Raising the Bar for Occupational Health Care through International Health Alliance: A Twinning Framework to Enhance and Expand Occupational Health Services at Bangkok Dusit Medical Services

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Abstract

In response to the rapidly changing occupational health environment, Bangkok Dusit Medical Services (BDMS) has recognized a need to increase the quality and availability of occupational health services. This manuscript describes the evolution of an international health alliance, based on the "twinning" framework, to achieve a collaborative goal of developing an Occupational Health Center of Excellence (COE-OH) in Thailand. Through this alliance, the COE-OH has supported the development of programs in the areas of health promotion, training and research. The twinning framework was applied as the alliance moved through initiation, implementation, monitoring and evaluation. Project evaluation was viewed as an iterative process that informed next steps in the process as the collaboration developed. Initial products of this alliance include adaptation of the "Let's Get Healthy!" health promotion and data collection tool for use as part of the Thai employee check-up; development and implementation of occupational health trainings for various levels of clinical staff; student exchange opportunities; and the creation of the infrastructure to support standing up of a fully human subjects compliant data repository for research. Three years into this alliance, the COE-OH has reached a point where feasibility has been established and the immense opportunities of future joint work have become apparent.

Keywords: occupational, healthcare, Oregon, BDMS, international, alliance, Thailand

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Over the past 50 years, Thailand has transitioned from a developing agrarian-based economy to a newly industrialized country at a very rapid rate, resulting in the development of service and knowledge industries sector alongside an agricultural and industrial sector as it attempts to integrate into the global economy.[1] This rapid transition stands in contrast to most developed nations where the shift to largely service and knowledge economies took place more slowly and sequentially, allowing for the concurrent development of state regulation, worker representation and worker health. According to the National Statistical Office of Thailand, the country's population was 65.58 million individuals in 2016 (Table 1).

Table 1: Thai population in employment, 2016

Summary of labor force	Population (millions) (n)
Aged over 15 years old	55.71 (100%)
1. Total labor force	37.72 (67.71%)
1.1 Employed	37.14 (98.5%)
Business	15.32 (41.2%)
Agriculture	11.21 (30.2%)
Industry	8.57 (23.1%)
Others	2.04 (5.5%)
1.2 Unemployed/seasonally unemployed	0.58 (1.5%)
2. Not in labor force	17.99 (32.29%)

When excluding individuals under 15 years or those no longer in the labor force (e.g., students or aging individuals), Thailand's workforce includes 37.1 million employees distributed predominantly across business, agriculture, and industry sectors (Table 1). Thailand's unemployment rate of 1.5% is one of the lowest among Association of Southeast Asian Nations (ASEAN) countries.[2]

Thailand workforce is made up of both formal and informal employment. Formal employees are defined as workers who work under employer's premises and have a contractual agreement. In addition, these employees are registered with the social security office (SSO), resulting in health and safety coverage by the Labor Protection Act (LPA). Thailand Social Security Act (SSA) also benefits formal workers with in-patient healthcare insurance in cases of disease and injuries. Informal employees make up to 62% of the total Thai workforce and these employees tend to work from home, as either self-employed individuals or temporary workers without any contractual agreement with employers. It was shown that workplace accident rates for informal employees are approximately 10 times higher than formal workers due to ineffective law enforcement and health coverage.[3] Informal employees are prone to increased risks and accidents due to safety conditions not being held to the same standards as in formal employment where the working environment is controlled.

The rapid rate of economic transition, resulting in the shift of employees from informal to formal employment, highlighted a gap in Thailand's occupational health care. For example, poor occupational health amongst Thai workers has been associated with lower education, lack of government and protection policy, as well as inadequate occupational health personnel. Thus, fixing these gaps can improve the labor employment system, improve coverage for formal and informal worker, and decrease disparities in health protection.[3] As a hospital in private sector, we aimed to improve and expand the occupational health standard and services by forming an international alliance with another institution. This collaborative approach gives rise to new opportunities for occupational health physicians to receive training, resulting in improvements to the quality of care, and ability to provide comprehensive and standardized services to the Thai workforce.

Restructuring of the Thai healthcare system

In response to the rapid economic shift, in 2001 Thailand actualized a comprehensive scope database to examine healthcare costs for its population and introduced the notion of a Universal Coverage Scheme (UCS) that would provide all Thai citizens with equal access to health care facilities regardless of their income or socioeconomic status. The National Health Security Act in 2002[4] aimed to provide widespread access to essential medical services while reducing out-of-pocket payments, particularly for workers in the agricultural and informal sectors. Specifically, the Act extended the government-subsidized welfare range to residents who are not insured, restricting their cash installments to 30 Baht (~$1 U.S) for each health care experience. [5] Out of 65.58 million Thai citizens residing in the country, 99.9% registered to one of the offered government health schemes, including the universal coverage/30 Baht scheme (73.7%), social security scheme (17.2%), and civil servant medical benefits plan (7.4%). Less than two percent of Thai citizens were covered by smaller plans, including local administration (0.93%), teacher welfare in private schools (0.12%), or by special government coverage called undefined workforce (0.61%). In 2006, out-of-pocket expenses from these schemes were terminated entirely. [5]

In addition to these UCSs, Thailand's social security system (SSS) and Civil Servant Medical Benefit Schemes (CSMBS) were maintained. Both SSS and CSMBS were designed to increase welfare of workers and government officers as well as their relatives.[6] SSS was funded by contributions by employees, government, and employers to cover illness and work-related injuries[7] whereas CSMBS was financed by tariff income and controlled by the Comptroller General Department. Despite the availability of government-funded health coverage schemes Thai people could still choose private insurance or self-pay.

As a nation, Thailand recognized the impact of globalization and embraced the goal of developing a framework for occupational safety and health that was consistent with international standards. In 1999, ASEAN developed ASEAN-OSHNET, a collaboration of the ten ASEAN nations to develop and improve occupational safety and health in the region. In 2007, Thailand promulgated a National Agenda for "Decent Safety & Health for Workers" with a goal of reducing preventable occupational injuries and illnesses as an economic development target. This included a national occupational safety and Health Master Plan that encouraged collaborations among public, private and academic sectors to improve the training of occupational health providers and the delivery of occupational safety and health services to Thai workers. This culminated in the passage of The Occupational Safety, Health and Environment Act B.E. 2554 (A.D. 2011),[8] the main occupational safety and health law of Thailand on July 16, 2011. Since its passage, national occupational injury and fatality rates have progressively declined.[9] Approximately, 9.13 million Thai workers are covered under a national Workers' Compensation Fund, and in 2014 the fund recorded 100,392 compensable injuries and illnesses and 625 deaths.[9]

An emergent need for an Occupational Health Center of Excellence in Thailand

In response to the rapidly changing occupational and health environment, Bangkok Dusit Medical Services (BDMS) has recognized a need to increase occupational health services. This paper describes the evolution of an international health alliance, based on the "twinning" framework, to achieve a collaborative goal of developing an Occupational Health Center of Excellence in Thailand.

Applying a twinning approach to international collaboration

Twinning is a widely known approach for establishing collaboration between institutions.[3,10-20] At its essence, the

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twinning approach is supported by peer-to-peer communication, mentoring and knowledge exchange, voluntary contributions to leverage resources, and ultimately local ownership to ensure alignment with in-country goals and strategies. The six principles of twinning provide specific guidance for the development of collaboration[20] (Table 2) and are consistent with the World Health Organization (WHO) definition of partnership, specifically "a collaborative relationship between two or more parties based on trust, equality and mutual understanding for the achievement of a specified goal".[21] Twinning has provided a framework for establishing numerous collaborations between high-income countries (HIC) and low to low-middle income countries (LIC/LMIC) to address disparities in health care or health outcomes,[22-25] respond to emergent issues,[25-27] as well as build capacity in public administration and policy.[3,12,28]

Table 2: Principles of a Twinning Framework, (adapted from Busse, et al.[20])

1. Community **involvement and volunteerism,** with both sides making significant in-kind contributions of staff time, materials, and resources and demonstrating an investment in the process.
2. Broad-based **institutional relationships,** where both institutions commit the resources of entire organizations or institutions, including contributions of the time, knowledge, and clinical expertise of their individual members.
3. **Peer-to-peer collaborative relationships,** where each collaborator works together as equals, finding mutually beneficial solutions and opportunities to establish trust and build multidisciplinary teams.
4. **Professional exchanges and mentoring** for transfer and sharing knowledge, ideas, and skills to disseminate information.
5. Non-prescriptive, demand- and process-driven collaboration that empowers joint effort on both sides by giving them **ownership** of the programs being jointly created, thereby encouraging sustainable capacity development.
6. **Local political support,** whereby the program is a recognized activity and fits within broader programming efforts by the Ministry of Health and leverages private-sector resources.

Methods

The twinning framework describes a model of collaboration and set of principles at each step, from initiation of the collaboration through the evaluation of results and reframing of projects as appropriate (Figure 1). The twinning framework was applied as the collaboration moved through initiation, implementation, monitoring and evaluation. Evaluation was viewed as an iterative process that informed next steps in the process as the collaboration developed.

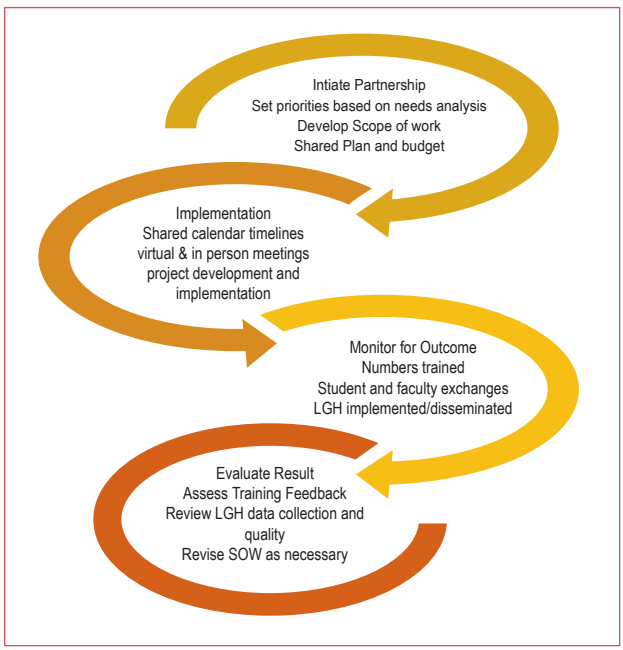

Figure 1: Four steps in the twinning approach.

Initiation of the BDMS-OHSU international health alliance

The collaboration between Oregon Health & Science University (OHSU) and BDMS was formally established in 2014 to address the strengths of both institutions and to create opportunities for leveraging the expertise and experience of each party. Stemming from inter-professional student education and study abroad experiences over the previous eight years, OHSU chose to centralize its global footprint in Southeast Asia and established 'OHSU Global' in 2014. Two 'OHSU Global' faculty members visited the BDMS flagship hospital in 2014 to present OHSU strengths and the institutions' interest in finding qualified Southeast Asian collaborators to help create and grow a formal international program for OHSU. From this initial meeting and subsequent video conferences between institutions, BDMS described their need for initial academic support in helping to create a Center of Excellence in Occupational Health (COE-OH) in Thailand. Thus, a five year, renewable Memorandum of Understanding was signed with distinguished collaborators in Southeast Asia, including BDMS in Bangkok, Thailand. The BDMS flagship hospital, located in Bangkok, was identified to serve as the home for regional activities of OHSU Global in Southeast Asia. BDMS is one of the largest private health system in Southeast Asia, comprising more than 43 hospitals across Thailand, and Cambodia. BDMS incorporates six hospital brands that care for a wide spectrum of patients across Thailand and Southeast Asia. BDMS is now poised to become the largest hospital systems among the Association of Southeast Asian Nations (ASEAN) as the ASEAN Economic Community (AEC) comes into effect in 2005. Due to the high prevalence of Thai workers, approximately 1/3 of BDMS hospitals (n=43) provide occupational health services with six hospitals providing comprehensive services: Bangkok Hospital Headquarters, Bangkok Phrapradaeng

Hospital, Bangkok Rayong Hospital, Bangkok Hospital Hat Yai, Samitivej Sriracha Hospital, and Phyathai 2 Hospital. Of these six hospitals, only Samitivej Sriracha Hospital has a dedicated occupational health clinic, while the remaining five hospitals mix occupational check–up clients with general health check-up. Since 2014, the majority of clients to these six hospitals are corporate/insurance clients (57% in 2016), followed by self-pay clients (40%), and hospital staff (3%). Since 2014, BDMS has increased its number of occupational health providers in these six hospitals by 40.6%, representing 97 providers comprising occupational health physicians (n=40), nurses (n=50) and industrial hygienists (n=7).

Occupational health services and programs at BDMS

BDMS occupational health hospitals implement various intervention projects to improve individual health based on emergent need identified from health screenings (Table 3). For example, over the past three years, work-related hearing loss and ergonomic-related conditions have been clients' primary complaints. Therefore, occupational health services have included ergonomic intervention programs aimed to improve worker's heath and prevent musculoskeletal diseases, hearing conservation programs, and other health promotion programs that promote healthy lifestyles and reduce the risk for metabolic syndrome. Biological monitoring of chemicals and metabolites in workers' urine over the past three years have revealed an urgent need to address environmental and occupational exposures among Thai workers.

Table 3: Top three abnormal findings identified by Bangkok Rayong Hospital in the past three years and corresponding number of corporate health intervention projects implemented across BDMS's six comprehensive occupational health hospitals.

Primary Issue	2016	2015	2014
	1. Work-related hearing loss 2. Work-related lung function abnormalities 3. Abnormal urinalysis from chemical contamination	1. Work-related hearing loss 2. Ergonomic issues 3. Lead in whole blood	1. Arsenic in urine 2. Work-related hearing loss 3. Ergonomic
Project Type	**2016**	**2015**	**2014**
• Ergonomic intervention program	6	2	9
• Hearing conservation program	14	7	4
• Other health promotion programs	27	13	14

A needs assessment identified initial priorities for the COE-OH

In order to begin this effort, a needs assessment was conducted in May 2015 by an occupational medicine physician (Rischitelli) and certified industrial hygienist (Montgomery), based around the core competencies of occupational and environmental medicine defined by the American College of Occupational and Environmental Medicine[29] and the World Health Organization (WHO).[30] The assessment identified a particular need in Thailand for seminars and training in occupational health core areas. It also identified a parallel need for a health risk assessment platform that could be used with the Thai population for health promotion, measuring behavior change, and rooting high-quality operational research out of the COE-OH. In contrast to traditional occupational health programs in the U.S., Thailand offers universally-provided healthcare to all workers,[1] thereby enhancing opportunities for implementing work-related occupational health programs while facilitating assessment of programmatic impact on organizational costs and health outcomes. This identification of direct benefits and contributions to overall worker health parallels the U.S. initiative identified by the National Institute of Occupational Safety and Health (NIOSH), termed Total Worker Health®. BDMS confirmed interest in offering occupational health programs for both BDMS employees and organizational clients for whom BDMS provides occupational health services. Thus, initial priorities for the COE-OH identified 1). Occupational health training, 2). A health risk assessment platform supporting health promotion, and 3). Research on the impact of offered worksite wellness programs on Thai employees[31] (Figure 2).

Figure 2: Capacity-building foci of the Occupational Health Center of Excellence

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Collaborative funding and joint ownership of COE-OH initiatives

Applying twinning principles, a joint leadership team was established that consisted of approximately three individuals per institution. This joint leadership team was responsible for decision-making, with ultimate oversight resting with the heads of both institutions, namely the BDMS CEO and the OHSU President. OHSU and BDMS agreed to match funding to pay for initial efforts. The joint leadership team agreed upon three capacity-building foci for the COE-OH (occupational health training, health promotion, and research development, Figure 2), with each having its own annually-renewed and agreed Scope of Work defining a mutually-acceptable set of activities in each focus area.

Implementation of foci activities based on shared priorities

Based on existing capacity and resources, Occupational Health Training and Health Promotion activities were developed and implemented in the first year, whereas research development followed as trust was established and the collaboration identified resources and expertise to lead key research development activities.

Occupational Health Training

Shared knowledge, peer-to-peer communication, and professional exchange are key tenets of the twinning framework, and were directly addressed via a jointly-developed educational program for Thai health care providers and occupational health practitioners. Based on the needs assessment, both parties identified gaps in occupational health education and training. Consistent with the twinning model's emphasis on long-term relationships to allow for shared decision-making and collective efficacy,[20] a three-year education plan was jointly developed to capitalize on the academic strengths of OHSU, existing training within the BDMS system, and shared willingness to volunteer significant time for curriculum development to ensure success. Trainings were developed by OHSU and conducted using a train-the-trainer model.[32] U.S. case studies were utilized and discussed in application to Thai corporate case studies at the end of the workshop. Participants included clinicians, occupational health practitioners, key managers, and administrators including marketing officials. For some training, participants received a completion certificate with the BDMS-OHSU International Health Alliance's dual logo upon completion. Specific trainings are described in Table 4, including the topic, target audience, and the number of trainees attending.

Table 4: Occupational health trainings using "Train-the-Trainer" approach

Topic	Target Audience	participants
Health and Productivity Management	Occupational health practitioners and key managers/administrators including marketing	24
Core Elements of Occupational Health: Hazard Identification and Control, Industrial Hygiene, Ergonomics and Occupational Health Nursing	Occupational medicine nurses	24
Industrial toxicology and hazardous materials incident management	Occupational medicine, Internal medicine and Emergency medicine physicians, nurses and pharmacists	41
Functional capacity evaluations, ergonomics, musculoskeletal injury, head injury and concussion management	Physiatrists and physical therapists	26

To ensure maintenance of the training program, a number of follow-up activities were developed and implemented, including monthly joint BDMS-OHSU industrial toxicology case conferences (which allowed for sharing of clinical cases and information amongst occupational medicine and toxicology peers attended by multiple BDMS/OHSU sites), opportunities for three clinical team members from BDMS to visit OHSU (e.g., Oregon Poison Center and other recommended toxicology training sites during the 2 week visit), as well as an Occupational Health professional exchange. In the exchange, two occupational health physicians and two occupational health nurses visited OHSU and related sites for 2 weeks to substantiate knowledge in industrial hygiene, occupational nursing, and occupational medicine in the United States. This exchange was followed by a full week training for an expanded group of BDMS practitioners on industrial hygiene, occupational health nursing and occupational health in Bangkok, led by OHSU industrial hygienist with support from two U.S. occupational health nurses. A functional capacity evaluation training workshop was also conducted for key rehabilitation/physical therapists in 2015 with follow-up training in 2016. Finally, an online learning platform was created by OHSU, with input on approach and functionality from the BDMS leadership team, to serve as a platform for regular exchange of didactic information in Occupational Health for healthcare providers and clients, and to create a host site for resources and summaries of important articles.

Health Promotion and Behavior Change

The COE-OH's second focus revolved around enhancing opportunities for health promotion through the expansion of the existing employee check-up system offered annually to every Thai employee.[31] Worksite wellness programs can result in significant healthcare cost savings and improve health outcomes, including diet, physical activity, physiologic changes (body mass index, blood cholesterol), and significantly greater smoking cessation.[31] While the Thai government is on

the forefront of preventive healthcare through the requirement of an annual physical for all employed individuals, there is no requirement for individual- or corporate -level feedback to promote or sustain healthy behaviors, such as good diet, adequate sleep, or appropriate exercise. Thus, implementation of a health promotion program with feedback to accompany the existing annual check-up was a priority for BDMS. The leadership team reviewed existing programs and jointly decided to expand a successful OHSU-developed health promotion program, *"Let's Get Healthy!"* to deliver health promotion activities. A team of experts in occupational health, population science, and informatics was assembled from both institutions and began meeting monthly to 1) Identify how to best integrate the *Let's Get Healthy!* Program into the annual employee check-up system; 2) Vet and approve health components to include in the package (Figure 3); 3) Develop a process for Thai translation and cultural adaptation of assessments and tailored feedback; 4) Complete *Let's Get Healthy!*'s module implementation and data integration into the existing clinical check-up and electronic health record systems. Thai occupational health leaders, information technology specialists, and researchers from both institutions worked very closely on development and implementation of this program. Through monthly videoconferencing, regular email communication, and quarterly visits to Bangkok, the collaborators established a strong and lasting bonding where there is shared ownership of the adapted product, *"Let's Get Healthy!-Global"*, its planned implementation, and resulting data over time. Thus, the twinning framework model developed a culturally-appropriate health promotion product that could rapidly assess employee health behaviors across workplaces in Thailand and other SE Asia regions. Consistent with efforts to promote opportunities for worksite health promotion, data captured on employee risk of metabolic syndrome[33] and behavioral risk factors (sleep, diet and cognitive function) are stored in a secure data repository and used in aggregate to inform a corporate report for employers that describes the prevalence of metabolic syndrome among employees, stratified by gender, age group, worker type, and in relation to behavioral risk factors as measured by *Let's Get Healthy!-Global* (e.g., sleep, diet, cognitive function). The desired function of this report is to guide employers in determining need and target audience for a tailored worksite wellness programs.

Figure 3: BDMS leadership determining Let's Get Healthy! modules for initial inclusion (left). BDMS employees pilot testing new modules to review translation accuracy, content length, and feedback effectiveness (Right).

Development of Joint Research Capacity

The third identified focus area of the COE-OH developed capacity for ongoing research activities that advance both science and employee/patient wellness. The incorporation of Let's Get Healthy!-Global into the BDMS annual checkup system provided a unique opportunity to develop an integrated, robust, and comprehensive research data repository containing clinical and behavioral data across a wide variety of worker types and industries.

Adaptation of existing informatics infrastructures to support research development

BDMS offers a rich infrastructure for data collection stemming from its already-existing health information systems (HIS) and electronic medical record (EMR) processes. The EMR is a digital/ computerized version of a paper chart that contains all of a patient's medical history. However, similar to many hospital systems in the U.S., BDMS's 43 hospitals used disparate HIS and EMR systems and not all were interoperable and consequently did not support integration of annual health check-up data into a single repository, nor were processes yet developed to support BDMS's research mission. Thus, an architecture and schema that integrated BDMS healthcare data were developed to support research purposes.

Specifically, informatics teams from OHSU and BDMS designed and developed an information architecture to integrate key data from the hospitals' disparate EMRs, leveraging BDMS's BExchange platform (BDMS's Enterprise Patient Index system) into a third data system that would serve as a central repository for data consolidated across BDMS EMR platforms. This single repository, termed the Occupational Health Repository (OHR), holds checkup data for approved research projects. OHR contains integrated clinical data and

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Let's Get Healthy!-Global data collected across many companies, industries, and hospital visits. Organized for easy use by researchers, it supports the use of healthcare data for research purposes and serves as a robust relational database permitting a variety of research activities, including intervention implementation and evaluation, cross-sectional risk assessment, and cohort analyses of disease risk using annual check-up data collected longitudinally.

Building capacity for human subject's protections to support research activities

BDMS hospitals have existing patient consent procedures for delivery of healthcare services, though patient approval for the broad-based collection of their healthcare data for use in research was not implemented across all hospitals' administrative procedures. Thus, initial collaboration activities prioritized the design and incorporation of patient consent processes, Institutional Review Board (IRB) approvals, and data governance processes that would support the collection and usage of BDMS data for ongoing research.

Specifically, an OHR joint governance team, consisting of BDMS and OHSU researchers, developed policies and guiding procedures for OHR content, structures, and output formats. This team was tasked with ensuring compliance with both Thailand and U.S. human subjects' protection regulations such that the team could review and approve data requests in line with scientific merit and feasibility. They also would ensure that researchers interested in utilizing OHR data have a) appropriate IRB project approvals in place prior to the release of any data; and b) that the researchers' data request is consistent with and appropriate for their approved protocol. To facilitate research capacity-building, the team also arranged cross-institutional communications between IRBs at OHSU and BDMS to increase understanding of protocols and procedures related to using data repositories stemming from EHRs for research in the United States. The international communication helped to increase understanding and preparation of BDMS IRB when reviewing incoming protocols. Likewise, to facilitate the development of an overarching BDMS research protocol using the OHR, OHSU shared their approved protocols, consent form language, data sharing agreements, and other documentation that supported protocol development in Thai. The submitted protocol was the first of its kind at BDMS, a critical step that could be replicated or leveraged to accelerate interdisciplinary research across BDMS hospital systems and researchers. Together, these areas of work reflect a larger agreed-upon vision of building a COE-OH and expanding research opportunities across institutions, similar to other twinning projects aimed at improving health outcomes.[11,22-26]

Results

Overall, the results of the international health alliance are measured in terms of the successful implementation of proposed programs, trainings and the development of shared resources that lay the groundwork for future research. Overall, and as described below in more detail, this alliance has resulted in the successful deployment of "Let's Get Healthy!" and integration of Let's Get Healthy! data with clinical data to inform reports to corporate clients. Training programs in occupational health and student exchanges have been developed and implemented, and approvals have been sought to allow for development and maintenance of a large data repository to support ongoing research.

Monitoring of Outcomes

The international health alliance outlined a logic model (Table 5) which applied twinning principles and approaches to accomplish each focus area. Working closely together, the team identified agreed targets, metrics for evaluation with timelines, and individual/ institutional responsibilities for reporting which were laid out in a jointly drafted document. In addition to each area of work for the three foci, detailed work plans were established and agreed to. For example, agreed upon measured outcomes for the training programs reflected the number of trainees as well as the number of training programs offered. In addition, an online learning process was developed to provide ongoing training resources and opportunities for information exchange between BDMS occupational medicine physicians and staff and their counterparts at OHSU using website analytics. The utility of the online learning process as well as the number of individuals who successfully complete all ten training modules are to receive a certificate of completion will be assessed. Finally, a long-term outcome of the educational aspects of this collaborative effort is the continued use of a newly created online platform for information sharing. While not yet measured, this will provide an opportunity to provide necessary feedback to update and adapt the training as is appropriate.

Measured outcomes of this work include the successful implementation of Let's Get Healthy!-Global (LGH-G) as part of the employee check-up package in six hospitals, development of individualized feedback for LGH diet, sleep and cognitive function assessments, development of a real-time report to corporate clients describing metabolic syndrome prevalence of their employees with tailored recommendations, and the development of a data repository that supports ongoing research. These outcomes are beneficial to both institutions and will support the later development of health promotion interventions that may be tailored to worksites' specific needs. A meaningful and lasting outcome of these collaborative activities has been the development of highly functioning team of individuals representing both institutions. This group continues to meet monthly, has participated in eight face-to-face meetings and is able to sustain ongoing collaborations.

Table 5: Logic model guiding the international collaboration built upon the Twinning framework.

Overarching International Health Alliance Goal		
To develop a Center of Excellence in Occupational Health (COE-OH) in Thailand to support international training opportunities, health promotion, and ongoing research.		
International Health Alliance Foci		
1) Expand training opportunities in occupational health for students and health professionals	2) Support health promotion and education of the Thai workforce	3) Develop a shared data repository to support ongoing scientific research.
Applied Twinning Strategies		
• Shared knowledge, peer-to-peer communication, professional exchange	• Institutional relationships, community involvement, collaborative relationships, joint ownership of collaborative products	• Institutional relationships, peer-to-peer collaborative support, professional exchanges and mentoring, local political support
Inputs and Resources		
• Access to occupational health expertise and academic strengths at OHSU • Existing training audience within BDMS (clinicians, occupational health practitioners, managers, administrators, marketing) • Student exchanges for workforce development	• Existing employee check-up system for adaptation • Existing health promotion program • Informatics expertise to integrate and deliver the health promotion program at scale • Expertise in occupational health, population science and informatics to guide approach and content	• Expertise in repository development • Existing electronic medical record (EMR) system • Existing Institutional Review Boards for international procedure sharing • Shared communication and interest in developing a repository to support ongoing research
Activities		
• Curriculum development to support training efforts and adaptation of train-the-trainer model and case studies for use in Thai settings • Creation of online learning platform for regular exchange of didactic information and host site for resources • Follow-up and maintenance activities: joint industrial toxicology case conferences, international exchange visits in occupational health, and online learning platforms	• Monthly meetings to plan approach, select modules to integrate, and monitor progress. • Thai translation and content testing • Staff training and tiered launch of program (LGH-G) in Thai hospitals • Collection of resulting data for research repository (Foci 3) • Development of corporate report to share summary health results with corporate clients • Development of intervention to offer corporate clients	• International IRB discussions and presentations for sharing procedures and processes • Co-development of a repository governance committee for vetting research requests • Protocol sharing and charter development to facilitate collaborative writing of a repository protocol overseeing the data usage • Seminars and symposia about research opportunities
Scope of Work Timelines		
• 3-year education plan	• Yr 1-2 health promotion launch • Yr 2-3 intervention development and corporate report frameworks	• Yr 1 to build trust and share expertise • Yr 2 to develop repository protocols • Yr 3-5 for research projects
Evaluation		
• Number of trainees and training programs offered • Website analytics to measure the utility of the online learning platform and number who complete all 10 training modules	• Number of hospitals launching the program • Percent of eligible individuals completing LGH-G • Reliability testing of intervention framework with existing clients	• Progress of repository activities against proposed timelines • Number of researchers leveraging the repository data • Number of publications stemming from the repository data
Outputs		
• Increased number of trainees across occupational health providers • Publications/presentations on international training procedures	• Launch of Let's Get Healthy!-Global • Product implementation in six hospitals • Health promotion publications	• Increased investigator awareness about research data and collaborative research opportunities
Impacts		
• Professional development with continued use of newly acquired information and procedures for rapid information sharing	• Support of health education at the individual and organizational level • Rapid identification of health issues in the Thai population	• Accelerating international research opportunities and collaborative projects

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Figure 4: BDMS occupational health staff undergoing training in industrial toxicology and hazardous materials incident management.

Figure 5: BDMS nurses undergoing respirator fit testing as part of respirator fit testing as part of the occupational health nurse training with OHSU.

Evaluation of Results

Occupational health training results

To date, training workshops have been held on five occupational health topics (toxicology, functional capacity evaluation and ergonomics, occupational health nursing, hazard recognition and control, and health and productivity management) resulting in the training of 115 occupational health providers who will disseminate accrued knowledge using the "train-the-trainer" approach. This initial success has led to an expansion of the annually-revised work plan to establish, implement and measure additional training programs.

Language, time zone differences, geographic distance between participants internationally and within Southeast Asia inhibited real time exchange of information for professional collaboration and peer to peer interaction. To address these barriers, the teams agreed to implement an internet-based learning management system to allow for sharing of announcements, promotion of online forum discussions and

Occupational Health Learning Management System Functions

Announcements
- Post new information and opportunities

Calendar
- Schedule and maintain deadlines, activities and events; link to announcements, assignments, assessments, materials, etc.

Chat
- Engage in real-time conversations with site participants
- Discussion Forum
- Create moderate and manage discussion topics, groups and private messages

Online Journal Club
- Post articles and have online discussions
  Online Lectures/Courses
- Develop learning modules for each of the OH competencies

Wiki
- Create and edit web content collaboratively
- Use for protocol and standard development

eLibrary of Resources
- Ease of access to international resources

consultations, facilitate an online journal club, and provide an eLibrary of resources. The leadership teams chose the Sakai learning management system (www.sakaiproject.org), an open source collaborative learning platform, because OHSU already used it successfully for its online courses. Content developed for the in-person classes was incorporated and adapted for online learning. Content from the health and productivity management (HPM) training was chosen for pilot development of an online course and was made available for participants in December 2016. Similar online training modules in toxicology and hazard recognition and control are in development and ultimately all ten of the ACOEM competencies will be represented. Participants are able to take the courses in a self-paced, distance learning format that encourages online discussion and demonstration of competency. Participants who complete the modules receive a certificate of completion for each individual module and a summary certificate when all ten modules are successfully completed. Ultimately, the goal of the online training and collaboration is to sustainably elevate the level of occupational health services and worker protection to an international standard and achieve regional and international excellence.

Health promotion results

Let's Get Healthy! Global had been successfully implemented in six BDMS hospitals by the end of 2016, with immediate feedback to individuals based on their diet, sleep, and cognitive function results. All collected data on consented patients are housed in the developed OHR. Products developed in 2016 include an automated "Corporate Report" which provides employers with a summary of employee metabolic syndrome risk, as well as how employee diet, sleep, and cognitive function are related to metabolic syndrome risk. As described previously, the evaluation of *Let's Get Healthy!* Global implementation and dissemination is an iterative process with results from the first two years of the collaboration guiding the development of new project modules to create a fully complete health risk assessment model. This U.S.-based risk assessment model will be adapted in 2017 to use data from the Thai employee population thereby defining culturally-appropriate risk strata for a Thai population. These additional modules will be developed jointly by BDMS and OHSU. Other 2017 activities will include the identification of a co-developed intervention for dissemination and implementation with corporate clients and targeting their health priorities.

Ongoing research results

Efforts in 2016 finalized the OHR, with a jointly-developed protocol submitted to BDMS's IRB for review and approval. This protocol submission marks the first of its kind at BDMS. The OHR joint governance team continues to meet annually and by teleconference to review OHR data structures and will begin vetting data use requests in 2017. Additionally, consent form language will be made consistent across BDMS' hospitals to permit data usage for research. Finally, as new health promotion modules become developed, the OHR will be adapted to accept the new variables and data. Thus, the OHR offers a rich source of occupational health data that will fuel the COE-OH's mission and activities.

Challenges

The international alliance that has been established between OHSU and BDMS has been highly successful to date, however, there have been challenges that are worth a mention. While language was not a significant barrier in discussions with clinicians and administrators, translation of all *Let's Get Healthy!* modules was necessary. In some situations, simple direct translation was not feasible, for example some key concepts or words (e.g. "vigilance", a word to assess attention within the cognitive function module) did not have a direct correlate in Thai. In these cases, it was necessary to ensure through translation, back translation, and pilot testing with individuals who spoke both languages fluently to ensure that the meaning of all surveys remained consistent. Cultural differences also came into play when developing appropriate individual survey feedback that was meaningful to Thai workers. Finally, as described previously, the need to provide trainings across large geographic differences and time zones created a scenario in which in person trainings were not always feasible. This issue was overcome through development and implementation of synchronous and asynchronous online training options.

Discussion

A twinning framework offers a rich set of principles for establishing and building upon an international health alliance. Efforts by BDMS and OHSU continue to move forward successfully in each focus area (training, health promotion and research), with the collaboration about to enter its three year with mutually-agreed activities. The annual scope of work offers an excellent format for establishing goals and activities based on emergent needs which are consistent with available time and financial resources. Trust has been established and re-enforced through in-person visits which allow personnel from both sides to better learn about each other and their unique set of interests and skills. Growth in the coming years will focus on product development for reaching a broader cross-section of Thai workers, including health promotion activities for increasing healthy habits among the Thai workforce as well as OHR-based research which will be critical for establishing the prevalence of environmental and occupational exposures in Thailand. This research will feed-forward to training activities and health promotion interventions, thereby improving and continuing the cycle of occupational health services offered by BDMS across its hospital systems.

Conclusion

The alliance developed between OHSU and BDMS provides an excellent example of a twinning partnership that brings benefits to both partners and promises to support further research efforts and improvements to clinical service provision.

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