APPLYING A NOVEL APPROACH TO IMPROVING THE SAFETY OF DRINKING WATER AND ICE PRODUCTION IN PHETCHABUN PROVINCE, THAILAND

Boadsaporn Anusornpanichakul[1], Nusaraporn Kessomboon[2] and Glenn Borlace[2]

[1]Department of Consumer Protection and Public Health Pharmacy, Phetchabun Provincial Public Health, Petchabun; [2]Department of Social and Administrative Pharmacy, Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen, Thailand

Abstract. The safety of drinking water and ice is important to prevent diarrheal disease. We applied an appreciative inquiry approach to improving the quality of water and ice production in Phetchabun Province, Thailand. Appreciative inquiry is an approach to organizational change that uses the knowledge, techniques and strategies of successful organizations to improve unsuccessful ones. An assessment of 52 water and ice production sites in Phetchabun Province, Thailand identified five successful manufacturers who regularly passed both site and product surveillance tests. The appreciative inquiry approach identified four additional techniques in the production process used by the successful producers. Changes to the production process in the washing and cleaning of production tools, methods for cleaning packing containers, methods for packing containers, and hygiene practices of workers were then implemented for 45 days at 47 unsuccessful water and ice manufacturing sites. Pass rates for site inspections increased from 86% for ice manufacturers (6 of 7 sites) and 53% for water manufacturers (21 of 40 sites) to 100% for ice manufacturers (7 of 7 sites) and 78% for water manufacturers (31 of 40 sites) following these changes. Pass rates for product quality testing also improved after the changes, from 40% (2 of 5 products) to 100% (5 of 5 products) for ice and from 30% (7 of 23 products) to 96% (22 of 23 products) for water. We believe that using an appreciative inquiry approach that focused on the experience of successful water and ice manufacturers added credibility to the findings and promoted the acceptance of organizational change by the unsuccessful manufacturers.

Keywords: appreciative inquiry, risk management, drinking water and ice in sealed containers, food surveillance system

Correspondence: Boadsaporn Anusornpanichakul, Department of Consumer Protection and Public Health Pharmacy, Phetchabun Provincial Public Health, 72 Nikorn Bumrung Road, Mueang, Phetchabun 67000, Thailand.
Tel: +66 (0) 87 4465615
E-mail: boadsaporn@kkumail.com, triplepiggy@hotmail.com

INTRODUCTION

Ensuring the production of safe of drinking water and ice for consumers is important to prevent diarrheal disease. Previous studies of water and ice producers in Thailand have shown that manufacturing sites and products do not

always meet designated safety standards, with failure rates varying wildly between studies. In five studies conducted over 20 years, 11-24% of sites failed quality testing and product failure rates varied between 6% and 98% (Bootsingh, 1996; Tongsakulpanid *et al*, 1997; Nienvitoon *et al*, 2000; Rungrueang, 2006; Setthetham and Jiaramae, 2012). In addition, passing a site inspection does not ensure that a producer will pass the product testing. A study of drinking water manufacturers in Kalasin Province, Thailand found 88.9% of sites met good manufacturing practice (GMP) standards but 48.2% of water samples from these sites failed water quality testing (Polying and Sungsitthisawad, 2013). Poor maintenance of equipment and unhygienic workplace practices are believed to be responsible for these failures but interventions designed to improve water quality have been unsuccessful (Bootsingh, 1996; Tongsakulpanid *et al*, 1997; Rungrueang, 2006; Nienvitoon *et al*, 2009; Setthetham and Jiaramae, 2012; Polying and Sungsitthisawad, 2013).

The production of drinking water and ice in Thailand is regulated by the Thai Food and Drug Administration (FDA) under the Ministry of Public Health. Provincial public health officers periodically inspect and evaluate water and ice manufacturing sites following Thai FDA guidelines (FDA Thailand, 2008; 2012a). Each inspected site must score at least 60% on the evaluation to pass inspection (FDA Thailand, 2007a,b). In addition, product samples are tested for physical, chemical and biological contaminants at the Regional Medical Sciences Center in Phetchabun at least once a year (FDA, Thailand, 2000; 2007a; 2012a,b).

The large number of water and ice products that fail quality testing indicates the current system for ensuring the quality of water and ice is ineffective (Bootsingh, 1996; Tongsakulpanid *et al*, 1997; Rungrueang, 2006; Nienvitoon *et al*, 2009; Setthetham and Jiaramae, 2012). In order to improve the quality of water and ice, the production process needs to be improved. However, previous attempts to improve production methods through stricter laws and penalties have not been successful and a new approach is required (Bootsingh, 1996; Tongsakulpanid *et al*, 1997; Rungrueang, 2006; Nienvitoon *et al*, 2009; Setthetham and Jiaramae, 2012; Polying and Sungsitthisawad, 2013).

One method that has been successfully used to help organizations improve is appreciative inquiry. The appreciative inquiry method works by asking open questions of successful organizations to identify the knowledge, techniques and strategies they used to become successful organizations. The answers to these questions can then be used to improve other organizations (Cooperrider *et al*, 2008).

Appreciative inquiry is comprised of four phases: discovery, dreaming, design and destiny. In discovery, questions are used to identify successful techniques and strategies. Dreaming is used to set the goals to be achieved by applying those successful techniques and strategies. Design is the creation of a plan to apply those successful techniques and strategies. Destiny is the execution of the plan (Cooperrider *et al*, 2008; Orr, 2009; Winter, 2012).

Here we describe how a novel appreciative inquiry approach was applied to the problem of poor water and ice quality in Thailand. First, by identifying the production techniques used by successful water and ice manufacturers and then applying these techniques to improve the production methods of unsuccessful manufacturers.

MATERIALS AND METHODS

Participants

In the 2016 fiscal year there were 137 manufacturers of drinking water and ice registered in Phetchabun Province, Thailand. Fifty-two of these manufacturers volunteered to be included in this study. Manufacturers were assessed and ranked for quality according to the production site inspections and product quality tests carried out at the provincial public health office and the regional medical sciences center in Phetchabun, Thailand in 2016. Manufacturers that passed all product tests and had a total production site audit score > 60% were classified as "good practice model" and the five manufacturers with the highest audit scores participated in the appreciative inquiry process. The remaining 47 manufacturers became the "intervention cohort" that were tasked with implementing the improvements identified in the appreciative inquiry process.

Study design

In the discovery phase, techniques and strategies used by the good practice model manufacturers were identified by provincial public health officers through interviews with factory owners and production staff and through direct observation of the production process during production site visits. Questions were designed to determine what made them a good practice model. Example questions included "What are your success stories and good practices in your manufacturing process?" "What is your inspiration or what stimulates you to do these good things?" "What are the key factors to success and becoming a good practice model?" The production sites of the best practice model manufacturers were visited by a provincial public health officer and two sub-district officers. The information collected in the interviews and production site visits was compared with the Thai FDA guidelines for food manufacturing sites (ice) and drinking water manufacturing sites to identify techniques that were different or additional to those already mandated.

In the dream phase, consumer protection officers (2 from the provincial public health office and 6 from the district level) met with representatives from all 52 participating manufacturers to clarify the dream for how they want to see their company and how they want to develop themselves. Participants discussed the benefits of succeeding in fulfilling their dream, and how could they achieve their dream. Questions asked of participants included, "What is your dream about how to improve your site?" "Who will benefit if these dreams come true?" "What can help the dream come true?"

In the design phase, the eight consumer protection officers from the dream phase met with 6 representatives of the good practice model manufacturers about how best to apply the techniques identified in the discovery phase to meet the goals identified in the dream phase. They developed a plan about how to introduce the successful methods identified in the discovery phase to the intervention cohort sites and an appropriate time period for implementation. The plan specified the objectives, benefits, roles of associated persons, practical guidelines, monitoring and evaluation processes, and reporting of outcomes.

In the destiny phase, district and provincial public health government officers and a researcher visited each of the 47 manufacturers in the intervention cohort and explained how to implement the plan. Each manufacturer was given 45 days to

implement the plan. The researcher followed up with the manufacturers during the implementation to identify any problems that had arisen with the plan and how the manufacturers coped with those problems. To verify the effectiveness of the intervention, district and/or provincial public health government officers re-inspected the water and ice production sites after the 45 days implementation period. Water and ice samples were collected for quality testing at the regional medical sciences center in Phetchabun as usual.

Ethical considerations

This study was approved by the Khon Kaen University Ethics Committee for Human Research and met the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines. All manufacturers and interviewees gave written informed consent before participation in the study.

RESULTS

The production site visits and interviews with the five good practice model manufacturers revealed four additional processing practices that they considered important for producing good quality water (Table 1):

1. Washing and cleaning production tools. The time for backwashing the manganese sand, carbon and cation resin filter beds was increased from 20 minutes to at least 30 minutes to ensure efficient cleaning of equipment.

2. Method for washing containers. Drinking water containers returned for re-use were cleaned with a long bamboo stick with a sponge on the end soaked in cleaning solution to scrub the entire inner surface of the containers before rinsing with water.

3. Packing. The bases of the reusable

Table 1
Techniques identified during discovery phase to improve water quality.

Technique	Model Factory 1	Model Factory 2	Model Factory 3	Model Factory 4	Model Factory 5
1. Washing and cleaning production tools.	+	+	+	+	+
2. Method for washing packing containers.	+	+	+	+	-
3. Packing:					
Dipping the base of the reusable packing container and the hands of the packer in a chlorine solution before each packing session.	-	+	+	+	-
Designated times to enter and exit the packing room.	+	+	+	+	+
4. Hygiene practices of the workers:					
Hand washing before entering the packing room.	+	+	+	+	+
Showering.	-	-	-	-	+

+, employed technique; -, not employed technique.

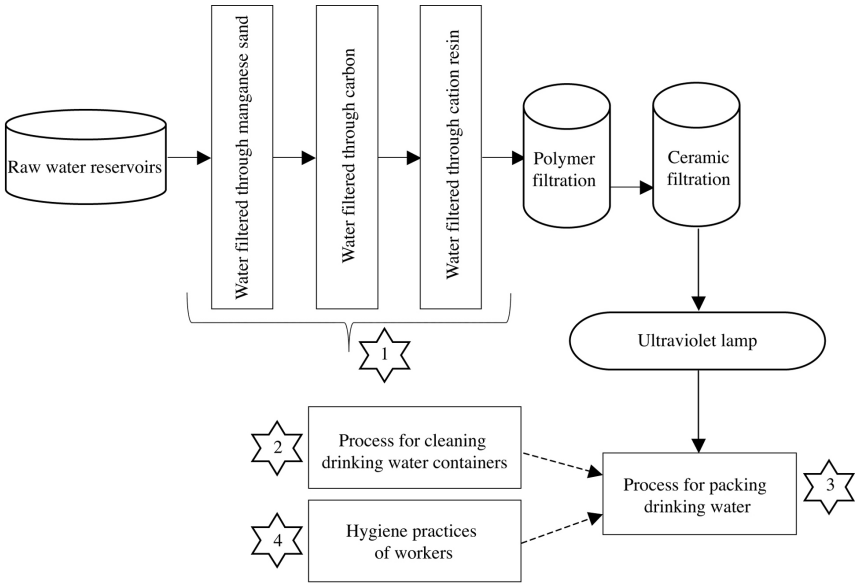

Fig 1–The drinking water manufacturing process. Numbered stars indicate the location of additional techniques identified to improve water quality.

drinking water containers and the hands of the personnel responsible for packing the drinking water were rinsed in chlorine solution before packing. Personnel working in the packing room had specific times for entering and exiting. If anyone left the packing room before the specified time, they were not allowed to re-enter the room. They were assigned another task at lower pay, providing an incentive to stay in the packing room until the work is finished.

4. Hygiene practices of the workers. Workers were required to wash their hands to their elbows using liquid soap, then dip their arms in chlorine solution, put on gloves and then dip their gloved hands in a mixture of water and chlorine or clean their hands with cotton soaked in alcohol. One manufacturer required their workers to shower at the factory before entering the packing room. A monthly stipend was allocated to enable personnel to buy personal toiletries.

Forty-seven manufacturers were included in the intervention cohort: 7 ice manufacturers and 40 water manufacturers. Prior to intervention the site inspection pass rate was 86% for ice manufacturers (6 out of 7 sites) and 53% for water manufacturers (21 out of 40 sites). Repeat site inspections were then conducted 45 days after implementation of the four additional production techniques. After the intervention, 100% of ice manufacturers (7 out of 7 sites) and 78% of water manufacturers (31 out of 40 sites) passed the site inspection. Pass rates also increased for ice and water product quality testing following implementation of the new production techniques. Before the intervention, 40% of ice products (2 out of 5 products) and 30% of water products (7 out of 23 products) passed quality testing. After the intervention, pass rates increased to 100% for ice products (5 out of 5 products) and 96% for water products (22 out of 23 products) sent for quality testing (Table 2).

Table 2
Site and product inspection of intervention cohort manufacturers.

Inspections	Before			After		
	Pass	Fail	Total	Pass	Fail	Total
Site inspection						
Ice	6 (86%)	1 (14%)	7 (15%)	7 (100%)	-	7 (15%)
Water	21 (53%)	19 (48%)	40 (85%)	31 (78%)	9 (23%)	40 (85%)
Total	27 (57%)	20 (43%)	47 (100%)	38 (81%)	9 (19%)	47 (100%)
Product inspection						
Ice	2 (40%)	3 (60%)	5 (18%)	5 (100%)	-	5 (18%)
Water	7 (30%)	16 (70%)	23 (82%)	22 (96%)	1 (4%)	23 (82%)
Total	9 (32%)	19 (68%)	28 (100%)	27 (96%)	1 (4%)	28 (100%)

DISCUSSION

Our finding that problems in water and ice production in Thailand can be categorized under water quality improvement, cleaning reused containers, product packing and worker sanitation is consistent with previous studies examining water and ice production in Thailand (Bootsingh, 1996; Tongsakulpanid *et al*, 1997; Loatrakul, 2001; Singthong, 2014). Previous studies have recommended allocating a budget for increased training and development of manufacturers, to develop uniform standards and quality throughout the country (Tongsakulpanid, 1997; Suicharoen, 2003; Singthong, 2014). However, the continuing issue with poor water quality in Thailand indicates that these solutions have either not been successfully applied by manufacturers or they do not solve the cause of the problem (Tongsakulpanid *et al*, 1997).

In this study we applied new techniques for improving water and ice quality and it was successful. It follows the Thai FDA principle of continually improving user time (FDA Thailand, 2008). This technique of appreciative inquiry can be used to continually improve products quality. Appreciative inquiry has been recommended for sustainable development though exploration, preparation, and intervention (Miruka *et al*, 2011). The appreciative inquiry is collaborative approach which was required cooperation of government officials and manufacturers working together in order to reach the quality standards. The engaging, uplifting, and powerful approach was considered productive and practical which created energy and motivation. Also, it can be transformative by focusing strengths rather than problems. Moreover, it is well proven in a diverse range of contexts.

Appreciative inquiry also has challenges that must be acknowledged for it to be used successfully to change organizations. For example, as appreciative inquiry is focused on providing solutions, it may not work if the model organizations cannot correctly identify the problems of the unsuccessful organizations (Reed *et al*, 2002; Miruka *et al*, 2011; Trajkovski *et al*, 2013). Also, as appreciative inquiry is based on trust, collaboration and effective communication, any doubts that the participants may have about the benefits

will limit its effectiveness (Reed *et al*, 2002; Kavanagh *et al*, 2010). In this study, the participants welcomed the opportunity to improve their organizations, and the communication of the mutual benefit of organizational change to all parties ensured an open and constructive process. The participation of successful manufacturers was found to add credibility to the findings, helping the implementation process. The drastic improvement in pass rates for site inspections and product testing carried out before and after implementation showed the suitability of the appreciative inquiry approach to improving water and ice quality in Phetchabun Province, Thailand.

ACKNOWLEDGEMENTS

This study was supported by the consumer protection agency and the public health pharmacy group under the Phetchabun Provincial Public Health Office and the Faculty of Pharmaceutical Science at Khon Kaen University. We thank the staff of the 52 manufacturers of drinking water and ice for their participation.

REFERENCES

Bootsingh P. Conditions for producing drinking water in sealed container of factories in Muang District, Chiang Mai Province. Chiang Mai: Chiang Mai University, 1996. 76 pp. MS Thesis.

Cooperrider DL, Whitney D, Stavros JM. Appreciative inquiry handbook: for leaders of change. 2nd ed. San Francisco: Berrett-Koeehler Publishers, 2008.

Food and Drug Administration Thailand (FDA Thailand). The notification of the ministry of public health (No. 193) B.E. 2544 (2000), the title is production processes, production equipments, and foods storages [online]: Nonthaburi: FDA Thaialnd, 2000. [Cited 2015 Aug 7]. Available from: http://food.fda.moph.go.th/law/data/announ_moph/ P193.pdf

Food and Drug Administration Thailand (FDA Thailand). The direction of food and drug administration Thailand (No. 204) B.E. 2550 (2007), the title is audit drinking water in sealed containers on the notification of the Ministry of Public Health (No. 193) BE 2544 (2000) and revised edition [online]. Nonthaburi: FDA Thailand, 2007a. [Cited 2015 Aug 7]. Available from: http://iodinethailand.fda.moph.go.th/food_54/law/data/command_fda/204_2550.pdf

Food and Drug Administration Thailand (FDA Thailand). The direction of food and drug administration Thailand (No. 205) B.E. 2550 (2007), the title is audit drinking water in sealed containers on the notification of the Ministry of Public Health (No. 220) B.E. 2544 (2001) [online]. Nonthaburi: FDA Thailand, 2007b. [Cited 2015 Aug 7]. Available from: http://iodinethailand.fda.moph.go.th/food_54/law/data/command_fda/205_2550.pdf

Food and Drug Administration Thailand (FDA Thailand). The specific guideline of producing drinking water in sealed container according good manufacturing practice revised. 2nd ed. Bangkok: The War Veterans' Organization of Thailand Printing, 2008.

Food and Drug Administration Thailand. Strategy development for health consumer protection of product in duration of the Eleventh National Economic and Social Development Plan. Bangkok: The Agricultural Cooperative Federation of Thailand Printing, 2012a.

Food and Drug Administration Thailand (FDA Thailand). The general guideline of producing food according good manufacturing practice revised. Nonthaburi: FDA Thailand, 2012b.

Kavanagh T, Stevens B, Seers K, Sidani S, Watt-Watson J. Process evaluation of appreciative inquiry to translate pain management evidence into pediatric nursing practice.

Implement Sci 2010 Nov 20; 5: 90.

Loatrakul V. Bacterial contamination in reused drinking water container, comparative between a rectangular and a cylindrical. Nakhon Pathom: Silpakorn University, 2001. 73 pp. MS Thesis.

Miruka M, Mania I, Rono JB, *et al*. Appreciative inquiry: farmer participatory identification of opportunities and interventions to strengthen agri-food systems in Kenya. *African Crop Science Conference Proceeding* 2011; 10: 349-53.

Nienvitoon T, Sungsitisawad T, Thiramanus V. Improving quality of edible ice and bottled water which registeration and issue in Khon Kean Province. Khon Kaen: Khon Kaen University, 2009 (in Thai).

Orr S. Appreciative inquiry: an introductory guide for use in the Church of Scotland [online]. Edinburgh: The Schurch of Scotland, 2009. [Cited 2015 Jul 12]. Available from: http://www.churchofscotland.org.uk/_data/assets/pdf_file/0013/20434/ appreciative_inquiry_introductory_guide.pdf

Polying M, Sungsitthisawad W. Survey of drinking water production in sealed container with good manufacturing practice (GMP) in Kalasin Province. *KKU Res J* 2013; 18: 1049-62.

Reed J, Pearson P, Douglas B, Swinburne S, Wilding H. Going home from hospital – an appreciative inquiry study. *Health Soc Care Community* 2002; 10: 36-45.

Rungrueang J. Quality of bottled water and sealed ice packages in Upper North Eastern Region. *KKU Sci J* 2006; 34: 275-82.

Setthetham D, Jiaramae N. An utensils used by Tumbol Health Promotion Hospitals at Mahasarakarm Province. *J Public Health Res* 2012; 5: 87-96.

Singthong N. Legal problems concerning controlling consumable ice manufacturing business. Bangkok: Dhurakij Pundit University, 2014 [in Thai]. 208 pp. MS Thesis.

Suicharoen S. Study for the acceptance of site examination rule according to GMP standard in the view of seal bottled drinking water company. Bangkok: King Mongkut's University of Technology North Bangkok, 2003 [in Thai]. 72 pp. MS Thesis.

Tongsakulpanid N, Inudum P, Leuprasert L, Vateevutajan S, Sa V. Quality of bottled water in the Upper North Eastern Region. *KKU Sci J* 1997; 25: 288-97.

Trajkovski S, Schmied V, Vickers M, Jackson D. Implementing the 4D cycle of appreciative inquiry in health care: a methodological review. *J Adv Nurs* 2013; 69: 1224-34.

Winter AD. Training appreciative inquiry. [online]. Brussels: AGID, 2012. [Cited 2015 Jul 12]. Available from: http://www.adam-europe.eu/prj/8549/prj/Appreciative Inquiry Handbook.pdf