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Ab s t r a c t:

Introduction:

The positive effect of feedback has long been recognized in surgical education. Surgical educators convey feedback to improve the performance of the surgical trainees. We aimed to review the scientific classification and application of feedback in surgical education, and to propose possible future directions for research.

Methods:

A literature search was performed using Pubmed, OVID, CINAHL, Web of science, EMBASE, ERIC database and Google Scholar. The following search terms were used: 'feedback', 'feedback in medical education', 'feedback in medical training' and 'feedback in surgery'. The search was limited to articles in English.

Results:

From 1157 citations, 12 books and 43 articles met the inclusion criteria and were selected for this review.

Conclusion:

Feedback comes in a variety of types and is an essential tool for learning and developing performance in surgical education. Different methods of feedback application are evolving and future work needs to concentrate on the value of each method as well as the role of new technologies in surgical education.

Introduction

Feedback has been defined as “actions taken by an external agent to provide information regarding some aspect(s) of one's task performance”.1 Feedback can also be defined as the process in which the effect or output of an action is returned to modify the next action. The term 'feedback' is taken from cybernetics with self-regulating systems. In its simplest form, feedback is a self-stabilising control system. Self-regulating mechanisms have existed since antiquity, and the idea of feedback had started to enter economic theory in Britain by the eighteenth century, but it wasn't at that time recognized as a universal abstraction and didn't have a name.2 Rocket engineers developed the concept of feedback in the 1940s when the system used information to reach its goal.3

In a review of 196 studies of feedback in the classroom, feedback has been described as one of the most influential factors in learning, as powerful as the quality and quantity of instruction.4 It was noted that feedback is vital and that the most effective and helpful feedback is based on observable behaviours.5 Feedback has also been regarded as crucial to improving knowledge and skill acquisition.6 The importance of feedback in clinical medical education extends beyond pedagogy, and without feedback good performance is not reinforced and mistakes are uncorrected.3 Feedback is an essential part of education and training programmes. Some authors suggested that learners should be encouraged to ‘seek feedback themselves from others … feedback actually works best when it is sought’.7 It is also important for the development

of learners in healthcare, and helps them to maximise their potential at different stages of training, raise their awareness of strengths, and identify actions to be taken to evaluate and improve their own and the performance of others.

In this article, we aimed to perform a narrative review of the classification, application and the future progress of feedback in surgical education.

Methods

A literature search was performed using Pubmed, OVID, CINAHL, Web of science, EMBASE, ERIC database and Google Scholar. The following search terms were used: 'feedback', 'feedback in medical education', 'feedback in medical training' and 'feedback in surgery'. The search was limited to articles in the English language. Specific articles on feedback in non-medical fields like business administration, coaching; or other specific non-surgical medical fields like psychology, internal medicine or anaesthesia were excluded. The first author performed the detailed literature search based on the agreed selection criteria. The final short list of the articles were included by consensus among both authors.

Results

This effort resulted in 1157 citations from which relevant studies were selected for this review. Twelve books and 43 papers from years 1967e2015 met the inclusion criteria.

Discussion

Classifications of surgical feedback

Feedback can be divided into negative and positive types.8 Each type can be subdivided into past and future. Negative past feedback is the corrective comments and assessments about past behaviour. These are things that were not rightly done. Negative future feedback is corrective comments about future behaviour.9,10 These are things that do not need to be repeated again. However, positive past feedback is affirming comments about past behaviour. These are things that were rightly done and have to be repeated. Positive future feedback is affirming comments about future behaviour. In some other words, they are things that would improve performance in the future.

Another classification listed five types of feedback.11,12 Evaluative: this feedback is divided into personal or behavioural types. In the personal evaluation, the observer is judging the whole person and not only his actions. In the behavioural evaluation, the actions are being judged and not the whole person. Interpretive: in this type the understanding of what has been said or done is tested. A discussion between the trainee and trainer allows the trainee to agree with the interpretation of the trainer for corrective actions to improve performance. Supportive: feedback can be given as a way of supporting the trainee often through praising comments. Although some criticism may be unavoidable, the idea is to help the other person change in a positive manner. Probing: by

asking more specific and deeper questions to find more information. And finally, understanding feedback: it is aimed to understand the trainee as a person and not only though his/her skills performance.

The feedback can also be classified into intrinsic and extrinsic.13 Extrinsic feedback is the most common type which comes from an external source as when provided by a trainer, while intrinsic feedback may consist of self-assessment in order to improve own performance. The role of self-administered feedback has been well recognised, and different authors studied its effect and application in surgical training.14e18

Applications of surgical feedback

The learning cycle begins as experiential through the practical activities of the learner.19 With increasing experiences, the novice trainee will eventually become competent. The cycle of learning a new skill can be demonstrated through the four components of Kolb's cycle.19 1) Concrete experience, which is when learners are enabled and encouraged to become involved in new experiences, 2) reflective observation, when learners are given time to reflect on their learning, 3) abstract conceptualisation, when learners have to be able to form and process ideas and integrate them into logical theories, and 4) active experimentation, as learners need to be able to use theories to solve problems and test theories in new situations.
The feedback process can happen at any one of the four points of the above cycle. It is important to ensure that the feedback given to the learner is aligned with the overall learning outcomes

of the training programme.

A common model for giving feedback in clinical education is the ‘Pendleton's rules'20. In this model, the learner identifies his positives first, followed by reinforcing these positives and discussing skills to achieve them. The next step involves both the learner (through self-assessment) and the trainer (through giving feedback) identifying ways to build on the strengths already identified in the previous step. The advantage of this method is that one avoids a discussion of weaknesses of the learner right at the beginning which may encourage more reflective behaviour in the learner. The rules may be applied to any type of the skill allowing the learner to express his own thoughts. This model offers the learner the opportunity to evaluate his own practice and behaviour. In addition, it allows initial observations by the learner to be built upon by the trainer. These rules mention specifics and target future improvements. On the other hand, the difficulties of these rules can be summarized in the loss of some important points while separating the strengths and weakness points.21 The learner may be anxious to explore the points that have to be improved as priority which may reduce the effectiveness of feedback on strengths. Furthermore, holding many separate conversations covering the same performance can sometimes be time consuming and inefficient.

Feedback is a dialogue between teacher and learner, not a one-way process. It can be seen as formal when it is part of an assessment, or informal as in the day-to-day encounters between teachers and students.21 Feedback provides students or trainees with an accurate perception of their own performance

as well as enhancing their self-awareness.22 Interacting while giving a feedback helps to develop a dialogue between the learner and the trainer as well as helping the learner take responsibility for his/her own learning through self-assessment. A structured approach ensures that both the trainer and the trainee know what is expected from them. Typically, the trainer starts with the trainee's agenda and asks what help is needed to achieve a specific goal. The next step is to encourage the trainee to problem solve. In this way, feedback is kept descriptive, balanced and objective.23e25

Although most feedback are given in a one-on-one setting, this becomes less appropriate when the feedback concerns several individuals working as part of a team. An example of group feedback is the WHO briefing and debriefing in the operating theatre.26 It has been observed that such a teambased feedback fosters a more efficient learning in theatre environment for the surgical trainees by ensuring a positive structured trainees experience.27

Several media have been used for giving feedback. The most common one is the verbal feedback given during the surgical task. Both positive and negative verbal feedback could be potent stimulants for improved performance and motivation. 28 Verbal feedback from an expert instructor can lead to lasting improvements in technical skills performance.29 Another common medium is the paper feedback. Postprocedural formative assessment in the form of paper feedback is the current gold standard in providing feedback to surgical trainees for the reasons of being cheap, fast, and

easily reproducible.30,31 The main limitation of paper feedback is its retrospective post-procedural nature requiring the information being retrieved from memory, often resulting in the loss of finer aspects to feedback.

The effect of video feedback has been well recognized. A study indicated that self-observation of performance promotes acquisition of motor skills.32 Video feedback can be used as a tool for assessment and it can improve the surgical task performance.33,34 The limitation of video feedback is that it is more labour intensive to produce. In contrast, audio feedback alone is easy to produce and can be listened to repeatedly, often on portable devices. Trainees often find audio feedback more personal than written form.35

Current trends towards the expansion of web-based digital platforms have created a powerful medium for trainer/trainee interaction and feedback.36 Online feedback is in common use giving the trainee access at a time of their choosing. The feedback with computer software is able to go beyond yesand-no answers providing constructive suggestions for improvement. In addition, online feedback has the advantage of flexibility, and the possibility of links to other online resources.

Giving feedback, whether reinforcing or corrective, is an essential component of clinical education. When done well, corrective feedback is seen helpful and highly appreciated.37 It has been proven that the feedback-seeking behaviour of the trainees is influenced by multiple factors that may include the

learning climate/culture, relationships with supervisors, quality of feedback and emotional response to feedback. These factors appear to interact to support or discourage feedback-seeking behaviour.38 There are both trainee and trainer factors acting as potential barriers to feedback, including gender, age, educational background and cultural identity.7 Defensive behaviour and lack of motivation on part of the trainee can interfere with the feedback loop, in addition to poor feedback technique applied by the trainer resulting in poor traineretrainee relationship. Examples of poor feedback technique include negative dominant feedback and inconsistent feedback.39

Over the past few years, new assessment feedback procedures have been introduced for junior doctors. Clinical practice, professional behaviours and attitudes are regularly assessed using a raft of workplace-based assessments (WPBA) providing evidence of everyday clinical competences. WPBA is a source for providing evidence of satisfactory progress and achievement as well as identifying areas needing further development. It has the advantage of high content validity through assessing actual performance in the workplace by judging performance against the standard that they are expected to reach by the end of their current stage of training.40e42 There is no evidence that the use of all WPBA tools lead to improvement in performance, although subjective reports on their educational impact are positive.43

An example of WPBA tools include Mini-Clinical Evaluation

Exercise which provides feedback on skills essential to the provision of good clinical care by identifying ways for trainees to improve their practice in areas such as communication, history taking, physical examination and professional practice. Clinical Encounter Cards help scoring trainees' performance based on direct observation of patient encounter from history taking, physical examination, professional behaviour, case presentation, diagnosis and problem solving. Clinical Work Sampling is another WPBA tool that provides direct observation of clinical performance and global assessment of trainees by both clinical staff and patients. Domains in clinical work sampling include communication and physical examination skills, consultation skills, management skills, interpersonal behaviour, continued learning skills, and health advocacy skills. Direct Observation of Procedural Skills focus on evaluating the procedural skills of trainees by observing them in the workplace setting, while Case-based Discussion focuses on evaluating the clinical reasoning of trainees to understand the rationale behind decisions made in clinical practice.40e42

An important WPBA tool is Multisource Feedback. A previous review showed that multisource feedback can lead to performance improvement, although the context of the feedback, and the presence of facilitation had profound effects on the response.43 Multisource feedback is utilized by organizations to solicit information on employees work related behaviour and/or performance. Examples of Multisource feedback for surgeons include, patient and colleagues multisource feedback. This is in common use currently for surgeons' appraisal

and revalidation.40,42

Future progress

There are theoretical advantages for the trainees being aware of their autonomic response to the surgical environment during the procedure as an indirect mean of assessing their level of stress. With biofeedback, the person is connected to electrical sensors that help receiving information (feedback) about his/her body. Biofeedback is a technique that can be used to learn to control the body's functions by measuring physiological changes such as heart rate, blood pressure, muscle tension and skin temperature. One area of consideration is the application of biofeedback as a method of controlling the trainees' level of stress intraoperatively.44 This can lead to an improvement of surgical performance through regulation of body's functions during the surgical tasks.

Neuro-feedback is a technique enabling the subject to monitor his/her own electrical brain activity (EEG). A previous study assessed whether two distinct EEG neurofeedback protocols could enhance surgical skills. The data were encouraging evidence of optimised learning of surgical skills via neuro-feedback training showing a significant improvement in the surgical performance by EEG-self-regulation.45 However, the application of neuro-feedback still is to be repeated in other studies.

Virtual reality (VR) laparoscopic surgical simulators are considered to represent educational tools with great potential.

They provide basic skills training without need of supervision in a controlled environment and without pressure of operating on patients.46,47 VR simulators offer immediate feedback and directly measure multiple aspects of psychomotor performance on specific laparoscopic skills. Therefore, virtual reality simulators offer a promising medium for training in laparoscopic surgery.46

During open procedures, surgeons can directly feel tissue characteristics. However, in laparoscopic surgery, tactile or haptic feedback during grip is limited to the resistance felt in the tool handle. Providing additional supplementary haptic feedback may allow trainees to have better control of grip force and identification of tissue characteristics, as excessive grip force during laparoscopic surgery can lead to tissue damage. The role of haptic feedback has been studied in grip force during laparoscopic training tasks by developing a tactile system into a modified laparoscopic grasper allowing forces applied at the grasper tips to be felt by the surgeon's hands.48 Another study tested the haptic feedback effect on a laparoscopic simulation training and proved that haptics allowed superior precision, resulting in faster completion of tasks with fewer technical errors.49 These data suggested that the additional expense of haptic-enhanced laparoscopic simulators may be justified for advanced skill development in surgical trainees.

Robotic surgery creates a new medium for acquisition of surgical skills in a wide range of operations with potentially immediate computerised feedback.50 Surgeons can use robots

to practise operations in VR simulators and on soft-tissue models that recreate the textures of human tissues through haptic feedback. Image-guided simulations will allow surgeons to practise procedures on 3-dimensional reconstructions of the anatomy of the actual patients who they plan to operate on the next day.[51,52] In all of these simulations, trainees can be guided through tele-mentoring. The telepresence surgery system permits the surgeon to operate on a patient across distances. This is achieved through real-time 3D video vision, stereo audio, and remote instrument control with haptic feedback. Telepresence surgery has been successfully used in teaching surgical skills to medical students.[53] These systems are expected to significantly enhance the learning curve of surgical trainees while improving patient safety by reducing surgical errors.[54]

Mobile apps and smart watches are being recently viewed as possible future solutions for post-operative monitoring of surgical patients. Mobile phone monitoring of patients in the post-operative period can allow expedited discharge and may allow early detection of complications. The use of mobile apps for monitoring the quality of recovery in post-operative patients at home appears to be feasible and acceptable to patients and surgeons.[55] A previous study aimed to assess the feasibility of using a mobile app for the monitoring of postoperative quality of recovery at home following surgery in an ambulatory setting by asking the patients to use a mobile phone daily to complete a validated quality of recovery scale and take photographs of the surgical site. Surgeons were asked to review patient-entered data on each patient on a

daily basis. Such immediate patient feedback has the potential of improving the quality of surgical care provided by the surgical team and particularly by trainees.55 The use of mobile apps in such settings and its effect on trainees' performance is yet to be proven.

Conclusion

Feedback comes in a variety of types and is essential for learning and developing performance in surgical education. If given correctly, feedback can significantly improve surgical trainees' self-awareness, enthusiasm and confidence. Feedback methods are ever evolving and future work needs to concentrate on the value of each method as well as the role of new technologies in surgical education.

Disclosures

The authors declare no conflict of interests.

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