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# Digital resources for transfusion education

Maria-Angustias Molina-Arrebola, Elena Fernández-Guerrero<sup>1</sup>,  
Francisco-Javier Aguirre-Ortega<sup>2</sup>, Cristóbal Avivar-Oyonarte<sup>3</sup>

## Abstract:

**INTRODUCTION:** Regular training in the blood transfusion process is crucial for transfusion safety. Hospital transfusion committees have an obligation to provide this education to hospital employees through training activities. E-learning is positioning itself as a valid alternative to physical-presence courses.

**MATERIALS AND METHODS:** We describe a training course on blood transfusion to members of our hospital who are involved in the transfusion process, including technicians, nurses, and doctors. The course uses Moodle as the e-learning platform; it is evaluated using a satisfaction survey along with a knowledge-transfer and impact survey a year after taking the course.

**RESULTS:** From 2015 to 2018, seven editions of the online transfusion course were developed. Six hundred and eighty students enrolled; of these, 124 did not take the final examination (18.2%); 60 never began the course (8.8%). Of the 556 students who completed the course, 546 passed (98.2%). The average score from the initial self-assessment was 7.3 while the average score from the final self-assessment was 9.2; the mean improvement was 1.9 (out of 10). The level of general course satisfaction was 9.27 (an average out of 10). More than 90% of the students stated that they were able to apply the acquired knowledge in the workplace after a year.

**CONCLUSIONS:** E-learning has demonstrated itself as an affordable solution that could help in the training of all staff involved in the transfusion process at our hospital, with the advantage that it includes general knowledge and particular skills in local transfusion medical practice.

## Keywords:

Blood safety, blood transfusion, e-learning, Moodle, patient blood management

## Introduction

The 2017 annual serious hazards of transfusion report stated in its initial keynote message “do not assume, verify: At each step in the transfusion process, do not assume that no errors have been made in previous steps; verify each step, particularly patient identification.”<sup>[1]</sup> There is a general consensus that regular training of all staff involved in the blood transfusion process (for the processes they participate in) is vital for transfusion safety. Transfusion committees advocate a risk-assessed approach, tailoring training

to staff groups while taking into account factors such as individual practitioner’s self-assessment regarding their own competency and transfusion-associated error rates.

Competency assessment was introduced to improve transfusion safety, calling on all staff who are clinically involved in the blood transfusion process to undertake an assessment of their own performance. The recommendation can be applied to practical transfusion skills such as sample labeling, collection, and the administration of blood components.<sup>[2]</sup> Training must be provided on each procedure for which employees are responsible, and the quality oversight personnel should assist in the development, review and approval of the training

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Department of  
Biotechnology,  
Haematology and  
Haemotherapy Unit,  
Poniente Hospital  
Public Health Agency,  
<sup>1</sup>Department of Integrated  
Training, Poniente Hospital  
Public Health Agency,  
<sup>2</sup>Information Technology  
Department, Poniente  
Hospital Public Health  
Agency, <sup>3</sup>Department of  
Biotechnology, Poniente  
Hospital Public Health  
Agency, El Ejido, Almería,  
Spain

## Address for correspondence:

Dr. Maria-Angustias  
Molina-Arrebola,  
Department of  
Biotechnology,  
Haematology and  
Haemotherapy Unit,  
Poniente Hospital  
Public Health Agency,  
Address: Carretera De  
Almerimar S/N, 04700,  
El Ejido, Almería, Spain.  
E-mail: [mariaangustias.molina@ephpo.es](mailto:mariaangustias.molina@ephpo.es)

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programs, including the retraining criteria.<sup>[3]</sup> In some countries, the role of transfusion practitioner has been implemented to improve transfusion processes focused on patient and staff education.<sup>[4]</sup> Globally, transfusion has been identified as an overused intervention by the choosing wisely campaign<sup>[5]</sup> and education initiatives are needed to determine the specific deficits and validated approaches for improving the current state of transfusion medicine.<sup>[6]</sup> One of the most important recommendations for patient blood management (PBM) implementation is that “Education should be provided to all clinicians involved in the decision to transfuse blood components in order to enhance their awareness of good PBM, including the avoidance of blood (transfusion) wherever possible.”<sup>[7]</sup>

Medical education is improving rapidly, both in complexity and advancement opportunities. Nowadays, active forms of continuing medical education (CME) are considered more effective than passive forms while internet-based CMEs, such as webinars or online modules, are successful at improving clinicians’ performance.<sup>[8]</sup> Indeed, a meta-analysis of online learning in the health professions found little difference between the effectiveness of online and face-to-face formats.<sup>[6]</sup>

Our hospital, which was founded in 1996, is a 289-bed tertiary care hospital situated in southern Spain, which provides care for a local population of 273,719 people. Most of its transfusional activity focuses on medical areas, specialties such as internal medicine, intensive care, and accident and emergency; and in surgical areas, mainly general surgery, urology, traumatology, gynecology, and anesthesia. In 2018, 3342 units of blood products were transfused, 3149 units of erythrocytes, 139 units of fresh frozen plasma, and 54 platelet pools. Our erythrocytes transfusion rate is quite low (11.5 / 1000 population) since there is no clinical hematology or oncology units and because there is a hospital-wide blood saving awareness campaign with restrictive policies and the regular use of transfusion alternatives.

Our transfusion committee was created in 1999, and since its inception, one of its primary objectives has been to develop educational programs that promote the optimal use of blood components. Up until a few years ago, training courses were carried out where people attended in person. We have now developed an e-learning refresher course to take advantage of the new technologies, offering participants the timetable of their choosing so as to be compatible with their work and family life. In this course, we update and develop current hospital treatment guidelines, but in a dynamic way with the intention of making it attractive and practical.<sup>[9]</sup> The educational objective of this training activity can be summarized as the transmission of new practical

concepts in blood therapy, crucial concepts, and skills to all the current medical, technical, and support staff working in medical fields related to the transfusion of blood derivatives, all focused on providing the patient with the greatest possible benefits in terms of therapeutic options and safety.

The aim of this study is summarize the results obtained after seven editions of our e-learning refresher course.

## Materials and Methods

This is a retrospective, observational study that analyzes the results of effectiveness and satisfaction among students and tutors after completing the course.

To develop this training activity, we used the Moodle digital platform,<sup>[10]</sup> a resource accessed from the teleformation interface on our hospital’s website. The course became operational after learning and training period for those in the hematology department in charge of its coordination.

It is important to emphasize that the training activity design was structured according to the accreditation requirements of the Junta de Andalucía’s Health Quality Assurance Agency. In accordance with the accreditation compliance criteria, the online course duration was set at 35 h over a 45-day period, with a maximum of 5-h online teaching/week. The course was divided into 7 thematic units [Table 1] with an approximate time/unit of 5 h. Up to two tutors were tasked with teaching each unit. The tutors were hematologists belonging to the hospital’s transfusion committee, along with an anesthesiologist, who collaborated on the topic of autologous blood use.

The student accessed the online training activity through the teleformation portal of the hospital’s main website ([www.ephpo.es](http://www.ephpo.es), <https://www.juntadeandalucia.es/ep-hospitalponientealmeria/Moodle>) using their intra-hospital employee log-in details.

The training activities were divided into four main sections:

- The introduction – this included the course’s teaching guide, a glossary of common terminology, a question-and-answer forum, news related to the course’s development, a course chat room and an initial self-assessment which was compulsory but not scored (so as to provide student guidance and to inform the faculty of the trainee’s knowledge-based prior to training)
- The teaching units – a total of 7 units developed in SCORM format using the EXE e-learning program.<sup>[11]</sup> The SCORM format has an intuitive and user-friendly design that allows readers to acquire knowledge in a

**Table 1: Education objectives of the e-learning course**

Thematic units	Unit contents
Basic concepts of immunohematology	Blood groups: antigen, antibody ABO, Rh, and other blood group systems of clinical significance Coombs: Direct and indirect tests Red cell transfusion Plasma transfusion Platelet transfusion
Transfusion indications	Indication for red cell transfusion: Acute and chronic anemia; preoperative anemia, hemolytic anemia, sickle cell disease, pediatric transfusion Indication for plasma transfusion: Accepted use and evidence, contraindications Indication for platelet transfusion: Prophylactic and therapeutic use, contraindications
Request, sample reception, processing and transfusion administration	Informed consent Transfusion request Blood sampling Type and screen procedure Extreme urgency request Sample reception and processing in blood bank Transfusion administration: Prior vital signs, transfusion flow, filters Blood products returned when decision not to transfuse Pediatric transfusion
Transfusional reactions and the Hemovigilance monitoring system	Hemotherapy in high resolution hospitals Acute transfusional reactions Delayed transfusional reactions Immunological reactions Nonimmunological reactions
Pharmacological alternatives to transfusion	Prothrombin complex Vitamin K Antifibrinolytics rFVIIa Iron, folic acid, and Vitamin B12 supplementation Erythropoietin
The use of autologous blood	Patients who refused transfusion Intraoperative blood salvage and autotransfusion procedure Predeposit autologous blood donation Normovolemic hemodilution Intraoperative blood salvage
Massive transfusion procedure	Multidisciplinary coordinated procedure Available resources and indications Methodology Pediatric procedure

dynamic and enjoyable way; this provides hyperlinks to official pages related to transfusion, interactive games, critical-thinking questions and examples of real situations, academic papers converted to PDF format, as well as the bibliography recommended for each unit

- The course’s general bibliography – with hyperlinks to the hospital’s official treatment guide, official documents, regulations and access to official websites, etc.,
- The final self-assessment-including the end-of-course training activity self-assessment, which is obligatory and scored; thus allowing us to assess each student’s achievement. There is also a voluntary and anonymous course satisfaction survey, which provides very interesting and valuable feedback.

Both the initial self-assessment and the final self-assessment were composed of 10 questions randomly chosen from a bank of 20. To be awarded the diploma, students had to complete the initial, indicative self-assessment and the final, compulsory self-assessment; the latter required a 70% score rate, with a maximum of 2 attempts to pass. The questions are chosen by the hematologists and covered the knowledge or skills related to blood transfusion considered essential in our practice. A score rate of 70% is set (rather than a higher one) because the course is directed at doctors, nurses, and technicians so we do not demand a very high level of knowledge to pass the examination.

The examination score difference (the posttest score minus the pretest score) was calculated for all the

trainees. As an example, we carried out a statistical analysis on trainees from the 5<sup>th</sup> group who had taken both tests to get a representation of the knowledge gain achieved from the training. The score difference was the outcome variable; a  $P < 0.05$  was used to denote statistical significance (a paired  $t$ -test analysis, Excel, MS Office 2007).

Throughout the course, the organizers monitored the activity of each student in terms of subject reading, course progress, and self-assessment results.

### Satisfaction surveys

The satisfaction survey was a general survey, voluntary and anonymous, validated by the Hospital Training Unit. It included general questions divided into scored questions (ranging from 1 to 4, from lowest to highest) and open-response questions.

### Transfer and impact

Considered in terms of training transfer, and the effective and regular utilization of knowledge, expertise, skills, and attitudes learned as a result of a training activity, we were interested in determining how our health professionals had been influenced by the training they received. The main objective was to evaluate the real impact of this training activity on the student, both over time (short, medium, and long term) and in its scope, especially regarding the application of acquired learning.

The questionnaires were created using the Google Forms application, which is easy and intuitive, both for designing the forms and answering the questions (in a voluntary and anonymous fashion). Google Forms provides the functionality of generating graphics and data, which can be downloaded in excel for subsequent in-depth analysis. A year after completing the course, the organizers E-mailed the form link to the students and another similar survey to the tutors.

## Results

From 2015 to 2018, seven editions of the online blood transfusion refresher course were developed. Six hundred and eighty students enrolled; of these, 124 did not take the final exam (18.2%), 60 of whom never entered the course (8.8%). Of the 556 students who completed the course, 546 passed (98.2%) while only 10 students failed it [Table 2]. The average score from the initial self-assessment was 7.3 while the average score from the final self-assessment was 9.2 for the editions overall; the average improvement was 1.9 (out of 10). As an example, in the 5<sup>th</sup> group ( $n = 69$ ), the median score from the initial test was 7 (with a standard deviation [SD] of 1.7) while the median score of the final examination was 9.1 (SD 0.8;  $P < 0.0001$ ) [Figure 1].

As for the course satisfaction surveys, 316 were received with an average level of overall satisfaction of 3.71 out of 4; translating to 9.27 out of 10. For survey details of overall student satisfaction regarding the different aspects of the course, as shown in Tables 3 and 4.

The questions asking students for their opinions (which were not quantifiable) provided responses regarding the degree to which their course expectations had been met. They expressed great appreciation of both the course contents and the teachers, and stated that they had broadened the useful knowledge applicable in their daily professional practice, thus fully meeting their expectations. No negative opinions were expressed concerning the teleformation course format or its content.

As for the course's knowledge transfer and impact, the data gathered from the anonymous voluntary survey conducted a year after the course ended allowed us to collate the student surveys for the first 5 editions. The total number of surveys received was 131, and an average of 91.1% of students considered that they had been able to apply "a lot" or "some" of acquired knowledge in the workplace [Table 5].

For the open question, where students could add any opinions or suggestions, some examples included: "All the hospital staff should do this course from time-to-time in order to acquire or refresh their knowledge of blood transfusion;" "My suggestion is that all these courses should be continuously available, especially online, because this makes it more likely that they will be taken;" "There should be more courses of this nature applied daily at work; we improve as professionals, improve our response time and avoid forgetting things over the years;" "This type of refresher course should be given at least once a year."

The total number of surveys received from the tutors was 12. An average of 95.8% of tutors considered that the students had been able to apply "a lot" or "some" of acquired knowledge in the workplace [Table 6].

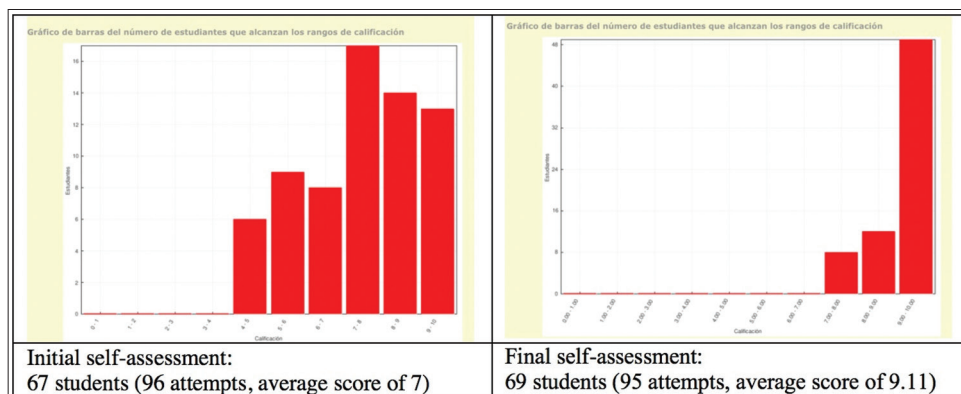
Finally, it should be noted that the course was recognized by the Andalusian Health Quality Agency, which awarded 5.08 credits to the first 4 editions and 6.96 credits to the 3 latter editions.

## Discussion

In accordance with the literature, there are few studies looking at all the health-care workers participating in transfusion procedures, including nurses and paramedical staff such as laboratory technicians;<sup>[12,13]</sup> however, the transfusion process as a whole, from the initial correct indication up to the transfusion procedure,

**Table 2: Summary of students enrolled on the online blood transfusion refresher course**

Edition	Date	Enrolled	Passed	Failed	Did not enter	No final examination	Initial score	Final score
1	October 30, 2015/December 17, 2015	84	73	1	4	6	8	9.8
2	May 13, 2016/June 30, 2016	208	151	2	27	28	8	9.3
3	October 15, 2016/November 20, 2016	83	72	1	9	1	7.2	9.1
4	April 25, 2017/June 11, 2017	55	42	3	2	8	7	8.9
5	October 02, 2017/November 20, 2017	83	69	0	5	9	7	9.1
6	January 05, 2018/February 22, 2018	85	73	0	4	8	7	9.2
7	May 02, 2018/June 17, 2018	82	66	3	9	4	7	8.9
Total		680	546	10	60	64	7.3	9.2



**Figure 1:** Example of scores in the 5<sup>th</sup> group: Initial and final self-assessment

it is not carried out and supervised by medical staff alone – for this reason, we believe that everyone in the process should have sufficient knowledge to guarantee patient security, and that is why our training program was designed for all the staff involved.

The results from the BEST-TEST international education needs assessment concluded that, internationally, internal medicine residents have poor transfusion medicine knowledge and would welcome additional training;<sup>[14]</sup> likewise, the transfusion camp project evaluation of a transfusion education program for multispecialty postgraduate trainees showed that transfusion medicine knowledge is deficient at this level, and that education programs are needed.<sup>[15]</sup>

The main aim of our training program is to refresh the transfusional procedures of personnel working in the hospital during the course period; this was a registration acceptance requirement since the course is designed to offer continuous training that can be developed in the professional environment. Considering that the course was taken by staff who are already familiar with the transfusion process, the initial self-assessment scores demonstrated an acceptable knowledge of the procedures (with an average score of 7.3), and the final self-assessment scores (an average of 9.2), confirmed the high course’s effectiveness compared with other evaluations.<sup>[16]</sup>

The traditional distance learning approach based on student self-access using textbooks, where minimal contact with the teaching staff takes place, is giving way to new training models. E-learning platforms and distance-communication spaces are being developed for training purposes, using information, communication technologies, and internet. For our training activity, we decided on Moodle, an “all-in-one” platform that offers the possibility of making courses 100% online, with the integration of topics in SCORM format and configurable self-assessments. It is web-based, so you can access it from anywhere, on any device and using different browsers. After a PubMed search, SCORM was scarcely used in the medical literature and no results were found in relation to transfusion.

The surveys responses have been overwhelmingly positive, pointing out the advantage of online learning not being subject to a fixed or compulsory schedule. On the other hand, our training unit considers this course to be one of the most highly valued and it has also been recognized by the Andalusian Health Quality Agency, attaining a high number of credits, despite it being online only.

Some countries have national online transfusion education programs (Bloodsafe <https://bloodsafelearning.org.au/> and LearnBloodTransfusion <https://www.learnbloodtransfusion.org.uk/>). We think that, in addition to these big national e-learning programs, which require

important infrastructure and financing, there is room for much simpler and more affordable solutions that can offer training related to the staff involved. As Solh described in the knowledge translation series,<sup>[17]</sup> knowledge alone is insufficient in ensuring that clinicians and the health system act on that knowledge; methods are required that bridge the knowledge-to-action gap.

**Table 3: Satisfaction surveys received: Sex and average age of respondents**

Edition	Received (n)	Females (n)	Males (n)	Average age (years)
1	61	47	14	45.5
2	24	20	4	46.9
3	27	22	5	45.4
4	36	29	7	42
5	50	44	6	38.5
6	57	43	14	41.8
7	61	51	10	43.3
Total	316	256	60	43.3

General knowledge is available in the national guidelines but each hospital should adapt them to the local practice and its own peculiarities. Consequently, one of the objectives of the transfusion committee should be to create local guidelines, disseminate them, and implement educational interventions to spread this knowledge to the target.<sup>[18,19]</sup>

Considering the training transfer, the effective and regular utilization of knowledge, expertise, skills and attitudes learned as a result of a training activity,<sup>[20]</sup> we were interested in determining how our health professionals had been influenced by the training they received, and more than 90% considered that they were still able to apply the knowledge acquired in the workplace even after a year.

In summary, scientific literature demonstrates that knowledge of transfusion medicine is deficient among health professionals fresh out of medical school. Although our study has the limitations to develop in a

**Table 4: Overall levels of student satisfaction regarding the different aspects of the course**

Survey questions	Overall satisfaction in the 7 <sup>th</sup> editions (rating out of 4)							Average (out of 4)	Average (out of 10)
	1	2	3	4	5	6	7		
	The course has been well organized (information, date and timetable fulfillment, and subject matter delivery)	3.77	3.54	3.59	3.69	3.58	3.77		
The course contents corresponded to my training needs	3.75	3.5	3.56	3.67	3.62	3.75	3.59	3.63	9.09
The course length has been sufficient for the objectives and contents to be adequately covered	3.71	3.5	3.56	3.61	3.54	3.68	3.59	3.60	9.00
The schedule has facilitated course attendance	3.72	3.5	3.56	3.61	3.64	3.67	3.61	3.62	9.04
The way the course was taught has facilitated learning	3.55	3.25	3.33	3.69	3.58	3.61	3.62	3.52	8.80
The teachers are familiar with the issues and have covered them in depth	3.6	3.42	3.48	3.72	3.58	3.67	3.61	3.58	8.96
The documentation and materials provided are understandable and appropriate	3.67	3.46	3.48	3.64	3.5	3.7	3.59	3.58	8.94
The tutorial guides and teaching materials have allowed the course to be easily followed (the printed material and the telematic applications)	3.71	3.46	3.52	3.78	3.54	3.3	3.57	3.60	9.00
The evaluation and self-assessment tests have enabled me to gauge the level of learning I've achieved	3.68	3.54	3.59	3.67	3.56	3.72	3.62	3.63	9.06
The course has helped me to acquire new skills/abilities that I can apply in the workplace	3.69	3.58	3.63	3.58	3.64	3.7	3.66	3.64	9.10
I have broadened my knowledge in a way that will help me progress in my professional career	3.58	3.5	3.56	3.53	3.64	3.75	3.61	3.60	8.99
The course has facilitated my personal development	3.66	3.54	3.59	3.72	3.66	3.77	3.7	3.66	9.16
Degree of overall satisfaction with the course (average out of 4)	3.79	3.58	3.63	3.78	3.72	3.79	3.67	3.71	
General level of satisfaction with the course (average out of 10)	9.48	8.95	9.08	9.45	9.30	9.48	9.18		9.27

**Table 5: The course's knowledge transfer and impact: Assessment of the effects and usefulness of the training received according to the students**

Percentage	A lot	Some	A little	Nothing
I know the basic transfusion guidelines	18.3	69.5	10.7	1.5
I know that informed consent is required for the transfusion and that this is available in the patient's notes	51.1	43.5	3.8	1.5
I know the potential risks related to the transfusion process	39.7	56.5	3.8	0.0
I know the most important indications for the transfusion of the different blood products	29.0	60.3	10.7	0.0
I can distinguish as to whether a transfusion request is correctly completed	38.2	56.5	5.3	0.0
To what extent your work activity has improved after you completed the course	23.7	60.3	12.2	3.8
Average	33.3	57.8	7.8	1.1

**Table 6: The course's knowledge transfer and impact: Assessment of the effects and usefulness of the training received according to the teachers**

Percentage	A lot	Some	A little	Nothing
The students know the basic transfusion guidelines	33.3	50.0	16.7	0.0
The students know that informed consent is required for the transfusion and that this is available in the patient's notes	41.7	50.0	8.3	0.0
The students are able to detect the potential risks related to the transfusion process	50.0	50.0	0.0	0.0
The students know the most important indications for the transfusion of the different blood products	50.0	50.0	0.0	0.0
The students are able to fill out the transfusion request correctly	25.0	75.0	0.0	0.0
To what extent their work activity has improved after they completed the course	16.7	83.3	0.0	0.0
Average	36.1	59.7	4.2	0.0

relatively small hospital, and further studies are needed on education resources, we believe that this kind of courses with the advantages of online learning focused on the update of concepts and their applicability in the daily practice might be very useful. In terms of future research, the aim is to offer this course to professionals who have no on-the-job experience and would thus be suitable receivers for this kind of education resources.

### Conclusions

We have designed and developed an e-learning transfusion refresher course to take advantage of new technologies. It is based on the SCORM format and uses Moodle as the teleformation platform. Its main objective is to update and develop the current hospital treatment guidelines in a dynamic way. Our intention was to make it attractive and practical, and to include the crucial concepts and skills required by all of the staff involved in the transfusion process, be they doctors, nurses, or technicians. The level of satisfaction regarding the course's knowledge and impact has been very high, as expressed both by the teachers and the students. This gives us great encouragement to continue, expand and disseminate this type of online training as a new and effective learning tool; a learning approach that, up to now, has scarcely been reported on in the scientific literature.

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### Conflicts of interest

There are no conflicts of interest.

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