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Original Article

Changes in availability and usage of electrophysical agents by physical therapists: a 5 year longitudinal follow-up study

Yuichi Abe, RPT, PhD[1)]

[1)] *Faculty of Health Sciences, Iryo Sosei University: 5-5-1 Chuodai Iino, Iwaki-shi, Fukushima 970-8551, Japan*

Abstract. [Purpose] There have been concerns that the availability and usage of electrophysical agents have decreased, based on data from cross-sectional surveys. The aim of this study was to conduct the first five-year follow-up longitudinal survey to determine the changes in the availability and usage of electrophysical agents in Nagano Prefecture, Japan. [Participants and Methods] This longitudinal observational study employed the same postal questionnaire survey of practicing clinicians in 2014 and 2019. A total of 22 modalities had been selected for inclusion in the questionnaire based on what is used in clinical facilities and hospitals. [Results] The response rate was 71% and 63% for 2014 and 2019, respectively. The modalities that were high in availability and usage for both 2014 and 2019 were hot packs, ultrasound, cryotherapy and low frequency. While most modalities demonstrated a decreased trend in usage, electrical stimulation devices increased from 2014 to 2019. The results also demonstrated that usage was affected by gender (males greater than females), years of experience (older greater than younger), qualifications (diplomas greater than degrees), and confidence (confident greater than non-confident). [Conclusion] Our results may assist educators with designing educational curricula that is consistent with the needs of clinicians.
Key words: Electrophysical agents, Availability, Increase and decrease usage

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INTRODUCTION

Together with manual and exercise therapy, electrophysical agents (EPA) is one of the main treatment approaches in physical therapy[1, 2)]. Depending on where it is being taught and practiced, EPA is also commonly referred to as therapeutic modalities[3)], physical modalities[4)], biophysical agents[5)], electrophysical therapy[6)] and electrotherapy[7)], among others. There is also a lack of consensus regarding the scope and practice of EPA within the profession. For example, in some textbooks, hydrotherapy[8)], therapeutic massage[3, 9)], positional release therapy[9)], electrophysiological testing[8)] and ultrasound imaging[10)] are regarded as within the scope of EPA. On the other hand, treatment using mechanical energy such as traction, continuous passive motion devices, and intermittent pressure devices[10, 11)], as well as devices that have been recently introduced into clinical practice such as transcranial magnetic stimulation, extracorporeal shockwave therapy, and magnetic field stimulation devices, among others, have been excluded from most undergraduate curriculum and almost all current EPA textbooks.

Goh et al.[2)] commented in an editorial that "many of these problems cannot be dealt with by individual physiotherapists, schools or even by national associations" (p 375). To address these issues, the International Society for Electrophysical Agents in Physical Therapy (ISEAPT) defines EPA as "the use of electrophysical and biophysical energies for the purposes of evaluation, treatment and prevention of impairments, activity limitations, and participation restrictions. Evaluation procedures involving EPA include (but are not limited to) ultrasound imaging and electro-neurophysiological testing in order to

Corresponding author. Yuichi Abe (E-mail: abe.yuichi@isu.ac.jp)

assist with physical therapy diagnosis, guide treatment procedures and to evaluate treatment outcomes. Treatment procedures involving EPA include (but are not limited to) the use of electromagnetic, acoustic and mechanical energies to produce biophysical effects at the cellular, tissue, organic and whole-body levels in order to achieve physiological and clinical effects which serves to maintain and optimize health"[1] (p 5).

Anecdotally, there have been concerns that the availability and usage of EPA have decreased within Japan, as well as in other countries. However, these concerns could not be verified because only data from cross-sectional surveys were available over the past few decades from countries such as Australia[12–14], Papua New Guinea[15], India[16], Israel[17], United Kingdom[18], USA[5, 19], and Japan[20]. While these studies vary in their survey population and time periods, the common underlying and consistent result from most of these national surveys demonstrates that EPA is still available and being used.

However, it is not possible to ascertain if availability and usage had changed over time without data from longitudinal surveys. To adequately assess and fully understand the current status and evolving trends of EPA within the profession in Japan, we began by conducting a regional cross-sectional survey in 2014[20] with the intention of obtaining a baseline status and conducting follow-up studies every five years. The aim of this current study was to conduct the first 5 year follow-up survey to determine the changes in availability and usage of electrophysical agents in Nagano Prefecture, Japan. In addition, this study also aims to investigate the factors affecting usage (gender, experience, and qualifications), and the effect of usage and years of experience on the therapists' confidence in using EPA.

PARTICIPANTS AND METHODS

This longitudinal observational study design employed the same postal questionnaire survey of practicing clinicians in 2014 and 2019. The development of the questionnaire had been previously described in our previous paper[20]. Only a short summary of the methodology is provided in this paper for context.

According to the Ministry of Health, Labour and Welfare estimates[21], there are approximately 105,000 and 125,000 physical therapists working within Japan in 2014 and 2018 respectively, across 47 prefectures. However, the education, clinical practice and governance of physical therapists within each of the 47 prefectures are considered to be similar. Therefore, a convenient sampling frame of one prefecture (Nagano) was chosen. The Nagano branch of the Japanese Physical Therapy Association maintains and updates an annual database of all the physical therapists working at the various institutions within the prefecture. In 2014 and 2019, there were 1,571 and 1,891 physical therapists working in 245 and 236 institutions within the region respectively. Physical therapists who were not working were excluded from the survey.

The questionnaire[20] consisted of three sections with a total of 10 items. Section 1 consisted of seven items concerning basic characteristics of respondents and demographic information; section 2 consisted of two items concerning the availability and usage, and what factors influenced their choice to use each of the 22 modalities; and section 3 consisted of one item concerning their confidence in using each of the 22 modalities.

A total of 22 modalities were selected for inclusion in the questionnaire based on what is currently being used in the clinical facilities and hospitals in Nagano Prefecture, Japan. These were categorized as follows:

1) Thermotherapy: hot packs, paraffin, infrared, ultrasound, shortwave, and microwave;
2) Cryotherapy: cold packs, and cold sprays;
3) Phototherapy: ultraviolet, and LASERs;
4) Mechanotherapy: traction, and continuous passive motion (CPM) devices;
5) Electrotherapy: low frequency, interferential, iontophoresis, transcutaneous electrical nerve stimulation (TENS), neuromuscular electrical nerve stimulation (NMES) and microcurrent (MCR);
6) Others: electromyography (EMG) biofeedback, pressure biofeedback, magnetic field, and ultrasound imaging.

Questionnaires were mailed out in bulk packages to each of the 245 and 236 institutions in 2014 and 2019 respectively. One week before the start of the survey, a postcard was sent to the chief physical therapist at each of these institutions to inform them of the aim and period of study, and to obtain their informed consent by giving them an opportunity to opt out.

All returned questionnaires were checked physically to ensure that all sections were answered and non-completion of any whole sections were excluded from further analysis. For the remaining valid questionnaires (N) that were included for analysis, some of them had missing data. The N values were adjusted to exclude the missing data, and the adjusted N values were used to calculate all the percentages.

All data input was performed on a spreadsheet software, Microsoft Excel for Mac v16.46 (Microsoft Corporation, Redmond, WA, USA). The frequencies and percentages were calculated for all nominal and ordinal data, and means and standard deviations for all interval and ratio data, using the Microsoft Excel software. In order to understand the changes and trends in availability and usage of the 22 modalities between 2014 and 2019, percentage availability and usage were grouped into four categories according to "High" (≥50%) or "Low" (≤49%) as follows: Category A (High Availability, High Usage); Category B (High Availability, Low Usage); Category C (Low Availability, High Usage); and Category D (Low Availability, Low usage). In addition, changes in availability and usage were also presented as ratios (A-Ratio and U-Ratio respectively) which were calculated based on the 2019/2014 percentages. Therefore, an A-Ratio or U-Ratio of 1.00, less than 1.00 and greater than 1.00 indicated no change, decreased and increased availability and usage, respectively.

In addition, a two-by-two χ^2 test of independence[22] on the frequencies (separately for 2014 and 2019) were carried out

for usage (yes vs. no) and factors affecting usage such as gender (males vs. females), years of experience (≥11 years vs. ≤10 years), and qualifications (degrees vs. diplomas). A similar two-by-two χ^2 test of independence[22] was also carried out for level of confidence (yes vs. no) and factors such as usage (yes vs. no) and years of experience (≥11 years vs. ≤10 years). The χ^2 test was calculated using the IBM SPSS version 23.0 (IBM Corporation, Armonk, NY, USA).

The level of significance was set at 0.05. The ethics committees of the Graduate School of Medicine, Shinshu University (No. 2661) and the Nagano University of Health and Medicine (No. 2019-1) approved this study.

RESULTS

The response rate was 71% and 63% for 2014 and 2019 respectively. Because 11 and 49 respondents did not complete either sections 1 or 2 in 2014 and 2019 respectively, they were excluded from further analysis. Therefore, from the mail-in responses, a total of 1,099 (99%) and 1,149 (96%) were analyzed for 2014 and 2019 respectively. The characteristics of respondents (gender, years of experience, and qualifications) for 2014 and 2019 are summarized in Table 1.

Availability and usage according to the four categories are summarized in Table 2. For Category A (Table 2-1), the availability and usage of hot packs, low frequency, ultrasound, and cold packs were all greater than 50% in 2014 and 2019, although the trends showed a slight decrease (A-Ratios ranged from 0.89 to 0.99; U-Ratios ranged from 0.85 to 0.93). In 2014, the availability and usage of Interferential, was 50% and 59% respectively, but in 2019 the availability and usage decreased to 47% and 49% respectively. The trends in availability and usage showed that Interferential was the only modality that dropped from Category A in 2014 to D in 2019 (A-Ratio 0.94: U-Ratio 0.83).

For Category B (Table 2-2), although the availability for traction was above 50% during both periods (65% in 2014, and 54% in 2019), the usage was below 50% (37% in 2014, and 28% in 2019). In 2014, the availability and usage of CPM devices was 55% and 40% respectively, but in 2019, the availability and usage decreased to 49% and 35% respectively. The trends in availability and usage showed that CPM devices was the only modality that dropped from Category B in 2014 to D in 2019 (A-Ratio 0.89; U-Ratio 0.88).

For Category C (Table 2-3), the trends for NMES and TENS were similar, i.e., availability increased but usage decreased. Between 2014 to 2019, the availability of NMES increased from 31% to 38% (A-Ratio 1.23), while the usage decreased from 56% to 51% (U-Ratio 0.91). For TENS, the availability increased from 42% to 44% (A-Ratio 1.05), while the usage decreased from 54% to 46% (U-Ratio 0.85). For MCR, however, while the availability remained the same (A-Ratio 1.00), the usage decreased from 56% to 42% (U-Ratio 0.75).

All other remaining modalities were categorized as D (Table 2-4). Except for the four modalities that dropped from Categories A (interferential), B (CPM devices) and C (TENS and MCR) in 2014 (described above), the others were the same 12 modalities for both 2014 and 2019. While the availability of some modalities increased (A-Ratios for ultrasound imaging 1.25; cold spray 1.06), all others demonstrated a decreased trend (A-Ratios ranged from 0.50 to 0.94). Similarly, while the usage of some modalities increased (U-Ratios for paraffin 1.15; ultrasound imaging 1.17; ultraviolet 3.60; iontophoresis 1.63; magnetic field 3.17), all others demonstrated a decreased trend (U-Ratios ranged from 0.64 to 0.88).

The results from the χ^2 tests of independence demonstrated that both usage and non-usage depended on gender (males were greater than females) for low frequency, ultrasound, NMES, microwave and pressure biofeedback in 2014; and ultrasound imaging and cold spray in 2019. Usage and non-usage also depended on experience (≥11 years were greater than

Table 1. Characteristics and demographics of respondents for 2014 and 2019

	2014	2019
1. Total mail-out	1,571	1,891
2. Total mail-out (institutions)	245	236
3. Total mail-in	1,110 (71%)	1,198 (63%)
4. Total mail-in (institutions)	171 (70%)	151 (64%)
5. Incomplete (Sections 1+2)	11+0	27+22
6. Total analyzed	1,099 (99%)	1,149 (96%)
7. Total analyzed (institutions)	170 (99%)	150 (99%)
8. Males:Females (ratio)	658:438 (1.50)	723:425 (1.70)
9. Experience		
a. ≤10 years	789	722
b. ≥11 years	308	427
10. Qualifications		
a. Diploma	826	766
b. Degree	271	383

Table 2. Availability (%), usage (%), availability ratios (A-Ratios) and usage ratios (U-Ratios) according to Categories A, B, C and D for 2014 and 2019

Modality	Availability			Usage		
	2014 (%)	2019 (%)	2019/2014 (A-Ratios)	2014 (%)	2019 (%)	2019/2014 (U-Ratios)
Table 2-1: Category A (High availability, high usage)						
Hot packs	88	84	0.95	72	67	0.93
Low frequency	76	68	0.89	58	52	0.90
Ultrasound	68	67	0.99	61	54	0.89
Cold packs	56	50	0.89	59	50	0.85
Interferential	50	Cat. D		59	Cat. D	
Table 2-2: Category B (High availability, low usage)						
Traction	65	54	0.83	37	28	0.76
CPM devices	55	Cat. D		40	Cat. D	
Table 2-3: Category C (Low availability, high usage)						
NMES	31	38	1.23	56	51	0.91
TENS	42	Cat. D		54	Cat. D	
MCR	14	Cat. D		56	Cat. D	
Table 2-4: Category D (Low availability, low usage)						
Interferential	Cat. A	47	0.94	Cat. A	49	0.83
CPM devices	Cat. B	49	0.89	Cat. B	35	0.88
TENS	Cat. C	44	1.05	Cat. C	46	0.85
MCR	Cat. C	14	1.00	Cat. C	42	0.75
Microwave	36	25	0.69	28	24	0.86
Infrared	30	20	0.67	19	13	0.68
Paraffin	28	22	0.79	13	15	1.15
US imaging	24	30	1.25	17	20	1.17
Lasers	20	12	0.60	28	18	0.64
SWD	19	18	0.95	19	19	1.00
Cold spray	17	18	1.06	18	15	0.83
EMG BF	16	15	0.94	28	28	1.00
Ultraviolet	6	4	0.67	5	18	3.60
Pressure BF	6	4	0.67	38	28	0.74
Iontophoresis	2	1	0.50	27	44	1.63
Magnetic field	2	1	0.50	12	38	3.17

BF: Biofeedback; Cat.: Category; CPM: Continuous passive motion; EMG: Electromyography; MCR: Microcurrent; NMES: Neuromuscular electrical stimulation; SWD: Shortwave Diathermy; TENS: Transcutaneous electrical nerve stimulator; US: Ultrasound; UVR: Ultraviolet radiation.

≤10 years) for traction in 2014; and CPM devices and cold spray in 2019. Usage and non-usage also depended on qualifications (diplomas were greater than degrees) for ultrasound and ultraviolet in 2014; and low frequency, cold packs, CPM devices and TENS in 2019.

The results from the χ^2 tests of independence also demonstrated that usage was related to confidence, and non-usage was related to non-confidence for all modalities in categories A, B and C.

The results for category D, however, was mixed with no particular trend demonstrated.

The results from the χ^2 tests of independence also demonstrated that confidence was related to years of experience (≤ 10 years more confident than≥11 years) for ten modalities (low frequency, interferential, ultrasound, traction, CPM devices, MCR, paraffin, infrared, microwave, EMG biofeedback).

DISCUSSION

Rather than giving the results for availability and usage separately, and ranking each of them from highest to lowest percentage as was done in our cross-sectional study in 2014[20], the results for availability and usage from the present study

was combined and classified into four categories. In this way, each of these categories was able to demonstrate the trends in the changes in availability and usage for each of the 22 modalities.

Modalities that were high in availability and high in usage (Category A, Table 2-1) could be considered as very important for clinicians, and four out of five in this Category A were the same in 2014 and 2019. Each of them represented a major treatment option; i.e., superficial heat (hot packs), deep heat (ultrasound), cryotherapy (cold packs) and electrotherapy (low frequency). Together, they provide the clinician with almost all the possible treatment options for EPA. Because of budget or space constraints, clinicians have either consciously or subconsciously selected the modalities that are deemed to be very important, i.e., providing the most desired treatment options without compromising on choices. The trend for all modalities in Category A, however, demonstrated a slight decrease in availability and usage over the five-year period by about 5 to 10% as shown by their A-Ratios and U-Ratios (Table 2-1).

Modalities that were high in availability but low in usage (Category B, Table 2-2) could be considered as moderately important for clinicians. Both modalities in this category are mechanotherapy devices (traction and CPM devices). Even though traction and CPM devices would be important additional treatment options, clinicians chose not to use them even though they were readily available. One possible reason may be that clinicians do not have adequate guidelines on proper usage for both modalities since it has not been properly covered in textbooks[10, 11]. It may be necessary to investigate this further in future studies.

Modalities that were low in availability but high in usage (Category C, Table 2-3) could be considered as slightly important for clinicians. All three modalities in this category were electrical stimulation devices (TENS, NMES, MCR). However, when all electrical stimulation devices were taken together (low frequency, interferential, TENS, NMES, MCR) and classified as "electrotherapy", their classification changed from Category C to A. In other words, when taken together, electrotherapy is highly available and highly used by clinicians. Our results, therefore, may suggest the growing importance of electrotherapy. Future studies should consider more appropriate terminologies to describe electrical stimulation devices.

Modalities that were low in availability and usage (Category D, Table 2-4) could be considered as not important for clinicians. Most of these modalities may also not be covered in the EPA teaching curriculum. Category D modalities can be described according to three distinct patterns. Firstly, one modality (ultrasound imaging) increased in both availability and usage by 25% and 17% respectively. While these numbers were still low compared with the other categories, this may indicate the growing importance of ultrasound imaging in clinical practice. Secondly, one modality (cold spray) increased in availability (6%) but decreased in usage (27%). However, as there are other options with cryotherapy such as cold packs (Category A), cold spray may be less popular by comparison. Thirdly, four modalities (paraffin, ultraviolet, iontophoresis, magnetic field) decreased in availability but increased in usage. These modalities (paraffin, ultraviolet, iontophoresis, magnetic field) had less than 10% availability in the first place, and these low numbers may result in large changes in percentages due to their low denominators. Therefore, it is important to recognize that modalities in Category C should not be considered as a homogenous group as illustrated by the three distinct patterns in availability and usage. Any discussions on whether to exclude them from EPA teaching curriculum should take these factors into consideration.

With regards to factors affecting usage, the results from our study suggest that gender (males greater than females), years of experience (older greater than younger) and qualifications (diplomas greater than degrees) all had an impact on usage and non-usage. However, this was only for certain modalities, and no distinct pattern has emerged.

Another important factor that may affect usage, but was not investigated in this study, is the different levels of complexity for the various modalities. Two out of the five modalities in Category A were of low complexity (hot packs and cold packs) and this could be a contributory factor for their popularity in usage. Therefore, future studies should consider investigating the relationship between usage and perceived levels of complexity for each of these 22 modalities.

With regards to the relationship between usage and confidence, the results of our study demonstrate that confidence was related to higher usage and non-confidence was related to higher non-usage for Categories A, B and C devices. This result is not surprising and may suggest that one possible reason for decreased usage may be due to lack of confidence because of inadequate teaching or practice. Future studies should investigate the relationship between EPA teaching curriculum and perceived confidence in using each of these 22 modalities.

With regards to the relationship between years of experience and confidence, an unexpected result of our study demonstrated that confidence was greater for clinicians with ≤10 years of experience, compared with their older colleagues. One possible explanation is that they were more current in their knowledge and skills compared with those who graduated much earlier (≥11 years).

In conclusion, this is the first longitudinal study on the availability and usage of EPA in Nagano Prefecture, as well as in Japan. As far as we are aware, no similar longitudinal study has been carried out in other countries. Our results partially support the anecdotal concerns expressed regarding decreased in availability and usage, albeit at a modest 5% to 11% for Categories A and B modalities, and between 1% and 50% for Category D modalities. On the other hand, the availability and usage for some modalities (TENS, NMES, cold spray and ultrasound imaging) actually increased by 5% to 25%. Therefore, it is simplistic and inaccurate to generalize and suggest that there is an overall decreased trend for EPA. It is important to understand the factors affecting the availability and usage trends in EPA to assist educators to design better EPA teaching curriculum which is consistent with the needs of clinicians, as well as to formulate research agendas that are essential for ensuring the continued relevance of EPA for the physical therapy profession.

Conference presentation

Results from this study were partially presented at the April 2021 World Physiotherapy Congress (online).

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Conflict of interest

The author reports no conflict of interest.

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