiveness of these initiatives. The participation of managers in these programs is linked to higher levels of competence and confidence among trainees (Munera et al., 2017). By engaging in peer-to-peer training, employees contribute actively to this culture. The versatility of TTT programs allows them to be customised to meet an organisation's specific needs, covering a wide array of topics such as hazardous materials handling and equipment usage (Pearce et al., 2012). The efficacy of TTT programs was substantiated in various contexts. Yarber et al. (2015) demonstrated the cost-effectiveness of TTT programs in broadly disseminating evidence-based public health principles, highlighting their adaptability to address local concerns. Similarly, Nakamura et al. (2014) revealed the effectiveness of TTT in fostering skill development and work practices by providing customised training tailored to specific audience needs. Summerside et al. (2018) also found that TTT programs effectively nurture technical and non-technical skills in interprofessional teams, further emphasising this training approach's versatility and broad applicability. Considering the homecare sector's unique aspects and the need for TTT programs for safety improvement in this area, this paper presents the content and the participants' evaluation of an adapted TTT program specifically tailored to the organisational needs.

### **1.3 Objective of the Study**

This paper aims to outline the key components and detail the overall satisfaction reported by participants regarding the Italian implementation of the TTT program, focuses on workplace safety in homecare respiratory therapy services, focusing on liquid gas production and delivery and involves analysing safety events from the past four years to identify training needs. The development of the program is extensively described in a previous work by Fraboni et al. (2023). Briefly, the program development process involved categorising and analysing safety events and contributing factors, ensuring data accuracy and consistency. The TTT program includes five modules addressing human factors issues. Table 1 presents an overview of the activities in each module. It was translated and adapted to the Italian context. Participants will then train their collaborators on the content of the

modules. The program, which leverages a team of Health, Safety, and Environment (HSE) managers to disseminate crucial safety information and best practices, comprises five key training modules. The Italian adaptation of the TTT program, initially implemented to address these diverse hazards, offers a framework for understanding and mitigating the unique risks associated with chemical safety in the homecare sector.

*Table 1. List and description of the activities in each of the 5 modules*

<b>Mod.</b>	<b>Activity Title</b>	<b>Activity Description</b>
1	Case Study 1	Identify Human Factors related issue in a real accident case study
	How workers behave?	Identify common behaviours in everyday activities that could lead to accidents (e.g. violations)
	Challenges for attention	List what challenges participants' attention focus during one selected routine activity
	Case Study 2	Identify attentional related issue in a real accident case study
	Are you distraction prone?	Complete a quiz with questions aimed to identifying if and how participants are "distraction prone"
	Strategies for reducing distractions	Identify two strategies that can be used to avoid distractions during everyday operations at work, then identify pros and cons of the selected strategies
	Describe an Event	Identify a safety related event in which fatigue contributed to the increased risk. List antecedents to fatigue, consequences, and strategies to mitigate its effects
2	Fatigue Checklist	Complete a checklist for identifying self-observables behavioral cues of fatigue
	Case Study 3	Identify fatigue-related risk factors in a real accident case study
	Chronotype and Fatigue	Complete a quiz to identify individual chronotype and related vulnerabilities to fatigue
	Role Playing: Fatigue	Role playing a situation in which fatigue created a risk but it was effectively managed
3	Work "inside the box"	Schedule a typical workday activity and identify sub-tasks related to the specific activities using a box-shaped timesheet.
	Case Study 4	Identify cognitive biases influencing decision-making strategies in a real accident case study
	Managing Priorities	Assign priorities, using the "ABC" method, to the tasks identified in the first activity of the module.
	Managing Contingencies	Order the selected activities in a matrix of importance and urgencies, thinking how activities should be prioritized if a contingency happened
	Writing in "behaviour mode"	Improve the list of activities writing down the actions or behaviors needed to carry out the tasks.
4	Case Study 5	Identify antecedents and consequences of customers aggression in a real accident case study
	De-Escalation techniques	Present a real-life situation at work in which they had to manage aggressive using de-escalation techniques
	Cognitive re-structuring and mindfulness	Participate to a brief mindfulness session and re-formulate their thoughts on real-life aggressions experienced ad work
5	Identify the type of Human Error	Identify the type of human error according to the taxonomy presented.
	Case Study 6	Identify factors contributing to human errors in a real accident case study
	Case Study 7	Identify antecedents to violations from procedure in a real accident case study
	Elaborating Feedbacks using the STAR model	Elaborate a feedback to a collaborator, thinking about a real event, using the STAR model

## 2. Method

Our case study examines the safety procedures of a multinational corporation providing home care services in European countries. Services include creating medical oxygen, distributing it to clinics and patients' homes, managing in-home care, and technical assistance with oxygen cylinder maintenance. The TTT program was structured into five modules, employing frontal teaching with slide presentations, supplemented by ad-hoc explanatory videos for straightforward concept delivery. Additionally, the course incorporated interactive

exercises and activities, including case study analysis and role-playing, to enhance engagement and practical understanding. At the conclusion of each training session, the tutors distributed a link to a brief questionnaire aimed at evaluating the suitability of the covered module. Furthermore, participants were asked to give feedback on the proposed activities, suggesting changes that were gradually incorporated by the tutors, directly editing the material that was shared.

## 2.1 Participants

A total of 24 employees (16 males and 8 females) from Italy were trained according to the TTT methodology, with the objective of further training their collaborators. Regarding the organizational roles of participants, the course was attended by 7 Operation Coordinators, 5 Planning Coordinators, 4 Production Managers, 3 QHSE Coordinators, 1 QHSE manager, 1 QHSE Specialist, 2 Technical Managers, and 1 Training Supervisor.

## 2.2 Measures

The brief questionnaire aimed at evaluating the suitability of the covered module in terms of its content alignment, congruence with training objectives, compatibility with the trainees' classroom management skills, and relevance to their specific work context, as well as the appropriateness in terms of duration and content. Additionally, participants were asked to evaluate, using a 5-point semantic differential scale, the perceived (a) usefulness of the module, (b) overall satisfaction, (c) enjoyment (referred to as 'fun'), and (d) level of difficulty. Finally, feedback was requested on any suggested changes to the various activities included in the module. The descriptive results will be presented in the following section.

Table 2. Training evaluation

	Range	Module 1	Module 2	Module 3	Module 4	Module 5
<b>Module duration</b>	<b>Adequate</b>	95,5%	86,4%	77,3%	76,2%	100%
	<b>Insufficient</b>	4,5%	13,6%	18,2%	23,8%	-
	<b>Excessive</b>	-	-	4,5%	-	-
<b>Activities Duration</b>	<b>Adequate</b>	86,4%	77,3%	72,7%	76,2%	95,7%
	<b>Insufficient</b>	13,6%	22,7%	22,7%	23,8%	4,3%
	<b>Excessive</b>	-	-	4,5%	-	--
<b>Number of slides</b>	<b>Adequate</b>	95,5%	86,4%	77,3%	90,5%	100%
	<b>Insufficient</b>	-	-	-	-	-
	<b>Excessive</b>	4,5%	13,6%	22,7%	9,5%	-
<b>Content of slides</b>	<b>Clear and effective</b>	72,7%	86,4%	63,6%	52,4%	95,7%
	<b>Some Adjustment</b>	27,3%	13,6%	31,8%	38,1%	4,3%
	<b>Need to modify</b>	-	-	4,5%	9,5%	-
<b>In line with... Training objectives</b>	<b>Yes</b>	95,5%	90,9%	81,8%	85,7%	91,3%
	<b>No</b>	4,5%	9,1%	9,1%	14,3%	8,70%
	<b>I don't Know</b>	-	-	9,10%	-	-
<b>In line with... Classroom management skills</b>	<b>Yes</b>	90,9%	95,5%	68,2%	61,9%	87%
	<b>No</b>	4,5%	4,5%	18,2%	19%	4,3%
	<b>I don't Know</b>	4,50%	-	13,60%	19%	8,70%
<b>In line with... Workplace</b>	<b>Yes</b>	90,9%	81,8%	72,7%	76,2%	91,3%
	<b>No</b>	9,10%	13,6%	13,6%	9,5%	8,7%
	<b>I don't Know</b>	-	4,50%	13,60%	14,30%	-

### 3. Results

In general, the overall evaluations of the training course were positive. Regarding the total duration of the module, 92% of participants considered it adequate. In addition, the time available to carry out the activities (85%) and the number of slides (92%) was also assessed as adequate. The 83% of participants considered the content of the slides explicit and effective. Regarding the evaluation of the activities carried out in the modules, 89.1% of the participants felt that they were in line with the training objectives. Furthermore, 80.1% of the participants assessed the activities as appropriate for their classroom management skills. 82.7% of the participants also considered the proposed activities to be appropriate for their work context: in line with this, 86.4% of them stated that they wanted to keep all the activities of the modules unchanged. Analysing open-ended suggestions from participants, the main request was to add more concrete examples adaptable to the work context. Based on the feedback received, several amendments have been made to the training modules. Across all modules, there is a need to standardize acronyms and ensure consistency between training materials (i.e. slides and videos). References should be added to provide insights into key concepts. Additionally, trainers are advised to customize slides, potentially by reducing text and focusing on images. Terms used, especially in exercises, should be neutral and non-judgmental. As far as the overall evaluations of the course are concerned, on average, the modules were rated as useful ( $M=4.13$ ;  $SD=1.15$ ), satisfactory ( $M=4.11$ ;  $SD=1.05$ ), somewhat enjoyable ( $M=3.62$ ;  $SD=1.29$ ) and relatively easy ( $M=3.51$ ;  $SD=1.37$ ). See Table 2 for details on training evaluation.

### 4. Conclusions

Workplace safety has emerged as a prominent and persistent challenge in recent decades. Within the distinctive context of homecare services, the chemical safety of operators engaged in the handling and delivering medical gases, notably oxygen, presents a unique array of challenges. Homecare organisations have responded to safety-related concerns by instituting comprehensive policies, procedural frameworks, and personnel training initiatives. The TTT technique has demonstrated efficacy in enhancing safety. Also, employees perceive a more significant commitment from their organization towards training and development when managers actively participate in these programs, increasing satisfaction with the training process and a stronger belief in the organization's commitment. Finally, a higher level of motivational involvement from participants is expected when managers lead by example. The influence of leadership behavior on employee motivation and performance has been well documented, underscoring the critical role that managerial involvement plays in the success of TTT programs. To date, there is a dearth of studies exploring Italian adaptations of TTT training courses for homecare workers. This paper addresses this gap by presenting participants' perceptions of the course's suitability. Overall, the evaluations of the training course have been positive. Over 90% of participants considered the total duration of the module as adequate, and more than 80% found the content of the slides to be clear and compelling. Furthermore, over 85% of the participants expressed satisfaction with the activities. In any case, the uniqueness of the training course provided participants with the opportunity to propose changes to the content of the modules, which were implemented to enable them to have usable material at the end of the course to apply the TTT principles. The average ratings for the modules indicate their perceived usefulness, satisfaction, enjoyability, and ease. These encouraging results not only affirm the viability of implementing this form of training but also suggest its potential applicability in the context of managing chemical risks. The positive feedback received from participants underlines the positive reception of the TTT approach in safety training, also in the context of home care. These results emphasise the importance of continued efforts to improve safety training, including in-depth chemical risk management.

### References

- Bhat, Z. (2011). Impact of Training on Employee Performance: A Study of Retail Banking Sector in India. *Indian journal of applied research*, 3, 292 – 293. <https://doi.org/10.15373/2249555X/JUNE2013/97>.
- Burke, L. A., & Hutchins, H. M. (2007). Training transfer: An integrative literature review. *Human Resource Development Review*, 6(3), 263–296. doi:10.1177/1534484307303035
- Chen, Y.L. (2016). Gas-cylinder handling tasks in Taiwan. *Occup Med Health Aff.* 04(2). 10. 4172/2329-6879.1000232.
- Fraboni, F., Morandini, S., Zappalà, S., Guglielmi, D., Mariani, M. G., De Angelis, M., & Pietrantoni, L. (2023). Occupational safety in homecare organizations: the design and implementation of a train-the-trainer program. *Home health care services quarterly*, 1 – 27.

- Goodyear, N., Markkanen, P., Beato-Melendez, C., Mohamed, H., Gore, R., Galligan, C., ... & Quinn, M. (2018). Cleaning and disinfection in home care: A comparison of 2 commercial products with potentially different consequences for respiratory health. *American journal of infection control*, 46(4), 410–416.
- Hansell, A. K., Knaster, E. S., & Phillips, L. E. (2018). Injury among home care workers in Washington State. *New Solutions: A Journal of Environmental and Occupational Health Policy: NS*, 27(4), 543–558. doi:10.1177/1048291117739419.
- Hollnagel, E. (2008). The changing nature of risk. *Ergonomics Australia Journal*, 22(1–2), 33–46.
- Karakaya, A., & Uçar, M., (2023). Stress perceptions of nurses serving in home healthcare services during the COVID-19 pandemic: A qualitative research. *Journal of Acute Disease*, 12 (2), 73–79. doi:10.4103/2221-6189.374314.
- Mariani, M. G., Vignoli, M., Dibello, V., Chiesa, R., & Guglielmi, D. (2017). The importance of considering emotions in the development of effective safety training courses in the food industry. *Chemical Engineering Transactions*, 2017, 1795–1800.
- Munera, S., Goldberg, M., Kandavel, K., & Pearlman, J. (2017). Development and evaluation of a wheelchair service provision training of trainers programme. *African Journal of Disability*, 6. <https://doi.org/10.4102/ajod.v6i0.360>
- Paolucci, A., Guglielmi, D., & Mariani, M. G. (2020). Can Perceived Quality of Protective Equipment Increase Safety Motivation?. *Chemical Engineering Transactions*, 82, 157–162.
- Pearce, J., Mann, M. K., Jones, C., van Buschbach, S., Olff, M., & Bisson, J. I. (2012). The most effective way of delivering a train-the-trainers program: A systematic review. *The Journal of Continuing Education in the Health Professions*, 32(3), 215–226. doi:10.1002/chp.21148.
- Pega, F., Hamzaoui, H., Náfrádi, B., & Momen, N. C. (2022). Global, regional and national burden of disease attributable to 19 selected occupational risk factors for 183 countries, 2000–2016: A systematic analysis from the WHO/ILO joint estimates of the work-related burden of disease and injury. *Scandinavian Journal of Work Environment & Health*, 48(2), 158–168. doi:10.5271/sjweh.4001
- Quinlan, M., Bohle, P., & Rawlings-Way, O. (2015). Health and safety of homecare workers engaged by temporary employment agencies. *Journal of Industrial Relations*, 57(1), 94–114. doi:10.1177/0022185614541179
- Rasmussen, J. (1990). Human error and the problem of causality in analysis of accidents. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 327(1241), 449–462.
- Reason, J. (2000). Human error: models and management. *British medical journal*, 320(7237), 768–770. doi:10.1136/bmj.320.7237.768.
- Ree, E., & Wiig, S. (2019). Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Services Research*, 19(1), 607. doi:10.1186/s12913-019-4456-8.
- Robson, L. S., Stephenson, C. M., Schulte, P. A., BC, A., 3rd, Irvin, E. L., Eggerth, D. E., & Rotunda, C. J. (2012). A systematic review of the effectiveness of occupational health and safety training. *Scandinavian Journal of Work Environment & Health*, 38(3), 193–208. doi:10.5271/sjweh.3259
- Sartori, R., Tommasi, F., Ceschi, A., Noventa, S., & Zene, M. (2023). Learning in the workplace: Evidence on the role of behavioural job crafting on fostering self-perceived employability. *European Journal of Training & Development*, 47(10), 133–146. doi:10.1108/EJTD-11-2022-0119
- Su, F. C., Friesen, M. C., Stefaniak, A. B., Henneberger, P. K., LeBouf, R. F., Stanton, M. L., ... & Virji, M. A. (2018). Exposures to volatile organic compounds among healthcare workers: modeling the effects of cleaning tasks and product use. *Annals of Work Exposures and Health*, 62(7), 852–870.
- Summerside, N., Abu-Rish Blakeney, E., Brashers, V., Dyer, C., Hall, L. W., Owen, J. A., & Moore, A. (2018). Early outcomes from a national train-the-trainer Interprofessional Team development program. *Journal of Interprofessional Care*, 37(sup1), S41–S44. doi:10.1080/13561820.2018.1538115
- Tharenou, P. (2001). The relationship of training motivation to participation in training and development. *Journal of Occupational and Organizational Psychology*, 74, 599–621. <https://doi.org/10.5465/APBPP.2001.6133171>.
- Triplett, N. S., Sedlar, G., Berliner, L., Jungbluth, N., Boyd, M., & Dorsey, S. (2020). Evaluating a train-the-trainer approach for increasing EBP training capacity in community mental health. *The Journal of Behavioral Health Services & Research*, 47(2), 189–200. doi:10.1007/s11414-019-09676-2.
- Yarber, L., Brownson, C. A., Jacob, R. R., Baker, E. A., Jones, E., Baumann, C., & Scharff, D. P. (2015). Evaluating a train-the-trainer approach for improving capacity for evidence-based decision making in public health. *BMC Health Services Research*, 15(1), 547. doi:10.1186/s12913-015-1224-2