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"Courage is resistance to fear, mastery of fear, not absence of fear."

Mark Twain (1835 – 1910)
American author

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Free Papers

Editorial

Malaria in 2018: Looking to the Past and Moving into the Future

Po Ying Chia, [1]*MBBS, MRCP*, Li Yang Hsu,[1,2]*MBBS, MPH*, Tsin Wen Yeo, [1,3]*MBBS, PhD*

World Malaria Day is observed and commemorated annually on 25 April in recognition of the ongoing global burden and the efforts to control it. Malaria is caused by *Plasmodium* parasites, of which 5 species are known to cause disease in humans, namely *P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi*.[1] It is a vector borne disease and is transmitted by Anopheles mosquitoes. Although potentially life threatening, prognosis is excellent if the disease is diagnosed early, and treated promptly with effective antimalarials.[1]

In the late 1990s, the incidence of malaria was at a peak and globally it was the major contributor of morbidity and mortality from an infectious aetiology. Since then, effective control efforts have led to a major reduction in both the incidence rate and mortality by 41 and 62 percent during the period 2000-2016.[2] However, in 2016, malaria still caused an estimated 216 million cases and 445,000 deaths.[2] The greatest burden of disease is in the World Health Organization (WHO) African region which has approximately 90 percent of cases; the next major area is Southeast Asia where Singapore is geographically located, with an estimated 6-7 percent of the global incidence.[2,3] Singapore's malaria control efforts in the 1970s and 1980s were effective and it achieved and maintained its malaria-free status (defined as no local transmission of all human parasites for 3 consecutive years) since 1982.[4] In fact, Singapore is 1 of only 4 countries in Asia, which has accomplished this, the others being Brunei in 1987, Maldives in 2015, and Sri Lanka in 2016.[2,3]

Since then, Singapore has reported clusters of human malaria suggestive of autochthonous transmission. These include a 3-cluster outbreak involving 29 individuals in 2009 with all cases within each cluster being epidemiologically linked.[3] In 2007 and 2008, Singapore also reported 5 cases of locally acquired *P. knowlesi* infection, which is strictly not a human but a simian malaria which causes zoonotic human disease.[5] The reservoir for *P. knowlesi* is the long-tailed macaque commonly seen in our nature reserves, and local studies have shown that forest dwelling but not urban monkeys harbour these parasites.[5] Human *P. knowlesi* infections have been reported in almost every Southeast Asian country with large foci in Indonesian Sumatera, Peninsular Malaysia and Malaysia Borneo where it is now the most common cause of malaria. Significantly, *P. knowlesi* is difficult to differentiate from *P. malariae* on microscopy alone and may require molecular diagnostic tools such as polymerase chain reaction and loop-mediated isothermal amplification.[6]

In 2016, Singapore only reported 31 laboratory-confirmed malaria cases of which all were imported. While this suggests that the risk of re-emergence is low, Singapore's geographical location in Southeast Asia, position as a travel and tourism hub, reliance of foreign workers from malaria-endemic countries, high population density and presence of Anopheles mosquitoes are reasons why Singapore remains vulnerable. A comprehensive system of vector surveillance and control, early case detection and notification system, aggressive prevention and actions upon detection of cases are thus necessary to allow Singapore to maintain its malaria-free status.

Clinical management of malaria requires accurate diagnosis and effective antimalarial agents. Microscopy is sensitive for detection of all *Plasmodium* species infecting humans but may not be able to differentiate *P. knowlesi* from the other species as mentioned above. Rapid diagnostic tests are sensitive for *P. falciparum* infections, but this decreases significantly for the other species.[6] Resistance to antimalarial agents is a defining feature of *P. falciparum* (and to a lesser degree, *P. vivax)* which complicates the clinical management of malaria especially in resource-challenged countries.[7] Increasing resistance of *P. falciparum* to first and even second-line drugs contributed to the high global mortality rate of malaria in the late 1990s.[7] Mefloquine resistance has already resulted in changes in choice of malaria chemoprophylaxis in the Cambodia and Thailand region. The development and widespread implementation of highly effective artemisinin-based combination therapies (ACT) which consists of an artemisinin derivative and a

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partner drug, has been a major contributor to the significant decrease in malaria-related deaths since the early 2000s.[7] However, development of subclinical resistance to artesunate (the major active ingredient in ACT) was first noted in Western Cambodia in 2008 with delayed parasite clearance.[7] This has been attributed to mutations in the Kelch 13 propeller domain.[8] Despite major efforts to counter this threat, reports of clinical failures to ACTs (including partner drugs) widely used in national malaria programmes in Southeast Asia emerged in Cambodia in 2016, and has since spread to Thailand, Laos, Cambodia and Vietnam.[9] This confirmed that *P. falciparum* had developed resistance to both artemisinin and the partner drug and in a repeat of the scenario with chloroquine, the possibility of spread of this drug-resistant strain to the rest of Asia and Africa with a recurrence of the high mortality associated with malaria in the 1990s.[7] Currently, major efforts led by the Global Fund's Regional Artemisinin Initiative are ongoing to try and avert this possible catastrophe. However, there is still debate and controversy about the optimal methods to achieve this.

While *P. vivax* is perceived to be less of a global threat, recent reports from Asia suggest that in contrast to traditional literature, vivax malaria can also cause severe disease.[1] In addition, resistance to chloroquine, considered the most cost-effective drug in the treatment of *P. vivax* malaria, is widespread in Indonesia and has been also reported in Malaysian Borneo as well other Southeast Asian countries.[7]

The development of ACTs in the late 20th century was pioneered by scientists from China which resulted in the award of a Nobel Prize in Medicine to Tu Youyou in 2015.[10] Recently, Singapore, (led by scientists at the Novartis Institute of Tropical Disease) has discovered 2 new agents, KAE609 and KAF156 from 2 novel antimalarial groups, the spiroindolones and imidazolopiperazines.[11,12] These drugs in phase 2 trials have shown superior or comparable parasite killing rates compared to even the ACTs.[11,12] However, the widespread use and deployment of these compounds require further studies to further evaluate safety, pharmacokinetic/pharmacodynamic parameters and barriers to the development of resistance with use of suitable partner drugs.

Malaria elimination has been on the global health agenda since 1955 and the Global Malaria Eradication Programme using a programme of effective case management and vector control successfully eradicated malaria from North America, parts of South-Central America, Europe, and parts of Asia.[13] However, the programme was suspended in 1969 due to resistance to drug and insecticide, lack of funding and inadequate community participation, as well as social unrest.[13] Consequently, malaria re-emerged in parts of Europe and central Asia. To continue the fight against malaria, the Roll Back Malaria initiative was launched in 1998, along with a set of interconnected goals consisting of action and investment to defeat malaria. This has continued with a Global Technical Strategy for Malaria, and Sustainable Development Goals in 2016, all of which are scheduled to continue until 2030.[2] The strategy aims for at least 90% reduction in malaria incidence and mortality rates globally (compared to 2015), to eliminate malaria in at least 35 countries, and to prevent resurgence in all countries that are malaria-free by 2030.[2] This has been mostly successful as mentioned above from 2000-2015, and there are 22 countries with the potential to eliminate malaria by 2020. In the Asian region, these include Bhutan, Nepal, Timor-Leste, China, Malaysia and the Republic of Korea.[2] However, in the recent 2017 World Malaria Report, it was noted that the rate of decline had stalled and even reversed, resulting in an increase of 5 million cases from 2015-2016 in all regions including Southeast Asia.[2] This has been coincident with decreased funding for malaria control since 2014 with the WHO estimating that USD$6.5 billion is required annually to achieve the 2030 targets but with only USD$2.7 billion invested in 2016.[2] These observations and the lack of an effective malaria vaccine with long-term protection suggests that the potential for a resurgence of malaria is always a possibility without continued resources invested in ongoing control and elimination programmes.

Historically, malaria has been prevalent in Singapore and the potential for resurgence is still present. Malaria knows no borders and it is imperative that we persevere in constant vigilance and commit necessary resources to eradicate it. However, much progress has been made and there is still hope, with renewed political efforts and substantial resources being allocated to fight malaria, novel drug candidates in the pipeline and vaccines being developed, that we can achieve targets set for 2030 and eventually, total eradication.

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Original Article

Comparison of Formulae for Orotracheal Intubation Depth in the Paediatric Population

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Abstract

Introduction: Multiple formulae have been proposed for calculating orotracheal depth for paediatric intubation. However, literature on the validation of these formulae in the emergency department setting is limited. Three methods described in the local Advanced Paediatric Life Support curriculum include the Broselow tape, endotracheal tube (ETT) size x 3, and the age-based formula of age divided by 2, add 12. We aimed to determine their accuracy. Materials and Methods: Patients with intubation performed in the Children's Emergency from 1 January 2009 to 31 December 2013 were included in this retrospective observational study. The depths of ETT placement based on the formulae were calculated from the actual depth of ETT. ETT position between T2 to T4 vertebral bodies of the chest radiograph was taken as the reference position for radiological accuracy. Results: ETT size x 3 has the highest accuracy of 76.5%, as compared to 67.9% for age-based formula and 63.5% for Broselow tape. When the formulae were inaccurate, Broselow tape often predicted a depth that was too shallow as compared to ETT size x 3 ($P = 0.006$) and age-based formula ($P = 0.011$). The accuracy of Broselow tape was not uniform across the age groups, with highest accuracy in patients 1 to 8 years old. ETT size x 3 had the highest accuracy in patients weighing more than 25 kg. Conclusion: ETT size x 3 was superior for determining orotracheal intubation depth but cannot preclude the confirmation of appropriate placement of ETT by auscultation and chest radiograph.

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Key words: Airway management, Emergency, Resuscitation

Introduction

Tracheal intubation can be a life-saving intervention performed during the emergency setting, with a wide range of indications in critically ill children.[1-2] The paediatric airway has unique challenges due to the patient's age, size, and underlying condition. Therefore, it is important to use an appropriate approach when performing tracheal intubation and anticipate the potential difficulties. Once intubation is done, the endotracheal tube (ETT) has to be secured at the appropriate depth—too shallow and it can lead to excess risk of inadvertent extubation; too deep, and it can lead to inadequate (endobronchial) ventilation and hypoxemia. In both situations, they are considered adverse tracheal intubation associated events,[3-4] having far-reaching consequences such as airway loss, barotrauma and hypoxia. The routine clinical confirmation of appropriate ETT insertion depth is in turn obtained through a chest radiograph.

Numerous formulae (Table 1) have been published to guide the physician in deciding this appropriate depth, with reference to age, body weight and length. As reported by Boensch M et al[5] in their systematic review, 13 different formulae were identified for use in paediatric patients ranging from newborns up to 16 years old. The maximal accordance for any formula when correlating the position of ETT with chest radiographs was 81%. However, existing studies have only examined each formula in isolation.

In our local curriculum of Advanced Paediatric Life Support Course (APLS), 3 formulae—Broselow tape, ETT size (internal diameter) x 3, and the age-based formula of age divided by 2, add 12 (for use in more than 1 year old)—are

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Table 1. Formulae for Estimating Depth of Insertion of Orotrachael Endotracheal Intubation

	Formula
Age-based (years)	Age/2 + 12[*,†,‡]
	Age/2 + 13[§]
Weight-based (kg)	Weight + 6[ǁ,¶,#]
	Weight/2 + 8[§]
	ln (weight) + 6.632[**]
Length-based (cm)	Broselow tape
	(Length + 5) x 0.1[††,‡‡]
Others	Size of endotracheal tube x 3[§§]
	(Gestation x 0.188) + 1.198[**]

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recommended for the calculation for depth of orotracheal intubation.[6] The Broselow tape relates a child's height to weight and provides information on size of resuscitation equipment as well as dosages for medications and energy level for cardioversion/defibrillation. By using the tape to measure the child from the head to heels, the user can get an approximate weight with corresponding information for resuscitation purpose. Drugs for rapid sequence intubation, the size (internal diameter) of ETT and depth of placement are provided on Broselow tape for intubation. We aimed to determine the accuracy of ETT insertion depth based on these 3 formulae against a radiological reference standard. This would allow us to identify any limitations in their clinical applicability in paediatric patients up to 16 years old.

Materials and Methods

Settings

This retrospective review was conducted in the paediatric emergency unit of a tertiary hospital in Singapore with an attendance of more than 170,000/year. One percent of the patients are of the high-priority emergent category. There was no general consensus or recommendation for using any formula to guide depth of placement of ETT for intubations in the department. This decision was often left to the discretion of the attending physician.

Design

Data was retrospectively collected using standardised forms for all intubations performed in the paediatric emergency unit from January 2009 to December 2013. Data fields pertaining to age, weight, gender, diagnosis, indication for intubation, size (internal diameter) and type (cuffed or uncuffed) of ETT and depth of placement measured at the patient's upper incisor were collected.

Patients with intubation performed prior to arrival at the emergency department were excluded. However, if the attending clinician deemed that reintubation was necessary for any reason such as tube dislodgement or persistent air leak due to wrong size in the department, they were included in the study. This study was approved by Institutional Review Board at SingHealth, Singapore.

Accuracy of ETT Insertion Depth against a Radiological Reference Standard

Proper placement of the ETT has been accepted as a position below the thoracic inlet and at least 0.5 cm above the carina.[7] However, the caudal movement of the ETT tip due to neck flexion has been reported to be 0.8 cm in neonates, with larger extent of movements in older children.[8] This suggests that the ETT might still be deep when the neck is not in neutral position.

Position between upper border of T2 to lower border of T4 vertebrae bodies—corresponding to the middle third of the traches—has also been accepted when the carina cannot be visualised.[9,10] The latter was used as a reference for radiological accuracy in our study to minimise the number of cases excluded due to technical difficulty in identifying the carina on chest radiographs. Furthermore, this method was applicable to the emergency unit setting as the other described method of using bronchoscopy[11-13] to determine satisfactory ETT placement would not be practical.

Using the visualised depth of the ETT on the chest radiograph with the corresponding numerical depth recorded in each case as a reference point, the hypothetical depths of ETT placement based on the 3 formulae were plotted with respect to it. Hypothetical depths that were higher than the T2 vertebrae were taken to be inappropriately shallow

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whilst depths that were lower the T4 vertebrae were taken to be inappropriately deep.

Statistical Methods

Statistical analysis was performed using SPSS version 16 and R3.3.1. Median and interquartile range (IQR) were presented for continuous variables while count and percentage were indicated for categorical variables. Kruskal-Wallis rank sum test was used to study the overall correlation of accuracy of each formula with body weight and ad hoc pairwise comparisons were performed using Wilcox test with Benjamini-Hochberg adjustment. The correlation of accuracy with age groups and gender were tested by chi squared test. The level of significance was 0.05.

Results

A total of 207 intubations were performed between January 2009 and December 2013, with an incidence of 1 intubation per 8.82 days on average.

Patient Characteristics

Table 2 describes the patient characteristics. The median age of the patients was 4 years old. A total of 60.9% of the study population required intubation for decreased consciousness and loss of airway reflexes. All intubations performed were successful, with a first attempt success rate of 84.1%.

Performance of the 3 Commonly Used Formulae

ETT size x 3 had the highest accuracy of 76.5%, as compared to the accuracies of age-based formula of age divided by 2, add 12 and Broselow tape (of 67.9% and 63.5%, respectively) (Table 3). When the formulae were inaccurate, Broselow tape often predicted a depth that was too shallow as compared to the formula of ETT size x 3 (P = 0.006) and the of age-based formula of age divided by 2, add 12 (P = 0.011).

Age and Weight Considerations

Age

The performance of the formulae ETT size x 3 (P = 0.034) and age divide by 2, add 12 were consistent across the age groups. Broselow tape performed best for patients between 1 to 8 years old but the accuracy fell below 40% for patients less than 1 or more than 8 years of age (P <0.001) (Table 4).

Weight

ETT size x 3 had the highest accuracy in patients weighing more than 25 kg (P = 0.015) but it predicted a depth that was too deep for children with weight <8 kg (Table 5). The higher accuracy in patients weighing more than 25 kg was

Table 2. Patient Characteristics

Demographics	
Age (years)	Median: 4; IQR: 11 months to 8 years
Weight (kg)	Median: 15; IQR: 8 to 25
Gender (male)	54.1%
Top 5 diagnostic categories*	
Neurological	109 (52.7%)
Trauma	28 (13.5%)
Respiratory	27 (13.0%)
Cardiology	22 (10.6%)
Infectious disease	14 (6.8%)
Indication for tracheal intubation	
Decreased consciousness and loss of airway reflexes	126 (60.9%)
Failure to ventilate	40 (19.3%)
Failure to oxygenate	35 (16.9%)
Anticipated clinical course or deterioration	6 (2.9%)

IQR: Interquartile range
*The remaining cases are intubated for metabolic, allergy, haematology and toxicology causes.

Table 3. Performance of the 3 Formulae

	Accurate Depth n (%)	**Depth Too Shallow n (%)**	**Depth Too Deep n (%)**
ETT x 3 (n = 187)	143 (76.5)	17 (9.1)	27 (14.4)
Age/2 + 12 (n = 140*)	95 (67.9)	18 (12.9)	27 (19.2)
Broselow tape (n = 178)	113 (63.5)	43 (24.2)	22 (12.3)

ETT: Endotracheal tube
*Only patients more than 1 year of age were included in analysis for this formula.

Table 4. Accuracy of 3 Formulae by Age Groups

	Less than 1 Year	**1 to 8 Years**	**More than 8 Years**	***P* Value**
ETT x 3 (n = 143)	32/47 (76.5)	72/96 (75.0)	35/35 (79.5)	0.628
Age/2 + 12* (n = 95)	NA	66/96 (68.8)	29/44 (65.9)	0.4
Broselow tape (n = 113)	17/44 (38.6)	83/91 (91.2)	13/43 (30.2)	<0.001

ETT: Endotracheal tube; NA: Not applicable
*Only patients more than 1 year of age were included in analysis for this formula.

Table 5. Performance of 3 Formulae by Weight Groups

		n (%)			
		Less than 8 kg	**8 to 25 kg**	**More than 25 kg**	***P* Value**
ETT x 3 (n = 187)	Correct	34 (65.4)	68 (74.7)	41 (93.2)	0.015
	Shallow	5 (9.6)	10 (11.0)	2 (4.5)	
	Deep	13 (25)	13 (14.3)	1 (2.3)	
Age/2 + 12* (n = 140)	Correct	5 (100)	63 (67.8)	27 (64.3)	0.16
	Shallow	0 (0)	15 (16.1)	3 (7.1)	
	Deep	0 (0)	15 (16.1)	12 (28.6)	
Broselow tape (n = 178)	Correct	26 (59.1)	53 (58.2)	34 (79.1)	0.202
	Shallow	12 (27.3)	25 (27.5)	6 (14.0)	
	Deep	6 (13.6)	13 (14.3)	3 (6.9)	

ETT: Endotracheal tube
*Only patients more than 1 year old were included in analysis for this formula.

also observed for Broselow tape, though the result was not statistically significant ($P = 0.202$).

Repositioned ETT

In this study, inappropriate depth of ETT post-intubation as confirmed on chest radiograph occurred in 32 (15.5%) cases. Twenty-seven (84.4%) of the cases were due to an initial insertion depth that was too deep from clinical examination and/or verification by chest radiograph, according to the discretion of the attending team. However, the retrospective nature of this study precluded further exploration into this observation as the formula used by the physician at the time of intubation was unknown.

Discussion

Variability in tracheal length across all age groups in the paediatric population makes accurate ETT placement critical and challenging. Incorrect placement of ETT can lead to significant morbidity or potential mortality. A depth that is too deep can lead to main stem bronchus intubation with potential for barotrauma and air leak syndromes in one lung, and insufficient ventilation and atelectasis of the other. A depth that is too shallow is at a higher risk of inadvertent extubation especially during transfer of these critically ill children. Despite the common use of the 3 methods of estimating depth of orotracheal intubation, there is limited medical literature to directly compare their use in the same patient population.

Performance of the Formulae

Our study directly compared the 3 commonly used methods of determining ETT depth in the emergency department setting which was not available in current literature. ETT size x 3 was the most accurate formula with an accuracy of 76.5% that was similar to that of 75% as reported by Phipps et al[7] in patients admitted to the paediatric intensive care unit. However, Mariano et al[13] reported an accuracy of a mere 42%. We postulated that this could be related to the difference in the definition of accuracy used in the studies. Like our study, Phipps et al used position of the ETT on the chest radiography to determine accuracy of the formula as per the practice of many clinicians. However, Mariano et al based the accuracy of the formula by determining depth with markers on the ETT after deliberate endobronchial intubation with subsequent withdrawal of the tracheal tube 2 cm above the carina (which was less feasible in our emergency department setting).

Like the depth of ETT insertion, several formulae for the determination of ETT size exist— of which Broselow tape and Advanced Paediatric Life Support (APLS) age-based formula of age divided by 4, add 4—are commonly used. The variable by which ETT size and type (cuffed vs uncuffed ETT) was determined may have subsequent effect on the depth of ETT placement if the formula ETT size x 3 was used and could not be accounted for in this retrospective study. Furthermore, narrowing of the airway as a result of infection, oedema and local trauma in critically ill children may lead to the use of a smaller ETT by the clinician during the intubation process, affecting the accuracy of the formula ETT size x 3 in predicting depth of ETT placement.

Length-based formula using the Broselow tape for selection of ETT size has been reported to be superior to age-based formula.[7,14-16] However, this comparison for the depth of ETT placement was not evaluated previously. Our study showed a slightly higher accuracy for the age-based formula as compared to the Broselow tape across all age groups. However, on closer examination across the age groups, the accuracy of Broselow tape was highest at 92.1% for the prediction of ETT depth in patients between 1 to 8 years old. This was consistent with the findings of a previous local study on the validation of Broselow tape for weight estimation in 1- to 10-year-olds by Loo PY et al.[17] Together, it seemed to suggest that Broselow tape may perform better for local children aged between 1 to 8 years. This was supported by reports of variable performance of Broselow tape across the age groups by validation studies in the non-United States population.[16,18-20]

ETT size x 3 and possibly Broselow tape were more accurate in patients weighing more than 25 kg. The clinician would need to be aware of this limitation in patients weighing 25 kg or less, and consider the use of other formulae to determine depth of ETT insertion (e.g. using weight-based formulae in neonates or infants less than 1 year of age).

Readjustment of ETT Depth

Orf et al[21] has reported that adjustment of tracheal tube insertion depth occurred in 33.3% of cases with 97% being inappropriately deep. The study population involved patients who were intubated by non-specialist teams and subsequently transferred to a specialist paediatric hospital. In our study, 15.5% required adjustment of tracheal tube insertion depth. This lower proportion of cases could be attributed to the presence of paediatric specialists to perform these intubations within the Children's Emergency. Nonetheless, inappropriately deep insertion formed the majority (84.4%) of cases requiring readjustment of ETT.

Limitations

The most significant limitation of our study was that we were unable to obtain information on the intended formula used by the clinician at the point of intubation for the depth of insertion. Therefore, we needed to calculate the depths of insertion for the 3 formulae based on the actual depth of insertion using the chest radiographs of the patients. The final number of cases analysed was also lower than the total number of intubations performed in the department due to no information on actual ETT depth due to missing documentation, or missing chest radiographs from the image viewer database.

It should also be mentioned that the effect of neck movement on position of ETT would be more pronounced in the paediatric population—neck flexion can move the tip of the tube towards the carina while neck extension can result in the tip moving away from the carina; and both of which affect the final position on the chest radiograph. As this was a retrospective study, we were not able to confirm that all radiographs were taken with the head in neutral position to minimise the effect of neck movement on ETT position seen on the chest radiograph. Given that these chest radiographs have been reviewed by the attending team after intubation with readjustments made—if indicated—it would be fair to assume that the radiographs were taken in a satisfactory position to make clinical decisions post-intubation.

Conclusion

Generally, ETT size x 3 was the superior formula across all age groups for determining orotracheal intubation depth. It has an accuracy of 76.5%, as compared to 67.9% and 63.5%, for the age-based formula of age divided by 2, add 12 and Broselow tape, respectively. ETT size x 3 was most accurate in patients weighing more than 25 kg, and Breslow tape had the best performance for paediatric patients aged between 1 to 8 years old. While the search for a more reliable formula to determine the appropriate depth of ETT placement in children continues, such a formula cannot preclude the confirmation of appropriate placement of ETT by auscultation and chest radiograph.

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Original Article

Evaluation of Community-based Hypertension Control Programme in South Korea

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Abstract

Introduction: This study was conducted to provide an overview of the community-based hypertension and diabetes control programme of 19 cities in Korea and to evaluate its effectiveness in controlling hypertension at the community level. Materials and Methods: In this longitudinal observational study, we analysed the data of 117,264 hypertensive patients aged ≥65 years old from the time of their first enrolment in July 2012 to October 2013 (up to their 2-year follow-up). Results: The hypertension control rate of 72.5% at the time of enrolment increased to 81.3% and 82.4% at 1 and 2 years after enrolment. Treatment continuity, completion of hypertension self-management education, and longer enrolment duration in the programme contributed to improvements in hypertension control rate. Conclusion: This programme was characterised by a public health-clinical partnership at the community level. Despite its simplicity, the programme was evaluated as a successful attempt to control hypertension among patients aged >65 years at the community level.

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Key words: Health education, Participatory research, Public health-clinical partnership

Introduction

Hypertension is the most common risk factor for all cardiovascular diseases. The World Health Organization (WHO) defined hypertension as a major risk factor for coronary artery and cerebrovascular diseases.[1] In Korea, the prevalence rate of hypertension was 29.1% in 2016. The number of hypertensive patients is expected to increase again in the future due to the ageing population of Korea.[2] Deaths caused by cardio-cerebrovascular diseases accounted for 21.6% of deaths in Korea in 2016—approximately half of this (49.3%) was caused by cardiac diseases, 38.8% was due to cerebrovascular diseases and the rest (8.9%) was due to hypertensive disease.[3] Additionally, these diseases have caused heavy financial burden for the country. For example, in 2008, the overall healthcare costs amounted to US$10 billion: cerebrovascular diseases (US$4.5 billion); hypertensive heart diseases (US$3.5 billion); ischaemic heart diseases (US$2.1 billion); inflammatory heart diseases (US$150 million); and rheumatic heart diseases (US$65 million).[4]

In 2006, the Korean government initiated a comprehensive plan to control the cardio-cerebrovascular disease cases in the country. As part of the plan, the community-based hypertension and diabetes control programme was implemented in 2009 to encourage patients to continue receiving relevant treatments and improve their behaviours toward these diseases.[5] This study describes the characteristics of the hypertension control system run by the programme and shows the effectiveness of the programme in controlling hypertension in the Korean context.

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Materials and Methods

Characteristics of the Community-based Hypertension Control Programme

To improve hypertension control at the community level, the programme aims to encourage behavioural change and continue hypertension treatment among participants. In line with this programme, the government established Hypertension/Diabetes Registration and Education Centers (HDRECs) in 19 cities. The steering committee of the centre is composed of public health officials, primary care physicians, pharmacists, and community leaders. Each centre manages the patient enrolment, provides education to encourage behavioural change and information on the disease, and reminds enrollees of the available services (Fig. 1).

Patients aged ≥30 years who visited the local clinics for hypertension treatment or were newly diagnosed with hypertension were advised to participate in the programme. Older patients (≥65 years) enrolled in the programme were eligible to receive financial incentives (discount on their medical expenses) of as much as US$3 per visit for a month. The designated clinics also received an additional payment of US$1-5 per patient per year from the government for their consistent efforts to register and provide education to the patients.

The regional HDRECs provide 8 hours of education on the control of hypertension and diabetes to new enrollees. This education provides patients with information on how to adopt a healthier lifestyle and to take one's medications properly. Furthermore, the primary care physician of the clinic registers patients who are newly diagnosed with hypertension and diabetes aged ≥30 years to the system. Moreover, the nurses, dietitians and exercise therapists who work in the regional centres provide professional periodical counselling on how to control hypertension. Each regional centre runs a call centre as well. The call centre agents counsel patients and remind them to make regular appointments with their doctors via text messages or telephone calls. This provision of information to patients is supported by an information system run by the Korea Centers for Disease Control and Prevention (KCDC), which sends automated text messages reminding patients enrolled in the programme to visit their doctors.

The characteristics of this system can be summarised as follows: 1) Medical approach: To encourage continued treatment, the programme provides incentives for enrollees and reminds them of their periodic visits to the doctor; 2) Behavioural approach: Regional centres provide enrollees with education on how to improve their individual lifestyles; 3) Community-based approach: The system strives to improve public health by mobilising community resources, such as primary clinics, public health centres, healthcare professionals, and lay leaders; 4) Public-private partnership: The government cooperates with primary clinics and provides small monetary incentives for their participation in the programme; and 5) Simple system: Only a few elements (regional centres, information system, and financial incentives) were added to the existing healthcare delivery system.

After the initiation of the programme in 2009, the number of enrolled patients has continuously increased. As of 15 October 2015, this figure had reached 318,419 patients from 19 cities. At the time, the number corresponded to 32.9% of all patients with hypertension or diabetes. The budget of the programme was set at US$13.4 million for 2016, half

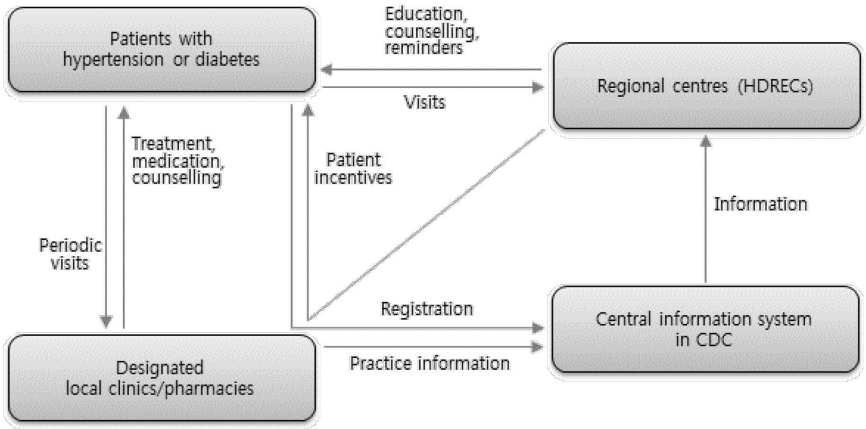

Fig. 1. Elements of the Hypertension/Diabetes Registration and Control Program in Korea. CDC: Centers for Disease Control and Prevention; HDRECs: Hypertension/Diabetes Registration and Education Centers.

of which was to be provided by the central government and the other half by the local governments participating in the programme.[6]

Data Source and Participants

We used the patient information from the central information system at the KCDC. Inputting of the blood pressure information of hypertensive patients into the central information system was mandated starting in July 2012. However, the blood pressure information of patients aged 30-64 years old participating in the study was incomplete because they were not eligible to receive financial incentives. To evaluate the effectiveness of this programme, the participants were chosen among hypertensive patients aged ≥65 years (with financial incentives), who had newly participated in the registration control programme from July 2012 to October 2013, and had been enrolled in the programme for over 6 months. Subsequently, these participants were followed-up for 2 years. The final number of participants included in the analysis was 117,264 and at 2 years and the post registration number was 97,680 (Fig. 2 and Table 1).

For these participants, the total data-points for patients who had information on blood pressure was 426,842 and the missing rate of blood pressure information was 0.27%. This study was approved by the Institutional Review Board of the Soonchunhyang University (Reg. no. 201604-BM-013-01).

Definitions of the Study Variables

'Hypertension control' was defined as <140 mmHg systolic blood pressure (BP) and <90 mmHg diastolic BP. The 'continued-treatment rate' was calculated as follows: (number of visits/total registration period [month]) × 100. 'Education completion' was determined based on whether the patient completed 8 hours of hypertension self-management education conducted by the HDRECs. The registration control period was divided into at-registration point, 6 months, 1 year, and 2 years (if the patient's blood pressure information at a certain period was missing, then it was replaced with the nearest value out of all measured data taken within a month).

Table 1. General Characteristics of the Study Participants based on the Registration Control Period

Characteristic	At-Registration	6 Months	1 Year	2 Years
No. of participants	117,264	108,372	104,694	97,680
Age (mean ± SD)	73.0 ± 6.1	73.7 ± 6.1	73.9 ± 6.0	74.6 ± 5.9
Male sex (%)	36.0	36.1	35.9	35.7
Education experience (%)	0.3	4.3	8.0	13.6
Treatment continuity (%)				
>90%	43.6	47.2	47.6	46.9
80% – 90%	21.0	22.6	22.3	21.6
<80%	35.4	33.2	30.1	31.5
Control rate (%)	72.5	76.0	81.3	82.4

SD: Standard deviation

Data Analysis

All analyses were conducted using STATA version 14.0 (StataCorp LLC, College Station, TX, USA). The general characteristics of the registered patients based on the registration control periods are presented as mean ± standard

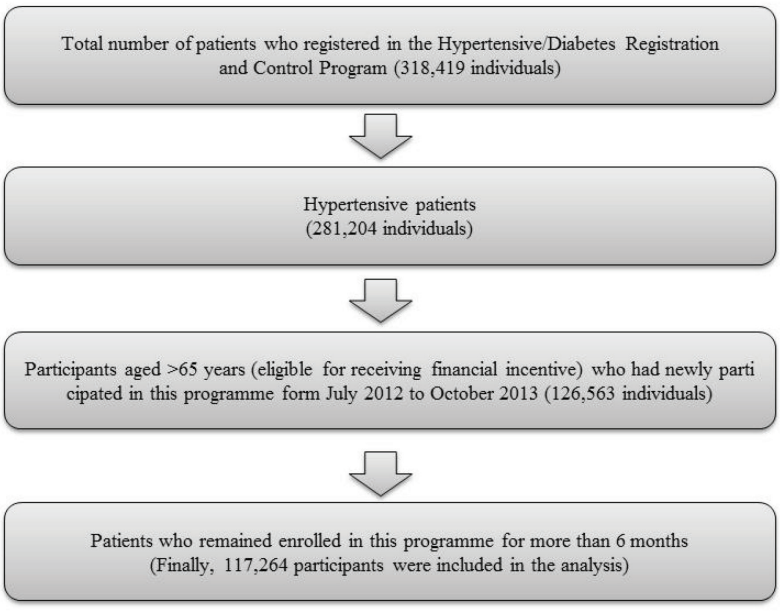

Fig. 2. Chart showing the number of participations included in the analysis from the programme.

deviation (SD) or percent. To identify the factors affecting hypertension control, the generalised estimating equation (GEE) models were applied by considering the clustering effects of the same patient pools and correlation of the repeat measures. The covariates included in this model were gender, completion of hypertension self-management education from the HDRECs, continued-treatment rate, and registration control period. Completion of hypertension self-management education was treated as a time-varying covariate for 'before' versus 'after' the completion of education.

Results

The total number of enrolled hypertensive patients between July 2012 and October 2013 was 117,264. Of these patients, 108,372, 104,694 and 97,680 were followed-up at 6, 12, and 24 months, respectively. The mean age of the 117,264 participants was 73.0 years (SD, 6.1), with men accounting for 36% of the overall number of patients. During the study period, 12.5% (14,677) of the total participants completed the 8-hour hypertension self-management education conducted by the HDRECs. Of the total number of patients enrolled, 43.6% and 21% had >90% and 80-90% continued-treatment rates. Meanwhile, <80% continued-treatment rate was reported for 35.4% of the total participants. The hypertension control rates among participants changed depending on the registration control period. For example, the hypertension control rate was 72.5% at the point-of-registration, which increased by 8.8% (81.3%) and 9.9% (82.4%) by the first and second year of registration control, respectively, compared with the point-of-registration. This finding showed an increasing trend for hypertension control rate after the enrolment of the patients to the programme (Table 1). When we analysed our data matching a patient retrospectively (based on 2 year, 1 year and 6 months, respectively), there were no big difference in the hypertension control rate at-registration between the remained-group at 2 years after registration, and the group-at-registration (73% vs 72.5%). And the result of McNemar's test for paired data showed that there were significant difference in hypertension control rate between at-registration and each observed periods (P <0.001) (Table 2).

We found that men experienced more difficulty in controlling hypertension than women (odds ratio [OR], 0.85; 95% confidence interval [CI], 0.84-0.87). Additionally, completion of hypertension self-management education provided by the HDRECs was proven effective in controlling hypertension (OR, 1.18; 95% CI, 1.14-1.23). Compared with the OR of patients whose continued-treatment rate was >90%, the ORs of those with continued-treatment rates of 80-90% and <80% were 0.91 (95% CI, 0.89-0.93) and 0.82 (95% CI, 0.81-0.84), respectively for hypertension control. Therefore, this finding suggests that the increase in continued-treatment rate is an important aspect in controlling hypertension. Moreover, compared with the OR of the point-of-registration, the ORs of the periods after 6 months, 1 year, and 2 years were 1.18 (95% CI, 1.16-1.20), 1.62 (95% CI, 1.59-1.65), and 1.72 (95% CI, 1.69-1.75), respectively. This result indicates that the hypertension control rate increased as the patient stayed longer in the programme and that the registration programme was effective in controlling hypertension (Table 3).

Discussion

This paper describes a national programme aimed at controlling hypertension in Korea. Considering that hypertension and diabetes are challenging issues for public health worldwide, many countries implemented diverse forms of national programmes, such as the National Diabetes Prevention Program (DPP) in the United States,[7] Disease Management Programme (DMP) in Germany,[8] and North Karelia Project in Finland.[9] The United States' National DPP is a partnership between public and private organisations, including the country's Centers for Disease Control and Prevention, community organisations, private insurers, employers, healthcare organisations, faith-based organisations, and government agencies, and the cost incurred by the programme is paid by private insurers and employers.[10] Meanwhile, Germany's DMP is a patient registration programme, where doctors provide continued medical treatment and education. When a doctor registers a patient in the programme, the doctor receives an incentive payment of 100 euros for the registration and another additional incentive payment for providing relevant

Table 2. The Result of McNemar's Test for Hypertension Control Rate

Registration Period	No. of Patients	Hypertension Control Rate (%)				*P* Value*
		At-Registration	6 Months	1 Year	2 Years	
At-registration	117,264	72.5				-
6 months	108,372	72.8	76.0			<0.001
1 year	104,694	72.8		81.3		<0.001
2 years	97,680	73.0			82.4	<0.001

*McNemar's test for paired nominal data.

Table 3. Multivariate Generalised Estimating Equation Models Used to Predict Hypertension Control among Hypertensive Patients who Participated in the Hypertension/Diabetes Registration and Control Programme

Variable	Odds Ratio	95% Confidence Interval	*P* Value
Sex (male vs female)	0.85	0.84 – 0.87	<0.001
Education experience (yes vs no)	1.18	1.14 – 1.23	<0.001
Treatment continuity (vs >90%)			
80% – 90%	0.91	0.89 – 0.93	<0.001
<80%	0.82	0.81 – 0.84	<0.001
Enrolment duration (vs at-registration)			
6 months	1.18	1.16 – 1.20	<0.001
1 year	1.62	1.59 – 1.65	<0.001
2 years	1.72	1.69 – 1.75	<0.001

education. As part of the programme, the patients receive diverse services, such as medical consultations (once every 3 months), health checks, blood tests, education, and evidence-based treatments. This programme was evaluated as successful in reducing mortality rates, decreasing disease complications, and lowering healthcare costs.[11]

Meanwhile, similar programmes in Germany and Australia have focused on paying apt incentives to primary care physicians to manage and encourage patients to take proper medications and seek treatment.[12,13] Registration and providing education and information, including telephone call reminders, are the common components of chronic care programmes in most countries.[8]

Korea's programme for hypertension and diabetes control, which was investigated in this study, is composed of elements also commonly used in other countries. The programme tried to adopt medical, behavioural, and community-based approaches at once, and the task was made possible by establishing regional centres (HDRECs) in addition to the existing healthcare delivery system. Successful public health-clinical partnership enabled the simple system to work properly because the clinics prevalent in communities were the core resources for the success of this strategy. Upon the examination of the effectiveness of the programme on hypertension control, the duration of staying enrolled in the programme was found to be related to improved hypertension control (which increased by 9.9% [82.4%] by the second year of the registration control). This result can be understood in the same context as that of a previous study, which examined this programme by comparing the enrollees with non-participants.[14] In the multivariate analysis using GEE models (Table 3), the effectiveness of the programme proved to be positively affected by treatment continuity, education experience, and enrolment duration. Although treatment continuity and education experience could have been related to enrolment duration, each of the 3 factors significantly affected the hypertension control rates given that their relationships were considered in the multivariate analysis. The effect of medical treatment continuity among the enrollees could be related to the financial incentive and the fact that the enrolled patients themselves chose their clinics for their healthcare needs, which allowed them not to change their doctors for trivial reasons. Many studies showed that patients who visited the same primary care physician consistently obtained a better treatment result than those who visited different primary care physicians.[15-17] Education was also found to be effective in controlling hypertension in this programme, as also shown in many previous studies.[18,19] However, only a small group (12.5%) of the enrolled patients received the education that this programme delivered. The institute (HDRECs) that can deliver the 8-hour standardised education programme was only at 19 places. The number of patients who participated in the education programme was 10~20 persons/time. And each centre delivered the programme 1~2 times/week. So, we thought that 19 HDRECs couldn't give enough opportunity of education due to the limitation of manpower, facilities and lack of publicity. Thus, increasing the number of patients receiving education is a pressing matter for this programme.

A previous study on this programme showed that patients who were enrolled longer in the programme more consistently adhered to their drug regimens than those who were enrolled for shorter periods, with the medication continuity rate increasing from 47.3% to 65.9% and 69.3% at 1 and 2 years, respectively after registration in the programme.[6] This result indicated that enrolment duration functioned via the medical treatment continuity. In this study, the effect of enrolment duration remained statistically significant even after considering the effects of treatment continuity and education experience. This finding means that some positive factors related to enrolment duration were present but were not analysed in this study. These factors might be counselling along with education, strengthened doctor-patient rapport, supportive environment for self-

care, and so forth, which are provided to the patients upon enrolment to the programme. Research on determining these additional factors may help improve the efficacy of this programme to obtain better results than the current one.

Conclusion

The hypertension control rate (72%) among hypertensive patients aged >65 years with treatment based on the Sixth Korea National Health and Nutrition Examination Survey (2013-2015)[20] was highly similar to the rate at the time of registration to this programme (72.5%). The rate increased by almost 10% (82.4%) 2 years after enrolment in the programme. The results of this study showed that the programme was successful in controlling hypertension among patients aged >65 years at the community level. However, this study has some limitations to consider. First, we could not fully exclude the possibility that the improvement in hypertension control might be attributed to the fact that patients who remained longer in the programme had better self-efficacy than those who were enrolled for shorter periods, accounting for 83.3% of the follow-up rate. But as mentioned above (Table 2), we thought that the follow-up loss didn't make a significant impact on our results. Second, this study did not include a control group because of the nature of its design. Therefore, we need to perform an additional study to evaluate the effect of this programme by analysing the hypertension control rate in communities that did and did not implement the programme.

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Commentary

Growth Assessment and Monitoring during Childhood

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Abstract

Growth is an indicator of the health and nutritional status of infants and children. Health organisations and professionals worldwide advocate monitoring the growth of children with the primary aim of identifying and preventing malnutrition and/or obesity. Growth monitoring should be part of every health care consultation for children. However, physicians during health care consultations are often so busy addressing acute health issues, that they miss the opportunity to monitor the child's growth and provide anticipatory guidance. Appropriate growth monitoring would enable health care providers to detect abnormal growth in a timely manner, as well as to reassure parents if their concerns are unfounded. To perform this effectively, physicians need to be familiar with measurement methods, use of appropriate growth charts and interpretation of results. As weight, height and growth rates may vary among children, physicians also need to understand what constitutes normal growth. This paper aims to clarify the purpose of growth monitoring and provide recommendations for physicians to assess, monitor and manage growth in infants and children in a primary care setting.

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Introduction

Human physical development is continuous from infancy to maturity and involves changes in body size and appearance, including the development of secondary sexual characteristics. Although children tend to have body shapes and sizes similar to their parents or grandparents, living conditions including nutrition and sanitation have significant influence on growth. Growth and development from conception to final height are influenced by genetics, prenatal factors such as maternal-fetal health and well-being[1] and postnatal factors such as nutrition and disease.[2]

There are 2 distinct components of physical development, namely height growth (which continues throughout childhood and puberty until attainment of final height by 18 years of age) and weight growth (which influences height growth during childhood and determines adiposity status even after final height is attained). Physicians should be familiar with height, weight and body mass index (BMI)-for-age growth charts, since comparison of a child's height, weight and BMI with the respective values of a reference population provides evidence or otherwise of the normal growth process.[3] Although growth is compared to population norms on growth charts, the 50th population percentile is not necessarily the target growth pattern for all individuals, and should be de-emphasised during growth monitoring. Growth involves height and weight changes over time and is quantified as growth velocity.[4] Hence, it is the monitoring of growth velocity that is important. Doing so will enable us to detect abnormal growth and assess the impact of interventions.[5]

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Puberty is an important consideration when assessing growth, because, as a child approaches puberty, growth velocity generally slows (preadolescent dip), then accelerates markedly during mid-puberty (pubertal growth spurt).[6] Puberty is delayed in onset if there are no secondary sexual characteristics by age 13 years in girls (e.g. breast development)[7] or 14 years in boys (e.g. attainment of 4 mL testicular volume).[8] If menarche is not attained by age 16 years in girls with breast development,[7] or if boys fail to attain 15-25 mL testicular volume by 17-18 years, then progression of puberty is considered delayed.[9] As puberty onset and progression varies, the age at which children stop growing in height will therefore vary from child to child.

In this review, we clarify the purpose and describe the process of growth assessment and monitoring, as well as provide recommendations for physicians to monitor and manage growth in infants and children in the primary care setting.

Purpose of Growth Monitoring

The aims of growth monitoring are to: a) Demonstrate normal size and growth to allay anxieties related to perceived inadequate or excessive size; b) Guide healthy and appropriate growth; and c) Identify abnormal growth patterns that may suggest underlying disease.

Demonstrate Normal Size/Growth

Demonstrating normal growth can manage expectations, correct misperceptions and allay undue anxiety. In many instances, growth is normal but parents may have their own perceptions about their child's growth. Perception is influenced by personal factors such as needs, values and beliefs.[10] Some parents may believe that bigger is better, and may be unduly anxious because their child's growth is not above the 50th percentile. Perceiving a normal child as underweight may lead to inappropriate overfeeding,[11] while incorrectly perceiving a child as short, when not, may lead to unnecessary referrals and investigations. Growth assessment and monitoring can assure parents of their child's appropriate size status and growth rates.

Guide Healthy and Appropriate Growth

To realise his or her genetic growth potential, a child must be in good health and have sufficient nutrition, optimal weight, adequate sleep and physical activity. In some instances, children may be provided with excessive nutrition to help attain the tallest possible height by parents (who may not realise that height growth is limited by genetic potential). Through growth monitoring and the use of growth charts, health care providers can help parents understand what constitutes healthy and appropriate growth, and guide parents to help their children attain healthy growth (i.e. optimal height that is not at the expense of excess adiposity).

Overweight and obesity in childhood are associated with increased risk of cardiometabolic problems in adulthood, including premature death.[12] Obesity has led to an increase in incidence of type 2 diabetes mellitus among children. Childhood obesity also predisposes children to develop hypertension in adulthood. Hypertension is a risk factor for developing cardiovascular disease, and identifying obesity in childhood can help with early identification of those at risk of developing hypertension later in life.[13]

A recent Singapore study suggested that mothers may not be able to accurately perceive their child's weight status, particularly if the child is under- or overweight, illustrating the need for measurements to be taken and used to guide parents and caregivers to ensure appropriate growth.[11] In addition, overweight or obese children are more likely to be perceived as healthy by parents in this decade than 10 years ago.[14] These observations imply that parents may not fully understand when growth is considered appropriate and may not be receiving sufficient guidance by current health practices.

Identify Abnormal Growth Patterns

Extremes in child size (e.g. severe short stature or severe underweight) may indicate underlying pathology, while faltering growth trajectory may be an early marker of illness or suboptimal nutrition. Abnormal growth patterns include weight faltering, height faltering, excessive weight gain and excessive height gain. Growth faltering or stunting can be a marker of underlying disease, and may be associated with irreversibly reduced neurodevelopmental and cognitive function,[15] while overweight or obesity is also linked to adverse long-term health outcomes.[12] If inappropriate growth is observed, assessments to detect occult underlying disease, hormone disorders or malnutrition should be undertaken, with subsequent intervention dependent on the aetiology.

Height faltering, also known as stunting, occurs when height fails to demonstrate age-appropriate increases over time leading to low height velocity. Poor height velocity may be due to underlying poor health, suboptimal nutrition or hormonal disease. Slow height gain may be physiological in children with constitutional growth delay[16] and in those who have passed peak growth velocity during puberty.

Weight faltering, or failure to thrive, describes weight that crosses more than 2 major centile spaces downwards (e.g. from 50th percentile to 3rd percentile) and should also be considered when BMI is below the 3rd percentile on the local BMI for age chart. Weight faltering may raise concerns about possible neglect, deprivation or organic disease. However, it is most commonly caused by under-nutrition relative to the child's energy needs and often involves problems with diet and feeding behaviour that typically respond to simple targeted advice.[17]

Excessive weight gain leading to high BMI is most commonly related to excessive calorie consumption, while excessive height gain suggests the possibility of conditions associated with overgrowth or early pubertal growth.

How to Assess and Monitor Growth

Monitor a child's growth by measuring height and weight, ideally every 3-4 months for children <2 years of age, and every 6-12 months for children >2 years of age. Plot the data on growth charts and compare them with population norms, genetic potential and with previous height(s) and weight(s). This can determine if children are growing appropriately (for population and genetic potential) and can indicate if further investigations or interventions are needed.

We recommend the following sequence of assessment: 1) Measure the child's height and weight, and note the age in years and months; 2) Measure the parents' heights (or obtain reported heights) and determine the mid-parental height (MPH) and target height range (THR); 3) Plot the child's height, weight and BMI for age; 4) Plot the MPH and THR; 5) Compare the height with population norms and THR; 6) Compare the weight against the height (i.e. determine BMI); 7) Compare the height, weight and BMI with previous measurements; and 8) Interpret the data to identify the nature of the growth abnormality, if any.

Step 1: Measure the Child's Height and Weight

Accurate and Timely Measurements

Measurements must be accurate and timely to be meaningful. Growth monitoring would reassure parents when growth is normal.[18] However, it may cause unnecessary alarm if results are misinterpreted, or faulty equipment or inconsistent methods are used. At the same time, suboptimal monitoring can result in delayed diagnosis and treatment.

To facilitate correct interpretation, we recommend measuring children at regular intervals (ideally every 3-4 months for children <2 years of age, and every 6-12 months for children >2 years of age) using appropriate technique and equipment. If there are concerns about faltering growth, weight should be measured weekly (if less than 1 month old), fortnightly (between 1-6 months old), and monthly (between 6-24 months of age). Length or height should not be measured more often than every 3 months.[19]

Whilst height and weight should be measured at least annually, the best practice is to take accurate measurements opportunistically at every clinic visit, e.g. vaccination visits, illness visits.

Length/Height Measurement

For children under 2 years of age, the supine length should be measured:

- Use a length board or mat, placed on a flat, stable surface (for e.g. on a table).
- Lay the child on his or her back, straight along the board, with shoulders touching the board, and without arching the spine.
- Children should not be wearing a nappy/diaper or footwear during measurement.
- Two persons (e.g. the observer and a parent) are needed to measure supine length.
- Repeat the measurement 2 or 3 times and take the average.
- For children over 2 years, standing height should be measured.
- Use a rigid upright measure with a T piece, or a stadiometer mounted at a right angle between a level floor and against a straight, vertical surface such as a wall or pillar.
- The observer should get on a face-to-face level with the child and position his or her head so that a horizontal line drawn from the ear canal to the lower edge of the eye socket is running parallel to the baseboard (i.e., the Frankfort plane positioned horizontally).
- Repeat the measurement 2 or 3 times and take the average.

In general, standing height is about 0.7 cm less than length measurement in young children, so it is important to adjust the measurements if length is measured instead of height.[20,21]

Weight Measurement[20]

The following are suggested when measuring children's weight:

- Babies should be weighed without clothes or nappies/diapers.
- Children older than 2 years may be weighed in vest and pants, without footwear.
- The World Health Organization (WHO) (2008) recommends the use of clinical electronic scales of up to 150 kg with graduations of 0.1 kg (100 g) graduations.[20] Scales should allow tared weighing to facilitate weighing a child younger than 2 years old held by a carer. For infants, electronic baby scales with better precision and smaller graduation (e.g. 20 g) should be used.[20]

Step 2: Measure Parental Heights and Determine MPH and THR

Measure the standing heights of both parents. Only measured (rather than reported heights) should be used to perform accurate evaluations of height, particularly when diagnostic tests or treatment interventions are being considered.[22]

Determine the MPH: MPH for boys = [(father's height + mother's height) + 13] divided by 2; and MPH for girls = [(father's height + mother's height) - 13] divided by 2.

Determine the THR. This is determined by first obtaining the MPH and then applying 2 residual standard deviations

above and below the MPH[23] (applying 2 residual standard deviations would imply that 9 out of 10 normal children would have an adult height within the THR). THR is sex- and population-specific, and dependent on adult heights of men and women in that population.[21,23] We recommend the following THR based on estimates derived from parental height data from a Singapore cohort:[24] for boys: THR = MPH ± 9 cm; and for girls: THR = MPH ± 8 cm.

Step 3: Plot the Child's Height, Weight and BMI

Plot the height, weight and BMI data using appropriate growth charts. Use dots to plot and do not join the dots. Note that age and measurement errors are common plotting mistakes. Plots should be accurate to age in years and months.

Step 4: Plot the Derived MPH and THR

The MPH should be plotted into the child's growth chart corresponding to age 18-20 years old. Sex-specific THR should also be plotted as ± 9 cm and ± 8 cm from the MPH for boys and girls, respectively, as described in Step 2. The MPH and THR serves to reference the child's genetic potential.

Step 5: Compare the Child's Height to Population Norms and with Genetic Potential

The appropriate height for a population may be determined by plotting the child's height on the relevant growth chart. For Singapore, we recommend growth charts published by the Health Promotion Board (HPB) of Singapore (available at: https://www.healthhub.sg/sites/assets/Assets/Programs/screening/pdf/health-booklet-2014.pdf).[25]

Parental heights are used to determine if a child has the appropriate height for genetic potential. For example, a child whose parents are short (e.g. MPH 3rd-10th percentile) and who is growing along the 3rd percentile, may not necessarily have poor growth but familial short stature instead. MPH adjusted for the THR will indicate whether the child is growing appropriately from a biological standpoint,[26,27] although do consider that very short parents may have a growth disorder themselves.[28]

To approximate the estimated adult height, extrapolate along the height percentile curve, until the value given for 18-20 years of age.[29] Height is likely to be normal if the extrapolated height falls within the THR. Estimation of genetic height potential cannot be done when the height of either parent is unavailable.[30,31] In this situation, we recommend the doctor to monitor the height velocity closely (see Step 7) as an alternative strategy and investigate or refer if height velocity falters.

Step 6: Compare the Weight Against the Height by Determining the BMI

There is rising concern about the number of overweight/obese children in developed countries due to the serious health conditions linked to obesity.[12] An overweight child has excessive weight for height, and it is recommended that BMI—adjusted for age and sex—should be used to estimate adiposity in children.[32,33] However, BMI should be interpreted with care because it does not directly measure adiposity. Waist circumference is not recommended as a routine measure,[33] as there is little clinical evidence to support this. Similarly, skinfold thickness and electrical bio-impedance do not have sufficient clinical evidence to date to be used routinely as a measure of overweight in children.[32]

Children Under 6 Years

Charts from Singapore HPB and the National Healthcare Group Polyclinics (available at the following websites) may be used: https://www.nhgp.com.sg/Our_Services/General_Medical_Services/Child_Health_Services/ and https://www.healthhub.sg/sites/assets/Assets/Programs/screening/pdf/health-booklet-2014.pdf.

There is currently no consensus in the definition of overweight and obese status in children <2 years of age, although the WHO international growth standard for children aged 0-59 months may be used to screen for unhealthy growth patterns.[34]

Children 6-18 Years

Use the HPB BMI-for-age percentile chart for classification in boys and girls between 6-18 years old. The HPB Obesity Clinical Practice Guidelines, 2016 are available from: https://www.moh.gov.sg/content/dam/moh_web/HPP/Doctors/cpg_medical/current/2016/obesity/Obesity%20CPG_Main.pdf.[35] Those with BMI between 90th to <97th percentile are classified as overweight, while severely overweight (obesity equivalent) children have BMI ≥97th percentile on the HPB chart. Adolescents older than 16 years may be defined as obese if BMI-for-age is equal to or greater than 97th percentile, or if BMI is equal to or greater than 30 kg/m^2.

Step 7: Compare Height, Weight and BMI with Previous Measurements

To determine height velocity, measure height over time, ideally every 3-4 months for children <2 years of age, and every 6-12 months for children >2 years of age. Approximate minimum growth rates in prepubertal children are as follows: 5-6 cm per year for those from 2-6 years old; and 4 cm per year (3rd percentile for the lowest nadir) for those between 6-12 years.

Typically, preschoolers and school age children put on 2-3 kg/year. To determine weight change, assess weight and BMI over time. Rising or falling BMI could indicate appropriate catch-up/down-growth, increasing overweight/obesity or worsening underweight/failure to thrive.

Step 8: Interpret and Identify the Nature of the Growth Abnormality, If Any

Interpret height according to Tables 1 and 2 if there are short and tall stature concerns, respectively. Interpret weight (i.e. BMI) according to the Singapore HPB BMI chart,[35] noting that weight interpretation is also relevant in the assessment of children with height concerns. In addition, as growth varies widely during childhood, always evaluate according to a child's age, gender, health status, nutritional status, genetic potential and hormonal changes.

Parents may worry if their child is not on the 50th percentile, and so should be reassured that height or weight above or below the 50th percentile can be appropriate. The 50th percentile is not to be emphasised (e.g. United Kingdom-WHO charts) to avoid suggesting to parents that all children should be on or near the 50th percentile.[21]

Table 1. Recommendations When There Are Concerns about a Child's Poor Height

Identify the Phenotype		Interpret: Clinical Diagnosis	Communicate*	Advise Next Steps: What You Can Do in Your Practice
Height for Population	**Height for Genetic Potential**			
Within 3rd to 97th	Within THR	Normal height	Your child's height is currently normal compared to both population norms and genetic potential.	• Assess weight and BMI status. • Advise yearly height, weight and BMI monitoring.
<3rd	Within THR	Short stature; may represent familial short stature	Although your child's height is below the normal population range, it is currently within his/her genetic potential.	• Assess if child is underweight or overweight relative to height. • Subsequent steps depend on this.
Within 3rd to 97th	Below THR	Short for genetic potential; may indicate pathology	Although your child's height is within the normal population range, it is currently below his/her genetic potential.	• Assess if child is underweight or overweight relative to height. • Subsequent steps depend on this.
<3rd	Below THR	Short stature; may indicate pathology	Your child's height is currently below both population norms and genetic potential. Investigations are needed.	• Full evaluation needed to determine reason for short stature.

BMI: Body mass index; THR: Target height range
*Note: Avoid labelling when communicating.

Table 2. Recommendations When There Are Concerns about a Child's Excessive Height

Identify the Phenotype		Interpret: Clinical Diagnosis	Communicate*	Advise Next Steps: What You Can Do in Your Practice
Height for Population	**Height for Genetic Potential**			
Within 3rd to 97th	Within THR	Normal height	Your child's height is currently normal compared to both population norms and genetic potential.	• Assess weight and BMI status. • Advise yearly height, weight and BMI monitoring.
>97th	Within THR	Tall stature; may represent familial tall stature	Although your child's height is above the normal population range, it is currently within his/her genetic potential.	
Within 3rd to 97th	Above THR	Tall for genetic potential; may indicate pathology	Although your child's height is within the normal population range, it is currently above his/her genetic potential.	• Assess if child is overweight (indicating excessive nutrition). • Assess for dysmorphic features (possibility of overgrowth syndromes). • Assess for secondary sexual characteristics (to consider precocious puberty).
>97th	Above THR	Tall stature; may indicate pathology	Your child's height is currently above both population norms and genetic potential. Investigations are needed.	• Assess if child is overweight (indicating excessive nutrition). • Assess for dysmorphic features (possibility of overgrowth syndromes). • Assess for secondary sexual characteristics (to consider precocious puberty).

BMI: Body mass index; THR: Target height range
*Note: Avoid labelling when communicating.

Potential Benefits of Growth Monitoring[18,36,37]

Growth monitoring may provide the following benefits: 1) Facilitates early diagnosis of underlying illness to allow early referral of growth disorders (e.g. Turner syndrome, achondroplasia), illnesses that affect growth (e.g. gastrointestinal, renal and cardiac disorders), and hormone disorders (e.g. hypothyroidism, growth hormone deficiency, precocious puberty); 2) Demonstrates normal growth to allay anxiety and manage expectations; 3) Identifies abnormal weight trends to guide appropriate nutrition (underweight, and overweight and obesity); 4) Assesses response to nutrition intervention/advice; and 5) Monitors recovery from illness.

Interventions: Strategies for Primary Care Physicians and Indications for Referral

Short Stature Concerns

When a child is short for population (below the 3rd centile) and short for genetic potential, or short for population (and weight is 2 percentiles higher), consider if the child has inadequate nutritional intake or a chronic illness with persistent symptoms and test the child for hypothyroidism. If thyroid function is normal, optimise nutrition and repeat height measurement in 4-6 months to determine the growth velocity. A child who is short for population but appropriate for THR may have appropriate small stature (e.g. familial short stature). However, it is recommended that all girls below THR or the 3rd height percentile (regardless of genetic potential) be assessed for Mosaic Turner syndrome.

Tall Stature Concerns

When a child is tall for population (97th centile and above) and/or tall for genetic potential, consider if the child is overweight/obese, has commenced pubertal development too early or has unusual facial features or a Marfanoid habitus. Assess if the child has features of thyrotoxicosis. In general, children who are inappropriately tall should be referred to a specialist for assessment.

Instructions on identification, interpretation, communication and further actions when there are concerns about a child's height are outlined in Tables 1 and 2. It is useful to complement this with the growth velocity and with serial measurements over time.

Overweight and Obesity

Overweight and obese children can be managed in primary care. Refer patients to tertiary care if management strategies fail after 6 months—although referral can also be guided by the degree of obesity, presence or likelihood of comorbidities (e.g. family histry), or where a pathological cause of obesity is suspected.[32]

Obese children and adolescents (BMI ≥97th percentile) should be evaluated for obesity-related comorbidities or complications.[32] Overweight children (BMI ≥90th-97th percentile) may also be screened for comorbidities if there is a strong family history of diabetes and other obesity-related morbidities.[32]

Inadequate Growth: Indications for Intervention[26]

These relate to: 1) Crossing down of 2 growth percentiles over 3 months in a child <2 years and over 6 months if the child is between 2-6 years; 2) Inadequate growth or weight gain for >1 month in a child <2 years; and 3) Weight loss or no weight gain for a period >3 months in a child >2 years.

Conclusion and Summary of Recommendations[38]

Growth monitoring can demonstrate normal size and growth to allay anxieties related to perceived size, identify abnormal growth patterns that suggest underlying disease, and guide healthy and appropriate growth. The commonly used indices to assess growth status are height-for-age, weight-for-age and weight-for-height or BMI. Low weight for height or BMI can indicate malnutrition or under-nutrition, while high weight for height or BMI can indicate obesity, and low height for age can indicate stunting. Timely measurements and accurate plotting on the relevant growth charts can enable physicians to assess the child's growth and help guide appropriate interventions where necessary.

Resources

Royal College of Paediatrics and Child Health:
http://www.rcpch.ac.uk/

National Health Care Group growth charts:
- https://www.nhgp.com.sg/Our_Services/General Medical_Services/Child_Health_Services/
- https://www.nhgp.com.sg/uploadedFiles/.../BMI%20CHART%20FOR%20BOYS.pdf
- https://www.nhgp.com.sg/uploadedFiles/.../BMI%20CHART%20FOR%20GIRLS.pdf

Assessment tools such as stadiometers and scales growth charts, among others, may be obtained via the following websites:
- http://www.progress.com.sg/product/seca-217-stadiometer/
- http://equipmedical.com.sg/catalog/seca/#all
- http://www.healthprofessionalsolutions.com.au
- http://www.stadiometer.com/
- http://amamedicalproducts.com.au
- http://www.detecto.com/product-family/stadiometers/

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A Review of Tinea Capitis in a Cohort of Asian Children

Dear Editor,

Tinea capitis most commonly affects children but rarely, adults.[1-2] *Trichophyton* and *Microsporum* species are the commonest dermatophyte species implicated. Non-inflammatory variants of tinea capitis are more common than inflammatory variants, such as kerion and favus. However, inflammatory variants can lead to scarring alopecia, necessitating early and accurate diagnosis and treatment. Optimal treatment of tinea capitis requires the use of prolonged courses of oral antifungal agents as topical monotherapy is usually inadequate. We performed a retrospective analysis of tinea capitis in our institution, aiming to provide data on disease presentation, natural history, treatment and outcomes.

Materials and Methods

Our study involved children aged 16 years and younger with tinea capitis—confirmed on fungal culture, identified over an 11-year period (2005-2016) at Dermatology Service, KK Women's & Children's Hospital, Singapore. Ethics approval was obtained from the Institutional Review Board. Cases were identified through records obtained from the hospital's microbiology laboratory. For patients who did not return for review after treatment, an attempt was made to contact their caregivers by phone, inquiring on the outcome post-treatment.

Results

Seventeen patients (13 females and 4 males) were identified (Table 1). The mean age at initial presentation was 4 years (range: 1 month-8 years). There were a disproportionate number of Malays (10 patients) compared to other races (Chinese and Indians). Mean duration of symptoms before presentation was 6.7 weeks (range: 1-16 weeks). Ten patients (59%) had a history of contact with animals, especially cats (9 patients). Three patients had contact with other family members with tinea.

Eight patients (47%) presented with scaly patches, 3 patients (18%) with erythematous plaques, 3 patients (18%) with erythematous nodules and 3 patients (18%) with papulovesicles. Itch was present in 9 cases (53%) and pain was reported in 7 (41%). There were 14 cases (82%) with alopecia, 5 (29%) with regional lymphadenopathy and 3 (18%) were febrile. Alopecia was non-scarring in all cases, except in 1 case of kerion.

Five cases (29%) were diagnosed clinically as kerion and 12 cases (71%) as non-inflammatory tinea capitis. Amongst the cases diagnosed as kerion, 4 cases had purulent or exudative discharge, 4 had associated alopecia (1 with scarring), 3 had lymphadenopathy and 2 were febrile. Histology was performed on 1 patient as the patient was initially admitted under the surgical service with suspicion of a deep scalp infection. The biopsy subsequently showed fungal spores coating the hair shaft (Fig. 1).

Fungal microscopy—performed on directly-pulled hair specimens—were positive for fungal hyphae in 7 cases (41%), blastoconidia in 1 case (6%) and negative in 9 cases (53%). Fungal cultures were positive for *Microporum* species in 10 cases (59%), *Trichophyton* species in 6 cases (35%), and *Epidermophyton floccosum* in 1 case. In cases of kerion, 2 were positive for *Trichophyton* species and 3 for *Microsporum* species. Seven cases (41%) had pyogenic cultures performed with 1 case (6%) positive for *Staphylococcus aureus*. This patient was concomitantly treated with oral antibiotics.

Fourteen patients (82%) were treated with oral antifungals, as selected by their treating dermatologist. Eight cases (47.1%) were treated with griseofulvin (20-25 mg/kg/day), 5 cases (29.4%) with terbinafine (20-40 kg: 125 mg, >40 kg: 250 mg) and 1 (5.9%) with itraconazole (5 mg/kg/day). All patients with *Microsporum* species were treated with either griseofulvin or terbinafine. Liver function tests were performed for 7 patients (before initiation therapy) and for 4 patients (within 1 month after initiating treatment). All results were normal.

Patients were treated for an average of 8.5 weeks. Those who received terbinafine had a shorter course of treatment (n = 5, 5.2 weeks) than those who received griseofulvin (n = 8, 10.8 weeks). Compared to terbinafine, those who received griseofulvin were treated for a longer duration before mycological clearance was achieved (11.3 weeks vs 4 weeks), though clinical improvement was achieved at around the same time (5.6 weeks vs 5.2 weeks).

All patients were concomitantly treated with topical antifungals (ketoconazole shampoo and clotrimazole cream). Three patients were treated with only topicals. They were younger (1, 5 and 15 months old) with less extensive disease. Two had significant improvement even before final fungal cultures returned, with average duration of treatment

Table 1. Patient Characteristics, Mycological Data and Treatment History

Patient No.	Age at Diagnosis	Race	Gender	Contact History with Animals	Clinical Diagnosis	Fungal Microscopy	Fungal Culture	Treatment	Duration (Weeks)	Outcome
1	8 years	Chinese	M	-	Kerion	-	*T. mentagrophytes*	Griseofulvin	10	Defaulted
2	5 months	Malay	F	+	Tinea capitis	-	*E. floccosum*	Topicals	12	Resolved
3	6 years	Chinese	F	+	Tinea capitis	+	*M. species*	Griseofulvin	16	Resolved
4	6 years	Others	F	-	Kerion	-	*T. rubrum*	Itraconazole	8	Defaulted
5	7 years	Chinese	M	+	Tinea capitis	Blastoconidia	*M. canis*	Terbinafine	6	Resolved
6	6 months	Malay	M	+	Tinea capitis	-	*M. species*	Griseofulvin	12	Resolved
7	6 years	Malay	M	+	Tinea capitis	+	*M. species*	Terbinafine	4	Resolved
8	3 years	Chinese	F	-	Tinea capitis	+	*M. species*	Terbinafine	8	Resolved
9	9 years	Malay	F	+	Tinea capitis	+	*M. species*	Terbinafine	4	Resolved
10	6 years	Malay	F	-	Kerion	-	*M. canis*	Griseofulvin	12	Resolved
11	2 years	Indian	F	-	Tinea capitis	-	*T. species*	Griseofulvin	8	Resolved
12	6 years	Malay	F	+	Tinea capitis	+	*T. tonsurans*	Terbinafine	4	Defaulted
13	1 month	Malay	F	-	Tinea capitis	+	*M. species*	Topicals	7	Defaulted
14	4 years	Chinese	F	-	Tinea capitis	+	*T. species*	Griseofulvin	10	Resolved
15	5 years	Malay	F	+	Kerion	-	*M. species*	Griseofulvin	10	Resolved
16	4 years	Malay	F	+	Kerion	-	*M. canis*	Griseofulvin	8	Defaulted
17	15 months	Malay	F	+	Tinea capitis	-	*T. rubrum*	Topicals	5	Defaulted

F: Female; M: Male

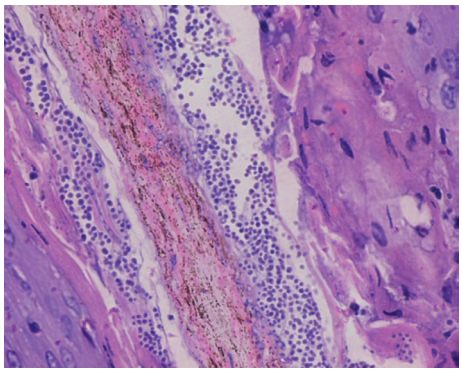

Fig. 1. Haematoxylin and eosin stain 100x demonstrating fungal spores encasing the hair shaft.

until clinical improvement and mycological clearance of 5.3 weeks and 8.7 weeks, respectively. The third patient did not attend follow-up.

Discussion

Tinea capitis is more common in children than adults. Reported incidence is highest amongst male school-going children aged 3-7 years.[2] In contrast, our study had a much higher female-to-male ratio of around 3:1. It is known that tinea capitis is more common in children of African descent compared to Hispanics and Caucasians. No clear cause for this racial predilection has been established.[3] Our study showed a higher incidence among Malays, especially if in contact with cats, a known predisposing factor.

Anthropophilic *Trichophyton* species are the most common species causing tinea capitis in the United States (*T. tonsurans*), Western Europe (*T. tonsurans, T. violaceum*) and Africa (*T. violaceum, T. soudanense*). In contrast, zoophilic *Microsporum* species was the most common in our series. This may explain the high incidence of inflammatory tinea capitis, with almost 30% (5 of 17 cases) presenting as kerion. Inflammatory tinea capitis is less common than non-inflammatory variants, with reported incidence of inflammatory tinea capitis ranging from 1.8 to 32%.[4-7] Inflammatory variants can mimic other conditions (e.g. bacterial furunculosis or deep abscesses) and are often inaccurately diagnosed leading to delayed treatment or unnecessary surgical intervention, with resultant scarring alopecia.[1,2,8,9]

Tinea capitis can be diagnosed with a high index of clinical suspicion. In a child presenting with alopecia associated with scaling, erythema or pustules—particularly with history of contact with animals—tinea capitis should always be excluded. A Wood's lamp examination demonstrates bright green florescence with *Microsporum* species. However, a negative examination does not exclude tinea capitis.

Microbiological cultures are important as results can influence the choice of therapy. Specimens can be obtained for microscopy by using a blunt scalpel if there is scalp scaling, and by plucking hair from the periphery.[8] Given the low sensitivity, relying on microscopy alone is insufficient and fungal cultures should be performed in all suspected cases. Empirical systemic therapy should be started if clinical suspicion is high, especially in inflammatory tinea capitis.

Treatment of tinea capitis requires the use of systemic antifungal therapy, as topical penetration of hair follicles is poor. Tinea capitis caused by *Trichophyton* species responds better to terbinafine, whilst *Microsporum* species responds better to griseofulvin.[10] Griseofulvin was used for most of our patients. Although it is not standard practice, terbinafine was used in some cases as it has been shown to demonstrate comparable efficacy and to require shorter duration of therapy, possibly improving compliance.[8] Clearance rates and tolerability were also comparable with griseofulvin. British guidelines recommend using either griseofulvin for 6-8 weeks, or terbinafine for 2-4 weeks, and to consider switching to an alternative if no clinical improvement is seen after the recommended treatment duration.[8]

Reported side-effects of oral antifungals include diarrhoea, nausea, vomiting and elevated liver enzymes. These are mild and reversible. Severe adverse events are rare.[10] The risk of haematological or hepatocellular derangement is low and laboratory monitoring for griseofulvin is generally unnecessary.[11-12] For prolonged terbinafine administration beyond 4-6 weeks, baseline evaluation of liver function and full blood counts are recommended.[12-13]

Topical antifungal therapy is considered ineffective due to poor penetration of the hair follicle and should not be used as monotherapy. In our series, topical therapy was used in 3 patients due to concerns about safety of oral antifungals in infancy. All 3 patients were less than 2 years of age with milder disease and responded to topical therapy. This may be due to higher topical penetration into hair follicles in thinner infant scalp. Infants also have a higher percentage of telogen hairs and this may contribute to the higher efficacy of topical antifungals.[14-15] We propose that topical antifungal therapy may be considered for children less than 2 years of age with non-inflammatory tinea capitis, if there are any contraindications to systemic therapy.

As this was a retrospective study, treatment outcomes were not standardised. There were a substantial number of patients who did not return for review. We, however, attempted to assess these patient outcomes by phone interview.

Conclusion

In conclusion, we hope to highlight the importance of early diagnosis and treatment due to the high proportion of inflammatory variants of tinea capitis in our local population, which can lead to scarring alopecia. Oral terbinafine has a shorter duration of therapy and may be a suitable alternative in children who cannot tolerate griseofulvin. Finally, topical antifungals may be suitable for younger infants with non-inflammatory tinea capitis. However this should not be used as firstline treatment and should only be considered in those unable to tolerate or unwilling to start on oral antifungals.

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Letter to the Editor

Knowledge and Attitudes of Intensive Care Unit Healthcare Workers towards Human Organ Donation in Singapore

Dear Editor,

Organ transplantation is the treatment of choice for end-stage organ failure. However, there still exists a great imbalance between organ demand and organ availability worldwide, limiting the application of organ transplantation.[1]

The Human Organ Transplant Act (HOTA) was enacted in Singapore in 1987, with amendments made in 2004 and 2008 to expand the organ donor pool. Currently, HOTA includes donation of kidneys, liver, heart and corneas after certification of brain death. It remains an opt-out scheme in which all Singapore citizens and permanent residents aged 21 years old and above, who are not mentally disordered, are presumed to consent for organ donation.[2,3] For a patient who is eligible, the process briefly starts with the certification of brain death by 2 independent specialists, activation of the transplant coordinator, followed by assessment of suitability of organs, and if suitable, proceeding to organ retrieval. This is coordinated by a trained brain death coordinator.

Despite legislative amendments, the rate of organ donation in Singapore has remained low at 6.6 to 8.9 organ donors per million population (pmp) (unpublished data from the National Organ Transplant Unit, Ministry of Health, Singapore), in contrast to other developed countries such as the United States, Spain and the United Kingdom.[4-6]

Healthcare workers caring for potential brain-dead donors face highly stressful circumstances. A perceived "ethical dilemma" between the physician's primary responsibility of acting in the patient's best interests and supporting the social objectives of HOTA may make some intensive care unit (ICU) physicians reluctant to actively identify and refer potential donors.[4] Other barriers include unfamiliarity, variability in the conduct of brain death certification, and lack of knowledge about donor identification.[4,7]

Good working knowledge and positive attitudes of healthcare workers towards organ donation may result in increased donor actualisation rates, as well as improved holistic care of the donor's family—2 goals that are not mutually exclusive. A survey of medical students in Singapore found that the majority had favourable attitudes towards organ donation, but knowledge on HOTA was inadequate.[8] To date, there is scant literature on the attitudes of ICU healthcare providers in Singapore.

This study aimed to determine the knowledge and attitudes of healthcare personnel in ICU in Singapore, as well as assess their confidence in handling the complex issues surrounding organ donation. A secondary aim was to identify key factors that could improve the competency of healthcare workers in this regard.

Materials and Methods

Ethics approval was obtained from the National Healthcare Group Domain Specific Review Board prior to the commencement of the study.

This cross-sectional study was conducted in a single tertiary healthcare institution in Singapore. For 2 consecutive weeks, doctors, nurses and allied healthcare personnel who were on duty in any ICUs, or from the Department of Anaesthesiology and Intensive Care Medicine were invited to participate. They were recruited after verbal consent was obtained. Participants were asked to complete the anonymous questionnaire without reference to other resources and the completed questionnaires were collected on the same day.

Questionnaire

The questionnaire was created in English by the study group (Appendix 1) and comprised 24 questions split into 3 sections: 1) Participants' demographics; 2) Participants' knowledge of HOTA and the brain death certification process; and 3) Participants' attitudes towards organ donation, and their perceived roles in caring for potential organ donors and their families.

The difference in HOTA knowledge—by seniority and occupation—were measured by Pearson's chi-squared test. All statistical tests were evaluated assuming a two-sided test at the 0.05 level of significance. Analyses were performed with STATA/SE 13.1 software (StataCorp, Texas 77845 USA, 1985-2013).

Results

Out of a total of 418 staff, 172 out of 200 questionnaires given out were completed, with a response rate of 86%. Study population demographics are shown in Table 1. Majority were Singapore citizens or permanent residents.

There was an equal proportion (43.0%) of doctors and nurses; 60.5% of them had 2 or more years of experience working in the ICU.

Knowledge

HOTA Legislation and Eligibility

Doctors had better knowledge than non-doctors about HOTA ($P<0.05$) (Table 2). However, only 10 (13.5%) doctors correctly answered all questions relating to the identification of organ donors. Of all the respondents, only 44.7% were aware that HOTA is only applicable to the mentally sound and 50% were aware the lower age limit is 21 years.

Table 1. Background Demographics of Survey Participants

Demographics	n	%
Age		
Not stated	4	2.3
<20	2	1.1
20 – 29	75	43.6
30 – 39	67	38.9
40 – 49	19	11.0
>50	5	2.9
Gender		
Not stated	3	1.7
Female	117	68.0
Male	52	30.2
Ethnicity		
Not stated	36	20.9
Chinese	96	55.8
Malay	6	3.4
Indian	9	5.2
Others	25	14.5
Citizenship		
Not stated	6	3.4
Singaporean	111	64.5
Singapore PR	28	16.2
Foreigner	27	15.7
Religion		
Not stated	7	4.07
Christian/Catholic	71	41.2
Freethinker/atheist	41	23.8
Buddhist/Taoist	35	20.3
Muslim	8	5.6
Hindu	7	4.07
Others	3	1.74
Occupation	**n**	**%**
Medical doctor	74	43.0
Anaesthesia	56	32.5
Internal medicine	8	32.5
Neurosurgery	5	2.9

Table 1. Background Demographics of Survey Participants (Cont'd)

Occupation	n	%
General surgery	1	0.5
Orthopaedic	1	0.5
Emergency department	1	0.5
Other discipline	2	1.1
Nurse	74	43.0
Staff nurse	22	12.7
Agency nurse	16	9.3
Senior staff nurse	16	9.3
Registered nurse	14	8.1
Nurse clinician	2	1.1
Advanced practice nurse	1	0.5
Others	3	1.7
Allied health staff	22	12.7
Medical social worker	4	2.3
Respiratory therapist	2	1.1
Physiotherapist	75	43.6
Pharmacist	67	38.9
Dietician	19	11.0
Not stated	2	1.1
Years postgraduation		
<6 years	67	38.9
6 – 10 years	51	29.6
>10 years	43	25.0
Not stated	11	6.4
Years working in healthcare		
<6 years	69	40.1
6 – 10 years	56	32.5
>10 years	44	25.5
Not stated	3	1.7
Years working in ICU		
≤2 years	62	36.0
2 – 9 years	69	40.1
≥9 years	35	20.3
Not stated	6	3.4
Total	172	

ICU: Intensive care unit; PR: Permanent resident

Preconditions, Clinical Tests and Supplementary Tests

Doctors were more familiar with clinical and supplementary tests done for brain death certification than non-doctors ($P<0.001$). Only 14 out of 74 (18.9%) doctors were able to correctly answer all questions pertaining to preconditions required, clinical tests and possible supplementary tests for brain death certification (Table 2).

Table 2. HOTA Knowledge by Profession

HOTA Knowledge	Doctors (n = 74)	Non-Doctors (Nurses + Allied Health) (n = 96)	Total (n = 170)	*P* Value*
Legislation (answered correctly)				
Organs for transplantation under the HOTA	28 (37.84%)	16 (16.67%)	44 (25.88%)	0.002
Eligibility for HOTA • Singaporean/PR • Lower age limit (21) • Upper age limit (none)	29 (39.19%)	22 (22.92%)	51 (30.0%)	0.022
• Possibility to opt out of HOTA • Applicable to mentally sound • Benefits of not opting out • Muslims included	28 (37.84%)	20 (20.83%)	48 (28.24%)	0.015
Certification must be done by 2 clinicians who cannot be involved in the care of the donor or recipient	24 (32.43%)	15 (15.63%)	39 (22.94%)	0.010
Correct for all sections (legislation)	10 (13.51%)	5 (5.21%)	15 (8.82%)	0.058
Brain death certification (answered correctly)				
Preconditions for brain death certification include: • Reversible causes of coma must be ruled out • Absence of neuromuscular blockade • Computed tomography/magnetic resonance imaging evidence of brain damage • Normothermic, normotensive	34 (45.95%)	15 (15.63%)	49 (28.82%)	<0.001
Tests for brain death include: • Pupil reflex • Doll's reflex • Gag and cough reflex • Cornea reflex • Apnoea test • Pain response	33 (44.59%)	17 (17.71%)	50 (29.41%)	<0.001
Supplementary tests include: • Cerebral angiogram • Radionuclide scan	35 (47.30%)	9 (9.38%)	44 (25.88%)	<0.001
Correct for all sections (brain death certification)	14 (18.92%)	1 (1.04%)	15 (8.82%)	<0.001

HOTA: Human Organ Transplant Act; PR: Permanent resident

*P value from chi-squared test.

There was a positive correlation between knowledge and years of experience working in the ICU for doctors (P <0.05). However, this correlation was not seen for the overall cohort which included non-doctors (Table 3).

Personal Attitudes and Preferences towards Organ Donation

Majority (93.0%) had a positive attitude towards organ donation and 92.4% supported donating their own organs under HOTA. There was significant difference when comparing between staff who had cared for organ donors versus staff who had not (supportive of organ donation 98% vs 90%, P = 0.01; supports donation of own organs 97% vs 88.6%, P = 0.03). However, 75.4% felt that organ donation should be entirely voluntary. Only 11.7% felt that people should not be allowed to opt out of HOTA.

Experience on Caring for an Organ Donor

A total of 83 (48.3%) of respondents were asked questions regarding organ donation by relatives of potential donors while 100 (59.2%) had been involved in the care of potential donors. Thirty-seven (21.8%) of respondents felt that medical treatment of potential donors may be compromised or prematurely terminated.

Confidence in Counselling Family and Relatives of Potential Organ Donors

A total of 124 (72.9%) of healthcare workers were willing to help counsel families; however, only 50 (29.1%) expressed confidence in doing so. Out of those who were not confident, 81 (66.4%) cited unfamiliarity with the process as a contributing factor. Other reasons cited

Table 3. HOTA Knowledge Stratified by Number of Years Working in ICU

HOTA Knowledge	ICU <2 Years (n = 62)	ICU 2 – 9 Years (n = 69)	ICU >9 Years (n = 35)	Total (n = 166)	*P* Value
All healthcare workers					
Preconditions for brain death certification	15 (24.19%)	16 (23.19%)	17 (48.57%)	48 (28.92%)	0.015
Tests for brain death					
Supplementary tests					
Correct for all sections (brain death certification)					
Doctors					
Preconditions for brain death certification	14 (35.00%)	9 (42.86%)	10 (83.33%)	33 (45.21%)	0.012
Tests for brain death	16 (40.00%)	10 (47.62%)	7 (58.33%)	33 (45.21%)	0.516
Supplementary tests	11 (27.50%)	14 (66.67%)	9 (75.00%)	34 (46.58%)	0.001
Correct for all sections (brain death certification)	5 (12.50%)	3 (14.29%)	6 (50.00%)	14 (19.18%)	0.012

HOTA: Human Organ Transplant Act; ICU: Intensive care unit

include inadequate medical knowledge (n = 50; 41.0%) and perceived lack of appropriate skills (n = 60; 49.2%). Only 9 (7.4%) cited personal conflict with the concept of organ donation as a factor.

Education

A total of 157 respondents agreed that education with regard to brain death certification should be part of their training while 110 (64.0%) felt the need for annual or biennial refresher courses.

Discussion

A previous study done in a Singapore tertiary neuroscience centre reported that 84% of physicians on the hospital brain death certification roster had performed 5 or fewer brain death certifications in the last 3 years.[9] Such infrequent exposure contributes to unfamiliarity with organ donation workflow.

In this study, we found that knowledge about HOTA amongst doctors, although better than non-doctors, was still suboptimal. The process of brain death certification is time-sensitive, often involving family members whom are acutely stressed. The capability of healthcare workers in the ICU to possess and dispense accurate information is important. Discrepancies in information received may lead to distrust of the medical team.

Our finding that healthcare workers were not entirely clear about HOTA emphasised the need for strict and systematic protocols during the conducting of brain death certification and organ donation.[9] There may be a need for refresher courses at regular intervals. Reassuringly, doctors' knowledge of steps for brain death certification was shown to improve with experience.

It may be tempting to rely on a highly subspecialised team to manage potential donors. However, a broad-based approach may be more practical. This is because family members may have questions about brain death and organ donation prior to formal activation of the brain death coordinator. Having frontline healthcare workers who are knowledgeable and supportive of the process may help to provide consistent care and information for patients and their relatives.

Previous studies have identified numerous ethnic, societal, cultural and religious factors that contribute to a negative attitude towards organ donation, especially in Asian and Chinese communities.[10-12] It is encouraging that a majority surveyed in our institution were supportive of organ donation. This compares favourably with other Asian countries.[13,14] A 2013 survey of healthcare workers in the ICUs of a public hospital in India showed that only 55% of healthcare workers—in contrast to 90% of our survey participants—were agreeable to donation of their own organs after death.[14]

Being a single-centre survey, limitations of this study include possible sampling bias. Majority of respondents worked in the surgical and neurosurgical ICUs, and many were relatively junior staff. Our institution has Singapore's largest neurosurgical ICU and contributes a large percentage of brain-dead organ donors nationwide. Hence, respondents may have been more knowledgeable of or accepting towards organ donation. The same may not be extrapolated for healthcare workers elsewhere.

Conclusion

Despite HOTA being an opt-out legislation, many healthcare workers do not have adequate knowledge of

the process and workflow. There are opportunities for improvement of knowledge and communication skills. Providing healthcare workers with more confidence to handle care of potential organ donors and their families may potentially increase the number of actualised donors and result in an overall positive experience for all involved.

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Appendix 1
Patient Questionnaire

Survey: Knowledge and Attitudes Towards Human Organ Transplant in Singapore

001

GENDER (*please check one*) ☐ Male ☐ Female	**CITIZENSHIP** (*Please check one*) ☐ Singaporean ☐Singapore PR ☐Other: _____
AGE (Please check one) ☐<20 ☐20-29 ☐30-39 ☐40-49 ☐ ≥50	**RACE**: ☐Chinese ☐Malay ☐Indian ☐ Other:_____
RELIGION: ☐ Free-thinker ☐Christian ☐Buddhist ☐Muslim ☐Hindu ☐Other: _____	
OCCUPATION: ☐ Doctor (Anaesthesia) ☐ Doctor (Dept: _____) ☐ Medical Student (year___) ☐ Pharmacist ☐ Nurse (pls circle): AN/ RN/ SN/ SSN/ APN/ Other: _____ ☐ MSW ☐ Other: _____	
NO. OF YEARS POST-GRADUATION:	
NO. OF YEARS WORKING AS A HEALTHCARE PERSONNEL:	
NO. OF YEARS WORKING IN ICU:	
HIGHEST EDUCATIONAL QUALIFICATION:	

* please indicate NA where not applicable

KNOWLEDGE

1. **The Human Organ Transplant Act (HOTA) in Singapore allows for the removal of which organs for the purpose of transplantation?** (*Select all that apply*)

☐ Cornea	☐ Blood vessels	☐ Liver
☐ Skin	☐ Pancreas	☐ Bones
☐ Lungs	☐ Kidney	☐ Tendons
☐ Heart	☐ Intestines	

2. **Eligibility for HOTA** (*Check ONE option for each stem*)

   a. **HOTA is applicable to:**
   ☐ Singapore Citizens only
   ☐ Singapore Citizens and Permanent Residents
   ☐ Anyone of any nationality residing in Singapore

   b. **HOTA is applicable to the mentally sound only**
   ☐ True ☐ False

c. **One can opt out of HOTA**
☐ True ☐ False

d. **There are benefits to not opting out of HOTA**
☐ True ☐ False

e. **Muslims are automatically included in HOTA unless they opt out**.
☐ True ☐ False

f. **The lower age limit of HOTA is:**
☐ None ☐ 16 ☐ 18 ☐ 21

g. **The upper age limit of HOTA is:**
☐ None ☐ 55 ☐ 65 ☐ 75

3. Regarding Certification of Brain Death

a. **It must be done by:** *(Select all that apply)*
☐ Two clinicians, both of whom cannot be involved in the care of the potential donor
☐ Two clinicians, both of whom cannot be involved in the care of the potential recipient
☐ One clinician will suffice.
☐ Only neurology specialists may certify brain death

b. **Brain death is irreversible brain damage causing the irreversible cessation of all brainstem functions**
☐ True ☐ False

c. **The following are necessary before brain death certification may be carried out:** *(Select all that apply)*
☐ CT or MRI evidence showing proof of extensive brain damage
☐ The patient must be sedated
☐ There must be no change to the patient's drug regime in the ICU over the last 24 hours
☐ The patient must be normothermic and normotensive
☐ There must be an absence of neuromuscular blockade
☐ Reversible causes of coma are ruled out

d. **What is tested during brain death certification?** *(Select all that apply)*

☐ Pupil reflex	☐ Masseter inhibitory reflex
☐ Corneal reflex	☐ Knee jerk reflex
☐ Jaw jerk reflex	☐ Apnoea test
☐ Gag and cough reflex	☐ Pain response over peripheries
☐ Doll's reflex	Tonic neck reflex

e. **During brain death certification, if all the standard tests cannot be completed for any reason, and those completed are consistent with brain death, which supplementary test(s) may be performed to confirm brain death?**

☐ Cerebral Angiogram	☐ Radionuclide scan
☐ Transcranial doppler	☐ MRI brain
☐ Diffuse optical imaging	☐ Electroencephalography

4. Regarding organ donation

a. In recent years, what percentage of patients who needed a liver transplant received one?

☐ 50% ☐ 25% ☐ 10% ☐ 5% ☐ 1%

Select True or False for the following statements:	TRUE	FALSE
b. The heart can be beating in a brain dead patient.		
c. It is acceptable to harvest organs from a brain dead patient who is for Coroner's case. (i.e. when a Coroner is called upon to investigate a death which occurs under unusual or suspicious circumstances)		
d. The hospital's involvement with organ donation is monitored and influenced by state laws.		
e. According to the law, people who are brain dead are legally dead.		
f. The time of death for a brain dead person is the time that the heart stops beating (i.e. asystole)		
g. The time of death for a brain dead person is the time when brain death is certified.		
h. Patients who are brain dead may still have limb movement to simuli		
i. The donor's family pays for the cost of organ donation.		
j. The recipient will know the identity of the donor.		
k. One can dictate who they prefer to donate their organs to.		
l. Malignancy is always a contra-indication to organ donation.		
m. Hepatitis B and C carrier can donate all solid organs except for their liver.		
n. It is possible to transplant an adult liver into a paediatric patient.		
o. In Singapore, there is an opt-in scheme for people to pledge their organs or body parts for the purposes of transplant, education or research after they pass away.		

PERSONAL ATTITUDES AND PREFERENCES REGARDING HOTA

Select Yes or No for the following statements:	YES	NO
5. I support organ donation as a philosophical concept		
6. I support the donation of my family member's organs under HOTA		
7. I support the donation of my own organs under HOTA		
8. I feel that organ donation should be a purely voluntary process		
9. I feel that people should not be allowed to opt out of HOTA		
10. I know of a friend or family member who has opted out of HOTA		

CARING FOR AN ORGAN DONOR *(medical students to skip questions 11-15)*

11. In my last 5 years of work, I have been asked questions pertaining to brain death by relatives:

☐ Not applicable ☐ 0 times ☐ 1-10 times ☐ 11-20 times ☐ >20 times

Select Yes or No for the following statements:	YES	NO
12. I have cared for an organ donor before		
13. I believe that I play a role in counselling organ donors' families regarding organ donation		
14. I am willing to play a role in counselling organ donors' families regarding organ donation		
15. I have discussed organ donation with families of organ donors		
16. I feel that there may be premature termination of medical treatment, or that medical care will be compromised for potential organ donors.		

COMPETENCE

17. I am confident in approaching relatives of potential organ donors and discussing issues related to organ donation with them.

☐ Yes (Skip question 18) ☐ No (Proceed to question 18)

18. Why is that so? *(Check all that apply)*

☐ Do not feel comfortable broaching a sensitive topic

☐ Not familiar with the process / workflow of organ donation and/ or brain death certification

☐ Not good at counseling distressed members of the family

☐ Personal conflicts with concept of organ donation

☐ Inadequate medical knowledge, therefore do not want to give wrong information to patient's relatives

☐ Other reasons: _____

EDUCATION

19. I have received teaching on the subject of brain death certification

☐ Yes (Proceed to question 20 and 21) ☐ No (Skip question 20 and 21)

20. How long ago was it?

_____ years/ months

21. How was it carried out?

☐ Lecture ☐ Bedside teaching ☐ Others: _____

22. Education regarding knowledge about brain death, donor management and communication with family needs to be part of my training

☐ Yes (Proceed to question 23) ☐ No (Skip question 23)

23. I would like to have additional training in: *(Select all that may apply)*

- ☐ Clinical management of the donor
- ☐ Coordinating the donation process
- ☐ Family grief counselling
- ☐ Brain death and certification of brain death
- ☐ Communication skills
- ☐ Others: _____

24. How often should refresher courses be? _____ years/ months

THE END.
Thank you for your participation.

Cardiopulmonary Exercise Testing for Evaluating Patients with Unexplained Exertional Dyspnoea: Potential Role in Risk Stratification?

Dear Editor,

Dyspnoea is a common complaint, the cause of which often remains elusive after comprehensive evaluation. Cardiopulmonary exercise testing (CPET) provides a global assessment of the integrative exercise response involving the pulmonary, cardiovascular, neuropsychiatric, haematopoietic and skeletal muscle systems. CPET is recommended early as a diagnostic tool for evaluation of unexplained dyspnoea.[1] Despite this, CPET is underused[2] and there is a paucity of literature regarding its practical usefulness for stratifying the need for further investigations. This study, therefore, aimed to evaluate the usefulness of CPET in risk-stratifying patients with unexplained dyspnoea by following up on their progress over 2 years.

Materials and Methods

Subjects

This study was a single-centre retrospective study of all consecutive patients who had CPET performed for the indication of "unexplained exertional dyspnoea for investigation" between the period of January 2009 to December 2010 (inclusive). The indication for CPET was based on the physician's discretion and may include some patients who were not responding to treatment based on clinical diagnoses. The study was approved by the SingHealth Institutional Review Board (2011/060/C).

Baseline Data

Spirometry and maximal voluntary ventilation (MVV) were performed according to the American Thoracic Society (ATS)/American College of Chest Physicians (ACCP) guidelines (2003),[1] using a spirometer (Medgraphics, USA) for all patients before CPET.

CPET

A total of 64 patients were referred for dyspnoea of unknown cause and all patients underwent maximal symptom-limited cardiopulmonary incremental protocol on a cycle ergometer as per ATS/ACCP guidelines.[3]

Cardiopulmonary exercise testing equipment included a metabolic cart (Oxycon alpha, Jaeger, Würzburg, Germany) with an interfaced bicycle ergometer (Ergoline, Jaeger, Würzburg, Germany). Exercise values were assessed breath-by-breath and were reported as mean values calculated over 10-second intervals. The predicted peak oxygen uptake (VO_2 peak [%]) was calculated according to Hansen's equation.[4] Anaerobic threshold was determined by the V-slope method according to Beaver.[5]

All tests were reviewed by 3 pulmonologists (Ong TH, Loo CM, Koh MS) who were blinded to the patient's clinical presentation and other data. The results were interpreted in accordance with the ATS/ACCP guidelines.[3] The results were categorised into "Normal", "Cardiac limitation", "Deconditioning" , "Cardiac limitation vs deconditioning", "Gas exchange limitation" or "Ventilatory limitation". Discrepancies were discussed to reach final consensus.

Follow-up

Healthcare utilisation (admissions and emergency visits) and significant laboratory results ordered after the CPET testing or new diagnosis were recorded and reviewed by cross-checking the electronic health records over 2 years.

Statistical Methods

Continuous variables were presented as mean ± standard deviation (SD) or median (interquartile range). Categorical variables were presented as numbers (%).

Results

Patient Characteristics

Out of the 64 patients, 47 completed maximal tests and were included for analysis. Patient demographics are presented in Table 1. Mean age was 36.8 (± 17.5) years and 63.8% were male. Majority of the patients were of Chinese ethnicity (91.5%). The CPET results are presented in Table 2.

Exercise Testing Results by Final Diagnosis

A total of 19 patients were categorised as "Cardiac limitation vs deconditioning" in the final diagnosis. Over a 2-year period, 10 patients had no further evaluations or healthcare utilisation. Nine patients had further evaluation, in which 1 was found to have minor coronary artery disease while another had mild pulmonary emphysema on computed tomography (CT) of the thorax.

Table 1. Demographic Characteristics and Baseline Results of Patients

Characteristics	Baseline Results* n = 47
Gender (male)	63.8% (n = 30)
Age (years)	36.8 ± 17.5
BMI (kg/m^2)	22.7 ± 3.7
Ethnicity	
Chinese	91.5% (n = 43)
Malay	2.1% (n = 1)
Indian	6.4% (n = 3)
Lung function test	
Normal	89.4% (n = 42)
Obstructive	6.4% (n = 3)
Restrictive	2.1% (n = 1)
Others (truncation in FV loop)	2.1% (n = 1)
Baseline electrocardiogram	
Normal	97.9% (n = 46)
Others (right bundle brunch block)	2.1% (n = 1)

BMI: Body mass index; FV: Flow volume
*Data represented as mean ± standard deviation or percentages.

Table 2. CPET Results of Patients (n = 47)

Characteristics	Results*
Maximum work rate (percentage predicted)	68.9 ± 18.7
Maximum VO_2 (L/min)	1367.7 ± 477.7
Max VO_2 (percentage predicted)	64.2 ± 15.2
AT (percentage predicted VO_2 max)	32.9 ± 9.2
Heart rate reserve (bpm)	33.1 ± 18.77
Oxygen pulse (percentage predicted)	81.6 ± 23.5
Maximum VE (L/min)	49.2 ± 14.8
Breathing reserve (percentage)	54.0 ± 14.8
VE/VCO_2 at AT	28.8 ± 6.2
Modified Borg scale†	5.2 ± 1.8
Reasons for termination (may have >1 reason)	
Breathlessness	44.7% (n = 21)
Leg fatigue	74.5% (n = 35)
Chest pain	2.1% (n = 1)

AT: Anaerobic threshold; CPET: Cardiopulmonary exercise testing; VCO_2: Carbon dioxide output; VE: Minute ventilation; VO_2: Oxygen uptake
*Continuous data represented as mean ± standard deviation or percentages.
†Two missing data.

There were 13 patients classified under "Deconditioning". Among these, 5 had no further evaluations while 6 had further evaluations, which were all normal.

Of the 10 patients with normal CPET, 3 had normal CT thorax and 2 had normal echocardiography.

Among the 4 patients classified in the "Cardiac limitation" group, 1 had normal CT thorax. One patient had left ventricular (LV) diastolic dysfunction in echocardiography and was found to have double-vessel coronary artery disease. One patient had moderate pulmonary hypertension and moderate tricuspid regurgitation. Her CT thorax showed arteriovenous malformation and she underwent successful embolisation. One patient had both gas exchange and cardiac limitation. He underwent several further tests including echocardiography, pulmonary function test, methacholine challenge test, diffusion test and lung volume measurement, which were all normal.

Discussion

While CPET is a recommended test for evaluating unexplained dyspnoea,[3,6] its value in risk stratification has not been explored. We found that among patients with "Normal" exercise test or abnormalities suggesting "Cardiac limitation vs deconditioning" or "Deconditioning", only 1 out of 42 (2%) subjects was found to have a minor cardiac problem. None of these patients had healthcare utilisation for related problems on follow-up for 2 years. In contrast, 2 out of 4 (50%) patients with "Cardiac limitation" were found to have significant heart diseases. Therefore, based on our limited sample size, CPET may be used as a tool to stratify the need for further investigations. In patients with results showing "Normal", "Cardiac limitation vs deconditioning" or "Deconditioning", it seemed reasonably safe to limit further investigations.

To our knowledge, none of the previous studies on CPET have evaluated its value in prognosticating outcome in the longer term. Martinez et al[5] examined the role of CPET in 50 patients with dyspnoea that was unexplained by routine evaluation (history, physical examination, chest x-ray, full blood count and thyroid function test) and they concluded that CPET was useful in identifying a cardiac or pulmonary cause but insensitive in distinguishing cardiac disease from deconditioning. Their study differed from ours with respect to the short median follow-up of 9.1 months (range, 2.5 to 80 months) and lack of information about healthcare utilisation or long-term outcomes. De Paso et al[7] evaluated 72 patients with unexplained dyspnoea and subjected patients to diffusion test, ventilation-perfusion scan and echocardiogram. Definite cause of dyspnoea was not found in 14 patients (19%) for which only 2 patients had CPET performed and both were normal. Although patients were followed-up for mean of 5 years (range, 1 to 8 years), the numbers were too small to make any conclusion.

The main limitation of our study lies in its retrospective nature and small sample size. Our study population also comprised predominantly younger patients (median age: 32 years) when compared to the Martinez's study (median

age: 55 years) as the main source of referral came from our armed forces for evaluation of national servicemen with dyspnoea. Therefore, this may affect the external validity of our study. The strength of our study lies in the standardised reporting of CPET by 3 pulmonologists in blinded fashion and a 2-year follow-up period. However, we were not able to capture the data for healthcare visits to other institutions.

While CPET can prognosticate several diseases including emphysema,[8] idiopathic pulmonary fibrosis,[9] lung cancer,[10] hypertrophic cardiomyopathy,[11] and chronic heart failure,[12] its value in unexplained dyspnoea is largely unexplored.

Conclusion

In patients with unexplained dyspnoea and CPET results showing "Normal", "Cardiac limitation vs deconditioning" or "Deconditioning", it seemed reasonably safe to limit further investigations for their symptom of dyspnoea. Larger prospective studies are required to confirm the findings.

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Letter to the Editor

Relationship between Theory and Workplace-based Assessment Scores in Medical Knowledge within a National Psychiatry Residency Programme

Dear Editor,

To date, previous reports have generally reported low-to-moderate correlation between standardised examination results such as In-Training Examination (ITE) scores and clinical evaluations by faculty in disciplines such as internal medicine and surgery.[1-5] However, there is no data on the relationship between objective ITE scores and subjective workplace-based assessments (WBAs) by faculty in psychiatry training programmes especially within Asia. In view of the limited extant data for psychiatry residency, we aimed to: firstly, examine the progression of Psychiatry Residency ITE (PRITE) scores and the workplace-based clinical performance ratings specifically concerning medical knowledge across residency years; and secondly, understand the inter-relationships between PRITE and the same WBAs within our cohort of psychiatry residents. We hypothesised that there would be progression of PRITE and WBA scores with seniority of residency.

Materials and Methods

This is a retrospective cohort study in which we assessed data of 36 psychiatry residents from 3 separate cohorts over a 6-year period. There were 9 residents in the 2010 cohort, 12 residents in the 2011 cohort, and 15 residents in the 2012 cohort. Twenty-three residents were males (63.9%) and 13 residents were females (36.1%). The residents were part of the 5-year National Psychiatry Residency Programme in Singapore and the study protocol was approved by the Institutional Review Boards of the Institute of Mental Health and the National Healthcare Group.

The PRITE which is administered and scored by The American College of Psychiatrists assesses 13 core areas in psychiatry and is taken annually by residents between years 2 to 4. In this study, the standardised score with a mean of 500 and standard deviation (SD) of 100 provided by The American College of Psychiatrists was used in the analysis to allow comparisons across cohorts.

For WBAs, we extracted 4 questions that were used to evaluate the competency of medical knowledge in the Resident Performance Evaluation which is performed quarterly, namely: 1) resident's demonstration of good basic science knowledge, 2) ability to apply medical knowledge in clinical context, 3) demonstration of up-to-date knowledge and, 4) good analytical thinking and problem solving techniques. Each question is rated on a 9-point performance scale (1-3: unsatisfactory, 4-6: satisfactory, and, 7-9: superior). For each resident, composite scores for each year of their training were calculated firstly by averaging the ratings on the 4 questions at each assessment period, then averaging the scores over an academic year. Residents were also rated by their supervisors using the Observer-Reporter-Interpreter-Manager-Expert (ORIME) framework, an adaptation of the Reporter-Interpreter-Manager-Expert (RIME) framework developed by Pangaro.[6] For each resident, the proportion of Manager/Educator ratings across all assessment periods over an academic year was included in this study as an indicator of overall clinical competency with a range from 0 to 1.

In terms of data analysis, we examined whether there is a difference in: 1) PRITE scores, 2) medical knowledge ratings, and 3) ORIME ratings by residency year. The assessment scores and ratings were fitted using linear-effect mixed model, and likelihood ratio test was used to find out whether residency year could predict assessment scores and ratings. Finally, Tukey pairwise comparisons were conducted to compare the difference in assessment scores across the residency years.

Results

Of note, residency year was a good predictor of medical knowledge ratings (P <0.001) and ORIME ratings by supervisors (P <0.001) (Table 1). Tukey pairwise comparisons found that medical knowledge ratings by supervisors were significantly higher for residents in year 3 than year 2 (P <0.001, 95% CI (confidence interval) [0.16, 0.79]), and higher for residents in year 4 than year 2 (P <0.001, 95% CI [0.18, 0.83]). For ORIME ratings, Tukey pairwise comparisons also found that ORIME ratings by supervisors were higher for residents in year 3 than year 2 (P <0.001, 95% CI [0.13, 0.41]) and higher for residents in year 4 than year 2 (P <0.001, 95% CI [0.26, 0.56]). Residency year of training was not a significant predictor of PRITE scores.

Correlation analyses (Table 2) found that medical knowledge ratings by supervisors were positively correlated

Table 1. Summary of PRITE, Medical Knowledge and ORIME Resident Scores by Residency Year

Year	PRITE Scores			Likelihood Ratio Test		Medical Knowledge Ratings			Likelihood Ratio Test		ORIME Ratings			Likelihood Ratio Test	
	n	Mean	SD	X^2	*P* Value	n	Mean	SD	X^2	*P* Value	n	Mean	SD	X^2	*P* Value
2	35	540.26	77.13	2.11	0.35	35	6.82	0.52	859.34	<0.001	35	0.2	0.21	990.93	<0.001
3	29	551.45	66.72			32	7.3	0.59			32	0.47	0.5		
4	27	560.85	57.22			28	7.33	0.53			28	0.62	0.55		

n: sample size; ORIME: Observer-Reporter-Interpreter-Manager-Educator; PRITE: Psychiatry Residency In-Training Examination; SD: Standard deviation

Table 2. Correlations between WBA Scores (Medical Knowledge & ORIME Ratings) and Standardised Examination (PRITE) Scores

Year	PRITE Scores and Medical Knowledge Ratings			PRITE Scores and ORIME Ratings			Medical Knowledge and ORIME Ratings		
	r	95% CI	*P* Value	r	95% CI	*P* Value	r	95% CI	*P* Value
2	0.40	[0.04, 0.66]	0.03	0.25	[-0.09, 0.55]	0.14	0.41	[0.02, 0.64]	0.04
3	0.19	[-0.31, 0.43]	0.61	0.04	[-0.43, 0.39]	0.73	0.43	[0.11, 0.70]	0.01
4	-0.02	[-0.38, 0.35]	0.73	0.02	[-0.38, 0.35]	0.73	0.32	[-0.10, 0.65]	0.13

CI: Confidence interval; ORIME: Observer-Reporter-Interpreter-Manager-Educator; PRITE: Psychiatry Residency In-Training Examination; WBA: Workplace-based assessment; r: Correlation coefficient

with standardised PRITE scores only in residency year 2 (r (34) = 0.40, *P* = 0.03, 95% CI [0.04, 0.66]). However, medical knowledge ratings and ORIME ratings by supervisors were positively correlated with each other both in residency year 2 (r (34) = 0.41, *P* = 0.04, 95% CI [0.02, 0.64]) and year 3 (r (34) = 0.43, *P* = 0.01, 95% CI [0.11, 0.70]).

Discussion

There were several findings in this study. Firstly, workplace-based assessment ratings involving medical knowledge ratings and ORIME ratings by supervisors significantly increased over time when comparing residents in years 3 and 4 to residents in year 2. Secondly, significant positive correlation between PRITE and medical knowledge scores were found only in year 2 residents. Thirdly, significant correlations between the WBA scores by supervisors (medical knowledge and ORIME) were found among residents in years 2 and 3.

Observed improvements in clinical evaluations of the domains of medical knowledge and overall clinical competency may reflect progress in application of medical knowledge in clinical scenarios over time. In the context of constructivism[7] and situated cognition[8] theories, learning is constructed from the learner's experience and medical knowledge is imbued with clinical meaning when the resident applies the theoretical information in his/her specific clinical encounters. The clinical experience in turn consolidates the medical information acquired which can then be applied to a different clinical encounter iteratively. The lack of difference in PRITE scores across years—in contrast to a study by Ryan et al[9] of residents in an emergency medicine programme—may be explained by our relatively small yearly cohort, or a focus on specific knowledge within clinical contexts in senior residency years. This could also reflect the ceiling effect of consistent above-average scores achieved by a self-selected and motivated group of residents within a national training programme with competitive entry and who are self-directed to take responsibility for their learning decisions.[10]

There was only weak-to-moderate correlation between PRITE and medical knowledge scores in year 2 which is consistent with earlier studies showing similar poor correlation although involving residents in other disciplines such as internal medicine, paediatrics, orthopaedic surgery and general surgery.[1-5,11] This may reflect the different nature and construct of assessments involved in standardised examinations such as PRITE, which evaluates a broad and general knowledge base compared with WBAs which evaluates specific clinical skills within different learning environments. WBAs may involve an overall clinical impression related to the reviewed case and the faculty may focus on medical knowledge within specific clinical contexts and not necessarily the broad scope of medical knowledge during their evaluations.[12,13]

In addition, there was observed correlation between WBAs of specific competency of medical knowledge and overall clinical performance in both years 2 and 3 in our study which suggests concordance in these constructs in evaluating medical knowledge over time. These assessments

may be helpful in looking into the impact of medical knowledge on overall clinical performance in earlier training years when there is a steeper learning curve. One major limitation of this study is the lack of local data on the predictive validity of PRITE and WBAs. Future efforts should focus on aligning the PRITE with the context of practice, evaluating the predictive validity of PRITE and WBAs for performance at summative examinations within the training programme, continual training of faculty in the administration and interpretation of these assessments and determination of the inter-rater reliability of these measures.

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