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**Is blood pressure measured correctly in dialysis centres?
Physicians and patients view**

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Title: Is blood pressure measured correctly in dialysis centres? Physicians and patients view

on behalf of the Working Group “Hypertension and the Kidney” of the European Society of Hypertension (ESH), the Working Group “European Renal and Cardiovascular Medicine (EURECA-m) of the European Renal Association-European Dialysis, Transplant Association (ERA-EDTA), the Northern Greece Haemodialysis Network, and the F-CRIN INI-CRCT (Cardiovascular and Renal Clinical Trialists) Network.

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Figure: 1

Blood Pressure (BP) is routinely measured as a vital sign before, during and/or after dialysis (peridialysis BP). Even if peridialytic measurements are widely used, the agreement with the interdialytic BP is poor and is often biased by many technical errors [1]. Since accurate BP measurements are critical for making decisions and evaluating patient's cardiovascular risk, working groups from the European Dialysis and Transplant Association (ERA-EDTA) and the European Society of Hypertension (ESH) issued recommendations on standardized BP measurement in dialysis patients [2]. Previous studies have underlined substantial differences between recommendations for BP measurement in general and effective BP measurements performed by medical staff [3], but whether these recommendations are followed in dialysis centres has not been investigated so far. The objectives of this multi-centric cross-sectional survey were (I) to assess the adherence to current recommendations [4] on BP measurements in dialysis centres both according to physicians and patients perspectives and (II) to evaluate the use of out-of-office BP measurements in dialysis patients.

In 2017 a call for participation was initially sent to 600 members of the European Renal and Cardiovascular Medicine (EURECA-m) Working Group of the ERA-EDTA and of the "Hypertension and the Kidney" Working Group of the ESH. Physicians were invited to fill an anonymous questionnaire on their adherence to BP measurement recommendations. In the second part of the survey, questionnaires were then sent to the participating centres in order to collect the same information from both patients and nurses. Only volunteers (physicians, nurses and patients) belonging to a dialysis centre were eligible for the survey. The study was presented to patients by the medical staff and, in case of interest, both filled questionnaires, and consent forms were collected from volunteers. Approval of the questionnaire by ethic

committee was obtained in countries where it was mandatory according to regulatory rules. Adherence to recommendations on BP measurement in dialysis centres was assessed through two roughly identical questionnaires, one addressed to the physicians and the second one to patients, made of 20 items (14 concerning BP measurement technique and 6 concerning patients' use of out-of-office measurements). For each patient we also collected demographic characteristics, information on type and duration of dialysis, and on frequency of out-of-office BP measurements. For obtaining a quality score, one point was assigned for each correct answer; hence, higher scores indicate a better adherence to recommendations. Statistical analysis was performed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, New York). A χ^2 test was used to compare the quality scores between patients and physicians' assessment, and a *k* Cohen test for assessing their agreement. A *p* value < 0.05 was considered to be statistically significant.

Ninety-five dialysis centres (92 haemodialysis [HD] and 46 peritoneal dialysis [PD] centres), mostly from Europe (77%) participated to the survey. Physicians were predominantly men (75%) with a mean age of 51 ($\pm$ 12) years. When considering only the fourteen main items, the median overall score obtained by the 95 physicians was 10 [IQR 10-12] out of 14 items. Interestingly, PD centres showed a higher score than HD centres (11 [10-13] vs. 9 [8-11], *p*=0.004), while no differences were found between university (*N*=60) and regional centres (*N*=35) and according to physician's gender or age. Only 36 centres (27%) showed adherence to at least the 80% of recommendations (HD vs. PD centres: 20% vs. 42%, *p*=0.006). Notably, only 20% and 39% of physicians measured patients' arm circumference at least once or investigated patients' conditions (physical and/or emotional stress, tobacco and/or caffeine consumption) before measuring BP, respectively. Sixty-eight % of physicians

used integrated devices for measuring BP and 74% stated that these devices had been validated.

Fourteen European centres (14 physicians and 13 nurses) recruited a total of 210 patients (80% >50 years old; 69% men), predominantly undergoing HD (96%) for more than 24 months (61%). Among these centres, the total score of adherence to BP recommendations was 12 [8-13], 10 [9-12] and 10 [9-12] out of 14 items for physicians, nurses and patients respectively, without significant differences between the groups (physicians vs. nurses: $p=0.17$; physicians vs. patients: $p=0.1$). Physicians overestimated their overall adherence ($\geq 80\%$ of recommendations) when faced to patients' report (36% vs. 14%, $p=0.027$). Furthermore, physicians seemed to overestimate their observance especially to some recommendations, such as avoiding to place the cuff over clothes (physicians vs. patients: 86% vs. 40%, $p=0.001$), measuring BP in both arms at least once (50% vs. 19%, $p=0.006$), avoiding noises and/or distractions in the room (61% vs. 29%, $p=0.017$) and investigating patients' conditions before measuring BP (43% vs. 18%, $p=0.02$). Finally, 75% of patients measured their BP at home, most of them only if needed (56%), and only 44% performed an ambulatory BP monitoring (ABPM) at least once.

To our knowledge, this is the first study assessing adherence to BP measurement recommendations in dialysis centres and comparing physicians' with patients' experience. In agreement with previous studies in other patient subsets [3,5], our findings show that standard recommendations on measuring BP are poorly followed in dialysis centres according to physicians themselves, and even less according to patients. In particular, few physicians use to measure BP on both arms and the arm circumference at least once, and/or ask whether patients have been exposed to stressful conditions before BP measurement. While patients' nervousness may be

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3 expected during medical consultations, measuring the arm circumference and BP on
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5 both arms should be mandatory in order to avoid incorrect BP values [6], inadequate
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7 clinical decisions and to properly stratify patients' cardiovascular risk [7].
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9 Furthermore, when compared to patients view, physicians' adherence to
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11 recommendations appears to be substantially overestimated.
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15 As a whole, the results of our survey may partly explain the poor association of
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17 peridialytic BP measurements with cardiovascular outcomes, as well as the fact that it
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19 does not reflect the actual variation of daily BP as assessed by ambulatory BP
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21 monitoring (ABPM) [1].
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24 Several reasons may account for poor adherence to BP measurement
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26 recommendations: lack of time, uncomfortable settings, insufficient training and
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28 tendency to give low importance to how perform BP measurements [8]. The better
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30 score in PD centres may be partly explained by the more relaxed setting in which BP
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32 is measured, much alike a regular out-patient clinic. On the other hand, the belief that
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34 BP measurement integrated devices have been clinically validated for dialysis patients
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36 as well as, for example, the habit to use the same cuff size irrespective of arm
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38 circumference [9] may be indicative of insufficient training and/or knowledge on
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40 correct measurement.
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44 Finally, we highlighted the underuse of out-of-office BP measurements, confirming
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46 previous results of a recent NDT Educational survey interviewing nephrologists about
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48 ABPM and home BP monitoring [10]. Such findings are even more alarming when
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50 considering the higher prevalence of specific BP phenotypes such as non-dipping
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52 pattern, nocturnal hypertension or intradialytic hypertension in dialysis patients [11-
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Although adherence to some recommendations is high, the fact that less than one third of all physicians adhere to at least 80% of main recommendations is worrying and unacceptable. Hence, a stronger adherence to BP measurement recommendations [2-14] and a more widespread and systematic use of out-of-office techniques, including patient training, should be strongly recommended in order to improve both hypertension diagnosis and management, especially in this high-risk patient category.

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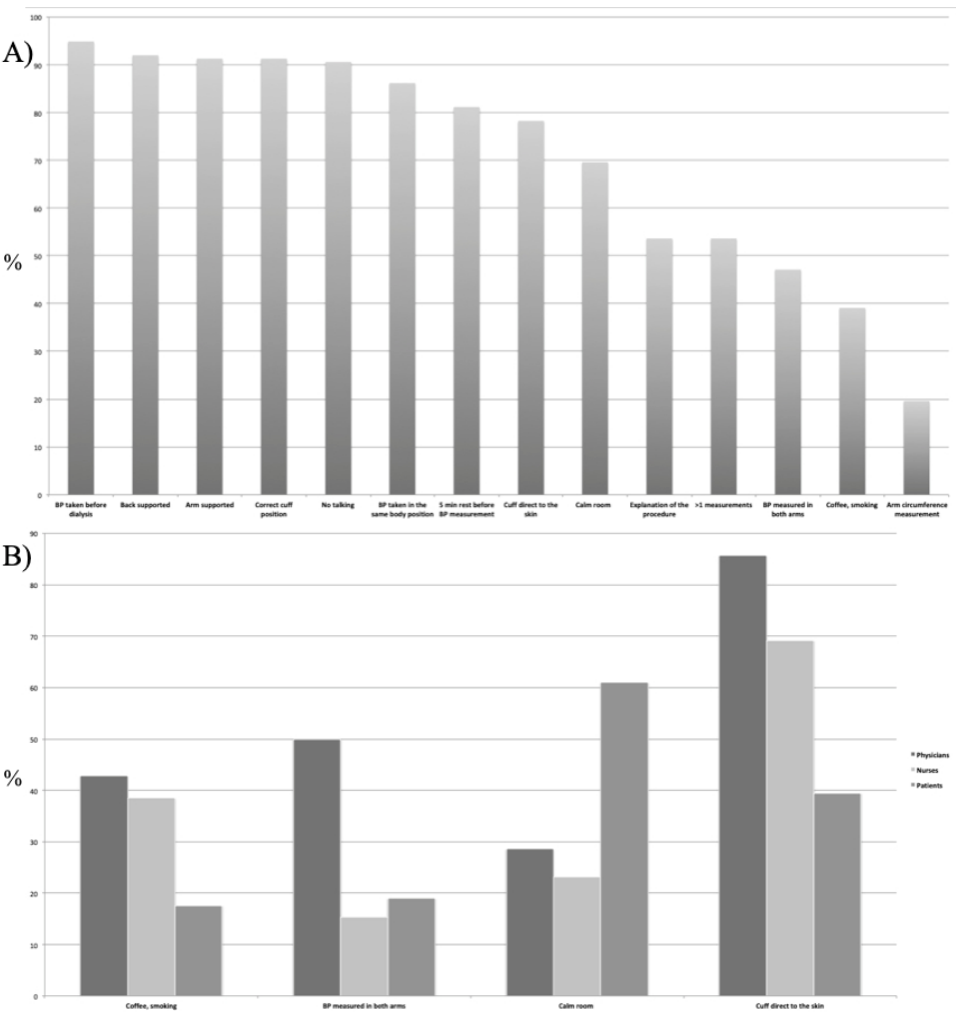
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Figure legend

Figure 1. Proportion of physicians adhering to different blood pressure measurement recommendations. Panel A) Physicians' perspective. Panel B) Comparison between physicians, nurses and patients' perspectives. Only items for which physicians and patients' assessment were significantly different ($p < 0.05$) are shown.

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Proportion of physicians adhering to different blood pressure measurement recommendations. Panel A) Physicians' perspective. Panel B) Comparison between physicians, nurses and patients' perspectives. Only items for which physicians and patients' assessment were significantly different ($p<0.05$) are shown.

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