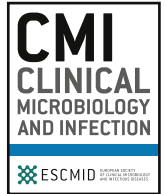




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## Review

## Mentor-mentee relationship in clinical microbiology

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## ABSTRACT

**Background:** Clinical microbiology is a field in constant evolution, with increasing technological opportunities and a growing emphasis on human and social issues. Maintaining knowledge and skills and anticipating future changes is challenging both for laboratory managers and for all the co-workers. Training and succession preparation represents a unique opportunity to adapt/prepare future generations according to the evolutions of the field.

**Aims:** The aim of this review is to provide to clinical microbiologists a reflection on ongoing technological and social changes in their field and a deepening of the central role of preparing future generations to these changes through a fruitful mentor-mentee relationship.

**Sources:** This narrative review relies on selected publications addressing mentor-mentee interactions in various academic fields, on interview with our colleagues and pairs, as well as on our personal experience.

**Content:** From the qualities and aspects that emerged as necessary for a productive mentor-mentee interaction, we selected and discuss five of them for the mentor: the role and responsibility, the positioning, the vision, the scientific credibility, and the moral credibility, as well as five for the mentee: creativity, flexibility, energy, responsibility, and self evaluation.

**Implications:** This review emphasizes the importance of both the scientific and the ethical credibility of the mentor and the mentee as well as the importance of human and social values such as solidarity, equality, equity, respectfulness, and empathy, and might support mentor and mentee in the field of clinical microbiology and also in the field of infectious disease in their intent for a fruitful interaction.

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## Introduction

Clinical microbiology is in the midst of a technological revolution, with the emergence of many new technological opportunities and with increased automation. This technological revolution is accompanied by a human and social revolution that notably interrogates the responsibility of each co-worker and the occupational well-being. This encompasses a large number of new notions that are now central and inevitable in the management of a team, including the company values, equality of opportunity, and equity between different employees. So far, human and social competencies have not been generalized as part of the academic training,

and these criteria are not sufficiently included in the selection process.

Such an evolving field also implies from its actors, vision and anticipation, creativity, and flexibility to face the new challenges but also communication to obtain the trust and the support of the teams, which are necessary to accompany the change and to avoid anxiety. In this narrative review we address the ongoing technological, human, and social change in clinical microbiology laboratories and focus on the importance of the mentor-mentee interaction. Indeed, training the future generation is an opportunity to face these evolutions and can be integrated into change management as it allows for adaptation of future generations according to the technological and social changes. In this context, the mentor-mentee relationship, a common model of formation of young individuals in the academic field plays a central role. In clinical microbiology mentorship applies to the academic staff in a broad range of situations: during specialization as a clinical

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microbiologist, during undergraduate training as a microbiologist or molecular biologist, during medical studies, during a PhD, or during postdoctoral studies. This relationship also applies to infectious disease specialists. Interestingly, one can be a mentee, as a young individual, and evolve to a mentor when more experienced. Thus, the challenge for mentors is to provide sufficient new skills and knowledge to their mentee including those that address human and social issues; it is therefore necessary that the mentors be interested and trained in such important issues. Such interactions and challenges not only apply to the academic staff but also applies to the technical staff, for whom a large part of the training is made by companionship.

This review relies on the available literature on the mentor-mentee relationship and on our personal experience to discuss the importance of this interaction in the field of clinical microbiology. Among the qualities and aspects that emerged as necessary for a productive mentor-mentee interaction, we selected and discuss five of them for the mentor: the role and responsibility, the positioning, the vision, the scientific credibility, and the moral credibility, as well as five for the mentee: creativity, flexibility, energy, responsibility, and self-evaluation. Many of the issues that we address also apply to other academic fields including the field of infectious disease.

## The laboratory's human and social environment

### *Human and social expectations*

Based on a questionnaire survey about the personal life and working conditions of trainees and young specialists in clinical microbiology and infectious diseases, Maraolo and colleagues reported that working conditions vary between different regions of Europe [1]. This survey also reported that alongside the scientific or technical expectations of co-workers in the field of clinical microbiology and infectious disease, there is a growing expectation on social and human qualities. Traditionally, the academic educational process is largely based on evaluation of theoretical and technical skills. For this reason, in addition to the scientific and technical competence assessments, efforts must be made for a very thorough evaluation on human, social, and managerial skills in academia. Team spirit must be part of the important skills for a future collaborator. Another essential feature is the interest and motivation for the discipline in which one engages, rather than the interest and the ambition to succeed. However, the interest and the motivation for a given activity is very much associated with success [2]. When engaging a new co-worker, this aspect must be evaluated very precisely, otherwise there is the risk of being very quickly faced with young individuals or new-co-workers who are demotivated or with failures. More generally, it is the responsibility of actual generations to present exciting and stimulating aspects of clinical microbiology to create a large number of vocations and guarantee effective succession both at the level of technical staff and university biomedical staff.

### *Values*

The different co-workers of a laboratory or a company may come from unrelated social and cultural environments, and as a consequence may have different personal and professional principles and values. In this case, common values must be those of the institution or of the laboratory. They may be proposed by the laboratory manager and it is important that they receive the support of all the co-workers [3]. The mentor and the mentee can thus use the values of the laboratory as common values.

### *Equality*

The growing concept of equality means to ensure that everyone has the same chances of success within the laboratory or company. It is not only the responsibility of the laboratory or the managers, but of all the co-workers and of the whole institution. An interview-based study performed with European clinical microbiologists and infectious disease specialists reported that inequality and discrimination occurs in hospitals and university and describes some existing inequities and discrimination patterns [4]. Such a study giving examples of inappropriate behaviours, including gender aspects and social or ethnic discrimination, may help with efforts to reduce such behaviours by identifying possible demotivating effects of inequality or discrimination [5]. It is therefore important that the company or institution provides new tools and solutions to promote equality and constructive behaviours.

### *Becoming a manager*

Management, defined as the implementation of the human resources and the material required for a company to achieve its objectives, can be broken down into an increasing number of different aspects including the management of human resources, quality management, project management [6], change management, risk management, and team management. As a result, a large number of employees within a company find themselves involved in managerial activities. In addition, the organization of a company is more like a fractal structure, including a group within a team, a team within a unit, a unit within a department, a department within an institution, and an institution within a network of institutions. This structure involves intermediate managers at each level of the fractal rather than a single 'head' leader in a strictly pyramidal structure. This implies horizontal interactions, and not vertical interactions with the hierarchy; regarding young individuals, this implies many interactions other than those with a hierarchic superior [7]. Thus, the widespread pyramidal representation of a company or a laboratory does not directly reflect the organization. It reflects a certain vertical hierarchy rather than the true responsibility level, which is central in terms of management. Finally, a pyramid cannot exist or stand without its base, and numerous decisions and responsibilities are also part of the duties of the co-workers constituting the different pillars of a laboratory. A horizontal representation might better reflect the process, which successively involves different people who are all essential. Whatever the organization of the laboratory or company, the positioning of an assistant manager is always complicated because he/she does not yet have experience or legitimacy, despite rapid responsibilities. It is interesting to note that so far, most management courses are proposed at postgraduate level. In the future, more management courses should be integrated into undergraduate training because, as discussed earlier, almost everyone will be led to manage at some point in his/her professional career. For too long, managerial skills have been associated with intuitions or feeling but such self-development in management is not efficient, being akin to learning to write alone. An introduction to the basic concepts of management early in the university curriculum would thus help to prevent development of erroneous management habits. This would also help to balance the impact of bad examples and to reduce the risk of reproducing negative behaviours. Early learning of management skills can yield positive results, as demonstrated by Cummings and colleagues with only a 2-day coaching workshop experience with residents in long-term care facilities [8]. Nevertheless, things are evolving very quickly, with, on one hand, for example at our institution, introduction of micro MBA courses for university executives; and, on the other hand,

systematic and in-depth evaluation of applicants for executive positions by the human resource department.

### Mentorship: ‘The whole purpose of education is to turn mirrors into windows’ (Sydney J. Harris)

#### Mentor: role and responsibility

Mentoring and teaching are part of the major duty of a laboratory manager or research group leader ([https://www.elsevier.com/about/this-is-elsevier?utm\\_source=HP&utm\\_campaign=HP-Unceasing&utm\\_medium=HP-Unceasing#change](https://www.elsevier.com/about/this-is-elsevier?utm_source=HP&utm_campaign=HP-Unceasing&utm_medium=HP-Unceasing#change)). However, there are many expectations and responsibilities resting on the mentor's shoulders (Fig. 1). Indeed, today's mentees are tomorrow's mentors. The positive impact of the mentor-mentee relationship has been established in several fields, especially in the biomedical field, and is rarely questioned [9]. Conversely, there have been a very large number of proposals on the role of mentors. For example, Martin J. Tobin has proposed seven roles that the mentor can adopt according to the characteristics of the mentee: teacher, sponsor, advisor, agent, role model, coach, and confidante [9]. Indeed, the role may vary according to the situation, for instance according to the number of years of training and to the training degree.

#### Positioning: the good distance

Interestingly, the term ‘mentor’ is used much more often than that of ‘tutor’. However, the botanical definition of the term ‘tutor’ ideally illustrates the positioning that may adopt a senior individual who accompanies the evolution of a young individual. Thus a tutor

is positioned next to the plant to promote and support its growth (Fig. 2). The distance of the tutor from the growing plant is paramount. Too far and not available, it will serve no purpose. Conversely, if the tutor is too close it could become stifling, inhibiting growth. Initially the tutor is stronger than the young germ. Generally, depending on the growth of the plant, the size of the tutor may change to become increasingly solid. Thus, regarding the mentor-mentee relationship, the role of the mentor may evolve according to the evolution of the mentee. The mentor may adjust his/her position throughout the training of young specialists in clinical microbiology and according to the needs, starting from a very close position to move away more and more so that the autonomy of the future manager develops. An important quality for a plant tutor is its flexibility. This flexibility will also allow the mentor to adapt and to accompany the mentee in the new chosen directions he/she may solicit; indeed, according to opportunities and acquired new skills, the mentee may ultimately move away from the mentor's initial thematic and main expertise. Importantly, the mentor also acts as a ‘role model’ for his/her mentee [9]. However, as said by Margaret Mead ‘Children must be taught how to think, not what to think (Margaret Mead, anthropologist, 1901–1978, Fig. 3). Thus the role as a model does not necessarily mean to produce human copies of the mentor; rather, as was said by Sydney J. Harris, ‘the whole purpose of education is to turn mirrors into windows’ (Sydney J. Harris, journalist, 1917–1986, Fig. 3).

Whatever the role of the mentor is, it is paramount that he/she is present and available. Consequently, a mentor may limit the number of mentees under his/her responsibility. The ability to listen often emerges as one of the main qualities of a good mentor (Fig. 1) [9]. The quality of listening is directly related to the presence and availability. The presence makes it possible to identify proactively the needs of the mentee and listening allows hearing his/her needs. In this regard, the ESCMID offers a 2-year mentorship programme that connects young scientists with more experienced mentors. To encourage interactions and exchanges between the mentor and the mentee, the ESCMID subsidizes part of the costs of travel and telephone calls (up to EUR 1500 per year and EUR 3000 per mentorship, for example [https://www.escmid.org/profession\\_career/mentorships/about\\_mentorship\\_programme/](https://www.escmid.org/profession_career/mentorships/about_mentorship_programme/)).

#### Vision

A mentor has an important responsibility in the vision of the evolution of the field. The choice of the mentee may depend on this vision but also on the needs of the institution. Fortunately, as we discuss later, the mentor should be able to rely on the flexibility of the trainee to adapt his/her profile according to the needs and according to the evolution of the field. The mentor's vision is thus very important in the selection of young individuals who, depending on their academic backgrounds or behaviour, are not necessarily ‘extremely bright’ people with outstanding scientific qualities. Thus, the criteria of choice may include all that helps and allows the fruitful development of the mentee, mainly human and social criteria such as motivation, perseverance, curiosity, ethics, generosity, politeness, respectfulness; these criteria are clearly not restricted to the scientific achievement of the person. Choosing a young person does not correspond to choosing a ‘prêt à porter’, but rather finding the right fabrics for the garment to be made as during the years of training, the person will adapt, change, and develop. It is therefore important to allocate the necessary budgets to train the youngest microbiologists in recent technologies and provide them the opportunity to regularly participate in post-graduate courses and workshops offered by scientific societies [10]. Moreover, in such a rapidly evolving field, it is important that clinical microbiologists develop adaptability and flexibility. Such



**Fig. 1.** Word cloud presenting some expected qualities of mentors (upper panel) and mentees (lower panel). These result from a qualitative survey in which co-workers of clinical laboratories and research laboratories were asked to define three important qualities for the mentor and three for the mentee academic staff and technician staff. Forty answers were received including answers from senior individuals, young training individuals, senior technicians, and young technicians.



qualities can be acquired by participating in research and development (R&D) projects.

#### *Scientific credibility*

It is clear that a mentor must have the necessary scientific skills to guide his/her mentee. However, in a rapidly evolving area, the mentor sometimes cannot fulfil all the skills to guide his/her trainee in all solicited directions. It is very important, then, that the mentor knows his/her own limits. Indeed, mentoring is not necessarily only the fate of a single person, but may arise from various persons interacting with the mentee [9]. As a result, it is expected that young individuals may rely on multiple mentors [11]. Finally, a mentor is not necessarily a hierarchical superior or an older person but a person who is more experienced in a particular field.

#### *Moral credibility: solidarity, kindness, and equality*

By analysing the nomination letters for a mentoring award, Cho and colleagues reported that among the top five qualities of admired mentors was that he/she exhibits admirable personal qualities; these included enthusiasm, compassion, and selflessness [12]. Any learning implies experimentation that involves errors, which requires solidarity and kindness from the mentor. In another study based on interviews with young people, it was reported that psychological and emotional support was considered to be one of the most important interventions of a mentor [13]. In the course of their careers, mentors will be faced with fairness and equality issues either because they have several mentees at a time or in the case of successive trainees. A US study conducted in a department of gynaecology and obstetrics demonstrated that mentors gave better results to their mentee than did non-mentoring-faculty. This study also reported that male faculty were more likely than female faculty to give male students better scores [14]. This underlies the difficulty for mentors to apply concepts such as gender balance and equity, even when they want to promote such policies, and the need for tools to help managers or mentors in changing their behaviours. For instance, the office of equality of the University of Lausanne (Switzerland) proposes a video and a tutorial highlighting the challenges for equal opportunities between women and men

**Fig. 2.** 'Tuteur-tutrice et tutoré-e' from Sibel Iliaz Brouillet. An artistic representation of the mentor-mentee relationship prepared especially for this review by the artist on request of the authors. Acrylic on paper 42 × 59.4 cm. As a tutor for a plant, a mentor is positioned next to his/her mentee to promote growth and provide support when necessary. The distance of the tutor from the growing plant is paramount. Too far and not available, it will serve no purpose. Conversely, if it is too close it could become stifling, inhibiting growth. The mentor may adjust his/her position throughout the training of the mentee and according to the needs. An important quality for the tutor will be its flexibility making him/her able to adapt and to accompany the mentee in the new chosen directions he/she may solicit; indeed, according to opportunities and acquired new skills, the mentee may ultimately move away from the tutor's initial thematic and main expertise.



**Fig. 3.** Pictures of authors of outstanding quotations about education. Left: Margaret Mead (1901–1978), anthropologist, 'Children must be taught how to think, not what to think'. Middle: Sydney J. Harris (1917–1986), journalist, 'The whole purpose of education is to turn mirrors into windows'. Right: Malcolm X (born Malcolm Little, 1925–1965) human rights activist, 'Education is the passport to the future, for tomorrow belongs to those who prepare for it today'.

and good practices for non-discriminatory recruitment [www.youtube.com/watch?v=TQG7zySAYaE&feature=youtu.be](http://www.youtube.com/watch?v=TQG7zySAYaE&feature=youtu.be).

#### *Mentee: growing in a moving world*

The large number of developments and innovations in the field of clinical microbiology represents an important challenge for current and future generations. The players in this sector need to develop a large number of new scientific and technical skills. This includes the advent of molecular biology incorporating understanding and the mastery of nucleic acid techniques, which led to methods based on DNA hybridization, amplification (PCR), and sequencing. Most of these techniques are now part of the diagnostic process in medical microbiology [15–18]; some are already available as point-of-care tests [19], with others, such as RNA detection to determine bacterial viability, anticipated [20]. Development in the sector of molecular diagnostic aims to increase the sensitivity and specificity of these methods while reducing the turnaround time. The challenge for microbiologists and physicians is to determine the clinical significance of these generally more sensitive methods. This revolution in molecular biology is continuing with genomics and metagenomics, disciplines that combine skills in bioinformatics, molecular biology, and microbiology [21]. Future clinicians should have sufficient knowledge of these new technologies to be able to use the methods and the associated instruments and to interpret the results according to the performances and the limits of each method. For instance, regarding metagenomics analysis, it is the responsibility of the clinical microbiologist to know that certain bacteria cannot be discriminated at the species level on the basis of the 16S ribosomal RNA gene; it is also his/her responsibility and that of the physician to question the relevance of a stool analysis according to the suspected disease [22]. MALDI-TOF MS (matrix-assisted laser desorption/ionization-time of flight mass-spectrometry) analysing protein spectra to identify species, and PCR/ESI-MS (PCR/electrospray ionization mass spectrometry) analysing DNA amplicon, represent major breakthroughs in the field of diagnostic microbiology that need to be conveyed via adequate teaching and mentoring, to fully exploit the opportunities offered by the new technologies, without reducing the overall quality [23,24]. Microbial culturomic [12,13] and the next phenotypic identification methods relying for instance on bacteria smell (detection of produced volatile molecules) [25,26], high-quality imaging with spectral colour or light diffraction analysis, and atomic force microscopy (AFM) as a nanomotion antibiotic susceptibility test method [27,28] will also largely transform culture-dependant methods. Automation of a large number of activities is also modifying the profession of technician [29]. It will be important for clinical microbiologists to define the performance, the limit of detection, the specificity, the sensitivity, and the reproducibility of these new technologies.

Therefore, there are also many expectations and requirements for mentees that not only include scientific and technical issues but also human and social ones.

#### *Creativity*

Evolving into a changing world offers the unique opportunity to actively participate in promoting the change rather than just act as a follower. This is challenging but gives the mentee a unique opportunity to express his/her creativity. As said by Malcolm X, 'education is a passport to the future, for tomorrow belongs to those who prepare for it today' (Malcolm X, human rights activist, 1925–1965, Fig. 3). It is therefore important to take the time to learn about the changes in the domain. This also underscores the importance of participating in international conferences on current

and future technological development [10]. Participating in stimulating conferences and meetings is entirely part of the training of ongoing specialists in clinical microbiology [30]. Alternatively, new competencies can be gained by doing part of the training aboard [31]. Another way to express creativity is to participate in R&D projects, which are rarely successful without creativity. Because of the importance of creativity, a PhD degree especially for innovation and R&D activities could be of significant benefit in training as a clinical microbiologist.

#### *Flexibility*

Depending on the information collected on the evolution of the domain and the vision of his/her mentor, it is necessary that the mentee be flexible to change orientation during the training. Flexibility also helps in adapting to new challenges, to co-workers such as other academic staff and technician teams, and to easily step into new projects when facing specific opportunities.

#### *Energy, ability to express, proactivity*

The trainee/mentor interaction implies important responsibility of the young individual in that he/she will have to solicit the mentor adequately whenever necessary. It must not be forgotten that sometimes several solicitations are necessary before obtaining a positive answer. Capacity to convince is clearly associated with the quality of expression, but also with good arguments and preparation. This also requires being very proactive and persistent.

#### *Responsibility (to gain someone's trust)*

By taking initiatives, while limiting the mistakes, one will gain progressively confidence of his/her mentor. They are a numbers of missteps that the mentee can make [32]. Among them is the risk for a trainee to disperse; especially if the objectives and projects are not clearly defined. Therefore, being proactive does not mean doing things that have not been planned and that are not part of a project, but rather proposing new projects and/or identifying new solicitations or opportunities as part of the ongoing project.

#### *Self-evaluation*

It is important to have ambitious goals rather than being ambitious and selfish. Ambitious objectives make it possible to move forward. However, it is also very important that a mentee know his/her own limits and also to respect his/her environment and the people within it. Ambition must not become excessive; it must not be the expression of an exacerbated narcissism [33,34]. An ability to self-assess and modesty must help to define one's own limits and accept them; even though sometimes it can be interesting and tempting to try to go beyond the limits to reach new unexplored horizons. A dialogue with the mentor may help to define where a mentee's own limits lie.

#### **Conclusions**

In a rapidly evolving field such as clinical microbiology and in a changing world, there is great responsibility in the formation of the succession. Indeed, the young individuals of today are the managers of tomorrow. Importantly, similar functions and issues apply to non-academic staff such as specialized technicians, and refer to companionship. Training represents a unique opportunity to adapt the profile of the next generation to current and future technological and societal changes. To be a tutor there must be a generosity, a desire to transmit his/her knowledge. For the mentee, there

must be a great desire to learn, a great motivation, and open-mindedness both on scientific and on societal evolutions.

The aim of this review was not to highlight the limits of the mentor or the mentee, but rather to provide a reflection axes and to open the discussion on certain topics that we considered to be important. We hope that this review helps mentor and mentee in their intent for a fruitful interaction by highlighting the equal importance of scientific and human issues, and the importance of human and social values such as solidarity, equality, equity, respectfulness, and empathy. This narrative review is not comprehensive on addressing the challenges of the mentor-mentee interaction, but the aim was to open the discussion for further publication or studies on this topic.

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