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# Videotraining and Expert System: a New Peritoneal Dialysis Training Model

Catia Tortone, Patrizia Barrile, Stefania Baudino, Loris Neri, Sara Barbieri and Giusto Viglino



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# VIDEOTRAINING AND EXPERT SYSTEM: A NEW PERITONEAL DIALYSIS TRAINING MODEL

Catia Tortone, Patrizia Barrile, Stefania Baudino, Loris Neri, Sara Barbieri and Giusto Viglino.

Nephrology and Dialysis, Ospedale Michele e Pietro Ferrero, Verduno

**Abstract.** Peritoneal dialysis (PD) is a kidney failure replacement therapy based on patients or their caregiver managing self-care of the dialysis procedure at home.
In order to perform PD, the patient or caregiver must receive an appropriate period of training, as incorrect performance of the procedure can result in serious complications such as peritonitis**.**
The training ends when the patient is capable of performing all the dialysis procedures, recognizing an infection, and identifying the right solutions for the different complications that may occur.
Traditional training is based on the physical presence of a nurse and the patient/caregiver, so it involves a transfer of the patient to hospital or of the nurse to the patient's home.
It is conditioned by space-time constraints in the following ways: duration - location - home visits - methodology.
In an attempt to overcome the limits of traditional training, a new training model has been devised by our Center based on three fundamental elements: standardization of the procedure, delivery using Telemedicine (Videotraining), and objective computerized evaluation of learning (Expert System).
This paper examines the advantages that Videotraining has over the traditional training method, and the potential that the use of the Expert System provides with regard to the evaluation and customization of learning.

**Keywords:** Peritoneal dialysis, Training, Expert System, Telemedicine

## 1. TRAINING IN PERITONEAL DIALYSIS

Peritoneal dialysis (PD) is a terminal kidney failure replacement therapy based on patients or their caregiver managing self-care of the dialysis procedure at home.

In order to perform PD, the patient or caregiver must receive an appropriate period of training, as incorrect performance of the procedure can result in serious complications such as peritonitis**.**

For this reason, the PD candidate undergoes a careful nursing assessment in order to evaluate physical, emotional and cognitive suitability to the learning of the procedure and safe self-care.

If the patient is not considered suitable, it is necessary to have recourse to a caregiver, generally a family member or paid carer; if the patient requires care as well as dialysis, it may be necessary to have recourse to placement in a Nursing Home (NH).

Recently [**1, 2**] a new model of remote caregiver (Videodialysis) has been proposed by our Center. With the use of this Telecare system, many patients/caregivers - especially those with cognitive or emotional barriers to PD such as the "fear of not coping" - can be assisted remotely. By connecting remotely by video from the Center, the nurse can see and guide the patient/caregiver at home in the performance of the dialysis procedure. The technical requirements and the way in which Videodialysis is used have been described in detail in a recent paper [1].

A patient or caregiver considered suitable is trained in the performance of the dialysis procedure. The training in PD self-care represents a very significant moment in the patient's dialysis history.

Since the '90s there have been numerous studies which have sought to determine the most important characteristics in defining the success of training. All this work represented the basis for the 2006 International Society of Peritoneal Dialysis (ISPD) training guidelines, which were extensively revised and updated in 2018 [**3, 4**].

The ISPD Guidelines analyze the characteristics that good training should provide in terms of the nurse who is teaching, and the methods of teaching (subjects, session structure, training duration and location) and of checking learning. In every case, the fundamental principle is that the training must be adapted to the characteristics of the patient/caregiver [**4**], which vary greatly from person to person.

The training ends when the patient is capable of performing all the dialysis procedures, recognizing an infection, and identifying the right solutions for the different complications that may arise [**4**].

## 2. TRADITIONAL TRAINING

Traditional training is based on the physical presence of a nurse and the patient/caregiver, so it involves a transfer of the patient to hospital or of the nurse to the patient's home, depending on whether it is performed in the Center or at the home of the patient.

The home visits required for periodic checks or retraining must then be added.

Space-time constraints condition traditional training in the following ways: duration - location - home visits - methodology.

**Duration**. A major multi-centre investigation carried out in 2006 showed how the training in most Centers lasts 5 days. In other words, the aim is to complete the training within one working week [**5**]. It is known, however, that a longer duration can produce better results [**6, 7**], in particular for patients with cognitive difficulties [**8**].

Furthermore, the need to reduce transfers and the duration of training inevitably means that the patients or caregivers selected for PD are those with a good cognitive capacity, who can guarantee the training will be completed in a short time, and who will not need future checks, as shown by the younger age of patients started on PD compared to those started on Hemodialysis (HD).

**Location**. The same multi-centre study highlighted how training is mainly carried out in hospital, less frequently in hospital and at home, and - despite its greater effectiveness [**9**] - only at home in a minimal percentage of Centers [**5**].

**Home visits**. Checking learning over time requires periodic home visits. However, Peritoneal Dialysis Census data highlight that only a minority of Centers employ this re-training method [**10**].

**Methodology**. The organizational conditions in Centers often require the training to be entrusted to the expertise of a single nurse, who is therefore subject to a considerable emotional burden and responsibility when making an assessment of suitability for self-care without engaging with other operators.

## 3. VIDEOTRAINING WITH THE EXPERT SYSTEM

In an attempt to overcome the limits of traditional training, a new training model has been devised by our Center based on three fundamental elements:

- standardization of the procedure;
- delivery using Telemedicine (Videotraining);
- objective computerized evaluation of learning (Expert System).

**Standardization of the procedure**. The dialysis procedure is divided into a series of steps, the number of which depends on whether it relates to a Continuous Ambulatory Peritoneal Dialysis (CAPD) manual exchange or Automated Peritoneal Dialysis (APD) preparation, connection and disconnection of the cycler (Home Choice Claria-Baxter).

For the CAPD exchange, the procedures are differentiated further in relation to the type of dialysis solution, and whether the volume introduced into the abdomen is complete or partial.

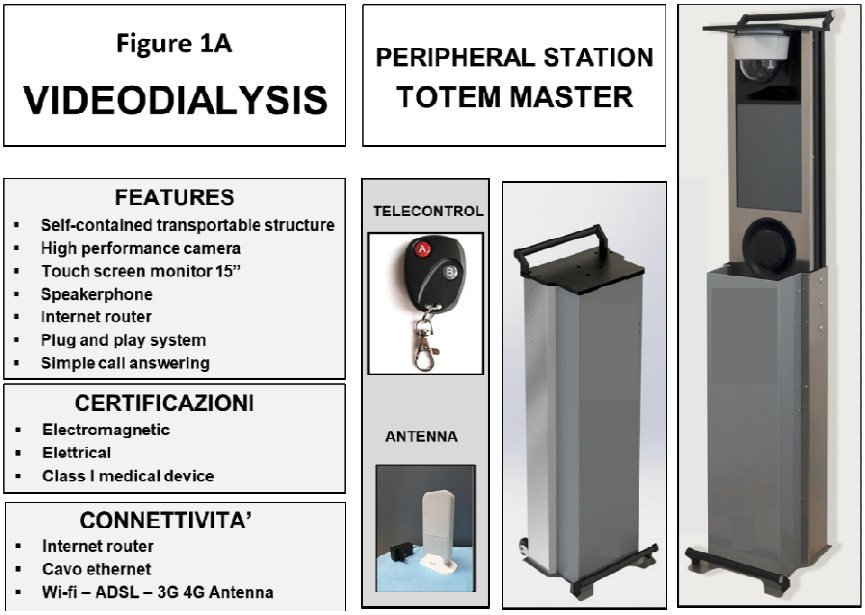
The procedures in APD are differentiated further in relation to the type of bag, if a last fill is envisaged, and whether it is performed with a mix or a different concentration (icodextrins).

The patient has a manual illustrating the actions comprised in the procedure, and is invited to read it while performing them.

All the nursing personnel involved in the training follow the steps in the chosen procedure.

**Videotraining**. With this method, the training is carried out using the Videodialysis system described in a previous paper [**1**].

**Figure 1** shows the Videodialysis system, with the Totem used at home (Figure 1A), and the control station used in the Center (Figure 1B).



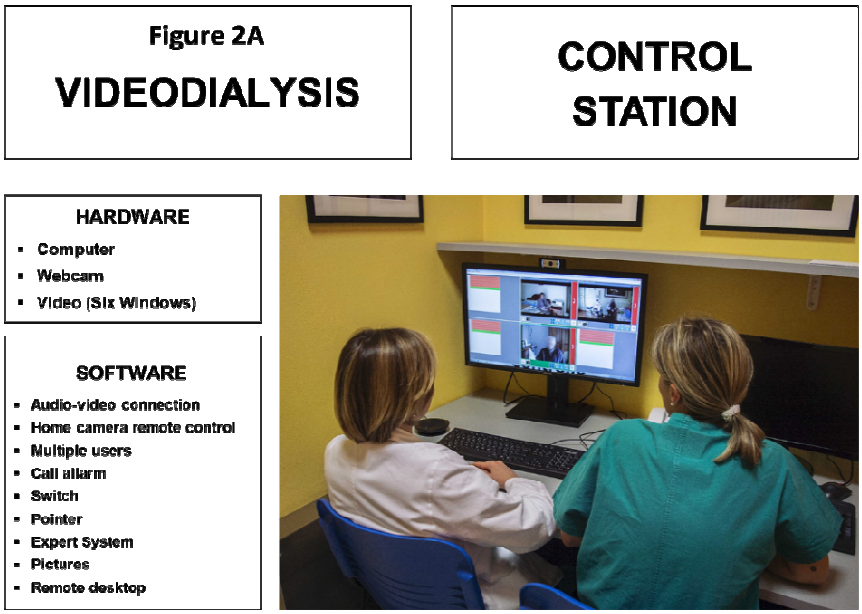




**Figure 1:** Videodialysis System: Figure 1A: Peripheral station. - Figure 1B: Control station

For CAPD, the nurse goes to the patient's home on two consecutive days:

- Day 1: the Videodialysis system is set up and the first exchange is performed, explaining it to the patient/caregiver; on the same day, the patient/caregiver is guided in the performance of a second exchange;
- Day 2: the training is carried out by a nurse in the Center using Videodialysis, while the nurse at the patient's home makes sure the procedure is performed correctly.

For APD, the nurse goes to the patient's home on three consecutive days:

- Day 1: the Videodialysis system is set up and the dialysis procedure is performed, explaining it to the patient/caregiver;
- Day 2: the patient/caregiver is guided in the performance of the dialysis procedure;
- Day 3: the training is carried out by a nurse in the Center using Videodialysis, while the nurse at the patient's home makes sure the procedure is performed correctly.

Starting from Day 3 in CAPD, and Day 4 in APD, the training continues remotely using Videodialysis.

**Expert System**. During the procedure, the nurse records the correctness of its performance, scoring each step as follows:

- score of 0: step carried out incorrectly
- score of 1: step carried out correctly, but guided
- score of 2: step carried out correctly, without guidance

The nurse can also award a score of N/A if an action is not performed.

A low or high risk level in the event of error is also given to each step.

In order for the training to be considered completed, all the steps must receive a score of 2; moreover, in the event of a low level step error, the step must be performed again at least once without errors, while if an error is found on a high level step, it must be repeated error-free at least three consecutive times.

Retraining in the dialysis procedure is carried out 2 and 4 weeks following the end of the training. If the patient makes any errors, the training restarts.

The evaluation of the steps can be carried out either with the patient/caregiver physically present or using Videodialysis as shown in **Figure 2**.

The recording and evaluation of the procedure is computerized on the basis of the criteria described previously; at the end of the procedure, the system expresses a positive or negative assessment, and the nurse can only express a positive or negative judgment as to whether the training can end or not if the system's assessment is positive.

The system can also provide a detailed analysis of the errors in tabular or graphical form, allowing the healthcare personnel to customize the training and assess its progress over time (**Figure 3**).

**Figure 2A – Videodialysis and Expert System**

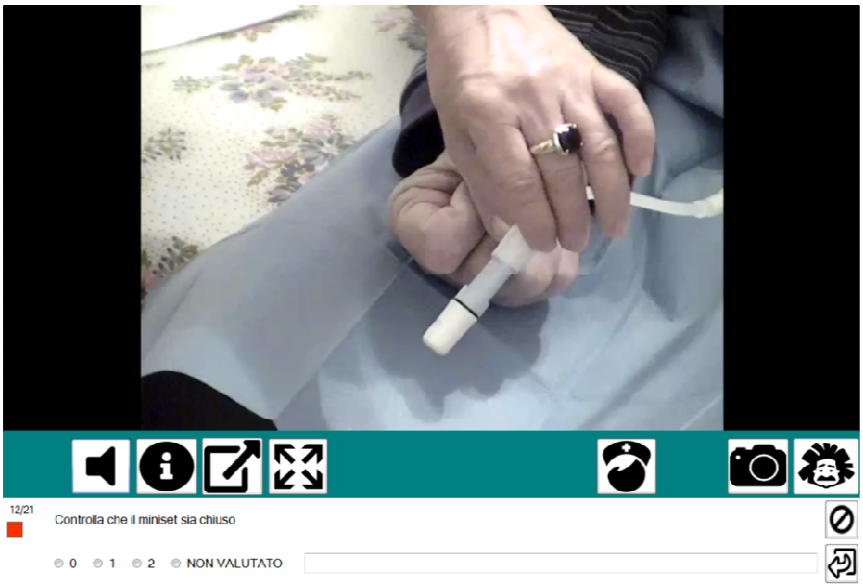



**Figure 2B – Videodialysis and Expert System**

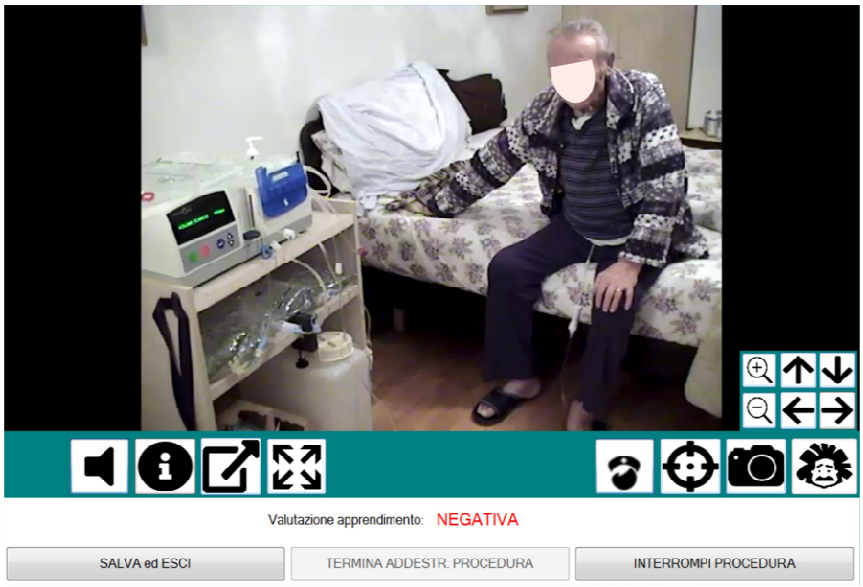



**Figure 2**: Use of the Expert System with Videodialysis.

**Figure 3A - TRAINING WITH THE EXPERT SYSTEM**

**TABLE:** SUM OF ERRORS TYPE 0-1 AND NOT EVALUATED IN THE DIFFERENT STEPS IN ALL SESSIONES

**BAR GRAPH** PERCENTAGE SUM OF ERRORS TYPE 0-1 IN THE DIFFERENT STEPS IN ALL SESSIONS

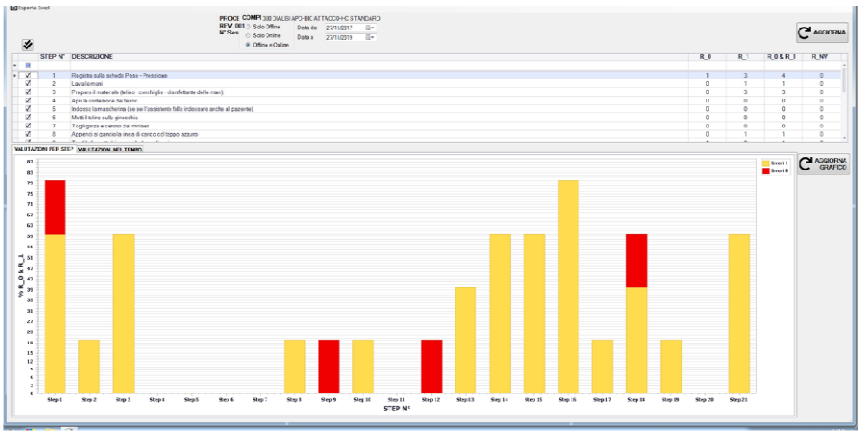


**Figure 3B - TRAINING WITH THE EXPERT SYSTEM**

**TABLE:** SUM OF ERRORS TYPE 0-1 AND NOT EVALUATED IN THE DIFFERENT STEPS IN ALL SESSIONES

**BAR GRAPH:** FREQUENCY OVER TIME OF ERRORS TYPE 0-1 AND NOT EVALUATED IN THE DIFFERENT SESSIONS

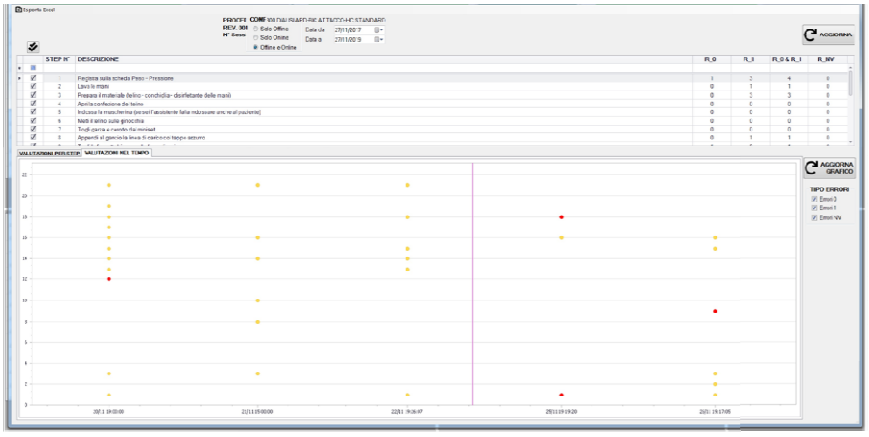


**Figure 3**: Display of errors during the Training with Expert System in tabular (**3A**) and graphical form (**3B**).

## 4. ACQUIRED EXPERIENCE AND OBJECTIVES OF THE STUDY

The experience with Videotraining and the Expert System began on 01/08/2016, and it is now at the point at which the results achieved can be analyzed, which is the aim of an observational retrospective study approved by the Joint Ethics Committee of the Province of Cuneo.

This study comprises two parts:

- comparison of Videotraining with traditional training
- analysis of learning using the Expert System.

**Comparison of Videotraining with Traditional Training.** The comparison in our Center of the Telemedicine and traditional nurse-at-home methods of training took the following variables into consideration:

- duration (number of days) and distribution over time (period between the first and last days of training);
- number of home visits by the nurse, and - only for the telemedicine method - number of video contacts required to complete the training;
- number of procedures (exchanges for CAPD - preparation, connection and disconnection for APD) performed during the training;
- patient outcomes: peritonitis, drop out to HD and technique survival.

For this first analysis we have considered all the incident patients on PD at our Center who completed training at home between 01/01/2014 and 30/06/2020.

The Videotraining Group included incident patients starting on PD from 01/08/2016, while the Traditional Training Group included incident patients from 01/01/2014 to 31/07/2016, and those subsequently who did not perform Videotraining due to technical problems or refusal.

Only the first training given to a patient or caregiver has been considered. The total number of trainings analyzed was 25 for the Videotraining Group and 21 for the Traditional Training Group.

The results show how Videotraining reduced home visits by 69.5% during CAPD training, and by 57.0% during APD training.

Furthermore, the cost and inconvenience of transfers of the nurse to the patient's home or of the patient/caregiver to the Center can be reduced using this new remote method of training.

The average duration of the training is not increased, but there is greater variability from patient to patient. In CAPD the Videotraining lasted 4.6±1.6 days, and the Traditional Training 4.9±1.2 days (p = NS); in APD the Videotraining lasted 9.3±5.0 days, and the Home Training 8.0±3.0 days (p = NS). This variability results from the greater flexibility, and customizability and adaptability to the patient's learning capacity of the duration of the training using Videodialysis and the Expert System.

A highly significant result of this first part of the study is the demonstration of the safety of Videotraining. As a matter of fact, there were no significant differences between the 2 groups in terms of peritonitis, drop out to HD and technique survival at 12

months (Videotraining Group: 86.3% - Traditional Training Group: 82.4%) and 24 months (Videotraining Group: 76.9% - Home Training Group: 56.3%).

**Expert System learning analysis**. The objective of this part of the study is to analyze learning with the possibilities offered by the Expert System.

Only trainings performed using the Expert System will be considered for this analysis, as a comparison with traditional training is not possible.

Subsequent trainings undertaken by a patient due to a change of peritoneal dialysis method will also be considered.

The data recorded using the Expert System allow for a detailed analysis of the following characteristics of training:

- duration of the various stages in the training: performed with the nurse at home, with remote guidance, retraining;
- duration of the training in CAPD and APD;
- error frequency and trends;
- types of error;
- correlation of errors with in particular the cognitive and emotional characteristics of the patient/caregiver;
- correlation of training with patient outcome.

## 5. DISCUSSION AND CONCLUSION

To our knowledge, no other experiences with Videotraining for Peritoneal Dialysis have been reported in literature.

Though its main limit is represented by its retrospective nature, this paper demonstrates that, compared to Traditional Training, Videotraining makes it possible to:

- significantly reduce home visits;
- achieve a superimposable mean duration, with greater interindividual variability;
- obtain PD outcomes which are not significantly different.

The reduction in the number of home visits by the nurse not only results in lowers costs due to fewer transfers and less traveling time, but - were the training to be performed in Hospital, as is the case in many Centers [5] - could also improve the quality of life of the patient and/or caregiver.

Furthermore, during the current Covid-19 pandemic, the reduction in transfers reduces the opportunities for contagion for both patients and nurses.

Videotraining's greater interindividual variability suggests it is more flexible and adaptable to the cognitive skills of the patient or caregiver.

This result is grounds for more in-depth analysis of the learning methods used by patients or caregivers, which it will be possible to examine in the second part of the study.

As a matter of fact, using the Expert System the level of learning can be evaluated, and the type, seriousness and frequency of errors can be analyzed and correlated with the emotional and cognitive characteristics of the patients or caregivers. The results of this analysis can provide key indications for customizing the teaching and assessing the learning.

The safety of Videotraining demonstrated by the analysis of the outcomes confirms the results of a previous work of ours in which there were no significant differences in incidence of peritonitis and technique survival between patients with no barriers to self-care and patients with barriers continually using Videodialysis as Videocaregiver [**1, 2**].

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