AJSTD

Vol. 33, No. 2, 2016
ISSN 0217-5460

A Journal of the ASEAN Committee on Science & Technology

ASEAN Journal on Science & Technology for Development

ABOUT THE ASEAN JOURNAL ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

The ASEAN Journal on Science and Technology for Development is a refereed Journal of the ASEAN Committee on Science and Technology (ASEAN COST). It reports on science and technology policies and programmes, and research activities undertaken by COST in support of social and economic development of the ASEAN member countries.

The coverage is focused but not limited to, the main areas of activity of ASEAN COST, namely, Biotechnology, Non-Conventional Energy Research, Materials Science and Technology, Marine Sciences, Meteorology and Geophysics, Food Science and Technology, Microelectronics and Information Technology, Space Applications, and Science and Technology Policy, Infrastructure and Resources Development.

ABOUT THE ASEAN COMMITTEE ON SCIENCE AND TECHNOLOGY

The ASEAN Committee on Science and Technology was established to strengthen and enhance the capability of ASEAN in science and technology so that it can promote economic development and help achieve a high quality of life for its people. Its terms and reference are:

- To generate and promote development of scientific and technological expertise and manpower in the ASEAN region;
- To facilite and accelerate the transfer of scientific and technological development among ASEAN countries and from more advanced regions of the world to the ASEAN region;
- To provide support and assistance in the development and application of research discoveries and technological practices of endogenous origin for the common good, and in the more effective use of natural resources available in the ASEAN region and in general; and
- To provide scientific and technological support towards the implementation of existing and future ASEAN projects.

Information on the activities of ASEAN COST can be obtained at its website http://www.asnet.org

DISCLAIMER

While every effort is made to see that no inaccurate or misleading data, opinion or statement appears in the Journal, articles and advertisements in the Journal are the sole responsibility of the contributor or advertiser concerned. They do not necessarily represent the views of the Editors, the Editorial Board nor the Editorial Advisory Committee. The Editors, the Editorial Board and the Editorial Advisory Committee and their respective employees, officers and agents accept no responsibility or liability whatsoever for the consequences of any inaccurate or misleading data, opinion or statement.

Editorial Board

Contents

ASEAN J. Sc. Technol. Dev.
Volume 33(2), 2016

ASEAN J. Sci. Technol. Dev., **33(2)**: 63 – 68

Synthesis of Biphasic Calcium Phosphate and its Behaviour in Simulated Body Fluid

X. V. BÙI[1,2*] AND T. D. THẮNG[1]

The main goal of this study is to elaborate and evaluate the physicochemical properties of the synthetic biphasic calcium phosphate (BCP) powder: an associate compound of hydroxyapatite (HA): $Ca_{10}(PO_4)_6(OH)_2$ and beta-tricalcium phosphate (β-TCP): $Ca_3(PO_4)_2$. The new compound BCP has two advantages: high bioactivity (HA) and fast biodegradation (β-TCP). The obtained powder of BCP was prepared by the precipitate method. XRD analysis confirmed the synthetic material contained both HA and β-TCP crystalline phases. SEM images showed that the small particles of HA attached to bigger particles of β-TCP in the structure morphology of BCP. The in vitro experiment was carried out in static condition by soaking of a series of 50 mg BCP powder in 100 ml of simulated body fluid solution at different period of soaking time. The XRD and SEM methods studied the microstructure and chemical bond after soaking. The obtained results confirmed the bioactivity of synthetic BCP material by the formation of a new apatite layer on its surface.

Key words: High bioactivity; beta-tricalcium phosphate; biphasic calcium phosphate; bioactivity; simulated body fluid

Hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$, HA] is commonly used as bioactive materials in bone graft, orthopaedic application, dental implant etc. since its unique ability to bond to bone after implantation (Ellinge *et al.* 1986). The ability of bond to bone can be predicted by its capacity to form HA layer on the surface upon immersed in simulated body fluid (SBF) solution, of which the ion concentrations is similar to human plasma (Nery *et al.* 1990). SBF screening is commonly used to predict the ability to bond to bone since its simplicity and economic, before implant into a live animal.

In the other hand, the β-tricalcium phosphate [β-$Ca_3(PO_4)_2$, β-TCP] is known as biodegradable materials, but exposes its weak bioactivity (Petrov *et al.* 2001). So if we can combine HA and β-TCP with proper ration, we are also possible to control the advantage of biphasic calcium phosphate (BCP): high bioactivity and its fast biodegradation (Victoria & Gnanam 2002; Aslanidou *et al.* 2012).

In this research, we aim to synthesize the BCP powder by the wet chemical precipitation method and evaluate the physicochemical properties of the synthetic material before and after in vitro test in SBF.

[1] Ton Duc Thang University, No. 19 Nguyen Huu Tho Street, Tan Phong Ward, District 7, Ho Chi Minh City, Viet Nam
[2] Ho Chi Minh City Industry and Trade College, No. 20 Tang Nhon Phu Street, Phuoc Long B Ward, District 9, Ho Chi Minh City, Viet Nam
* Corresponding author (e-mail: buixuanvuong@tdt.edu.vn)

MATERIALS AND METHODS

Preparation of BCP Powder

BCP is prepared similar to the research of Nezahat Kivrak with the weight ratio of HA and β-TCP is 20/80 (Kivrak & Cuneyt Tas 1998). At first, $(NH_4)_2HPO_4$ 0.1128 M was dropped into $Ca(NO_3)_2.4H_2O$ 0.4 M so that the weight ratio of HA/β-TCP is 20/80. The dropping rate was approximately at 3 ml/min, and chemical reaction was maintained at 40°C, then adding NH_4OH 0.1 M to adjust pH = 8. After finishing, it was filtered many times by distilled water to remove the bad smell of NH_4OH solution. Then the aqueous suspension was transferred into the oven and dried at 120°C for 8 h to obtain the powder, following the calcination at 1000°C for 5 h. The synthetic flowchart is presented in *Figure 1*.

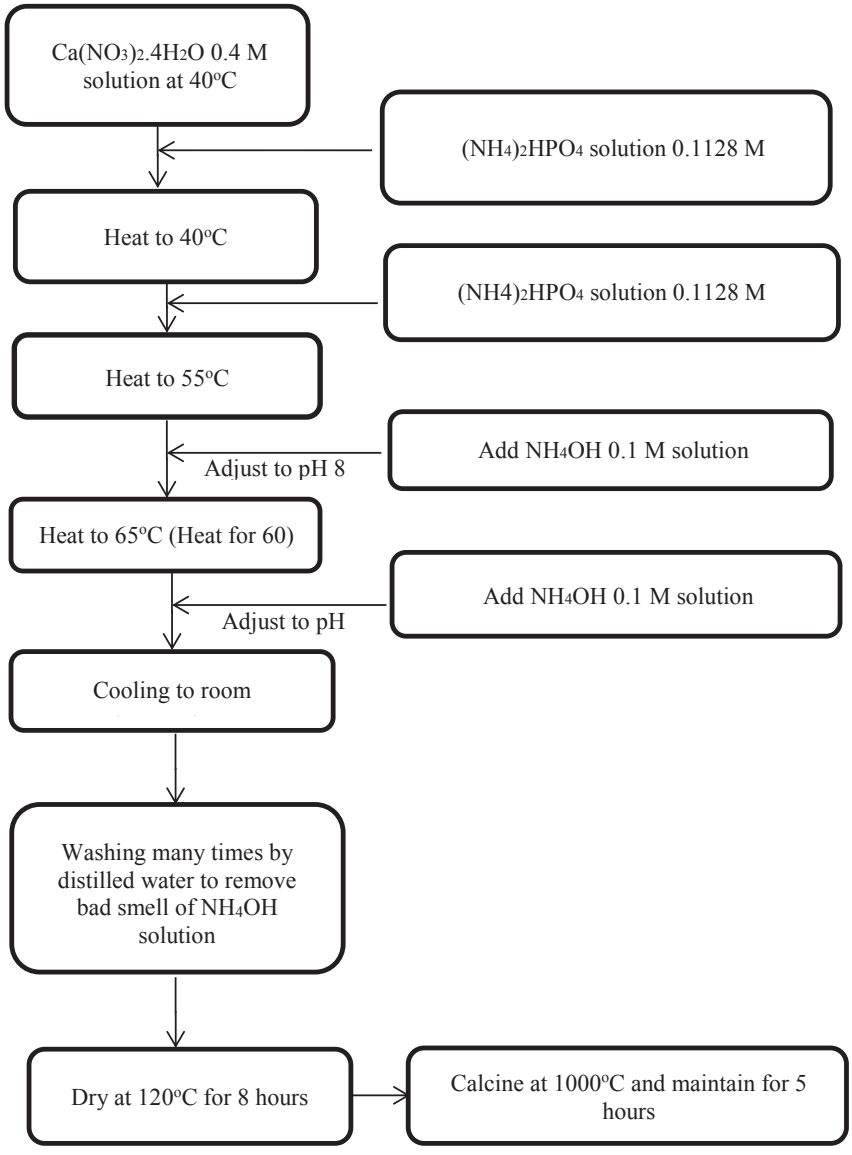

Figure 1. Synthetic process of BCP powder.

In vitro Experiment

To predict the bond to the bone ability of BCP, we soaked BCP powder in the SBF solution. The ion composition of SBF solution is similar to human plasma. SBF solution was prepared by NaCl, $NaHCO_3$, KCl, $K_2HPO_4.3H_2O$, $MgCl_2.6H_2O$ and C_aCl_2. They are dissolved in distilled water and buffered with $(CH_2OH)_3CNH_2$ and HCl (6N) to adjust the pH value at 7.4. This process is according to the Kokubo's method (Kokubo & Takadama 2006). The ratio (50 mg of material in 100 ml of SBF solution) was chosen in in vitro experiment.

Characterization of BCP Powder

To characterize physicochemical properties of biomaterial before and after soaking in SBF solution, some analysis of physico-chemical methods were used like X-ray diffractometer (XRD) and scanning electron microscopy (SEM). To evaluate the crystalline phase, constitution and component of BCP, XRD (Bruker D8 Advance) were employed. The XRD performed with a scan speed of 0.02°/min and step time was 1 s/min. XRD data were acquired in the range of 2θ from 5° to 65°. SEM (Hitachi, Joel 5) was used to observe and evaluate the morphology of material before and after soaking in SBF solution, and determine the formation of the new apatite layer after soaking in SBF solution.

RESULT AND DISCUSSION

Characterization of Synthetic BCP Material

Figure 2 shows XRD patterns of synthetic BCP with HA standard and β-TCP standard. The synthetic BCP had specific peaks of both HA and β-TCP and had not stranger peaks (Pramanik *et al.* 2007; Biqin *et al.* 2008; Mir *et al.* 2012). XRD pattern of BCP had the sharp peaks which showed that BCP had an excellent crystallinity. The obtained result confirmed that the synthetic BCP was a combination of two phases: HA and β-TCP and of complete purity.

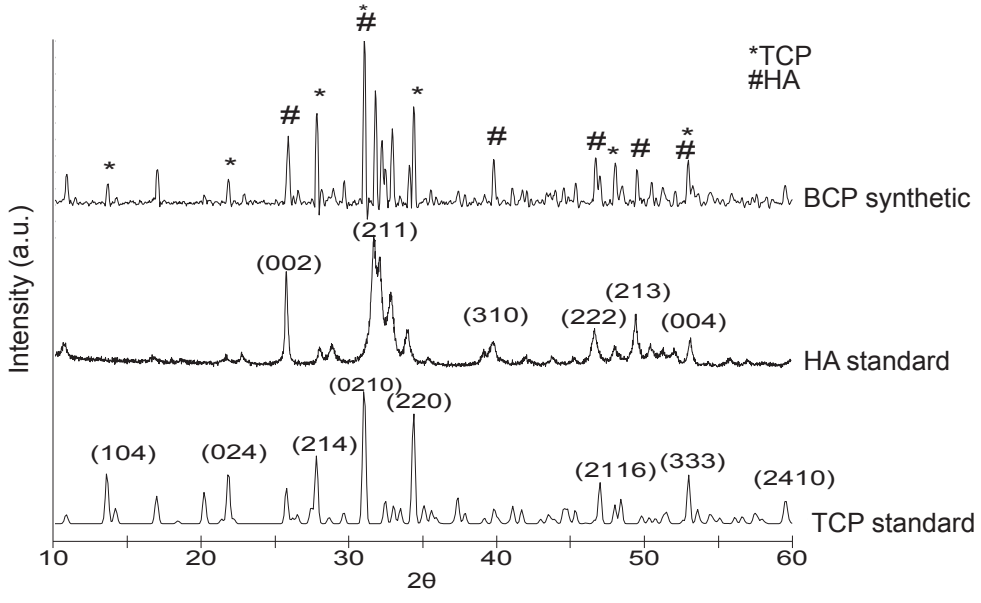

Figure 2. XRD patterns of synthetic BCP with HA standard and β-TCP standard.

Figure 3 shows SEM images of β-TCP, HA, and BCP. The SEM micrograph showed two phase of HA and β-TCP with HA phase was the small particles that attached to bigger particles of β-TCP. This result confirmed the combination of HA and β-TCP in the structure of BCP.

In vitro test

Figure 4 regroups the XRD patterns of BCP after 0, 1, 5 and 10 days of soaking in SBF solution. After 1 day of soaking in SBF, there was a significant change before soaking. The β-TCP phase in BCP had crystallized while the HA phase had decomposed. But from 5 to 10 days the process carried out reversely. The HA phase had crystallized, and the β-TCP phase had decomposition. These phenomena confirmed the chemical interactions between BCP and SBF medium to conduit a new apatite layer on its surface. After a long time of soaking, β-TCP phase in BCP would have been completely decomposed and replaced by a new apatite layer.

Figure 5 shows SEM micrographs of BCP after 0, 1, 5 and 10 days of soaking in SBF solution. After one day of soaking, no phenomena appeared. After five days of soaking, a thin layer was coated on BCP surface like grass. After ten days, the new layer continued to develop. This confirmed the bioactivity of synthetic material.

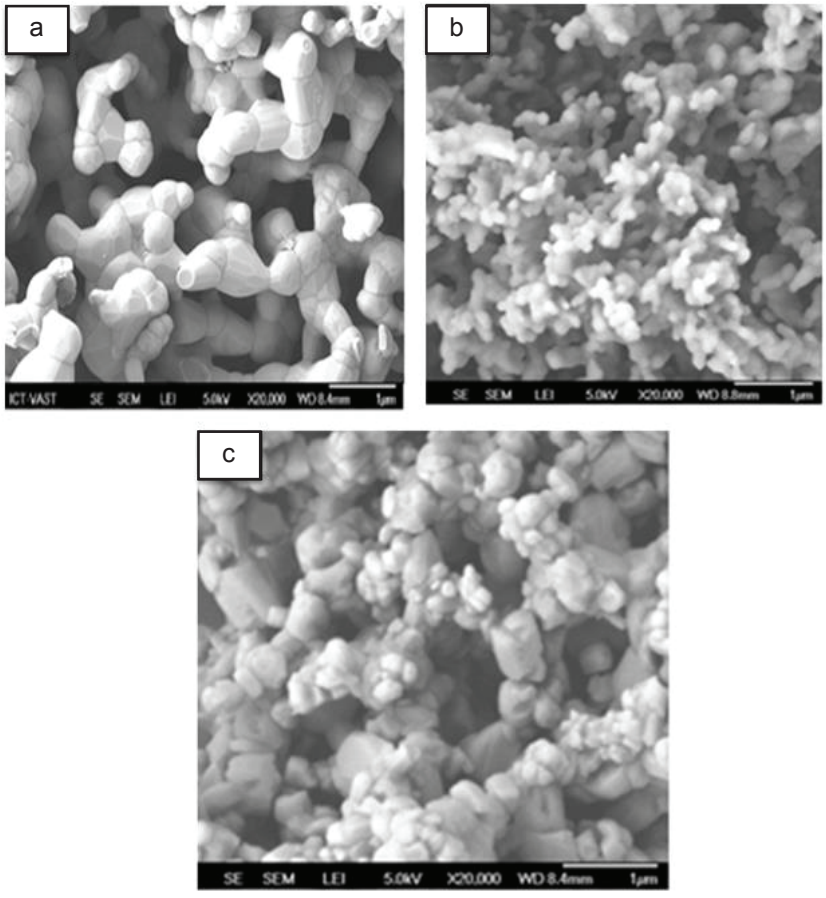

Figure 3. SEM images of (a) β-TCP, (b) HA and (c) BCP.

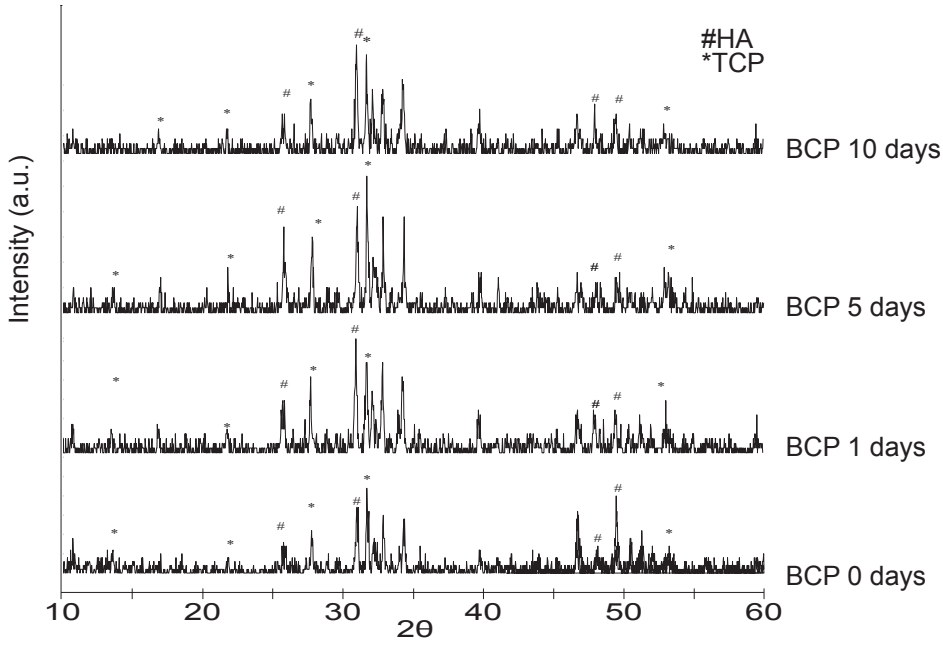

Figure 4. XRD patterns of BCP after 0, 1, 5 and 10 days of soaking in SBF solution.

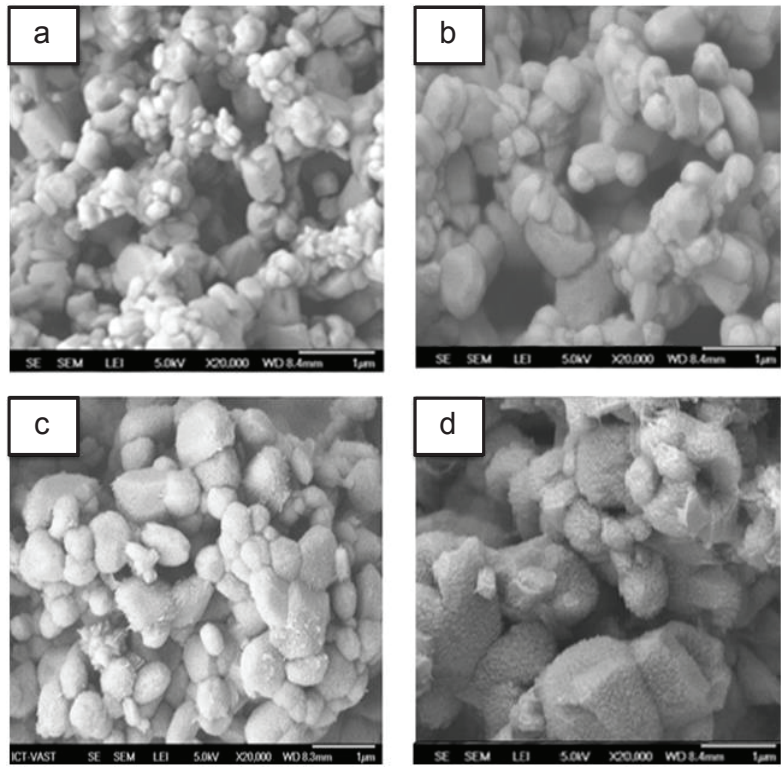

Figure 5. SEM micrograph of BCP after (a) 0, (b) 1, (c) 5 and (d) 10 days of soaking in SBF solution.

CONCLUSIONS

Our research group succeeded to synthesise BCP powder via wet chemical precipitate method. Physicochemical characterization by XRD and FTIR confirmed the presence of two phases HA and β-TCP.

In vitro test to evaluate the bioactivity was carried out in the SBF solution. XRD and SEM analyses showed that the formation of a new apatite layer and the disappearance of β-TCP phase. This material could be used as biomaterials for bone replacement.

Date of submission: December 2016
Date of acceptance: January 2017

REFERENCES

Aslanidou, M, Vaimakis, T, Anastasios, M & Trapalis, C 2012, 'A novel approach on the preparation of biphasic calcium phosphate bioceramics under physiological conditions. The effect of the starting material', *ScieVerseScienceDirect, Ceramics International*, nd.

Biqin, C, Zhaoquan, Z, Jingxian, Z, Qingling, L & Dongliang, J 2008, 'Fabrication and mechanical properties of β-TCP pieces by gelcasting method', *Mater. Sci. Eng. C.*, vol. 28, pp. 1052–1056.

Ellinger, RF, Nery, EB & Lynch, KL 1986, *J. Periodontol. Restor. Dent.*, vol. 3, pp. 1035–1038.

Kivrak, N & Tas, AC 1998, 'Synthesis of calcium hydroxyapatite–tricalcium phosphate (HA–TCP) composite bioceramic powders and their sintering behavior', *J. Am. Ceram. Soc.*, vol. 81, no. 9, pp. 2245–2252.

Kokubo, T & Takadama, H 2006, 'How useful is SBF in predicting *in vivo* bone bioactivity?', *Biomaterials.*, vol. 27, no. 14, pp. 2907–2915.

Nery, EB, Lee, KK & Czajkowski, S *et al.* 1990, *J. Periodontol.*, vol. 61, no. 12, pp.737–744.

Petrov OE, Dyulgerova, E, Petrov, L & Popova, R 2001, 'Characterisation of calcium phosphate phases obtained during the preparation of sintered biphasic Ca-P ceramics', *Material letters*, vol. 48, pp. 162–167.

Victoria, EC & Gnanam, FD 2002, 'Synthesis and characterisation of biphasicalcium phosphate', *Trends in Biomaterials and Artificial Organs*, vol. 15, no. 1, pp. 12–14.

Pramanik, S, Agarwal, AK, Ra, KN & Garg, A 2007, 'Development of high strength hydroxyapatite by solid-state-sintering process', *Ceramics International*, vol. 33, no. 3, pp. 419–426.

Mir, M, Leite, FL, Sérgio, PPH Jr., Pissetti, FL, Rossi, AM, Moreira, EL & Mascarenhas, YP 2012, 'XRD, AFM, IR and TGA study of nanostructured hydroxyapatite', *Mat. Res.*, vol. 15, no. 4. (E-pub July 03, 2012)

ASEAN J. Sci. Technol. Dev., **33(2)**: 69 – 77

Wound Healing Post-mesh Repair — An Observational Study

M. N. LEBBE[1], J. KULARAJASINGHAM[2] AND R. (III) P. DIOSO[3*]

This study identified the best surgical mesh repair techniques for inguinal hernia and prevalence of wound healing post-mesh repair. The cross-sectional study design used cluster sampling for data collection. Of the 120 respondents, 48.3% preferred anterior tension-free mesh repair and 49.2% Lichtenstein mesh repair, both identified as the common surgical techniques in eastern Sri Lanka. About 82.5% of the respondents (n = 99) healed while 17% (n = 21) had recurrence of hernia after one month. Nevertheless, 2.5% of the total respondents said that the hernia repaired after one month but less than two months; and 97.5% of the interviewees stated that they recovered in less than one month regardless of the surgical mesh repair technique. Respondents aged 30–39 faced little impact on healing time with mesh repair (p = 0.4393), while those aged 40–49 probably had also longer healing time (p = 0.3947). Recovering period differed significantly (p = 0.862), on pain or discomfort, especially when bending over, coughing or lifting heavy objects.

Key words: Mesh repair; observational study; cross-sectional; wound healing; recovery room

The eastern province of Sri Lanka primarily is agriculture based and is commonly known as the "Granary of Sri Lanka" where Sri Lankans usually work (Wimalaratana 2011). Inguinal hernias are among the most common problems encountered by their farmers.

Several techniques of inguinal hernia repair have been done over the years to achieve a faster healing outcome (Amato *et al.* 2009; Kark *et al.* 1998). In Sri Lanka, surgical mesh repair such as: (1) open repairs (Anterior, Lichtenstein, Desarda, and Guamieri (which are tension-free), and Bassini and Shouldice (with tension), and (2) laparoscopic mesh repairs are usually used (Amato *et al.* 2009; Aufenacker *et al.* 2004; Vrijland *et al.* 2002; O'Dwyer *et al.* 2004). Wound healing regardless of the techniques for mesh repair varies on the types of meshes and methods (O'Dwyer *et al.* 2004; Bilsei 2012). Biological mesh types (Bilsei 2012) in *Table 1* are ideally used in Sri Lanka, however, not observed in this study.

Research Problem

There is an estimated wound healing time for post-mesh repair among adult patients with inguinal hernias. The fundamental issue of this study was based on a resolution adopted by a variety of problems such as:

1. How many days would patients need to return to their regular activities of daily living?

2. What was the best mesh repair techniques that might lead to a quick recovery?

[1] Batticaloa Teaching Hospital, Sri Lanka
[2] Batticaloa General Hospital, Sri Lanka
[3] Faculty of Nursing, Lincoln University College, Malaysia
* Corresponding author (e-mail: duke@lincoln.edu.my)

Table 1. Types of biologic meshes (Bilsei 2012).

	Description	Advantages	Drawbacks
	Human Dermis		
AlloDerm®	Aseptic proprietary process removes all cellular material, freeze-dries dermis and non-cross-linked	Long record of safety and went on terminal gas sterilization	Relatively small sizes; must be refrigerated/rehydrated and placed under tension; stretches out over time
FlexHD®	Aseptic processing. No refrigeration or rehydration needed; minimal elasticity	No refrigeration or rehydration needed	Minimal elasticity
AlloMax™	Proprietary Tutoplast processing removes all cells	Sterilized by low-dose radiation	Hydration required
	Porcine Dermis		
Permacol™	Acellular, chemically cross-linked to resist collagenase	No refrigeration or rehydration requirement	Available only in large sizes
CollaMend®	Acellular, cross-linked collagen, and elastin	Lyophilized	Requires hydration
Strattice™ and XenMatrix®	Acellular, Non-cross-linked	Available in large sheets	Long term follow up
	Porcine Intestine		
Surgisis®	Acellular, Non-cross-linked	No refrigeration requirement	Needs hydration; susceptible to collagenases
FortaGen®	Low-level cross-linking	No hydration	Unclear safety profile
	Bovine Dermis		
Veritas®	Bovine pericardium	For staple line reinforcement	Insufficient data
SurgiMend™	Fetal bovine dermis, Non-cross-linked	Long shelf life	Requires rehydration
Tutopatch®	Bovine pericardium	Small inflammatory response	Insufficient data

Aims

On account of these issues, it was hoped that:

1. Identify the best surgical mesh repair techniques for inguinal hernias; and

2. Identify prevalences of wound healing post-mesh repair.

Variables

The cause variable was the surgical mesh repair procedure among patients with an inguinal hernia while the effect variable was the healing time. The variables would then answer the question: Was there a significant evidence of faster wound healing time for post -mesh repair among adult patients with an inguinal hernia?

Hypothesis

It was however hypothesized that there is an important technique of surgical mesh repair leading to a faster wound healing time among patients with an inguinal hernia admitted to government hospitals in the eastern province of Sri Lanka.

LITERATURE REVIEW

Search strategy

Review of literature of the publications relating to the fast wound healing of inguinal hernia post mesh repair among adult patients came from the published reports of the Ministry of Health, Sri Lanka, the published annual reports of the Central Bank, the documents of the Department of Census and Statistics Sri Lanka, the Sri Lankan government publications, the documents of the World Medical Association, the published annual reports of the World Health Organization, the documents from the Sri Lankan eastern provincial council, Google Scholars, Biomed Central, and Proquest. A total number of 22 000 kinds of literature were found; however, only five studies would be used in this review.

Few studies most relevant were:

1. Randomized Clinical Trial of Non-mesh versus Mesh Repair of Primary Inguinal Hernia, by W. W. Vrijland *et al.* 2002

2. Randomized Clinical Trial Assessing Impact of a Lightweight or Heavyweight Mesh on Chronic Pain after Inguinal Hernia Repair, by P. J. O'Dwyer *et al.* 2005

3. Reoperation after Recurrent Groin Hernia Repair, by Haapaniemi *et al.* 2001

4. The Role of Antibiotic Prophylaxis in Prevention of Wound Infection after Lichtenstein Open Mesh Repair of Primary Inguinal Hernia: A Multicenter Double-blind Randomized Controlled Trial, by Aufenacker *et al.* 2004

5. Three Thousand One Hundred Seventy-five Primary Inguinal Hernia Repairs: Advantages of Ambulatory Open Mesh Repair Using Local Anesthesia, by Allan *et al.* 1998

Critical Appraisal

Three hundred patients were studied by Vrijland *et al*. (2002) between September 1993 and January 1996. Based on all patients scheduled for repair of a unilateral primary inguinal hernia were randomized to non-mesh or mesh repair. The patients were followed up at one week and 1, 6, 12, 18, 24 and 36 months. Clinical outcome, such as quality of the mesh, its weight and stiffness and isotropy were analyzed. The results were to compare mesh and non-mesh suture repair of primary inguinal hernias on quality of mesh in a multi-center randomized trial in general hospitals. The result of the study of Vrijland *et al.* (2002), says that 300 patients healed after a 3-year recurrence rate: 1% for non-mesh repair (n = 143) and 7% for mesh repair (n = 146) (p = 0·009). Mesh repair with quality meshes was superior to non-mesh repair.

On the other hand, O'Dwyer *et al.* (2005) conducted a study aimed to compare the pain of any severity at 12 months after inguinal hernia repair with a partially absorbable lightweight (LW) mesh group or with a non-absorbable heavy weight (HW) mesh group. They used 321 patients, 162 in the LW group and 159 in the HW group and patients were assessed for pain at 1, 3 and 12 months by questionnaire, and were examined clinically at 12 months. O'Dwyer *et al.* (2005) found after 12 months, significantly fewer patients in the LW group than in the HW group had the healing time of 39.5% versus 51.6% (difference — 12·1 (95% confidence interval — 23·1 to 1·0)%; p=0·033). The recurrence of inguinal hernia rate was higher in the LW group (5.6% versus 0.4%; p=0·037). Five of 8 recurrences in LW group were associated with a single participating center. Finally, O'Dwyer *et al.* (2005) has taken a decision that the "use of LW mesh was associated with less chronic pain but an increase in hernia healing time post-mesh hernia repair. The latter may be related to technical factors associated with fixation of such meshes rather than any inherent defect in the mesh".

Re-operation after recurrent groin hernia repair was the study done by Haapaniemi *et al.* (2001) analyzing re-operation rates for recurrent and primary groin hernia repair documented in the Swedish Hernia Registration from 1996 to 1998. Postoperative complications and direct hernia were associated with its burst strength which increased relative risk for re-operation. Actuarial analysis adjusted for patients' death was used for calculating the cumulative incidence of re-operation. Haapaniemi *et al.* (2001) found that from 1996 to 1998, 17 985 groin hernia operations were recorded in the Swedish Hernia Registration, 15% for a recurrent hernia and 85% for a primary hernia. At 24 months the risk for having a re-operation was 4.6% after recurrent hernia repair and 1.7% after primary hernia repair. The relative risk for re-operation was significantly lower for laparoscopic methods and anterior tension-free repair because of the significant burst strength of the meshes.

The study of Aufenacker *et al.* (2004) aimed to determine whether the use of prophylactic antibiotics are effective in the prevention of postoperative wound infection after Lichtenstein open mesh inguinal hernia repair. Patients with primary inguinal hernia scheduled for Lichtenstein repair were randomized to a preoperative single dose of 1.5 g intravenous cephalosporin or a placebo. Patients with recurrent hernias, immunosuppressive diseases, or allergies for the given antibiotic were excluded. Aufenacker *et al.* (2004) found that 1008 patients analyzed had infections (1.6%) in the antibiotic prophylaxis and the placebo group (p = 0.82). There were deep infections (1.8%) in the antibiotic prophylaxis group and the placebo group (p = 0.57). Statistical analysis showed an absolute risk reduction of 0.19% (95% confidence interval, −1.78% to 1.40%) and a number needed to treat of 520 for the total number of infections. For deep infections, the absolute risk reduction is 0.20% (95% confidence interval, −0.87% to 0.48%) with a number needed to treat of 508. Aufenacker *et al.* (2004) concluded that a low percentage of wound infection after Lichtenstein open mesh inguinal (primary) hernia repair was found, and there was no difference between the antibiotic prophylaxis or placebo group. The result showed that, in Lichtenstein inguinal major hernia repair, antibiotic prophylaxis is not indicated in low-risk patients but rather the tensile strength and compliance of the mesh.

Finally, Allan *et al.* (1998) a imed to study the "Controversy existing over the relative advantages of open mesh repair compared with open stitching methods and the laparoscopic approach." Allan *et al.* (1998) examined 2906 consecutive unselected adult patients who underwent 3175 primary inguinal hernia repairs using polypropylene mesh, analyzing its elasticity on an ambulatory basis. The age range was 15–92 years. The study specifically investigated the postoperative course about pain, complicati ons, and time of return to work. Allan *et al.* (1998) found that there were neither shrinkages nor deformations with strains

from the meshes and no cases of unhealed wounds post-mesh repair. The incidence of deep infection was 0.3%. However, n o cases of testicular atrophy occurred. There was a gradual decrease in time of return to work over four successive 1-year periods. Manual workers returned to work in 15 days (median) in the first year, reducing to 9 days in the fourth year. The overall median time of performance to work across the whole group was nine days. There were eight recurrences with an 18-month to 5-year follow-up. Allan *et al.* (1998) conclude d from this study that "open mesh repair under local anesthesia is an effective day case technique, particularly in the elderly and medically unfit. The economic benefits are enhanced by low morbidity, early return to normal activities and low recurrence rates".

Analysis

The literature reviewed will help design the method of this research (Hopkins 2008). It was also examined that there were varieties of terms that needed to be observed and variables that affected the healing time. Moreover, surgical methods of mesh repairs are based on the physical characteristics of the meshes (Bilsei 2012). Surgical techniques are still considered. However, these methods would fail if the quality of the meshes was not considered (*Table 2*).

METHODOLOGY

Design

A quantitative cross-sectional study design was used in this research. This was because two hospitals were selected to cross analyze the data collected from the samples.

Sampling Technique

Cluster random sampling used 120 populations; at 20% estimated prevalence and precision of 5% margin of error at 95% confidence interval. The sample size was calculated using this formula:

$$n = \frac{Z^2.P(1 - P)}{d}$$

where, n = population; Z = confidence P = prevalence, and d = precision.

Data Collection

The questionnaires were issued directly to 120 inguinal hernia patients who were admitted to two government hospitals.

The questionnaire was in the form of a constructed survey based on the Likert five-point scale (Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree). According to Hopkins (2008), validity as an indicator of research measures the questionnaires set. According to Johns (1999), questionnaires must have greater validity if they consider the ease of its use.

Data Analysis

The results from the data analysis included an analysis of response rate, demographic characteristics of respondents, about their disease, symptom of disease and healing time after surgery. The analysis was further divided into sections: (1) exposure to surgical mesh repair of an inguinal hernia; and (2) evidence of wound healing regardless of the surgical technique.

The descriptive data results used central tendencies such as:

- Mean and standard deviation;
- Anova test; and
- Probability findings.

Ethics

The approval started with the ethical committee of Lincoln University College, Research Management. The Sri Lankan Ministry of Health also approved the use of the government hospitals for data collection. Lastly, letters from the two government hospitals selected were sought.

Table 2. Prevalence of healing post mesh-repair.

Anterior tension-free	48.3%
Lichtenstein tension-free	49.2%
Bassini tension	17.0%
Laparoscopic	0.0%

Table 3. Prevalence of the time of recovery.

Time	N	%
Less than one month	117	97.5%
Less than two months	3	2.5%
Total	120	100.0%

Tables 2 and *3* shows that the vast majority of the respondents regardless of age group, healed post-mesh repair ($p<0.05$).

However, on *Table 4* ages 30–39 faced low impact with mesh repair ($p = 0.4393$), while ages 40–49 were also probable to have longer healing time ($p = 0.3947$). These age brackets (30–49 years old) were facing pain or discomfort in their groin, especially when bending over, coughing or lifting.

Table 5 on the other hand, identifies the number of respondents admitted for a re-occurrence of the hernia thus subject for second mesh repair. A 6.7% ($n = 8$) previously had hernia repair ≥1 year while 93.3% ($n = 112$) only had one-time experience of mesh repair.

Table 4. Mesh repair healing time by age group.

	N	Mean	Std. deviation	Probability
20–29	24	1.00	0.000	0.0000
30–39	58	1.02	0.131	0.4393
40–49	28	1.07	0.262	0.3947
50–59	8	1.00	0.000	0.0000
60–69	2	1.00	0.000	0.0000
Total	120			

Table 5. Previously with hernia repair.

Response	N	%
≥1 year	8	6.7%
One time experience	112	93.3%
Total	120	100.0%

Table 6 shows the symptoms of post-mesh repair. The μ within the range of ≥1 to ≤ 2.5 indicates that all the symptoms had no impact on the healing time of post-mesh repair. Recovering period among symptoms differed significantly using F-test (s = 0.862), on pain or discomfort, especially when bending over, coughing or lifting symptom. The F-test significant value (4115) = 0.719, for the rest of the symptoms except serious mesh repair pain was not statistically significant at 0.05. Serious mesh repair pain ($p<0.05$) did influence the longer recovery period for post-mesh repair. Other symptoms such as irregular bowel ($p = 0.3736$), blood in stool ($p = 0.3567$), black tiny stool ($p = 0.2392$), and pain on exertion ($p = 0.3579$) were not significant. Age bracket 30–39 years old ($p = 0.4393$) and 40–49 ($p = 0.3947$) had more problems with recovery as compared with the other age brackets since they were facing pain or discomfort in their groin, especially when bending over, coughing or lifting.

CONCLUSION

Of the 120 respondents, 82.5% (n = 99) healed while 17% (n = 21) had recurrence of hernia. There was no significant technique of surgical mesh repair leading to a faster wound healing time among patients with an inguinal hernia admitted to government hospitals in the eastern province of Sri Lanka. However, 48.3% preferred anterior tension-free and 49.2% said that Lichtenstein tension-free mesh repair healed faster. Nevertheless, 2.5% of the total respondents said that a hernia healed after one month but <2 months; and 97.5% respondents stated that they recovered in less than one month regardless of the surgical mesh repair techniques they had.

RECOMMENDATION

Prophylactic antibiotics could be used with the high rate of wound infection post-surgical mesh repair irrespective of the technique (Praveen & Rohaizak 2009). Local anesthesia is a suitable and economical option for extensive repairs and should be popularized in day-case settings (Simons *et al.* 2009). Mesh repairs are superior to "non-mesh" tissue-suture repairs in Sri Lanka. Lichtenstein repair and endoscopic/laparoscopic techniques have similar efficacy (Akinci *et al.* 2010; Khajanchee *et al.* 2004; McCormack *et al.* 2005) however, only tension-free (Lichtenstein) is the preferred technique of Sri Lankans. Standard polypropylene mesh was still the choice, whereas the use of partially absorbable lightweight meshes seemed to have some advantages.

According to the data analysis, mesh repair of inguinal hernias was superior to non-mesh repair and showed comparable results regarding postoperative complications, pain, and quality of life. However, quality of meshes (*Table 7*) could also affect healing time and was therefore recommended to surgeons for further research.

Table 6. Symptoms of post-mesh repair.

Symptoms	Results		
	Mean μ	Standard deviation ó	Probability
Bowels are irregular	1.23	0.719	0.3736
Blood in stool	1.31	0.868	0.3567
Black tiny stool	1.38	0.536	0.2392
Pain on exertion	1.13	0.357	0.3579
Serious mesh repair pain	1.00	0.000	0.0000

Table 7. Quality of meshes for further research.

Cause variables	Effect variables
Weight	Measurement of the "heaviness" or "heft" delays healing time (O'Dwyer *et al.* 2005; Vrijland *et al.* 2002)
Shrinkage	Dimensional decrease in length or width delays healing time (Allan *et al.* 1998)
Strain	Deformation of a material in response to an applied force delays healing time (Allan *et al.* 1998)
Tensile strength	Maximum stress subject to its load that can withstand stretching without tearing or breaking speeds up healing time (Aufenacker *et al.* 2004)
Burst strength	The maximum uniformly distributed pressure applied at right angle to its surface that will withstand under standardized conditional pressure speeds up healing time (Haapaniemi *et al.* 2001)
Elasticity	Changes its shape and size under the action of opposing forces, but recovers its original configuration when the forces are removed, increases healing time (Allan *et al.* 1998)
Stiffness	Ratio of steadily increasing or decreasing force acting on a deformable elastic material to the resulting displacement or deformation speeds up healing time (Vrijland *et al.* 2002)
Compliance	Displacement or deformation of a material as the result of application of a unit force affects healing time (Aufenacker *et al.* 2004)
Isotropy	When a material do not exhibit differences in properties based on the direction of the applied load, affects healing time (Vrijland *et al.* 2002)

Date of submission: December 2016
Date of acceptance: February 2017

REFERENCES

Akinci, M, Ergül, Z, Kulah, B, Yilmaz, KB, & Kulacoglu, H 2010, 'Risk factors related with unfavorable outcomes in groin hernia repairs', *Hernia*, vol. 14, pp. 489–493.

Allan, EK, Kurzer, MN & Belsham, PA 1998, Three thousand one hundred seventy-five primary inguinal hernia repairs: advantages of ambulatory open mesh repair using local anesthesia', *Journal of the American College of Surgeons*, vol. 186, no. 4, pp. 447–455.

Amato, B, Moja, L, Panico, S, Persico, G, Rispoli, C, Rocco, N, *et al.* 2009, Shouldice technique versus other open techniques for inguinal hernia repair,' *Cochrane Database Syst. Rev.*, vol. 4, CD001543.

Aufenacker, TJ, van Geldere, D, van Mesdag, T, Bossers, AN, Dekker, B, Scheijde, E, van Nieuwenhuizen, R, Hiemstra, E, Maduro, JH, Juttmann, Jan-Willem, Hofstede, D, van Der Linden, Cunera TM, Gouma, DJ, Simons & MP 2004, 'The role of antibiotic prophylaxis in prevention of

wound infection after lichtenstein open mesh repair of primary inguinal hernia: a multicenter double-blind randomized controlled trial', *Annals of Surgery*, vol. 240, no. 6, pp. 955–961.

Bilsei, Y 2012, 'The search for ideal hernia repairs; mesh materials and types', *International Journal of Surgery*, vol. 10, no. 6, pp. 317–321.

Haapaniemi, S, Gunnarsson, U, Nordin, P & Nilsson, E 2001, 'Reoperation after recurrent groin hernia repair', *Annals of Surgery*, vol. 234, no. 1, pp. 122–126.

Hopkins, W 2008, 'Quantitative research design', *Sport Science*, vol. 4, no. 1.

Khajanchee, YS, Kenyon, TA, Hansen, PD & Swanström, LL 2004, 'Economic evaluation of laparoscopic and open inguinal herniorrhaphies: the effect of cost-containment measures and internal hospital policy decisions on costs and charges', *Hernia*, vol. 8, pp. 196–202.

McCormack, K, Wake, B, Perez, J, Fraser, C, Cook, J, McIntosh, E, *et al.* 'Laparoscopic surgery for inguinal hernia repair: systematic review of effectiveness and economic evaluation', *Health Technol. Assess.*, vol. 9, no. 14, pp. 1–203.

O'Dwyer, PJ, Kingsnorth, AN, Molloy, RG, Small, PK, Lammers, B & Horeyseck, G, 2005, 'Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair', *British Journal of Surgery*, vol. 92, no. 2, pp. 166–170.

Praveen, S & Rohaizak, M 2009, 'Local antibiotics are equivalent to intravenous antibiotics in the prevention of superficial wound infection in inguinal hernioplasty', *Asian J. Surg.*, vol. 32, pp. 59–63.

Simons, MP, Aufenacker, T, Bay-Nielsen M, Bouillot, JL, Campanelli, G & Conze, J, *et al.* 2009, 'European Hernia Society guidelines on the treatment of inguinal hernia in adult patients', *Hernia*, vol. 13, pp. 343–403.

Vrijland, WW, van den Tol, MP, Luijendijk, RW, Hop, WCJ, Busschbach, JJV, de Lange, DCD, van Geldere, D, Rottier, AB, Vegt, PA, IJzermans, JNM & Jeekel, J 2002, 'Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia', *British Journal of Surgery*, vol. 89, no. 3, pp. 293–297.

Wimalaratana, W 2011, *Agriculture and rural development in Sri Lanka*, Department of Resource Centre, Colombo, Univ. Colombo Pub.

ASEAN J. Sci. Technol. Dev., **33(2)**: 78 – 84

Synthesis and in vitro Experiment of Biomaterial Tricalcium Phosphate

X. V. BÙI[1,2*]

Calcium phosphate ceramics consist of materials such as hydroxyapatite, tricalcium phosphate (TCP), calcium phosphate cement (CPC), biphasic calcium phosphate, etc. CPCs have been used for filling bone defects in dentistry and orthopedics. Among these materials, β-tricalcium phosphate is suggested as an ideal candidate for bone graft in hard tissue engineering due to its high biocompatibility, bioactivity and bone bonding. The preparation, as well as the application of this powder material, has been the important topic of research in material science. In this paper, β-tricalcium phosphate (β-TCP), a component that has chemical formulation similar to bone structure, was synthesized by the precipitate method and then calcinated at 1000°C for 5 h. The physico-chemical properties of synthetic material were examined by XRD, FT-IR and SEM methods. In vitro experience was also carried by soaking β-TCP simulated body fluid powder in a different period of time. Obtained results confirmed the quality of β-TCP synthetic material and its bioactivity.

Key words: β-tricalcium phosphate; bone minerals; precipitate method; simulated body fluid; HA; physico-chemical properties

Calcium phosphates have been successfully used as bone repairing and substituting material for many applications in dentistry and orthopedics. Calcium phosphate has 12 substances but there are few materials used in biomaterial field, and one of them is tricalcium phosphate or TCP, with a chemical formula $Ca_3(PO_4)_2$ (Fernández *et al.* 1999). Due to the similar structure of the bony mineral, excellent biological properties like high biocompatibility, high biodegradation and quick biosorption, TCP has been becoming an ideal choice for clinic applications for a long time.

TCP has two allotropes forms which are α-TCP and β-TCP. β-TCP is a low-temperature phase of TCP. It is stable at room temperature and transforms into α-TCP phase at 1125°C (Welch & Gutt 1961; Carrodeguas 2010). On account of fast resorption rate, α-TCP was used limitatively in biomedical application although it has a precisely the same chemical composition like β-TCP (Bahman *et al.* 2011; Sergey 2009).

β-TCP can be synthesized via numerous techniques and methods, with a different range of reactants like wet chemical precipitate method (Kivrak & Cuneyt 1998; Rohaida *et al.* 2004; Albuquerque *et al.* 2004), hydrolysis of other calcium phosphate method (Kazuhiko *et al.* 2008), sol-gel method (Ruan *et al.* 2006) and hydrothermal method (Ain *et al.* 2008).

The primary purpose of this study was by using synthesized β-TCP by wet chemical precipitation method and then characterizing it by several physico-chemical analysis methods like XRD, FT-IR, and SEM. In vitro experiment was carried out by soaking of 50 mg of β-TCP in 100 ml simulated body fluid (SBF) solution to estimate bioactivity of this material.

[1] Ton Duc Thang University, No. 19 Nguyen Huu Tho Street, Tan Phong Ward, District 7, Ho Chi Minh City, Viet Nam
[2] Ho Chi Minh City Industry and Trade College, No. 20 Tang Nhon Phu Street, Phuoc Long B Ward, District 9, Ho Chi Minh City, Viet Nam
* Corresponding author (e-mail: buixuanvuong@tdt.edu.vn)

EXPERIMENTAL

Synthesize Tricalcium Phosphate Powder

Raw materials to synthesize β-TCP are tetrahydrate calcium nitrate ($Ca(NO_3)_2.4H_2O$, 99%, Merck); diammonium hydrophoshate ($(NH_4)_2)HPO_4$, 99%, Merck). Ammonia solution (NH_4OH, 25%, Merck) was used as a solvent to adjust pH of the reaction mixture. β-TCP was synthesized according to Bahman Mirhadi's research (Bahman *et al.* 2011). Briefly, 500 ml $(NH_4)_2HPO_4$ (0.2 M, pH = 4) was dropped with rate 3 ml/min into 500 ml $Ca(NO_3)_2.4H_2O$ (0.3 M, pH = 7.3). The mixture was stirred vigorously at room temperature during the process. NH_4OH 0.1 M was used to adjust pH = 8 to precipitate a white suspension. After finishing dropping, the mixture was continued to be stirred for 6 h to produce the β-TCP suspension. Then the suspension was filtered two times by distilled water to remove bad smell of the ammonia solution. After that, the white suspension was transferred into the oven and dried for 8 h at 120°C. The last step was calcination of material powder in the alumina crucible at 1000°C for 5 h to form the crystalline β-TCP powder.

In vitro Experiment in SBF Solution

In vitro analysis was to estimate bioactivity of β-TCP powder which was carried out in SBF by soaking 50 mg of material powder in 100 ml SBF. SBF was a solution with minerals composition nearly equal to those of human plasma (*Table 1*). The synthesis of SBF solution is according to Kokubo's protocol (Kokubo *et al.* 1990).

Physico-chemical Characterization

To evaluate physico-chemical properties of β-TCP powder before and after soaking in SBF solution, XRD, FT-IR and SEM analysis methods were employed. The crystalline phase of β-TCP was investigated by X-Ray diffractometer (Bruker D8 Advance). The Fourier transformed infrared spectroscopy (FT-IR) (Bruker Equinox 55) was used to identify the functional groups. Scanning electron microscopy (SEM) (Hitachi, Joel 5) was used to observe and evaluate the morphological shape and particle size of the material.

RESULTS AND DISCUSSION

Physico-chemical Characterization of Synthetic TCP Powder

Figure 1 shows XRD patterns of synthetic β-TCP and standard β-TCP (from database in website <http://icsd.fiz-karlsruhe.de>, Germany. Compared with XRD pattern of standard β-TCP, synthetic β-TCP completely had no stranger peaks. This result demonstrated the purity of obtained powder. Besides, β-TCP synthesis had sharp peaks, proved that β-TCP had good crystallization.

Figure 2 shows FT-IR spectra of synthetic β-TCP. Compared with other paper about synthetic β-TCP, FT-IR spectra of our synthetic material was almost similar. There was a range of bands at 900–1200 cm^{-1}, characterized for stretching vibration of PO_4^{3-} group of β-TCP (Behzad *et al.* 2012). Besides, there were two bands at 607 and 561cm^{-1} characterized for vibration of PO_4^{3-} group in β-TCP (14). A band at 1653 cm^{-1} was assigned to bending vibration of water.

Table 1. Ionic concentrations of SBF solution versus human plasma (10^{-3} mol/l).

Ions	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	HPO_4^{2-}
SBF	142.0	5.0	2.5	1.5	148.8	4.2	1.0
Plasma	142.0	5.0	2.5	1.5	103.0	27.0	1.0

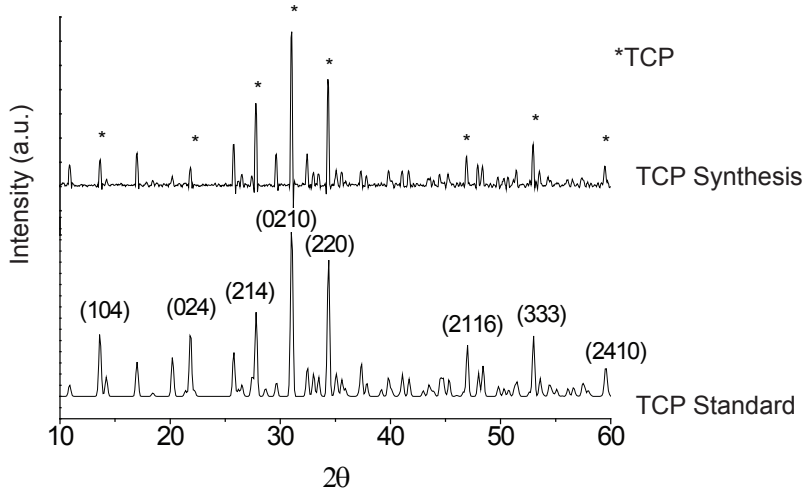

Figure 1. XRD patterns of synthetic TCP and standard TCP.

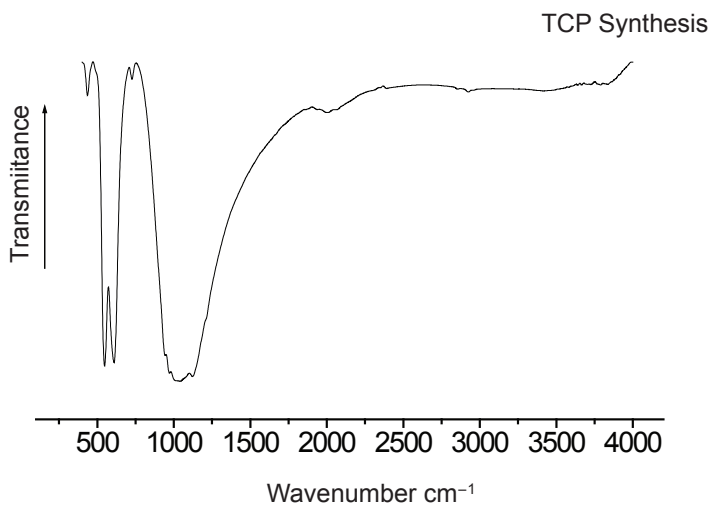

Figure 2. FT-IR spectra of synthetic TCP.

Figure 3 shows SEM micrograph of synthetic β-TCP at magnification (a) × 2000 and (b) × 5000. Synthetic β-TCP had an average diameter about 2 μm, with a cylindrical particle shape, matched with the hexagonal crystal structure of β-TCP.

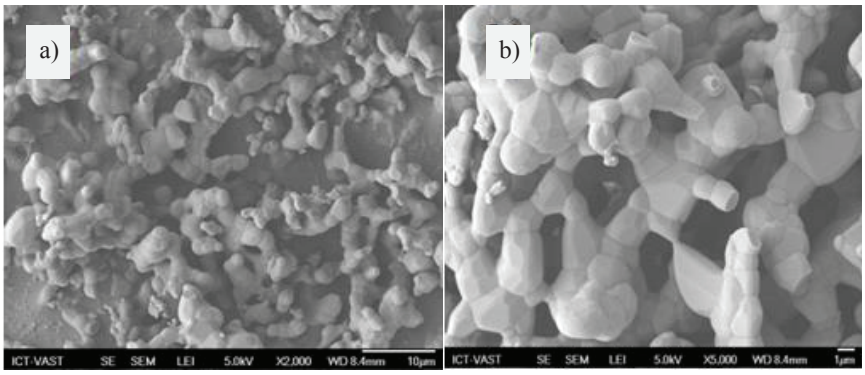

Figure 3. SEM micrograph of synthetic TCP.

Bioactivity of TCP Powder in in vitro Experiment

Figure 4 shows XRD patterns of β-TCP synthesis after 1, 5 and 10 days immersing in SBF solution. After 1 day, the peak number and peak shape of β-TCP did not change compared with initial XRD diagram. That demonstrated that β-TCP was not transformed nor decomposed to another matter when soaking in SBF solution. After 5 days of soaking in SBF, peaks of β-TCP shifted in position and changed in intensity. This demonstrated that there were chemical interactions between β-TCP material and SBF solution. These interactions would lead to the commute of β-TCP (beta-tricalcium phosphate) to HA (hydroxyapatite) versus time and continued until β-TCP completely transformed into HA (Mirta *et al.* 2012). Obtained result confirmed the bioactivity of β-TCP.

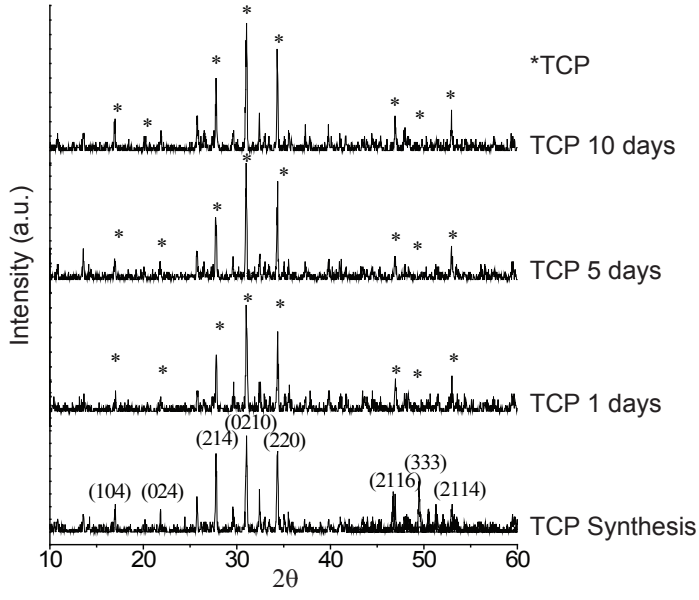

Figure 4. XRD patterns of TCP synthesis after 1, 5 and 10 days immersing in SBF solution.

Figure 5 reveals FT-IR spectra of synthetic β-TCP and β-TCP after 1, 5, ten days dipping in SBF solution. After one day in SBF solution, a band at 3433 cm^{-1} appeared, which characterized for hydrate OH^-, demonstrated that when soaking in SBF solution, β-TCP absorbed water. After five days, the band at 1042 cm^{-1} disappeared and replaced with the band at 1043 cm^{-1}, characterized PO_4^{3-} a group of HA (in the range of 1000–1100 cm^{-1}) (Mirta *et al.* 2012). That demonstrated that after 5 days in SBF solution, β-TCP had transferred one part into HA.

Figure 6 present SEM micrographs of synthetic β-TCP and β-TCP after 1, 5 and ten days in SBF solution. After one-day dipping in SBF solution, few small spots appeared on the β-TCP surface. After five days, these little spots developed into the small particle with different shape compared with the β-TCP shape. That was hydroxyapatite and was different in shape because of the different polymorphs. β-TCP had hexagonal polymorphs while HA had rhombohedral polymorphs.

CONCLUSIONS

This study presented a simple process to synthesize β-TCP powder via wet chemical precipitate method using tetrahydrate calcium nitrate and diammoni um hydrophosphate precursor. XRD patterns showed β-TCP had a good crystallization, and FT-IR favoured XRD data. In vitro experiment was carried out by dipping β-TCP powder in SBF solution. FT-IR demonstrated that there was a new apatite layer on the β-TCP surface and SEM micrograph showed that there was a particle of crystal HA appeared on β-TCP surface when dipped in SBF solution.

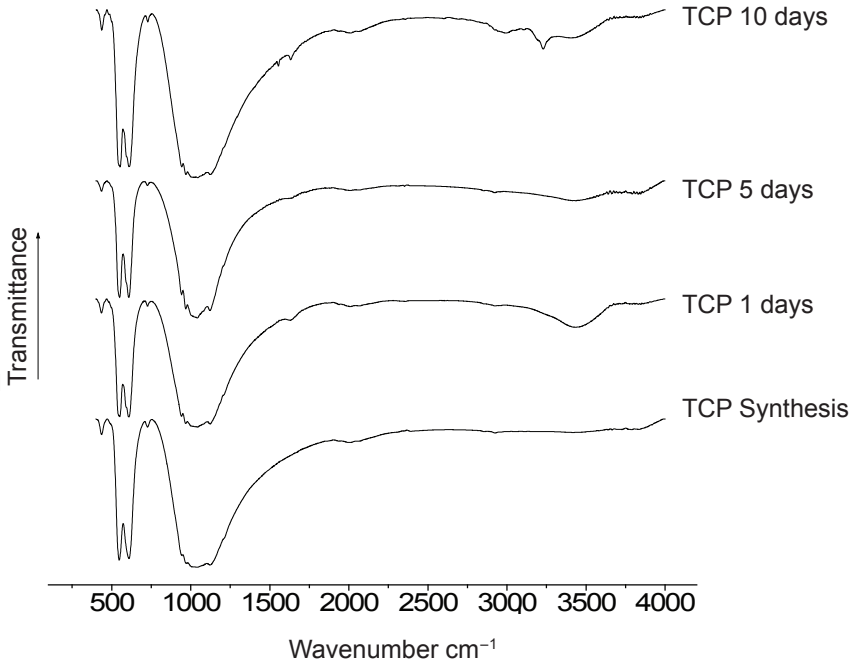

Figure 5. FT-IR spectra of synthetic TCP and TCP after 1, 5 and ten days of soaking in SBF solution.

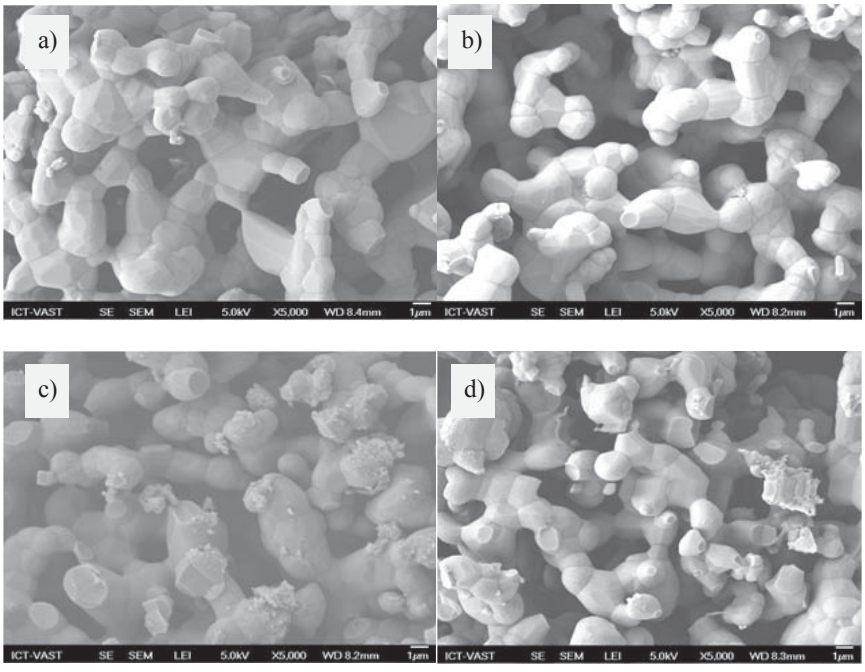

Figure 6. SEM micrographs of synthetic TCP (6 a) and TCP after 1, 5 and 10 days in SBF solution (6 b, 6 c, 6 d), respectively.

Date of submission: December 2016
Date of acceptance: January 2017

REFERENCES

Ain, RN, Sopyan, I & Ramesh S 2008, 'Preparation of biphasic calcium phosphate ceramics powders and conversion to porous bodies', in *International Conference Construction and Building Technology*, *ICCBT*, vol. 49, pp. 69–69.

Albuquerque, JSV, Neto, JVF., Junior, JILA., Lima, DO, Noguire, RFQA & Prado, DSMH 2004, 'Porous triphasis calcium phosphate bioceramics', *Key Eng. Material*, vol. 254–256, pp. 1021–1024.

Bahman, M, Behzad, M & Nayereh, A 2011, 'Synthesis of nano-sized β-tricalcium phosphate via wet precipitation', *Processing and Application of Ceramics*, vol. 5, no. 4, pp. 193–198.

Behzad, M, Bahman, M & Nayereh, A 2012, 'Sintering effects on the hardness of *β*-tricalcium phosphate', *Journal of Ceramic Processing Research*, vol. 13, no. 4, pp. 486–490.

Biqin, C, Zhaoquan, Z, Jingxian, Z, Qingling, L & Dongliang, J 2008, 'Fabrication and mechanical properties of β-TCP pieces by gel casting method', *Mater. Sci. Eng. C*, vol. 28, pp. 1052–1056.

Carrodeguas, RG, De Aza, AH, Garcia-Paez, I, De Aza, S & Pena, P 2010, 'Revisiting the phase-equilibrium diagram of the $Ca^3(PO^4)^2$-$CaMg(SiO^3)^2$ system', *J. Am. Ceram. Soc.*, vol. 93, pp. 561–569.

Fernández, E, Gil, FJ, Ginebra, MP, Driessens, FCM, Planell, JA & Best, SM 1999, 'Calcium phosphate bone cements for clinical applications, Part I: solution chemistry', *J. Mater. Sci. Mater.Med.*, vol.10, pp. 169–176.

Kazuhiko, K, Hironobu, S & Tomoyuki, Y 2008, 'Local Environment analysis of Mn ions in beta-tricalcium phosphate', *Journal of the Ceramics Society of Japan*, vol. 116, pp. 108–110.

Kivrak, N & Cuneyt, A 1998, 'Synthesis of calcium hydroxyapatite-tricalcium phosphate (HA-TCP) composite bioceramic powders and their sintering behavior', *J. Am. Ceram. Soc.*, vol. 81, pp. 2245–2252.

Kokubo, T, Kushitani, H, Sakka, S, Kitsugi, T & Yamamuro, TJJ 1990, 'Solutions able to reproduce in vivo surface-structure changes in bioactive glass-ceramic A-W', *Biomed. Mater. Res.*, vol. 24, pp. 721–734.

Mirta, M, Fabio, LL, de Paula Herrmann Junior, PS, Pissetti, FL, Rossi, AM, Moreira, EL & Mascarenhas, YP 2012, 'XRD, AFM, IR and TGA study of nanostructured hydroxyapatite', *Mat. Res.*, vol. 15, no. 4.

Rohaida, CH, Idris, B, Reusmazaran, YM, Rusnah, MAM & Izwan, AMF 2004, 'Hydroxyapatite and tricalcium phosphate preparation by precipitation method', *Med. J. Malaysia*, vol. 59, pp. 156.

Ruan, JM, Zou, JP, Zhou, JN & Hu, JZ 2006, 'Porous hydroxyapatite-tricalcium phosphate bioceramics', *Powder Metallurgy*, vol. 49, pp. 69–69.

Sergey, VD 2009, 'Calcium orthophosphates in nature, biology and medicine', *Materials*, vol. 2, pp. 399–498.

Welch, JH & Gutt, JH 1961, 'High-temperature studies of the system calcium oxide–phosphorus pentoxide', *J. Chem. Soc.*, vol. 29, pp. 4442–4444.

ASEAN J. Sci. Technol. Dev., **33(2)**: 85 – 92

A Clinical Audit on the Compliance of Ultrasound Users to the Standard Operating Procedure of Ultrasonography in a Private Radiologic Academy

Y. YULIAWATI[1] AND R. (III) P. DIOSO[2*]

This clinical audit identified the compliance rate of ultrasound users to the standard operating procedures (SOP); and identified the factors that led to a compliance rate of ultrasound human users. The review was conducted for six days in a private radiologic academy in Indonesia. Only 23 subjects selected randomly were audited. Of the 23 participants, there were 11 males and 12 females. Of the 11 males, seven were compliant, and three were non-compliant. Of the 12 females, eight were compliant, and four were non-compliant. The factors that affect the compliance to the SOP were based on the skills of the participants. Another factor identified was the way the standard operating procedure communicated to the human users on how to perform the ultrasound. Further training was therefore planned.

Key words: Clinical audit; ultrasonography; standard operating procedure; ultrasound among students; radiography; SOP on ultrasound

The standard operating procedure (SOP) for the use of ultrasonography found on *Table 1* is audited. The review is conducted in a private radiologic academy in Indonesia. The authors are the auditors.

Furthermore, this audit seeks to: (1) identify the compliance rate of ultrasound users in demonstrating the SOP and (2) identify factors that led to compliance of human users to the SOP of ultrasonography.

It is also best to introduce ultrasonography having it done at primary referral centres where patients referred from primary health care for diagnostic examination (Dorland 1988). To introduce further, the use of ultrasound in performing and examining human bodies have potential risks, and benefits, particularly in the field of medicine (Dorland 1988; Chan 2009). Medical diagnostic ultrasound is an imaging modality that makes images showing slices of the body, or so-called tomographic images (tomo = Gr. tome, to cut and graphic = Gr. graphein, to write) (Dorland 1988; Chan 2009; Kossoff 2000). It is a diagnostic modality, as it gathers information about the biological medium (Dorland 1988). Also, medical ultrasonography uses high-frequency sound (in the megahertz [mHz] ranging millions of cycles per second/s) (Kossoff 2000).

Therefore, clinical audit on the use of ultrasound equipment is important to avoid errors (Patel 2010) in the operation of ultrasonography in diagnosing patients. Errors in ultrasonography may compromise diagnostic investigations. Also, the audit is an effort to improve service quality, therefore evaluating audit on the implementation of human comfort and safety (patient safety), the experiences of human users and the effectiveness of service delivery must be identified (Patel 2010).

[1] ATRO Persada Nusantara, Indonesia
[2] Faculty of Nursing, Lincoln University College, Malaysia
* Corresponding author (e-mail: duke@lincoln.edu.my)

Table 1. Standard operating procedure for the use of ultrasonography.

ATRO PERSADA NUSANTARA	**STANDARD OPERATING PROCEDURE (SOP)**	
	ULTRASONOGRAPHY	
	DOCUMENT NUMBER: 110/ATRO.PN/SOP/2011	AUDIT REF NUMBER 2016-06-xx-xx
Verified by:	Date Issued: 01 MARCH 2011 Effective Date: 01 April 2011	Name of the person being audited: Identification number:
AUDITOR NAME(s)	xxxxxxxx	
Aims	1. Demonstrate the proper techniques for operating the ultrasound 2. Perform the standard operating procedures of the ultrasound machine	
Policy: ATRO Persada Nusantara Bekasi No. 99/ATRO.PN/SK/I/2011 for maintenance of medical-based devices. ***Note: only less than 99 human users will be scheduled for auditing, on a daily basis.***		

Operating Procedure(s)	Done	Not done
1. Connect the stabilizer cables to a power source, and wait for the signal to flash on screen		
2. Ensure that a requisition/s is/are provided; if in the case of emergency, ensure that ultrasonography reference number is documented as "emergency."		
3. Select the type of examination to be used or press automatic selection (20 Hz to 20 kHz or 1 MHz and 20 MHz)		
4. Check the patient, or see if the desired object from the body is ready for shooting while placing the acoustic gel on the hand-held transducer		
5. Double check the button freeze if functioning; a trial capture is a must to test the frequencies and acoustic impedance		
6. If the image needs to be printed, the printer must be turned on, and the ultrasound must be connected with the stretcher-printer device		
7. Verify, quality of the picture if it requires being repeated; repeat as it deems necessary and print again		
8. Turn off the machine and clean		
9. Unplug the stabilizer if it is still connected		
10. Ensure patient comfort, and label the ultrasound result		
Remarks:		

BACKGROUND

Ultrasound is used for more than 20 decades (Dorland 1988; Masic *et al.* 2010; Fine 1989; Gautschi 2002; Dalecki 2004; Krautkrämer & Krautkrämer 1990). Ultrasound has lesser complications, and it is safer for humans to use as compared to any other radioactive diagnostic investigation devices (Dorland 1988; Chan 2009; Kossoff 2000).

Ultrasonography has a sound wave with a frequency above the audible range from 20 Hz to 20 kHz (Patel 2010). If the sound is a mechanical energy that needs a medium to propagate (Masic *et al.* 2010; Fine 1989; Gautschi 2002; Dalecki 2004), it cannot travel in vacuum (Krautkrämer & Krautkrämer 1990). That is why the ultrasound machine is designed. The ultrasound machine generates the sound that first acts as a loudspeaker are sending out an acoustic pulse in a given direction (Masic *et al.* 2010). The acoustic pulse then echoes along the paths which are emitted by the ultrasound machine (Kossoff 2000). Thus carry information such as the images of the tissues and organs (Krautkrämer & Krautkrämer 1990). However, humans can only hear echoes in the range of about 30 to 20 000 cycles per second, and therefore cannot listen to the echoes of the ultrasound (Chan 2009). The sound frequencies of ultrasound machines are usually between 1 MHz and 20 MHz, impossible for humans to hear (Kossoff 2000; Krautkrämer & Krautkrämer 1990).

Ultrasounds also have the advantage of being real-time rather than static and can display not only image but live blood flow as information useful in a diagnostic examination (Dalecki 2004). Besides, it is possible to perform therapeutic procedures with the guidance of an ultrasound machine (Chan 2009).

LITERATUR REVIEW

The review of literature is necessary to validate the credibility of the SOP that was audited.

This section is further divided into: (1) the principle of ultrasonography; and (2) transducer's reflected echoes.

The Principle of Ultrasound

There are three components of ultrasonography (Kossoff 2000; Gautschi 2002; Dalecki 2004; Krautkrämer & Krautkrämer 1990; Baun 2004). First, the transducers, to stream sound waves and receive the reflection and change acoustic waves into electronic signals (Baun 2004). Second, the monitor, functioning to conjure images (Baun 2004). Lastly, an ultrasound machine itself which serves to change the reflected sound waves into images flashed on a monitor (Baun 2004).

The ultrasound machine as the last component has a radiation that is believed to be the less dangerous (Dalecki 2004; Baun 2004). Because the diagnostic imaging uses a magnetic field, radio-frequency, and a computer to produce images of the pieces of the cross section of the human body, a minuscule amount of rads are emitted (Palmer 2002).

The monitor, which is the easiest component, as it converts electrical pulses amplified and further shown in the form of light from the oscilloscope screen (Baun 2004). The data obtained are then processed in the monitor as images printed out in the shape of photographs (Dorland 1988; Baun 2004).

Primarily, a hand-held probe called a transducer is placed directly on and moved over the human body to acquire the image (Gautschi

2002). The acoustic gel is used to couple the probe to the body because the high-frequency sound waves do not travel well through the air (Masic *et al.* 2010).

The emission of acoustic energy and the recording of the echoes take place at the same time and recorded (the detectors) on the opposite side of the body (Cutnell, & Jhonson 1998). The amount of echo returned after hitting a tissue interface is determined by a tissue property called acoustic impedance (Dorland 1988; Cutnell & Jhonson 1998). This is an intrinsic physical property of a medium defined as the density of the medium times the velocity of wave propagation in the medium (Masic *et al.* 2010; Fine 1989; Cutnell & Jhonson 1998). Sample organs and their acoustic impedance nonresidents in *Table 2*.

bone or the lung generate very strong echoes due to a large acoustic impedance gradient (Kossoff 2000; Cutnell & Jhonson 1998).

Transducers' Reflected Echoes

The resulting picture of the ultrasound from the transducer is to utilize the reflected echo of the ultrasonic waves when transmitted to a particular tissue or organ (Fine 1989). Echo of the waves is then detected by the transducer which converts acoustic waves into electronic signals to be processed and reconstructed into an image (Gautschi 2002). The development of ultrasonic transducers with excellent resolution capability, followed by the rapid advancement of digital computer technology and its supporting software, makes digital image processing possible (Dalecki 2004; Krautkrämer & Krautkrämer 1990).

Table 2. Acoustic impedances of different body tissues and organs (Dorland 1988; Kossoff 2000; Cutnell & Jhonson 1998).

Body tissue	Acoustic impedance in Rayls unit
Alveoli	0.0004
Lung lobes	0.18
Peritoneum	1.34
Liver	1.65
Blood fluids	1.65
Kidney	1.63
Muscle	1.71
Bone	7.8

The intensity of a reflected echo is proportional to the difference (or mismatch) in acoustic impedances between two mediums (Masic *et al.* 2010). If two tissues have identical acoustic impedance, no echo is generated (Dalecki 2004). Interfaces between soft tissues of similar acoustic impedances usually produce low-intensity echoes (Cutnell & Jhonson 1998). Conversely, interfaces between soft tissue and

METHODOLOGY

Before audit commences, the use of ultrasound was evaluated. Participants were then selected randomly, who were laboratory instructors and students of the radiography course. Participants were selected on-the-spot while demonstrating the use of ultrasound in the academy.

The auditors ensured that the audit was approved by the Dean of the academy to be issued to the head of the laboratory. The auditors also ensured that the participants selected, autonomously allowed the auditors to observe them while demonstrating their skills on how to use the ultrasound.

The audit was conducted for six days. Only five subjects were audited per day. A total of 23 human users were audited.

The auditors prepared the checklist found on *Table 1* and the written consent for the subjects to be signed, and filed in a portfolio with reference numbers. The participants were called one by one, in turn, to carry out the operation of the ultrasound and were observed using the checklist (*Table 1*).

Subjects or participants who could demonstrate the SOP of ultrasonography were categorized as compliant while non-compliant participants for those who could not perform the steps.

FINDINGS

Twenty-three participants consented to be audited (*Table 3*). There were 13 residents (Jakarta) who complied while ten did not (13/10) as tabulated in *Table 3*. While the non-compliant were 10 being non-local residents of Jakarta while 13 did not (10/13). The picture found on *Figure 1* compared compliance and non-compliance.

Data showed that the audit results had identified more compliant participants.

The indicated reliability of the estimate was set at 95% confidence interval (CI). The standard deviation (σ) to perfect compliance was found to be 2.64, which described the tightness of the clustering of compliant human users with a mean of 9.5. Of the 23 participants, it was likely probable to have 65% compliance ($p = 0.0005847$).

For the non-compliant, a $\sigma = 4.79$ with a mean of 7.5 was identified. The clustering was not too much tight, and therefore non-compliance to the standard operating procedure can easily be avoided. The $p = 0.04946$, described confidently that there were only 35% of the 23 human users who were non-compliant.

The figure further identified compliance, where participants could get the hepatic object well. While the non-compliance showed a mistake that was full of whitish discolouration of the hepatic object. This whitish discolouration occurred because the setting of the time gain control was not properly adjusted and calibrated when the participants shot the object using the ultrasonography.

Table 3. Result the audit ultrasonography in a private academy.

Categories	Male	Female	Jakarta	Non Jakarta	Mean	σ	p= @95% CI
Compliance	7	8	13	10	9.5	2.64	0.0005847
Non-compliance	3	4	10	13	7.5	4.79	0.04946

Compliance Non-compliance

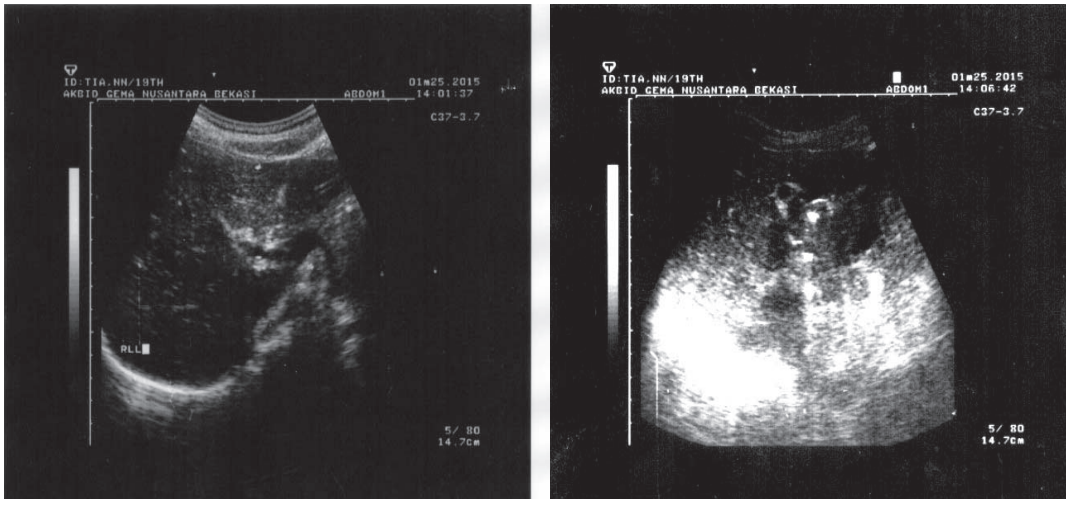

Figure 1. Identifying compliance and non-compliance.

One of the factors identified was the improper use of the transducers. Most of the participants audited did not demonstrate skills in dexterity. Skills in performing the steps should be practiced. Since the ultrasound users were still a novice, the demonstration of the use of ultrasound was not done using the proper techniques. Another factor identified was the communication skills of the ultrasound machine users to the provided with procedure manuals written in English. Since there were language barriers, the users misunderstood the written manuals thus making the steps confusing. Furthermore, there were ultrasound users that were not trained well in reading the English language and were confused with the steps of the standard operating procedure. Those who did not practice in Central Hospitals which were affiliated with the Academy who were non-compliant, might have experienced barriers in the written operating system.

ACTION PLAN FOR CHANGE MANAGEMENT

The selected private academy that prepared skilled radiographer should be able to master their radiographic technique and also be able to operate ultrasound equipment anticipated to be practiced in the hospital setting. This was the primary plan of the authors that was why the SOP was developed.

Secondly, planning on how to communicate the language of the SOP was to be addressed to enhance the change management. Handbooks might be an action plan to improve the communication process, and it must be written in the national language of Indonesia and English as well. This manual must have a high level of competence relating to student skills.

Thirdly, there should be education and training on the use of ultrasound equipment. Training was for participants to be proficient in the skills of using the cutting-edge technology of ultrasonography.

The plan to use the SOP in the laboratory and the use of ultrasound should be implemented within a year. Where the results would be followed up by the director if necessary so

to make changes to the existing SOP and for its further development should be done semi-annually. The SOP would then be submitted to the relevant heads and disseminated throughout the academy within a month.

It was important for all participants to know how to use ultrasound within a year. Planning to practice in the laboratory of the Academy before facing the real patients should be done monthly to avoid the pitfalls of the training provided before going to the hospitals. It was anticipated that those who attended the seminars and training would disseminate the information and their knowledge of the SOP to those who used the laboratory as their workplaces.

The use of the SOP for the utilization of the ultrasound would be identified as a potential threat to the success of the change process if they do not comply. Therefore, a continuous audit should always be done every six months to freeze the change process (*Table 4*).

CONCLUSION

Of the 23 participants, there were 11 males and 12 females identified. Of the 11 males, seven were compliant (65%), and three were non-compliant (35%). Of the 12 females, eight were compliant (65%), and four were non-compliant (35%) participants. It was also identified that the non-compliant participants used the transducers incorrectly. This is tailored to the type of examination identified, that the object to be inspected using the ultrasound, and pieces or slices in shooting and shooting techniques to produce optimal pictures were not properly demonstrated because of the incorrect use of the transducers.

Therefore, it was identified that the factors that affect the compliance to the standard operating procedures were based on the skills of the participants. Another factor identified was the manner of communication to the human users on how to use the ultrasound. Lack of further training was also designated as an element and is therefore planned.

Table 4. The continuous semi-annual auditing tool.

What we want them to do (Standard operating procedure)	What they are doing (Findings)	What they need to do (Action plan)
Using Standard Operational Procedure Ultrasound	☐ Complied ☐ Not Complied	Read the handbooks and attend seminars
Step in the use of the machine Ultrasound	☐ Complied ☐ Not Complied	Read the handbook
Demonstrate the ideal use of the ultrasonography	☐ Complied ☐ Not Complied	Attend seminars and training

Date of submission: August 2016
Date of acceptance: November 2016

REFERENCES

Baun, J 2004, *Physical principles of general and vascular sonography*, Chap 8, San Fransisco, California, USA.

Chan, VWS 2009, *Ultrasound imaging for regional anesthesia*, 2nd edn, Toronto, ON, Toronto Printing Company.

Cutnell, JD & Kenneth, W Jhonson, KW 1998, *Physics (frequency range of human hearing)*, 4th edn, Wiley, New York, pp. 466.

Dalecki, D 2004, 'Mechanical bioeffects of ultrasound', *Annu. Rev. Biomed. Eng.*, vol. 6, pp. 229–48.

Dorland, NW 1988, *Dorland's illustrated medical dictionary*, 27th edn, W.B. Saunders Co., Philadelphia, PA, USA.

Fine, MJ 1989, *Introduction to ultrasound imaging*, Interson Corporation Parkway, Pleasanton, USA.

Gautschi, G 2002, *Piezoelectric sensorics: force, strain, pressure, acceleration and acoustic emission sensors, material and amplifiers*, Springer.doi:10.1007/978-3-662-0473-3. ISBN 978-3-662-04732-3.

Kossoff, G 2002, 'Basic physics and imaging characteristics of ultrasound', *World J. Surg.*, vol. 24, pp. 134–142.

Krautkrämer, J & Krautkrämer, H 1990, Ultrasonic testing of materials, 4th edn, Springer.

Masic, I, Ridjanovic, Z & Pandza HM 2010, 'Medical informatics', *Avicena, Sarajevo*, pp. 416–430.

Palmer, PES 2002, *Manual of diagnostic ultrasound*, University of California Davis, California, USA.

Patel, S 2010, 'Achieving quality assurance through clinical audit', *Nursing Management*, vol. 17, no. 3, pp. 1–19.

ASEAN J. Sci. Technol. Dev., **33(2)**: 93 – 105

Knowledge and Caring Attitude of Sri Lankan Nurses in Providing Care for Dying Patients — A Cohort Study

M. M. RAJUDEEN[1], M. JANOOF[2], AND R. (III) P. DIOSO[2*]

This research identified evidence of knowledge and caring attitude among Sri Lankan nurses caring for dying patients; and identified the factors affecting nursing care for the dying in the eastern province of Sri Lanka.

A quantitative cohort study design was used having questionnaires as the means of collecting the data. The purposive way of sampling selected 120 staff nurses employed in a government hospital as respondents who falls under the inclusion and exclusion criteria.

There was significant evidence of caring attitude towards the dying ($p = 0.005534$) and knowledge on the end-of-life nursing care ($p = 0.0004703$) for the dying patients. Educational attainment ($p = 0.050001$), clinical experiences ($p = 0.01499$), age ($p = 0.01061$) and civil status ($p = 0.001782$) were factors affecting the knowledge and attitude of Sri Lankan nurses in delivering nursing care for the dying patients admitted to a government hospital.

Key words: Cohort study; observational study; nursing; knowledge and caring; dying patients; end-of-life care

This research observes the knowledge and caring attitude of Sri Lankan nurses in providing nursing care for the dying patients in a government hospital. Palliative care for the dying and the quality of life of patients are issues in healthcare in Sri Lanka (McKeown *et al.* 2010). When the prognosis for the patient was imminent death, care was focused on reducing the severity of the disease symptoms rather than vainly trying to stop or delay development of the illness itself or providing a cure (Kinder & Ellershaw 2003, p.12).

The delivery of similar quality end-of-life care to patients in most Sri Lankan hospital foundations was developed by the Base Hospital Hospice Friendly (BHF) programme that respects the curative model of attention but ensures that the quality of life for the dying patients (BHF 2010).

Therefore, the purpose of this research is to recommend quality standards for end-of-life care in a government hospital in consultation with hospital staff and professional bodies to set out a vision for the type of end-of-life care that all Sri Lankan hospitals should aim to provide. The Liverpool Care Pathway

[1] Pottuvil Base Hospital, Sri Lanka
[2] Batticaloa Teaching Hospital, Sri Lanka
[3] Faculty of Nursing, Lincoln University College, Malaysia
* Corresponding author (e-mail: duke@lincoln.edu.my)

(LCP) for the dying patients will also be acknowledged in the recommendation section after a conclusion is offered. The LCP is an inter-professional documented care pathway that provides guidance on the different aspects of care required, including comfort measures, anticipatory prescribing of medication and discontinuation of inappropriate interventions (Kinder & Ellershaw 2003); and frequent monitored outcomes of care in the last days of the patient's life (Walker & Read 2010).

RESEARCH PROBLEM

Health Service Executive (2009) says that the influences of the nursing approach in delivering end-of-life nursing care is deteriorating. It is similar in the Sri Lankan set up where the nurses' knowledge and caring attitude was slowly disappearing, as influenced by the medical and non-nursing models in government hospitals. There was a need in Sri Lanka to develop a pathway that is a research-based plan to establish a recommendation for end-of-life care.

Variables

The cause variable is the knowledge and caring attitude of nurses while the effect variable is the provision of end-of-life care (using the LCP) given to dying patients. The variables will then answer the question: do Sri Lankan nurses have the knowledge and caring attitude in providing care for the dying patients?

Aims

At the end of this research, it is hoped to:

1. Identify evidence of knowledge and caring attitude among Sri Lankan nurses caring for dying patients.

2. Determine factors affecting end-of-life nursing care in the eastern province of Sri Lanka.

Hypothesis

There is a significant evidence of knowledge and caring attitude among nurses caring for the dying patients.

Literature Review

Search engines were Google Scholars and Cumulative Indexes for Nursing and Allied Health Literatures having 20 000 numbers of hits using key words such as *"Nursing, knowledge and caring, dying patients, end-of-life care"*. The thematic system of reviewing literature divided this section into three themes. The literature review will be divided into:

(i) Identification of the dying phase – describes the knowledge and caring attitude

(ii) Comfort Care – describes the caring attitude alone

(iii) Symptoms Control – describes the knowledge alone

Identification of the Dying Phase

The unpredictability of hematological malignancies, hormones shutting down and degeneration of hydration and nutrition are primary in identifying the dying phase (Preston 2007; McKeown *et al.* 2010). Furthermore, pain, nausea, vomiting, agitation and respiratory tract secretions are among the most usual symptoms to be identified in the dying phase (Glare et al. 2003; Toscani et al. 2005, Gambles et al. 2006; Lhussier *et al.* 2007). Failure to identify that a patient is dying affects the quality of end-of-life care they receive (Thompson *et al.* 2006; Dalgaard *et al.* 2010).

In a qualitative study of terminal illness stages, Dalgaard *et al.* (2010) found that it was important to identify the terminal phase progression towards death. The research

approach observed various staff functions and conducting informal interviews with patients (n = 74), relatives (n = 11), doctors and nurses in a haematology department in Denmark. The unpredictability of hematological malignancies, patients' and relatives' lack of acceptance of impending death and their investment of hope in further treatment, were found to hinder doctors in formally identifying the terminal phase. Nurses reported poor inter-professional cooperation, caused by doctors focusing on treatment and cure, while nurses gave priority to the patient's general condition. Dalgaard et al. (2010) concluded that open communication with all concerned in decision-making was essential in the transition to the terminal phase.

The qualitative study on the delivery of palliative care in an intensive care unit (ICU) in Ireland was conducted by McKeown *et al.* (2010) also examined the difficulty of identifying the terminal phase, using a grounded theory interview-based approach. The volunteer sample comprised of ten nurses, five consultants, and ten junior medical staff. Nurses reported that dying patients were treated aggressively for too long with a focus on cure instead of palliative care. Doctors stated that they were responsible for deciding when to cease curative care and begin palliative care, but many preferred to wait for visible signs that the patient had deteriorated rather than intervene. Nurses felt they had a more accurate view of their patients' conditions, but they found it difficult to get the doctors to accept this. McKeown *et al.* (2010) suggested that multidisciplinary team education on palliative care would improve confidence in decision-making in end-of-life care issues. While it is recommended in this study that education on end-of-life care was needed there was no actual identification for the dying phase.

A qualitative study conducted by Walker and Read (2010) on identifying the terminal phase in an ICU in the United Kingdom in the northwest Midlands using the LCP. The LCP is commenced on the presence of two out of the following four criteria: "the patient is bed-bound, semi-comatose, and only able to take sips of fluid or no longer able to take tablets." A purposive convenience sample of doctors (n = 1) and nurses (n = 5) who had used the LCP was interviewed in a descriptive phenomenology study. It was considered that when end-of-life decisions were made the doctor made the decision and care of the patient was then handed over to nurses. Some nurses felt that the weight of responsibility made end-of-life decision-making difficult for physicians. The nurse felt their education was adequate, but doctors and nurses both felt that teaching in this field could not identify the terminal phase. Walker & Read (2010) concluded that there was a need for interdisciplinary educational strategies on end-of-life care in the ICU to determine the terminal phase.

Comfort care. Movement of the patient in the final days of life and assisting in the daily activities are measurements of comfort care (Thompson *et al.* 2008; McKeown *et al.* 2010).

McKeown *et al.* (2010) stated that when patients have been diagnosed as dying, their care goals should be adjusted to comfort care. Research studies on the care of the dying patient were reviewed under the above headings to investigate the approaches to the delivery of this care. Comfort care of the dying by McKeown *et al.* (2010) noted that the development of standards for end-of-life care that was important as almost 50% of Irish died in hospitals. In this research, it draws the conclusion that comfort care of the dying "tends to be generic rather

than specific in the sense that it might be more appropriate to describe it as 'care at the end of life' rather than 'end-of-life care', because the care seems to lack an effective palliative care component" (McKeown K. *et al.* 2010, p.158).

A less satisfactory experience on the delivery of comfort care was found by Thompson *et al.* (2008) in a qualitative study using a grounded theory approach to examine the transition of attention from curative to palliative. Semi-structured interviews were conducted on a convenience sample of nurses (n = 10) from two hospitals. Nurses perceived that physicians hesitated to switch to end-of-life care measures because they viewed commencing palliative care as doing nothing for the patient. The nursing staff was frustrated that the over-emphasis on the curative model impacted on their ability to deliver comfort care as they were required to perform unnecessary procedures rather than care holistically for the patient. Thompson *et al.* (2008) concluded from the research evidence that it is essential that all parties acknowledge the fact that cure of the disease is not possible before the establishment of an appropriate end-of-life care plan is based on the patient's needs.

Similar barriers to delivering optimal terminal comfort care were found in a qualitative study conducted by Espinosa *et al.* (2010) in the United States of America on ICU nurses' experiences. A descriptive phenomenological study using a purposive sample of ICU nurses (n = 18) was conducted by holding focus group interviews on previously identified themes. As in the study conducted by Thompson *et al.* (2008), it was found that nurses considered that the different perspectives in medical and nursing care presented a problem for their delivery of comfort care to the dying patient. Nurses who were trying to achieve a peaceful end-of-life for the patients found it difficult to deliver care ordered by physicians when it had no apparent benefit at all. Relatives' unrealistic expectations that everything possible is done for the patient was also a barrier to delivery of end-of-life care. Based on the study it was concluded that nurses needed education and training on delivering terminal care and that knowledge by observation was not sufficient. Espinosa *et al.* (2010) also recommended that research is conducted on methods to improve communication between the different professionals involved in end-of-life care.

Symptoms control. The symptoms that need to be controlled are dehydration, pain, nausea, vomiting, agitation and respiratory tract secretions among the dying patients (Glare *et al.* 2003; Toscani *et al.* 2005, Gambles *et al.* 2006; Lhussier *et al.* 2007). However, palliative care among professionals felt that a dry mouth for a dying patient did not indicate thirst but a good mouth care was more appropriate than medical hydration (Preston 2007).

Toscani *et al.* (2005) conducted a qualitative study on symptom control in hospitals by collecting data from clinical records and interviewing the nurses in charge of dying patients (n = 370) in 40 Italian hospitals. They found that a substantial proportion of dying patients received inadequate symptom control (75%) and inadequate pain relief (40%). Dying patients also suffered distressing symptoms such as nausea, vomiting, insomnia and anorexia. It was found that nurses assessed the overall management of the patient as good/excellent in 88% of cases despite the presence of uncontrolled symptoms. Toscani *et al.* (2005) considered that pain and symptom control was poor in these hospitals and resources should be provided to improve end-of-life care and educate healthcare professionals.

Gambles *et al*. (2006) conducted a qualitative survey of doctors' and nurses' perceptions of comfort care in Sri Lanka using exploratory interviews. The purposive sample comprised of nurses (n = 8) and physicians (n = 3). Doctors felt that patients had better symptom control with the use of the LCP, as signs were picked up and addressed earlier. They felt that good care and symptom control contributed to a good death. Nurses reported that the LCP made it clear to inexperienced staff what they could expect when looking after a dying patient making them more pro-active and consistent (Gambles *et al.* 2006). Gambles *et al.* (2006) recommended that continued education was necessary with the use of the LCP.

With a view to developing good quality end-of-life symptom control care, the LCP was introduced in a volunteer sample of nursing homes (n = 8) in Northwest of England (Watson *et al.* 2006). Over a 12 month period, using an action research approach involving field notes and questionnaires it was found that there was a lack of control of end-of-life symptoms due to poor knowledge of palliative care drugs among staff (Watson *et al.* 2006). From patient notes, it was found that loss of swallowing reflex was seldom noted for dying patients and as a result, subcutaneous or rectal medication was rarely prescribed to circumvent the problem. Watson *et al.* (2006) viewed anticipatory prescribing of the necessary drugs for symptoms that might arise as being necessary for end-of-life care. They also concluded from their research that collaborative learning groups are useful for sustaining change in practice in end-of-life care.

Similarly, Lhussier *et al.* (2007) conducted a qualitative evaluation using action research methodology in two Primary Care Trusts in Sri Lanka with a view of the LCP for symptom control. The volunteer sample of participants comprised of LCP facilitators (n = 10), professionals implementing the LCP (n = 22) and bereaved carers (n = 10). Experts felt that the LCP enabled them to pinpoint symptom problems and address them before they became too dangerous for the patient. One respondent commented that the LICP made staff more pro-active in controlling symptoms. Some criticism of the LCP model of care was expressed as it was felt that its 'tick box' approach resulted moved the focus from the symptom control needed by the dying patient. However, Lhussier *et al.* (2007) concluded that overall the implementation of the LCP had met several challenges in end-of-life care and they considered that symptom control should be given a higher profile on the professional agenda.

Analysis of the review. Most of the researchers on the reviewed literature are qualitatively designed although appropriate. Also, no research in Sri Lanka was yet done to evaluate the effectiveness of an end-of-life care by nurses. It would also be more interesting to observe a mathematical expression of the knowledge and caring attitude of Sri Lankan nurses in caring for the dying. The variables — identification of the terminal phase, comfort care, and symptom control — would then be numerically expressed that measured knowledge and attitude of nurses in end-of-life care.

Methodology. This section will describe the design, sampling technique, data collection and the how data are analyzed. Ethics on how this research commenced will also be discussed.

RESEARCH DESIGN

A cohort quantitative study design was hence appropriate since the respondents answering the questionnaires only came from one gro up that organizes in advance the research question and a one-way method of data collection (Parahoo 2006; Polit & Beck 2010; Robson 2007). A detailed design involving a survey, as outlined by LoBiondo-Wood & Haber (2006), was chosen for this study. Quantitative design should be objective, systematic and repeatable (Proctor *et al.* 2010).

Population/sampling technique. The samples in this study were staff nurses working in a cohort — a government hospital in Sri Lanka. Purposive sampling technique will form the target group. This population will be delimited to a homogenous group of subjects through inclusion/exclusion criteria (LoBiondo-Wood & Haber 2006; Proctor *et al.* 2010).

Inclusion criteria. Registered general staff nurses who worked at Pottuvil Base hospital were chosen as the target population. Only nurses caring for adult patients in the end-of-life care were purposively included. Nurses who had served more than one year in the ward were individually selected. The researcher obtained the names of all qualified nurses from the Human Resources Department in the hospital. This list of nurses formed the sample frame from which the researcher selected.

Exclusion criteria. Registered nurses working with children were excluded. Nurses who had already tendered their resignation or have filed their retirement were also excluded to limit biases. Biases might also occur if the nurse respondents had come from the private hospitals outside Sri Lankan territory, and who were newly hired from the particular government hospital selected were excluded. Lastly, nurse respondents who had admitted their relatives, and loved ones in the said government hospital also were excluded.

Sample Size

In quantitative research, the size of the sample should be calculated at the design stage (Proctor *et al.* 2010). Parahoo (2006, p. 258) defines a sample population as "the total number of units from which data can potentially be collected." According to Polit and Beck (2010), quantitative researchers should select the largest sample possible so that it is representative of the target population. For this reason, it was proposed that a sample size of 120 nurses be used for the study.

The calculations used to get the population was:

Σ— Sum of values
μ— Mean estimate
σ— Standard deviation
n— Prevalence
x— Total

$$\sigma = \frac{\sqrt{\Sigma (\times - \mu)}}{n}$$

Data Collection

Robson (2007) says that a researcher should use the simplest manner of collecting the data to get answers from the research question and should not collect any more data than necessary. A questionnaire is a method of data collection that asks participants to give written or verbal replies to a written set of questions (Parahoo 2006). It is a quick, convenient and inexpensive method of collecting standardized information (Jones & Rattray 2010). A structured written questionnaire that uses a quantitative self-report technique was used to gather data in this study.

A Likert-type scale will be used in the questionnaire to gather data. According to Parahoo (2006) a Likert-type questionnaire formulates statements which the researcher considers that will represent the concept being measured without going through the validation process.

Part A consisted of positively and negatively worded statements with six different response options ranging from 'strongly disagree' to 'strongly agree', with the knowledge on identification of the terminal phase, comfort care, and symptom control. Positive statements are scored one to two ('agrees', and 'disagrees'), and scores are reversed for negative statements. The score for each item will be reported individually. Parts B and C will are caring attitudes that used a fill the box format and will gather data divided into frequencies.

Validity of the questionnaire. Face validity checks that the sampling seems to measure the concept being tested (LoBiondo-Wood & Haber 2010) and this will be assessed by a pilot study to test-run the instrument and see if the questions appear to be relevant, clear and unambiguous (Jones & Rattray 2010).

A panel of experts was used to evaluate the content validity of new questionnaires (Polit & Beck 2010). The questionnaire would be submitted to a panel to check that the questions reflected the concepts being studied and that the scope of the questions was adequate, in the manner proposed (LoBiondo-Wood & Haber 2010). The panels were qualified in end-of-life care with research experiences on the topic.

Reliability of the questionnaire. The researchers did a stability test using the test-retest method on a small population. The questionnaire was administered on two occasions, two weeks apart and the results compared. A reliability coefficient was calculated on the two sets of data for each part of the questionnaire. Reliability coefficients ranged from 0.00 to 1.00, with higher values indicating greater reliability. According to Jones and Rattray (2010), good reliability is indicated by a coefficient >0.8, so the researcher will attempt to achieve a liability at this level or greater (Polit & Beck 2010). The 'test-retest' will be included in the pilot study. However, according to Parahoo (2006) reliability is necessary but not a sufficient condition for validity but rather focuses mainly on stability and consistency (Polit & Beck 2010).

Data Analysis

The questionnaire was split into three equal halves, and the data was checked for similarity. Consistency would be checked by Cronbach's alpha ranging between 0.00 and 1.00, and a value of >0.7 is acceptable (Polit & Beck 2010).

Central tendencies were be carried out on the data collected. Analysis of part A of the questionnaire was coded using numbers on an ordinal scale of 1 to 6. The Central tendency of the data was calculated using the mode (most frequent response) for Part A as the data was represented by ordinal numbers. Numbers on an ordinal scale are in ascending order, with no same steps implied between the numbers. The reply to each question of Parts B and C of the questionnaire will be coded using numbers in the ordinary sense. For Part B and Part C central tendency will be calculated by calculating the mean response and the standard distribution around the mean. The frequency of a particular response to a question was calculated as a percentage, and the data was illustrated using tables and bar charts.

To check on possible connections between variables, inferential statistics were used (Parahoo 2006). Correlations were verified between (i) data on participants' nursing experience in the number of years, and (ii) participant's education in end-of-life care. Contingency tables were set up to cross tabulate the above variables. Correlation coefficients would check the intensity and direction of the correlations. The values of these coefficients ranged from +1.00 for a positive relationship through 0.00 to −1.00 for a negative correlation.

Pilot Study

The validity and reliability of the questionnaire was also checked at the pilot study stage (Jones & Rattray 2010). As recommended by Robson (2007) the researcher to run a trial test on the selected method of data analysis could use the data collected in the pilot study to generate dummy data for 120 participants.

A pilot study was carried out using a small sample of subjects, ≥10% of the principal study (Jones & Rattray 2010; Proctor *et al.* 2010; Polit & Beck 2010). Twenty-three subjects were chosen in the same manner as the topics for the main study. The pilot participants were debriefed to check for problems with the questionnaire and issues concerning it. The structure and content of the questionnaire was amended accordingly. Care was taken that the participants in the pilot study were excluded from the main study and that details of the study were not passed on to main study participants.

Ethics

Ethical considerations for this particular research study started with the Lincoln University College, Faculty of Nursing approval. It was then shown to the Research Committee of the University for approval. Written consent was also secured. Hospital Approval was also sought, and a letter of approval from the selected hospital was granted.

It is hoped that the chosen methodology will generate useful information through the collection and analysis of data on the attitude, and knowledge of staff nurses on the effect of care for the dying patient in a government hospital in the eastern province of Sri Lanka.

According to Polit and Beck (2010), researchers must deal with ethical issues when their proposed research involves human beings. As a gatekeeper, the Director of Nursing must be made aware of all nursing research taking place in the organization to monitor the effect of all such projects taking place.

The main ethical principles that were considered in conducting this research study was respect for persons, confidentiality and beneficence/non-maleficence.

FINDINGS AND RESULTS

Of the 123 nurses as respondents, 66% were female, and 34% were male (*Figure 1*). It is interesting to identify that the nursing profession is always associated with the female gender. However, gender differences were not correlated with the caring attitude and knowledge on nursing care towards the dying patients admitted to the selected government hospital.

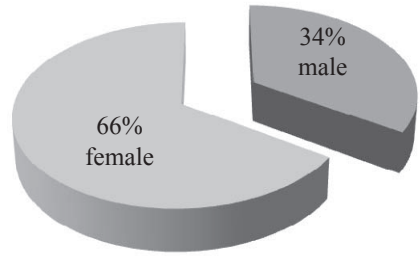

Figure 1. Gender distribution.

The educational attainment (*Figure 2*) was identified to have affected the caring attitude and knowledge of caring for the dying patients. There were more diploma holders (94%) as compared to the bachelor's degree (6%) and masters (0%). Symptom control identified knowledge while comfort care identified the caring attitude and identification of the dying phase identified both knowledge and caring attitude — all of which were affected by the educational attainment of the respondents.

Figure 2 identifies the prevalence of the Sri Lankan nurses that had no master's degree and a limited number of bachelor's degree holder. The results showed that the higher the education the nurses attained, the better the delivery of nursing care for the dying patients which correlated with their knowledge and attitude.

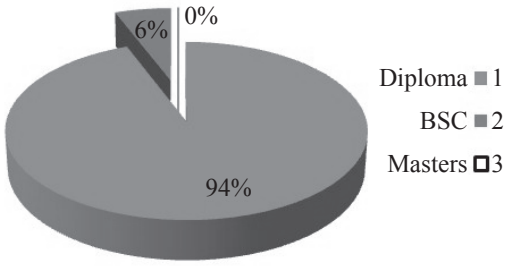

Figure 2. Educational Attainment.

Aside from the educational attainment (p = 0.050001) of Sri Lankan nurses caring for the dying, it was also identified that their clinical experiences (p = 0.01499), age (p = 0.01061) and civil status (p = 0.001782) were more probable to have affected their caring attitude and knowledge (*Table 1*).

The civil status showed a high standard deviation (ó) of 25 from the mean (μ) of 60. This result identified a good compliance to nursing care for the dying patients. Specifically, those who were married had more caring attitude and knowledge of nursing care.

The age was the second factor that was more probable to have affected the caring attitude and knowledge of the Sri Lankan nurses. Nurses who were ages 25 to 40 years old were more probable ($p \leq 0.05$) than those who were 40 to 50 years old ($p \geq 0.05$) in delivering nursing care for the dying.

The experience however was still probable even though the deviation (ó = 15) was nearer to the mean (μ = 24) as compared with the age group. Experiences from 1 to 20 years in the nursing service identified a higher probability ($p \leq 0.05$) of delivering nursing care with knowledge and attitude for the dying patients. On the other hand, 21 to 30 years of experience had the least probability ($p \geq 0.05$).

Table 1. Factors affecting knowledge and attitude.

	Probability	N
Experience 1 to 5years	≤0.05	36
Experience 5 to10years	≤0.05	43
Experience 10 to 15years	≤0.05	27
Experience 15 to 20years	≤0.05	12
	≥0.05	2
Total	0.01499	μ = 24 σ= 15
Age 25 to 30	≤0.05	34
Age 30 to 35	≤0.05	36
Age 35 to 40	≤0.05	33
Age 40 to 45	≥0.05	10
Age 45 to 50	≥0.05	7
Total	0.01061	μ = 24 σ= 13
Civil status (married)	≤0.05	85
Civil status (unmarried)	≥0.05	35
Total	0.001782	μ = 60 σ= 25

It was evident that the respondents were aware of the LCP code of practice on providing a caring attitude towards the dying. One of the negative practices which the LCP measured were the "No respond attitude" (n = 104) and the "negative feelings towards providing care" (n = 69) which the respondents agreed to deliver. However, there were more respondents who agreed on delivering comfort care (n = 108) and adapted focus care (n = 103) and routinely providing care (n=100) saturating the populations. Besides, giving honest and genuine answers (n = 99) and routine care before death (n = 90) were also important.

The LCP code of practice on the knowledge on end-of-life nursing care starts with the patient safety (n = 107) which a lot of respondent nurses agreed to have delivered followed by respect for patient's decision towards the care to be given to them or the decision to end their life such as mercy killing (n = 99). Treatment modalities (n = 104), reassessing current medications (n = 04), medicating patients (n = 119), and symptoms control (n = 20) were also identified together with the routine nursing practice (n = 105) which were more of the physiologic needs of the dying patients.

It was worth noting to identify evidence of caring attitude towards the dying (p = 0.005534) and knowledge on the end-of-life nursing care (p = 0.0004703) to be probably among Sri Lankans.

Tables 2 and *3* identify the specific knowledge and caring attitude of Sri Lankan nurses to the dying patients.

Table 2. Caring attitude towards the dying.

Caring attitude towards the dying	N	%
No response attitude	104	84.6
Routine care	100	81.8
Spending personal time	89	72.4
Giving honest and genuine answers	99	80.5
Routine care before death	90	73.2
Adapted focus of care	103	83.7
Comfort care	108	87.8
Negative feelings towards providing care	69	56.1
Mean	60	
Standard deviation	36	
Probability	0.005534	

Table 3. Knowledge on end-of-life nursing care.

Knowledge on end-of-life nursing care	N	%
Patient safety	107	87
Respect for patient's autonomy	99	80.5
Treatment modalities	104	84.6
Routine nursing practice	105	85.4
Identification of the dying phase	65	55.8
Re-assessing current medication	104	84.6
Medication	119	96.7
Symptoms control	20	16.3
Mean	90	
Standard deviation	32	
Probability	0.0004703	

DISCUSSION

In this section all aspects of the research process including the results, limitations, and benefits, will be discussed.

The nurses' attitude and knowledge in caring for the dying were identified through education, age bracket, civil status and clinical experiences. This revealed other factors such as gender impact that was also useful in the delivery of care for the dying patients.

Primarily, this study was reliable however limited to only one government hospital. Also, only the LCP was the primary guideline that was used in this selected government hospital. It was acknowledged that there were other guidelines in caring for the dying, however; it was not used to indicate a weakness on this research.

Secondly, the questionnaire revealed some disagreement between nurses about newly admitted patients on their dying phase since the LCP guideline was limited to long-term care and not for the acute. This study showed the need for professional consensus among newly admitted patients who were dying before appropriate end-of-life care was initiated. Some studies found that even when the patient was identified as dying, their primary physicians still continued with diagnostic and therapeutic interventions and nurses who wished to deliver care focused only on comfort care and symptom control. This is why studies found on the literature review on the use of the LCP found that clinical experiences and educational attainment contributed to the successful delivery of comfort care for the dying. Therefore healthcare professionals' education level in end-of-life care was noted in the result section.

Lastly, euthanasia was not included in the aims of this study although it could also contribute to the identification of knowledge and caring attitude. Euthanasia or respecting autonomy for the dying patient to decide to end their life was a part of the guideline of the LCP and would require a special research process which this study did not identify.

The strength of the results, however, quantitatively contributed to recommendations in future nursing practice, nurse education and research. Unlike other qualitative studies, this study moved palliative care higher up on the agenda of the nursing profession in Sri Lanka.

CONCLUSION

There was significant evidence of caring attitude towards the dying ($p = 0.005534$) and knowledge on the end-of-life nursing care ($p = 0.0004703$) for the dying patients. It was also concluded that educational attainment ($p = 0.050001$), clinical experiences ($p = 0.01499$), age ($p = 0.01061$) and civil status ($p = 0.001782$) were some factors affecting the knowledge and attitude of Sri Lankan nurses in delivering nursing care for the dying patients admitted to a government hospital.

RECOMMENDATIONS

The researcher recommends that Sri Lankan cities do more studies in the end-of-life nursing care. It is the intention of the researcher to share the findings of the study with the management of the selected government hospital and to the Sri Lankan schools of nursing and midwifery. It is hoped that this will highlight the necessity of planning on-going education and training for nurses in end-of-life nursing care.

To present this research to a broader audience, the researchers intend to apply the study's recommended code of nursing practice on:

(1) Attitude — empathetic response to patients, routine nursing care, spending personal time, giving honest answers when asked about their conditions, routine care before death, adapted focus of care, comfort care, and their feelings manifested through gestures when providing care to the dying patients; and

(2) Knowledge — understand treatment modalities to ensure patient safety, respect for patient's decisions, routine nursing practice, re-assessing current medications, and identification of the terminal phase and symptoms control.

Date of submission: August 2016
Date of acceptance: November 2016

REFERENCES

Dalgaard, K, Thorsell, G, Delmar, C 2010, 'Identifying transitions in terminal illness trajectories: a critical factor in hospital-based palliative care', *International Journal of Palliative Nursing*, vol. 15, no. 8, pp. 87–92.

Espinosa, L, Young, A, Symes, L, Haile, B & Walsh, T 2010, 'ICU nurses' experiences in providing terminal care', C*ritical Care Nursing Quarterly*, vol. 3, no. 3, pp. 273–281.

Gambles, M, Stirzaker, S, Jack, BA & Ellershaw, JE 2006, 'Liverpool care pathway in hospices: an exploratory study of doctor and nurse perceptions', *International Journal of Palliative Nursing*, vol. 12, no. 9, pp. 414–421.

Glare, P, Virik, K, Jones, M, Hudson, M, Eychmuller, S, Simes, J & Christakis, N 2003, 'A systematic review of physicians' survival predictions in terminally ill cancer patients', *BMJ*, vol. 327, pp. 195.

Health Service Executives, National Service Plan 2009, Viewed 5 October 2009, <http://www.hse.ie/eng/Publications/corporate/National_Service_Plan_2009.pdf >.

Haber, J 2010, 'Sampling', in *Nursing research: methods and critical appraisal for evidencebased practice*, 7th edn, Lobiondo-Wood G & Haber J eds, Mosby Elsevier, St. Louis.

Jones M & Rattray J 2010, 'Questionnaire design', in *The research process in nursing*, 6th edn, Gerrish K & Lacey A Eds, Wiley-Blackwell, Oxford.

Lhussier, M, Carr, SM & Wilcockson, J 2007, 'The evaluation of an end-of-life integrated care pathway', *International Journal of Palliative Nursing*, vol. 13, no. 2, pp. 74–81.

Lobiondo-Wood, G & Haber, J 2010, 'Introduction to quantitative research', in *Nursing research: methods and critical appraisal for evidence-based practice*, 7th edn, LobiondoWood G & Haber J eds, Mosby Elsevier, St. Louis.

Kinder, C & Ellershaw, J 2003, 'How to use the Liverpool Care Pathway for the dying patient?', in *Care of the dying*, Ellershaw J & Wilkinson S eds, Oxford University Press, New York.

McKeown, K, Haase, T, Pratschke, J, Twomey, S, Donovan, H & Engling, F 2010, 'Dying in hospital in Ireland: an assessment of the quality of care in the last week of life', *National Audit Report 5, Dublin: Irish Hospice Foundation*, <http://www.hospicefriendlyhospitals.net>.

Parahoo, K 2006, Nursing research: principles, process and issues, 2nd edn, Palgrave Macmillan, Houndsmill.

Polit, DF & Beck, CT 2010, *Essentials of nursing research: appraising evidence for nursing practice*, 7th edn, Wolters Kluwer Health / Lippincott Williams & Wilkins, Philadelphia.

Proctor, S, Allan, T & Lacey, A 2010, 'Sampling', in *The research process in nursing*, 6th edn, Gerrish K & Lacey, A eds, Wiley-Blackwell, Oxford.

Preston, M 2007, 'The LCP for the dying: a guide to implementation,' *End Life Care*, vol. 1, pp. 61–68.

Robson, C 2007, *How to do a research project: a guide for undergraduate students*, Blackwell Publishing, Oxford.

Thompson, G, McClement, S & Daeninck, P 2006, 'Nurses' perceptions of quality end-of-life care on an acute medical ward', *JAN*, vol. 53, no. 2, pp.169–177.

Toscani, F, Di Giulio P, Brunelli, C, Miccinesi, G & Laquintana, D 2005, 'How people die in hospital general wards: a descriptive study', *Journal of Pain and Symptom Management*, vol. 30, no. 1, pp. 33–40.

Watson, J *et al.* 2006, *Nursing end of life care. A theory of nursing*, National League for Nursing, New York.

Walker, R & Read, S 2010, ' The Liverpool Care Pathway in intensive care: an exploratory of doctor and nurse perceptions', *International Journal of Palliative Nursing*, vol. 16, no. 6, pp. 267–273.

CONTRIBUTIONS TO THE JOURNAL

Contributions from academics, policy makers, research personnel and managers in public institutions as well as those in private organizations and industry are welcome. However, it is required that manuscripts submitted to the Journal should not have been published and will not be simultaneously submitted or published elsewhere. Research papers must also be factual and original.

Contributions to the Journal will normally include original research work, papers on science and technology policy, and technical notes and communications. As the Journal is a prime source in information on science and technology for development, contributions that fall within the following areas are particularly welcome:

- Science and technology policy
- Original research work; and
- Technical notes and communications.

MANUSCRIPT PREPARATION

Manuscripts should be prepared in Microsoft Word 6.0 and above. Two copies of the manuscripts on A4-size paper and a soft copy on cd should be provided. The manuscript should not exceed 5000 words and specialist terminology and footnotes should be avoided. Each paper should be provided with an abstract of about 150 words, reporting concisely on the purpose and result of the paper. All papers will be published in English. The names(s) of the authors(s) should only appear on the title page which will be detached from the paper before the referees comments are invited.

Mathematical analysis and statistical data should be placed in appendices whenever possible. Numbered tables, figures and illustrations should have their intended position in the printed text clearly indicated. Photographs in black and white should be printed on glossy paper or scanned into text at the intended position. For illustrations, the original and one copy should be provided, if the illustration is not scanned into the text. Similarly, line drawings should either be provided in soft copy or be in a form suitable for reproduction, in Indian ink, with lettering, etc., completed.

References, or citing, should follow the Harvard author-date system. The in-text reference should contain: the author's or editor's family name (or organization responsible); year of publication; page number if appropriate and where available. The bibliography at the end of the article should be arranged alphabetically. Authors are responsible for checking and accuracy of all references.

The Editor-in-Chief reserves the right to adjust the style to certain standards of uniformity. All articles should be directed to:

Emeritus Prof Md Ikram Mohd Said
Editor-in-Chief
School of Chemical Sciences and Food Technology
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor D.E.
(e-mail:kiamco65@gmail.com; kiam@ukm.my)

Manuscripts are accepted for publication on the understanding that the copyright is assigned to the Journal. The completed copyright transfer form should be submitted together with the manuscript to the Editor. We regret that manuscripts without the copyright transfer from will not be considered for publication.

TRANSFER OF COPYRIGHT AGREEMENT

The author(s) agree that upon acceptance for publication, copyright (including the right to authorise photocopying and reproduction in all media, whether separately or as a part of a journal issue or otherwise) in any manuscript submitted, including its modifications thereafter, is transferred to the *ASEAN Journal on Science and Technology for Development*.

The author(s) agree that the Editors (including its Editorial Advisory Committee and its Board Members) of the *ASEAN Journal on Science and Technology for Development* will have world-wide rights, perpetually, to the manuscript (and the final published article with all its amendments), including the right to distribute the article in whatever form deemed appropriate in the information dissemination process (including the use of internet and WWW). This transfer includes the right to adapt the manuscript/article for use in computer systems and programme, including reproduction in machine readable form and incorporation in retrieval systems.

The author(s) retain the rights to:

i. Any intellectual property rights to any process of procedure described in the manuscript.

ii. Photocopy or make copies of the published article for their own personal use or use by colleagues, including for classroom teaching purposes, provided the copies are not offered for sale and are not distributed in a systematic way outside their employing institution; and

iii. Compile the article into their own collection of printed works.

The author(s) should however, include an indication that the copyright ownership of article rests with the *ASEAN Journal on Science and Technology for Development*, and provide a full citation of the Journal source.

Warranties and Copyright Transfer

The author(s) warrant that the article is the author's original work that has not been published elsewhere. The author(s) warrant that the article contains no material that infringes the rights of other or are of a libelous nature. The author(s) warrant that if excerpts from copyrighted works are included, permission of the relevant copyright owners have been obtained and due acknowledgement given in the article.

If the article is prepared jointly with other author(s), the signing author has informed the co-authors of this copyright transfer and has obtained their permission to sign on their behalf. If copyright is held by the employer, the employer or an authorised representative of the employer must sign. If this assignment is signed by the author, it is taken that the author has the authorisation of the employer and that the terms and conditions of this transfer are with the acceptance of the employer.

Signature of copyright owner(s) : _____
(Please indicate if signing on behalf of all co-authors) YES/NO (Delete as appropriate)

Full name (Please print) : _____

Name and designation if employer representative : _____

Company or institution : _____

Date : _____

PLEASE RETURN AN **ORIGINAL** COPY OF THIS COMPLETED FORM, together with the relevant manuscript to the Editor-in-Chief. We regret that manuscripts without the copyright transfer form will not be considered for publication.

ASEAN JOURNAL ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT
(*ASEAN J. Sc. Technol. Dev.*)

SUBSCRIPTION FORM

The annual subscription rates for two issues per volume including CDs are as follows:

ASEAN countries: USD10.00
Outside ASEAN: USD30.00

Note that the above rate does not include the air mail charge. The air mail charge will be available individually for each subscriber upon request.

Please use the following form, to be returned together with the bank draft or send separately if you pay through bank:

I wish to subscribe to the ASEAN Journal on Science and Technology for Development.

Name of Subscriber: _____

Name of Contact Person: _____

Telephone No.: _____ Fax No.: _____

E-mail Address: _____

Mailing Address: _____

Cheque/Bank Draft No.: _____ Amount: _____

Signature: _____

Date: _____

All subscription correspondence should be addressed to:

Emeritus Prof Md Ikram Mohd Said
Editor-in-Chief
School of Chemical Sciences and Food Technology
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor D.E.
Tel: +603 8921 5445
Fax: +603 8921 5410

Or
You can send information through e-mail:
(e-mail:kiamco65@gmail.com; kiam@ukm.my)

ADVERTISEMENTS

(a) Scientific conferences/Seminars/Training courses
(b) Books/Publications
(c) Scientific instruments/Company/Industrial products
(d) Technologies for licensing/research collaboration
(e) Vacancies and appointments
(f) General publicity on science and technology matters of interest to the scientific community.

The terms and conditions for advertising are as follows:

(a) All advertisements will be in black and white.
(b) The advertisement will be interspersed within the various pages of the Journal and will be charged at a flat rate of USD1000 per B5-sized page for two (2) issues or USD1800 for four (2) issues on a running basis.
(c) Acceptance of advertisements will be on a first-come-first-served basis.
(d) All advertisers will receive two (2) copies of each issue of the Journal and CDs free of charge for the duration of the advertisement.
(e) Requests for advertisements should be accompanied with the following information:
    - Name of Advertiser
    - Contact Person
    - Tel. No., Fax No. and e-mail of contact person
    - Mailing address
    - Bank draft/cheque number of relevant amount made payable to the *ASEAN Journal on Science and Technology for Development*.

The Advertiser shall provide the copy in print ready form, in electronic copy using a common publishing software, together with a hard copy sample of the expected final print form. Advertisements will be published on an "as-is" basis using the material submitted by the Advertiser. No proofs will be given.

The Editor reserves the right to accept or reject requests for advertisements to ensure that the scholarly intent of the Journal is upkept.

All advertising and business correspondences should be addressed to:

Emeritus Prof Md Ikram Mohd Said
Editor-in-Chief
School of Chemical Sciences and Food Technology
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor D.E.
Tel: +603 8921 5445
Fax: +603 8921 5410
(e-mail:kiamco65@gmail.com; kiam@ukm.my)

ASEAN JOURNAL ON SCIENCE & TECHNOLOGY FOR DEVELOPMENT

Contents

ASEAN J. Sc. Technol. Dev.
Vol. 33, No. 2, 2016