A Pronunciation of English Medical Loanwords Produced by Thai Nurses: A Case Study at Nopparat Rajathanee Hospital

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Abstract—The study of English loanwords produced by Thai speakers has received much attention. However, to the best of our knowledge, this is the first study of English medical loanwords produced by Thai nurses. The aim of this study is to investigate the production of English medical loanwords produced by L2 Thai nurses. The data used was 395 English medical loanwords in sentences. The analysis was divided into two main parts: phonological and morphological. For the phonological analysis, the influence of L1 Thai was found in the production. It was also found that there is a difference between the way Thai nurses and L2 Thai learners say the same English sounds, especially when the English sounds do not exist in the Thai sound system. For the morphological analysis, seven strategies of word formation were found, including keeping the same word, acronym, abbreviation, phrasal clipping, back clipping and adding other sounds, lengthening of abbreviation, and different pronunciations to distinguish words. Some strategies, such as lengthening of abbreviation, were not found in the formation of English loanwords in Thai, and some strategies in the formation of English loanwords in Thai were not found in the formation of English medical loanwords. These results suggest that English medical loanwords used by Thai nurses have unique characteristics which enhance the communication among healthcare professionals.

Index Terms—Thai, nurses, English medical loanwords, healthcare professionals, loanwords

I. INTRODUCTION

In this modern generation, English loanwords have played an essential role in the Thai vocabulary repertoire. English words were taken into Thai in the early Ratanakosin period when there was an increase in trade and power of the British to Southeast Asian countries (Nacaskul, 1979). When dealing with medical sciences, English has greater influence on Thai than other languages. This might be due to the universal property of English as a means to communicate globally. The other reason might be due to the medical superiority of some of the countries that use English as their first language. The latter reason is particularly true in the conversational communication among nurses, especially Thai nurses.

With regards to the working environment of health care practitioners, speed and accuracy of communication is important as time is often of the essence when trying to save people's lives. For nurses, the communication among them needs to be effective within limited time. They are in the profession where diversity in cultural and social communication is part of their working context (Lolaty et al., 2011). Miscommunication might result in dissatisfaction of staff and patients, or even poor care collaboration (Chapman, 2009). Nurses are in a working environment which is different from other professionals. The language they use when communicating amongst themselves, with other health care professionals and patients is thus interesting.

A number of studies of English loanwords produced by Thai speakers have been carried out (e.g., Gandour, 1979; Kenstowicz & Suchato, 2006; Nacaskul, 1979; Rungruang, 2007). For example, Kenstowicz and Suchato (2006) reviewed the results of a study of English loanwords in Thai and explained these results with a model of loanword adaptation. Another study is by Gandour (1979) and this investigates the rules for converting the English stress and intonation into Thai tonal categories. However, none of these studies looked specifically at English medical loanwords produced by Thai nurses. This might be due to the small percentage of English loanwords which were found in Thai medical sciences. This was highlighted in a paper by Nacaskul (1979) which showed only 3.08% of English loanwords were used in the field of English loanwords in Thai. Moreover, many studies of L2 Thai speakers have been carried out with English loanwords in written texts (e.g., Kenstowicz & Suchato, 2006).

Thus, this is the first study to explore the pronunciation of English medical loanwords produced by Thai nurses. Thai nurses in this study were Thai learners who used English as a foreign language in Thailand; hence their aims might not be to have complete mastery in the L2 (Kitikanan, 2019). This study uses the pronunciation of Thai nurses at Nopparat

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Rajathanee Hospital. The context of this speech study is the working environment where Thai nurses mainly speak Thai and only use English loanwords when referring to medical terms. The research aim of this study is to investigate the pronunciation of English medical loanwords produced by L2 Thai nurses. It is interesting to find out how Thai nurses communicate among themselves and with other healthcare providers, and to what extent their native language (Thai) affects their pronunciation of English medical loanwords. This study provides the analysis of the pronunciation at the both phonological and morphological levels.

II. RESEARCH QUESTIONS

There are two research questions in this study: 1) What are the English sounds of the English medical loanwords which are phonologically produced by Thai nurses? and 2) How do Thai nurses morphologically form English medical loanwords?

III. LITERATURE REVIEW

A. Background on Thai Sounds

Thai is a tonal language. There are 21 consonant sounds: /w, p, pʰ, b, t, tʰ, d, k, kʰ, ʔ, m, n, ŋ, r, f, s, h, t͡ɕ, t͡ɕʰ, j, l/. Nine are voiced and 12 are voiceless. These consonants can occur in the initial position. For the consonants in the final position, only some sounds can occur: /n, m, ŋ, j, w, k, t, p/, such as /líːaw/ "to turn" and /bâːŋ/ "some". The consonant sounds in Thai are presented in Table 1.

TABLE 1
CONSONANT SOUNDS IN THAI (ADAPTED FROM KITIKANAN, 2020B)

Manner of articulation \ Place of articulation	Bilabial	Labial-velar	Labio-dental	Alveolar	Alveolo-palatal	Palatal	Velar	Glottal
Plosive	p pʰ b			t tʰ d			k kʰ	ʔ
Nasal	m			n			ŋ	
Fricative			f	s				h
Affricate					t͡ɕ t͡ɕʰ			
Approximant		w				j		
Trill				r				
Lateral Approximant				l				

With the vowels in Thai, there are 18 monophthongs and three diphthongs. The monophthongs are divided into short and long. The short ones are: /a, i, ɯ, u, e, æ, o, ɔ, ə/ whilst the long ones are: /aː, iː, ɯː, uː, eː, æː, oː, ɔː, əː/. The diphthongs are: /iːa, ɯːa, uːa/, such as /sǐːa/ "spoiled".

B. Background on English Sounds

In English, there are 24 consonant sounds: /p, b, m, w, f, v, θ, ð, t, d, n, s, z, ɹ, l, ʃ, ʒ, t͡ʃ, d͡ʒ, j, k, g, ŋ, h/ as shown in Table 2. All consonants, except /ŋ/ can occur in the initial position. For the final position, all consonants, except /ɹ, h, j, w/ can occur.

TABLE 2
CONSONANT SOUNDS IN ENGLISH (ADAPTED FROM KITIKANAN, 2020B)

Manner of articulation \ Place of articulation	Bilabial	Labial-velar	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Plosive	p b				t d			k g	
Nasal	m				n			ŋ	
Fricative			f v	θ ð	s z	ʃ ʒ			h
Affricate						t͡ʃ d͡ʒ			
Approximant		w			ɹ		j		
Lateral Approximant					l				

The vowels in English are composed of 22 monophthongs and eight diphthongs (Roach, 2009). From these 22 monophthongs, there are seven short vowels: /ɪ, ʊ, e, ʌ, æ, ɒ, ə/ and five long vowels: /iː, ɜː, ɑː, ɔː, uː/. The schwa /ə/ is

not the focus of this study as it is reduced vowel and only occurs in unstressed syllable, following the study of Kitikanan et al. (2022). The diphthongs are /ɪə, eə, ʊə, eɪ, aɪ, ɔɪ, əʊ, aʊ/. Unlike Thai, English is a stress language. However, there is no generalisation for stress rules in English. The broad rules are that in most content words, stress is placed on the first syllable (Clopper, 2002).

C. Pronunciation of English Loanwords in Thai

With regards to the pronunciation of English loanwords in Thai, many studies were carried out (e.g., Bickner, 1986; Gandour, 1979; Kenstowicz & Suchato, 2006; Nacaskul, 1979; Rungruang, 2007). The consonant sounds in English that also occur in the Thai sound system are often mapped with the Thai sounds in the same category, such as /b/ in "bit" as /bit/ and aspirated /k/ in "cute" as /kʰíw/. In the initial position, the English sounds that do not exist in Thai are often replaced by Thai sounds as follows: /v/ as /w/; /θ/ as /t/; /ð/ as /d/; /z/ as /s/; /ɹ/ as /r/ in written communication, but as /l/ in oral speech; /ʃ/, /t͡ʃ/ and /ʒ/ as /tɕʰ/; /d͡ʒ/ as /tɕ/; and /g/ as /k/.

For personal names in English, some changes in the sounds are made to help with the pronunciation, with remembering them, and sometimes a mixture of humour was added, such as saying '(Mr.) Rankin' as /rǽ:ŋ.kin/ 'vulture devours' or 'Mr. Hunter' as /mít.hǎn.træ:/ 'Mitr turns a trumpet' (Nacaskul, 1979). Regarding the length of English loanwords, the number of syllables of Thai words is often similar to that of English ones; however, they can be shortened, such as saying 'carburetor' as /kʰa:.biw/ (Endarto, 2015; Raksaphet, 1991). When pronouncing unstressed syllables in English words, Thai speakers tend to accent them, and for stressed syllables, they are more likely to accent them especially when they occur in the last syllable of words (Nacaskul, 1979).

There is also some variation in the pronunciation of English loanwords as produced by educated and low-educated people. For example, Nacaskul (1979) mentioned that educated Thai speakers could pronounce clusters: /br, bl, dr, fl, fr/ and plosives preceding by /s/ in the initial consonants which are not permissible clusters in Thai. These clusters are changed into simple initial sound with the deletion of the second consonant in the cluster for low-educated people. In addition, in the pronunciation of some English clusters, /a/ (Nacaskul, 1979) or /ə/ (Kenstowicz & Suchato, 2006) is inserted.

For the pronunciation of English vowels, the diphthongs /ei, eə, ou, ɔə/ are realised as the long vowels in Thai /e:, æ:, o:, ɔ:/ (Nacaskul, 1979). In the pronunciation of final consonants after the vowels, they are often omitted, such as omitting /n/ in 'down' (saying as /da:w/) (Nacaskul, 1979). Regarding the final /p, t, k, m, n, ŋ/, Thai speakers tend not to have problem pronouncing them, but for the final /b, d, g/, the voicing is omitted; hence, /p, t, k/ are used to replace them (Endarto, 2015). Final /l, w/ after long vowels and final /ɹ/ after diphthongs are often omitted (Nacaskul, 1979). Similarly, final /d͡ʒ/ is omitted or changed into /t/ (Nacaskul, 1979). Final /d, ʃ, t͡ʃ, d͡ʒ, θ/ in English are often replaced by Thai /t/ whereas final /l/ is often replaced with Thai /n/ (Nacaskul, 1979). Clusters in final position are often reduced into single final consonant (Nacaskul, 1979).

IV. METHODOLOGY

A. Data Production

395 English medical loanwords were used in sentences. These sentences were composed by the first author who was a nurse in the medical intensive care unit with seven years of experience. The sentences were in Thai but the target words were in English. For example, 'หลังให้ Streptokinase พบผู้ป่วยมี Coffee ground' (After giving streptokinase, it was found that the patient had coffee ground). The spelling of English medical loanwords was according to the spelling the doctors wrote for the healthcare providers. If the loanwords were in abbreviations, the target words would also be abbreviated. As there was no word with diphthong /ʊə/, nor /ð/ and /ʒ/ in the initial position of a syllable, there was no information on how these sounds would be articulated in English medical loanwords by Thai nurses.

The sentences were produced by the same author using an iPhone SE2020. The sound files are in MP3 format. For the validity of the analysis, the pronunciations of the target words in the sentences were checked by three nurses at Nopparat Rajathanee Hospital. They listened to the sentences and if there was a disagreement of the pronunciation between the three nurses and the first author, the target word would be changed. The target words were then transcribed using IPA symbols by the second author who had received phonetic training during her PhD degree. The transcription was also checked by another trained phonetician who is an English teacher with Thai background.

B. Data Analysis

The target words in English and their transcriptions were transferred to Microsoft Excel. The analysis was divided into two levels: phonological and morphological. For the phonological level, i.e. the realisations of consonant sounds: both single and cluster sounds, were investigated in the initial and final position. Similarly, the realisations of vowel sounds were also explored for short and long vowels, and diphthongs. For the morphological level, the word formation of English medical loanwords was examined. All data here were recorded in Microsoft Excel. The research project and its methodology, including data collection and data analysis, were ethically approved by Nopparat Rajathanee Hospital (Reference number: 16/2565).

<center>V. RESULTS AND DISCUSSION</center>

To explore the pronunciation of English medical loanwords by Thai nurses, the analysis was divided into two levels: phonological and morphological. The details are as follows.

A. Phonological Analysis

As the first research question is: Which are English sounds in English medical loanwords are phonologically realised by Thai nurses? The analysis at the phonological level was divided into two main parts: consonants and vowels. The consonant sounds were divided into two types: single consonant and cluster sounds. Each type has been divided into initial and final positions.

1. Consonant Sounds

In general, the articulation of the consonant sounds for English medical loanwords by Thai nurses was found to be rather similar to the production of English consonant sounds by L2 Thai learners. The production of English medical loanwords greatly received positive transfer from the English phonemes that also existed in the Thai phonological system, i.e. Thai nurses tended to replace the Thai sounds for the English sounds that also phonologically occurred in Thai. For example, /f/ in 'femur' was articulated as /fiː.môː/, and /s/ in 'sat' was articulated as /sǽːt/. They also benefited from the aspiration in Thai, both at the beginning and after /s/ as Thai has both aspirated and unaspirated voiceless stops. For example, /t/ in 'tube' was pronounced with aspiration as /tʰíw/, and /t/ in 'stoke' was without aspiration as /sà.tók/. With regards to English /t/ and /n/ in the final position, sometimes they were found to be pronounced with the target-like sounds, but they could also be deleted in their production. For example, /t/ in 'right' /ɹaɪt/ was pronounced as /lái/, and 'n' in 'sign' /saɪn/ was pronounced as /saːj/. In addition, the results for the realisations of English sounds that did not exist in the Thai sound system and English vowels are presented as follows.

a. Consonant Sounds in Initial Position

Thai nurses were more likely to replace English consonant sounds which do not exist in the Thai phonological system with other Thai consonant sounds. The following single sounds in the initial position in English were found to be replaced with Thai sounds:
  1) English /ʃ/ with Thai /t͡ɕʰ/, such as 'pressure' /ˈpɹeʃə/ as /pʰét.t͡ɕʰôː/;
  2) English /v/ with Thai /w/, such as 'vessel' /ˈvesəl/ as /wát.sôn/;
  3) English /g/ with Thai /k/, such as 'gown' /gaʊn/ as /kaːw/;
  4) English /ɹ/ with Thai /l/, such as 'right' /ɹaɪt/ as /lái/;
  5) English /z/ with Thai /s/, such as 'wheezing' /ˈwiːzɪŋ/ as /wíːt.sîŋ/;
  6) English /θ/ with Thai /tʰ/, such as 'thermometer' /θəˈmɒmɪtə/ as /tʰəː.mo:.mí.tôː/;
  7) English /t͡ʃ/ with Thai /t͡ɕʰ/, such as 'discharge' /dɪsˈt͡ʃɑːd͡ʒ/ as /dít.t͡ɕʰaːt/; and
  8) English /d͡ʒ/ with Thai /t͡ɕ/, such as 'oxygen' /ˈɒksɪd͡ʒən/ as /ʔɔ́ːk.sí.t͡ɕên/.

The following results showing the replacement of sounds in the initial position are inconsistent with the findings in the study of Kenstowicz and Suchato (2006): English /ʃ/ with Thai /t͡ɕʰ/, English /v/ with Thai /w/, English /g/ with Thai /k/, English /z/ with Thai /s/, and English /d͡ʒ/ with Thai /t͡ɕ/. According to that study, these substitutions were considered as context-free mapping of consonants between English and Thai sounds.

b. Consonant Sounds in Final Position

For the consonant sounds in the final position, it was found that Thai nurses changed English sounds that did not exist in the Thai phonological system as follows:
  1) final voiceless stop was articulated with no audible release, such as /t/ in 'admit' /ædˈmɪt/ as /ʔǽːt.mít/;
  2) English /d͡ʒ/ with Thai /t/, such as 'bandage' /ˈbændɪd͡ʒ/ as /bæːn.dèːt/;
  3) English /f/ was deleted or replaced with /p/, such as 'off' /ɒf/ as /ʔɔ́ːp/ and 'life' /laɪf/ as /lái/;
  4) English /θ/ with Thai /t/, such as 'both' /bəʊθ/ as /bóːt/;
  5) English /l/ was either deleted, replaced with /n/ or /w/, such as 'alcohol' /ˈælkəˌhɒl/ as /ʔæːn.kɔː.hɔː/, 'vessel' /ˈvesəl/ as /wéːt.sêːw/ and 'muscle' /ˈmʌsəl/ as /mát.sôn/;
  6) English /s/ was either deleted or replaced with /t/, such as 'epistaxis' /ˌepɪˈstæksɪs/ as /ʔiː.pʰiː.tʰǽːk.sia/ and 'thrombus' /ˈθɹɒmbəs/ as /tʰɔ́ːm.bát/;
  7) English /b/ with Thai /p/, such as 'rub' /ɹʌb/ as /láp/;
  8) English /d/ with Thai /t/, such as 'ward' /wɔːd/ as /wɔ̀ːt/;
  9) English /g/ with Thai /k/, such as 'bag' /bæg/ as /bǽːk/;
  10) English /v/ with Thai /p/, such as 'observe' /əbˈzɜːv/ as /ʔɔ́ːp.sôːp/;
  11) English /ʃ/ with Thai /t/, such as 'push' /pʊʃ/ as /pʰút/;
  12) English /t͡ʃ/ as Thai /t/, such as 'stitch' /stɪt͡ʃ/ as /sà.tít/; and
  13) English /z/ with Thai /t/, such as 'gauze' /gɔːz/ as /kɔ́t/.

For these results, Thai nurses might have a problem of aurally differentiating English medical loanwords 'right' and 'life' when they occurred out of the context as they both pronounced as /lái/. In addition, the results of the following substitutions were in agreement with the findings in the study of Nacaskul (1979): English /d͡ʒ/ with Thai /t/, /θ/ with

Thai /t/, English /l/ was either deleted and replaced with /n/, English /d/ with Thai /t/, English /ʃ/ with Thai /t/, and English /t͡ʃ/ as Thai /t/.

c. Clusters in Initial Position

Regarding the cluster in the initial position of English medical loanwords, some words showed that Thai nurses maintained the cluster in the production, such as 'plan' /plæn/ as /pʰlæ:n/ and 'bleed' /bli:d/ as /blì:t/. However, for most clusters, the cluster was changed into single phoneme. The examples are as follows:

1) English /gɹ/ with Thai Thai /k/, such as 'degree' /dɪˈgɹiː/ as /di:.ki:/;
2) English /bl/ with Thai /b/, such as 'block' /blɒk/ as /bɔ́:k/;
3) English /tɹ/ with Thai /t/, such as 'stroke' /stɹəʊk/ as /sà.tók/;
4) English /θɹ/ with Thai /tʰ/, such as 'thrombus' /ˈθɹɒmbəs/ as /tʰɔ:m.bát/; and
5) English /dɹ/ with Thai /d/, such as 'drop' /dɹɒp/ as /dɒ̀p/.

According to Nacaskul (1979), the existence of clusters in English loanwords used in Thai often occurs in the pronunciation of modern educated people. However, this reason might not be applicable with Thai nurses as they were speakers educated to degree level. The reason for the omission of the post-consonant sound after the first sound might be due to time pressures often found in their working environment which requires fast and efficient communication. For clusters with initial /s/, Thai nurses often inserted Thai /a/ after /s/ before the second sound in the cluster. For example, English /sk/ was realised as /sà.k/, such as 'score' /skɔ:/ as /sà.kɔ:/, and English /st/ was produced as /sà.t/, such as 'step' /step/ as /sà.tèp/.

d. Clusters in the Final Position

For English medical loanwords with clusters in the final position, the clusters were reduced to single consonant sounds. For example,

1) English /st/ was reduced to /t/, such as chest /t͡ʃest/ as /t͡ɕʰé:t/;
2) English /sk/ was reduced to /t/, such as 'mask' /mɑːsk/ as /mǽ:t/;
3) English /nt/ and /ns/ were realised as /n/, such as 'stent' /stent/ as /sà.té:n/, and 'ambulance' /ˈæmbjʊləns/ as /æ:m.bu:lǽ:n/;
4) English /gz/ was produced as /k/, such as 'legs' /legz/ as /lé:k/; and
5) English /ft/ was replaced with /p/, such as 'left' /left/ as /lép/.

All replacing sounds were the sounds in Thai and they were used according to the Thai phonotactic rules, i.e., Thai does not allow clusters in the final position. The results of these substitutions were consistent with the findings in the study of Nacaskul (1979): English /st/ with /t/, English /ns/ with /n/, and English /ft/ with /p/. It is interesting that although /nt/ is an acceptable sound in the final position in Thai, only /n/ was preserved in the production of the final cluster.

2. Vowel Sounds

With regards to the vowel sounds in English medical loanwords in Thai, they can be divided into three categories: short vowel, long vowel and diphthong as follows.

a. Short Vowels

There are in English: /ɪ, ʊ, e, ʌ, æ, ɒ/. Each of them was realised as follows.

1) English /æ/ was produced as long vowels /a:/ and /æ:/, such as 'palliative' /ˈpælɪətɪv/ as /pʰa:.lai.tʰi:p/, and 'admit' /ædˈmɪt/ as /ʔǽt.mít/;
2) English /e/ was articulated as /e/, /a/ and /e:/, such as 'sepsis' /ˈsepsɪs/ as /sép.sìt/, 'vessel' /ˈvesəl/ as /wát.sôn/, and 'leg' /leg/ as /lé:k/;
3) English /ɪ/ was produced as /i:/, /e:/, /ia/ and /i/, such as 'injury' /ˈɪndʒərɪ/ as /ʔin.t͡ɕu:.lî:/, 'bandage' /ˈbændɪdʒ/ as /bæ:n.dè:t/, 'epistaxis' /ˌepɪˈstæksɪs/ as /ʔi:.pʰi:.tʰǽ:k.sia/, and 'admit' /ædˈmɪt/ as /ʔǽt.mít/;
4) English /ɒ/ was pronounced as /ɔ:/ and /o:/, such as 'oxygen' /ˈɒksɪdʒən/ as /ʔɔ́:k.sì.t͡ɕê:n/, and 'thermometer' /θəˈmɒmɪtə/ as /tʰə:.mo:.mí.tê:/;
5) English /ʌ/ was replaced with /a/, such as 'lumbar' /ˈlʌmbə/ as /lam.bâ:/;
6) English /ʊ/ was produced with /u/ and /u:/, such as 'push' /pʊʃ/ as /pʰut/, and 'ambulance' /ˈæmbjʊləns/ as /ʔæ:m.bu:.lǽ:n/.

The results above showed that most short vowels in English were replaced with Thai long vowels, i.e. English /æ/ with both /a:/ and /æ:/, English /e/ with /e:/, English /ɪ/ with /i:/, English /ɒ/ with /ɔ:/, and English /ʊ/ with /u:/. Many short vowels could be pronounced with more than one Thai sound, i.e. English /e/ with both /e/, /a/ and /e:/, English /ɪ/ with /i:/, /e:/, /ia/ and /i/, English /ʊ/ with both /u/ and /u:/, and English /æ/ with both /a:/ and /æ:/. The results from three vowels in English showed that they were replaced with the Thai vowels which were counterpart with one another, i.e. English /e/ with both /e/ and /e:/, English /ɪ/ with both /i:/ and /i/, and English /ʊ/ with both /u/ and /u:/. The results that English /ɪ/ was replaced with /i/, and English /ʌ/ was replaced with /a/ are consistent with the findings in the study of Kitikanan (2020a) that L2 Thai learners mostly perceived English /ɪ/ as Thai /i/, and English /ʌ/ with /a/. Only English

/ʌ/ was replaced with short vowel in Thai, suggesting that English /ʌ/ and /a/ might be phonetically and articulatory closed in terms of duration of the vowels.

b. Long Vowels

Long vowels in English /iː, ɜː, ɑː, ɔː, uː/ were produced as follows.
1) English /iː/ was realised as /iː/, such as 'piece' /piːs/ as /pʰíːt/;
2) English /ɜː/ was produced with /əː/, such as 'observe' /əbˈzɜːv/ as /ʔɔ́ːp.sə̀ːp/;
3) English /ɑː/ was articulated with /æː/ and /aː/, such as 'mask' /mɑːsk/ as /mǽːt/, and 'discharge' /dɪsˈt͡ʃɑːdʒ/ as /dít.t͡ɕʰaːt/;
4) English /ɔː/ was realised as /ɔː/ and /ɔ/, such as 'ward' /wɔːd/ as /wɔ̀ːt/, and 'gauze' /gɔːz/ as /kɔ́t/;
5) English /uː/ was articulated with /i/ and /uː/, such as 'tube' /tjuːb/ as /tʰíw/, and 'balloon' /bəˈluːn/ as /bɔːn.luːn/.

For the production of English long vowels, most of them were produced with long vowels in Thai, i.e. English /iː/ with /iː/, English /ɜː/ with /əː/, English /ɑː/ with /æː/ and /aː/, and English /ɔː/ with /ɔː/. The result that English /ɜː/ was produced with /əː/ is in agreement with the finding in the study of Kitikanan (2020a) that L2 Thai learners mostly perceived English /ɜː/ as Thai /əː/. In addition, the result that English /uː/ was produced with /uː/ is consistent with the finding in the study of Kitikanan (2020a) in the high-experienced group who mostly perceived this English vowel as similar to Thai /uː/.

c. Diphthongs

Regarding diphthongs in English /ɪə, eə, eɪ, aɪ, ɔɪ, əʊ, aʊ/, they were realised as follows.
1) English /ɪə/ was produced with /ai/, such as 'palliative' /ˈpælɪətɪv/ as /pʰaː.lai.tʰiːp/;
2) English /eə/ was realised as /æː/, such as 'airway' /ˈeəˌweɪ/ as /ʔæː.weː/;
3) English /eɪ/ was articulated with /aː/ and /eː/, such as 'nasal' /ˈneɪzəl/ as /naː.sɔ̂ː/, and 'airway' /ˈeəˌweɪ/ as /ʔæː.weː/;
4) English /aɪ/ was pronounced as /aːj/ and /ai/, such as 'sign' /saɪn/ as /saːj/ and 'life' /laɪf/ as /lái/;
5) English /ɔɪ/ was produced with /ɔːj/, such as 'void' /vɔɪd/ as /wɔːj/;
6) English /əʊ/ was realised as /oː/, such as 'stroke' /stɪəʊk/ as /sà.tóːk/;
7) English /aʊ/ was produced with /aːw/, such as 'ground' /graʊnd/ as /kaːw/.

From the results above, two out of three diphthongs ending with /ɪ/ were mostly substituted with the Thai vowel ending with /j/, i.e. English /aɪ/ as /aːj/, and English /ɔɪ/ as /ɔːj/. Two diphthongs ending with /ʊ/ were replaced with sounds with lip rounding, i.e. English /əʊ/ as /oː/, and English /aʊ/ as /aːw/. The result that English /aɪ/ was realised as /ai/ was contrastive to the finding that English /aɪ/ was produced with a Thai vowel followed by the semi-vowel /j/ in the study of Nacaskul (1979).

B. Morphological Analysis

The second research question is: How do Thai nurses morphologically form English medical loanwords? In order to answer this question, analysis was carried out at the morphological level. With regards to the analysis at morphological level, seven strategies were found in the formation of English medical loanwords by Thai nurses as follows.

1) Keeping same word: In general, most English medical loanwords were pronounced with similar number of syllables, such as 'content' as /kʰɔːn.tʰéːn/, 'disease' as /diː.síːt/, and 'balloon' as /bɔːn.luːn/.

2) Acronym: Sometimes, English medical loanwords could be articulated with acronym, such as 'STEMI' (ST-Elevation Myocardial Infarction) as /sà.ti.míː/, and 'APACHE' (acute physiology and chronic health evaluation) as /ʔà.pa.t͡ɕʰêː/.

3) Abbreviation: Thai nurses also employed abbreviation to pronounce English medical loanwords, such as 'CPR' as /siː.pʰíː.ʔaː/, 'DI' as /diː.ʔai/, and 'BD' as /biː.diː/.

4) Phrasal clipping: It was found that English medical loanwords could be clipped in the phrasal level, such as pronouncing 'underlying disease' as /ʔan.dô̂ː.la:j.ʔîŋ/; the word 'disease' was clipped in the word formation. However, this strategy was rare.

5) Back clipping and adding other sounds: Some English medical loanwords might be clipped at the back, such as 'stethoscope' as /sà.téːt/, and 'respiratory' as /léːt/.

6) Lengthening of abbreviation: Many abbreviations were found to be fully pronounced, such as 'DOT' (dead on table) as /déːt.ʔɔːn.tʰeː.bɔ̂ː/, 'S/P' (status post) as /sà.te:.tát.pʰóːt/, 'U/S' (ultrasound) as /ʔan.tâː.sa:w/, 'NSS' (normal saline) /nɔː.mɔ̂ː.sa:.la:y/, and 'ICH' (intracerebral hemorrhage) as /ɪn.tâː.si:.liː.bɔ̂ː.hi:.mo:.leːt/. However, when they were used many times, the speakers might shorten the words and pronounced them as abbreviation in order to save time.

7) Different pronunciations to distinguish words: This strategy was found to distinguish pairs of words that might cause confusion during the communication. For example, for 'Atrial fibrillation' and 'Atrial flutter', they could be abbreviated into 'AF. However, abbreviating them into 'AF' might cause confusion, so Thai nurses called 'Atrial fibrillation' as /ʔeː.ʔéːp/, and 'Atrial flutter' as /ʔeː.fat.tɔ̂ː/.

VI. CONCLUSION AND IMPLICATION

In summary, the production of English medical loanwords by Thai nurses seems to be influenced largely by L1 sounds. Many English sounds that exist in the Thai sound system were produced with Thai sounds that are phonemically similar to the English sounds. This might be due to positive transfer of the Thai sounds in the production of the English medical loanwords, such as pronouncing /t/ as aspirated for the /t/ at the beginning of the word, and as unaspirated for the /t/ after /s/. In the same way, the production of English sounds that did not occur in the Thai sound system seems to be due to negative transfer of the Thai sounds, such as replacing English /v/ with Thai /w/. These findings support the concept of L1 transfer as agreed in many researchers (Best, 1995; Best & Tyler, 2007; Flege, 1995; Lado, 1957). As negative transfer might cause confusion in communication, especially in the context requiring accuracy and speed, Thai nurses might be aware that some words might be pronounced the same, such as pronouncing 'right' /ɹaɪt/ and 'life' /laɪf/ as /lái/. In this case, the context of speech or carrier phrase plays an important role in helping Thai nurses to understand each other.

This study also found that Thai nurses employed many strategies to form English medical loanwords, such as acronym, lengthening of abbreviation and phrasal clipping. It is interesting that even when constrained by time, some pronunciations were extended beyond the original words, such as pronouncing 'DOT' (dead on table) as /déː.t.ʔɔː.n.tʰeː.bɔ̂ː/, and 'NSS' (normal saline) /nɔː.mɔ̂ː.saː.laːy/. Although Nacaskul (1979) mentioned that many personal names in English were changed into Thai words with humour, such as '(Mr.) Rankin' as /rɛ́ŋ.kin/, this characteristic of word formation was not found in this study. It might be due to the environment in which the health provider work requires a high level of seriousness. This implies that the word formation of English medical loanwords by Thai nurses is rather different from that of English loanwords used by the general Thai population.

VII. LIMITATIONS AND FUTURE DIRECTIONS

This study has three main limitations. Firstly, the pronunciation of English medical loanwords in this study was based on the production of Thai nurses at Nopparat Rajathanee Hospital. Thai nurses at other hospitals might pronounce some words differently. For example, 'ID' is pronounced as abbreviation /ʔai.diː/ for Thai nurses at Nopparat Rajathanee Hospital, but is fully produced as /ʔin.tâː.dəː.mɔ̂ː/ for the ones at Chulalongkorn Hospital. Another example is from 'ROM' which is pronounced as /lɛ́ː.ŋ.ʔɔ́ː.p.moː.tɕ͡ʰân.pòk.kà.tì/ ('regular range of motion' in Thai) for Thai nurses at Nopparat Rajathanee Hospital, but as /fuː.lɛ́ː.ŋ.ʔɔ́ː.p.moː.tɕ͡ʰân/ ('full range of motion' in Thai) for the ones at Suranaree University of Technology Hospital. Future study might investigate the pronunciation of English medical loanwords by Thai nurses at other hospitals as compared with the one by Thai nurses at Nopparat Rajathanee Hospital in this study.

Secondly, as the data used in this study had no diphthong /ʊə/, nor /ð/ and /ʒ/ in initial position of the syllable, the investigation of these sounds in English medical loanwords by Thai nurses was limited. Further study might be carried out on the English medical loanwords by Thai nurses with these three sounds in the target words. It might be found that these three sounds were substituted with the Thai sounds similar to the ones used by general L2 Thai learners when pronouncing these English sounds.

The third limitation is on the analysis of the Thai tones in the loanwords. Although there were studies on tonal rules in English loanwords in Thai (e.g., Gandour, 1979; Nacaskul, 1979), the analysis for tonal rules was not the focus of this study. For future research, it would be interesting to carry out an examination of the rules when using Thai tones in English medical loanwords by Thai nurses.

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