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A Comparison of Computer-Based and Standard Training in the Integrated Management of Childhood Illness in Uganda

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TEL (301) 654-8338
FAX (301) 941-8427
www.qaproject.org

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Abstract

The WHO/UNICEF Integrated Management Childhood Illness (IMCI) guidelines are being introduced in developing countries worldwide. The standard IMCI training course requires 11 days of lectures and clinical practice, with about six facilitators for 20 first-level health providers. The Quality Assurance (QA) Project developed a computer-based version of the course that reduced the training time to nine days and requires only four facilitators. The Ugandan Ministry of Health and the QA Project collaborated on a randomized comparison study of the two training courses in 1999–2000.

The objective of the study was to compare the cost-effectiveness of the two courses on trainees' knowledge, skill, and performance of IMCI. Three rounds of training were conducted with clinical officers and nurses from primary health facilities in three districts. In all, 114 providers were trained (55 using the standard course and 59 using the computer course). Knowledge and skills between the two groups were compared pre-training, immediately post-training, and three to four months after training. Costs of the two courses were also calculated.

Results indicate that the courses had equivalent effects on participants' knowledge and skill achievement, as well as their retention after three to four months. Computer-trained males seemed to

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have better knowledge and skills; no difference was discerned for female trainees. Computer trainees expressed enthusiasm for computer-based learning. Cost analysis indicates that the computer course was 23–29 percent less expensive than the standard course, if the costs for developing the software and for the computers are excluded.

While the computer course appears to be more cost-effective than the standard course, the feasibility of implementing computer training of in-service providers is unclear due to the trend toward decentralization of IMCI training. However, the computer course appears to be appropriate and feasible for pre-service training, refresher training, and private practitioner training. A new version of the IMCI computer course, expected by the end of 2002, includes elements that could make it more effective than standard training.

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A Comparison of Computer-Based and Standard Training in the Integrated Management of Childhood Illness in Uganda

Paula Tavrow, Addy Kekitiinwa Rukyalekere, Albert Maganda, Grace Ndeezi, Abby Sebina-Zziwa, and Elisa Knebel

Abbreviations

CBT	Computer-based training
CSTU	Child Survival Training Unit (Kampala)
IMCI	Integrated Management of Childhood Illness
IMCI-CBT1	Computer-Based Training in Integrated Management of Childhood Illness (Version 1)
IMCI-CBT2	Computer-Based Training in Integrated Management of Childhood Illness (Version 2)
IMCI-WHO	Standard Training in Integrated Management of Childhood Illness (WHO course)
MOH	Ministry of Health
NGO	Nongovernmental organization
QA	Quality assurance
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

1. Introduction

Because of the dynamism in medical information, technology, and pharmaceutical products, healthcare providers require continuing education to update their skills and knowledge. In developing countries, in-service training of heathcare providers typically has been classroom based and instructor led, with paper modules. The expense and time associated with standard training in poor countries, combined with heightened interest in delivering subject matter to dispersed providers in a more interactive and consistent manner, have spawned alternative educational approaches. Examples include distance education (Knebel 2001), on-site or whole site training (Bradley et al. 1998), and computer-based training (Knebel 2000).

For the last two decades, computer-based training (CBT) has been used widely in the United States for training medical students and for the continuing education of health professionals (Lassan 1989; Kulik 1994). CBT differs from traditional training in that the subject matter is primarily presented through a computer, rather than a human instructor. Various media, such as text, graphics, pictures, animation, sound, and video, can be offered on the computer. CBT can be either facilitator led or self-paced. Components of CBT often consist of drill-and-practice, tutorials, simulations, feedback, and content exams (pre- and post-training). CBT is particularly effective for presenting material that is three-dimensional, difficult to conceptualize, or involves complex processes (Phillips 1996). A key advantage of CBT in medical training is that it permits trainees to practice in simulated situations, instead of on real patients (Lassan 1989). It has also been found to reduce by 34–43 percent the time spent to master new material in industrialized countries (Lyon et al. 1992; Kulik 1994). However, little is known about the long-term performance of providers after using computer-assisted training, the cost-effectiveness of computer-assisted training, and the application of computer-assisted training in developing countries (Knebel 2000).

A challenge now facing many developing countries is to introduce the Integrated Management of Childhood Illness (IMCI) guidelines, developed by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) in the mid-1990s, to all first-level providers who see sick children. If performed properly, IMCI is expected to lead to a reduction in mortality and morbidity associated with the four major childhood diseases and malnutrition in poor countries (Kolstad et al. 1998). The main component of the IMCI strategy is to train providers in an

algorithmic, holistic approach to the management of sick children between the ages of one week and five years. Providers also learn about disease prevention and improved communication with caretakers. The standard IMCI training course consists of 11 days of classroom instruction and hands-on clinical practice (WHO 1999). The course usually costs between $350 and $430 per participant (World Bank 2000; Kelley et al. 2000). WHO has expressed interest in investigating and lowering the costs of implementing IMCI (Lambrechts et al. 1999).

Uganda was one of the first African countries to adapt IMCI and begin training first-level providers. The standard course offered by Uganda ran for 11 days and required six facilitators for 20 participants. Providers spent nearly a third of the course in clinical practice, both inpatient and outpatient. Between 1996 and 1998, Uganda had trained 701 of approximately 3200 in-service providers (MOH Uganda 1998). The high costs of the standard training and its intensive use of scarce facilitators led the Uganda Ministry of Health (MOH) to consider other options.

II. Study Objectives

One mandate of the Quality Assurance (QA) Project, sponsored by the U.S. Agency for International Development (USAID), was to develop and test innovative training approaches for IMCI. In the mid-1990s, the QA Project developed a computer-based training program to teach the principles of IMCI to trainees. This computer program, which fits on a single CD-ROM, will be referred to here as IMCI-CBT1.[1] Trainees do not need any prior exposure to computers: the program includes a tutorial on how to use a computer for those without previous experience. IMCI-CBT1 was not intended as stand-alone training: it requires clinical practice led by facilitators, videos supplied by WHO, the IMCI chartbook (job aid), and paper modules for participants to consult between day-long computer sessions and after completing the training. The CBT substituted for most of the classroom-based component of the standard 11-day IMCI training (hereafter referred to as IMCI-WHO).[2] Certain skill areas, such as recognition of physical signs and counseling techniques, were still intended to be facilitator led.

The QA Project designed the computer course to permit more individual pacing and interaction than the standard course, which requires considerable reading. The software comprises an introduction, screening tests, tutorials, theory tests, and simulated patients (aged two months to five years). For selected topics, the trainee is offered the option of more in-depth information illuminating the scientific considerations behind the IMCI algorithm. Once a satisfactory level is reached for each section of a module, trainees are presented with an overall competency test on the content of that module and receive feedback by content area. The QA Project hoped that IMCI-CBT1 would prove less costly than IMCI-WHO and be sufficiently effective to permit its use in other settings (e.g., for pre-service training or private practitioners). A comparison of the two course types is in Table 1. For the computer course, trainees also received a two-hour orientation to computers.

In 1997, the QA Project and the Ugandan MOH decided to collaborate on a beta-test of the IMCI CBT program. The first step was to set up a computer laboratory, consisting of ten computers, at Mulago Hospital in Kampala. Next, IMCI facilitators in Uganda reviewed the IMCI CBT program to ensure that it conformed to Ugandan policy. The program was subsequently beta-tested twice in 1997 with about 20 participants each time. Based on the tests and reviews, the software was modified to better fit the Ugandan context and to remove computer bugs. Instruments for assessing healthcare provider knowledge and competence were also developed and pretested.

In 1998–2000, researchers from the QA Project and the Child Survival Training Unit (CSTU) in Kampala conducted a prospective study to compare the two training programs: IMCI-CBT1 and IMCI-WHO. The specific objectives were to:

- Assess the effectiveness of computer-based versus standard IMCI training on provider knowl-

[1] The QA Project's new version of the IMCI computer-based training (IMCI-CBT2), with more interactivity and functionality, is on schedule to be available by the end of 2002.

[2] Six of the seven content areas in the standard IMCI modules were included in IMCI-CBT1. Not included was management of the sick young infant (one week to two months); this content area is covered only by lecture.

Table 1
Comparison of the Two IMCI Course Types

	Standard (IMCI-WHO)	Computer (IMCI-CBT1)
Duration of course	11 days	9 days
Number of facilitators	6	4
Hours per component		
■ Course content: 6 modules (by lecture or computer)	27 hours	21 hours
■ Course content: 1 module* (by lecture only)	4 hours	4 hours
■ Discussion on course content and videos**	12 hours	9 hours
■ Clinical practice	27 hours	21 hours
■ Video viewing	6 hours	6 hours
■ Exams (written and case observation)	4 hours	4 hours
Total hours spent	80 hours	65 hours

Notes: *Management of the sick young infant. **With two students per computer, students in IMCI-CBT1 discussed the modules with each other as they learned the material on the computer. This reduced the need for discussion time.

edge and skill achievement by end of training

- Assess the effectiveness of computer-based versus standard IMCI training on provider knowledge and skill retention after three to four months
- Compare the costs of the two types of training
- Assess the acceptability and feasibility of using computers for IMCI in-service training in a developing country

This paper presents the results of the study and discusses the prospects for computer-based training of IMCI in developing countries.

III. Methodology

A. Research Design

The research design was a prospective, randomized cohort study. The researchers chose a sample size of 60 per course type, which would give sufficient power (80 percent) to detect significant differences of 25 percent or more, presuming one course type had an average score of 75 percent. The outcome measures were the effects of two different course types on in-service providers' achievement and retention of knowledge and skill in IMCI. To minimize potential confounders, the study was conducted in three rounds. Each round of training consisted of 40 participants from the same district. Participants were stratified by cadre (clinical officer, registered nurse, or enrolled nurse) and then randomly assigned to either the standard or the computer course. The target was to have 20 participants in each course per round. The same course director and clinical instructor led both courses in a round and oversaw the follow-up and assessment visits at the trainees' worksites.[3]

All courses were conducted in the pediatric ward of Mulago Hospital in Kampala. The first round of training occurred in January–February 1999 (Mpigi district); the second in May–July 1999 (Kampala district); and the third in November–December 1999 (Luwero district). The districts were chosen based on their need for IMCI training and their proximity to Kampala, to permit easy access by the study team for the three-month assessment. Participants in the first two districts received a follow-up visit after two weeks and an assessment visit after three to four months. Due to difficulties in organizing two-week follow-up visits during the holiday period, participants from the last district received only the three-month assessment visit. One of the investigators (AKR) kept track of all expenses associated with all courses for subsequent cost-effectiveness calculations.

All trainees were required to meet the following criteria: (a) currently work as a health provider in a government or nongovernmental organization (NGO) health facility, or in the outpatient department of a hospital; (b) be involved in the day-to-day management of sick children; (c) be available for all days of

[3] Although the computer course required fewer facilitators, follow-up visits involved the full complement of facilitators, as did exams. These follow-up visits are considered as integral to the IMCI strategy.

training; and (d) intend to remain in the same district for at least one year after the training. Because of logistical difficulties, investigators were not able to conduct screening of trainees prior to commencing the first standard course. Of the 20 participants, three were expelled from the course prior to completion because they were determined to be insufficiently qualified (lacked the requisite pre-service training) and two left due to family emergencies. Hence, only 15 participants completed the first standard course. All other courses had 19 or 20 pre-screened participants. Only three participants in the computer courses had ever used a computer before, and none had used a computer regularly.

In all, 55 participants completed the standard course, and 59 completed the computer course for a total of 114. A profile of the participants who completed the training appears in Table 2. There were no significant differences by district, age, cadre, sex, or worksite.

Facilitators made up to three visits per facility to try to assess each trainee at his or her worksite three or four months after the training. A total of 104 trainees were assessed: 47 from the standard course (of 55 trainees who completed the course, or 85 percent) and 57 from the computer course (of 59 who completed the course, or 97 percent). Knowledge scores of two computer trainees were misplaced, so analysis was performed on 102 trainees' knowledge scores and 104 trainees' skills scores. Trainees not found at the three- to four-month assessment did not differ significantly from those who completed the course.

Table 2

Profile of Participants Who Completed Training, by Course Type

		IMCI-WHO		IMCI-CBT1		Total	
		N	Percentage	N	Percentage	N	Percentage
District	Mpigi	15	(27.3)	20	(33.9)	35	(30.7)
	Kampala	20	(36.4)	19	(32.2)	39	(34.2)
	Luwero	20	(36.4)	20	(33.9)	40	(35.1)
Cadre	Clinical officer	16	(29.1)	18	(30.5)	34	(29.8)
	Registered nurse	8	(14.5)	7	(11.9)	15	(13.2)
	Enrolled nurse	31	(56.4)	34	(57.6)	65	(57.0)
Sex	Male	14	(25.5)	11	(18.6)	25	(21.9)
	Female	41	(74.5)	48	(81.4)	89	(78.1)
Age	21-29	19	(34.5)	16	(27.1)	35	(30.7)
	30-39	24	(43.6)	26	(44.1)	50	(43.9)
	40-52	12	(21.8)	12	(20.3)	24	(21.1)
	Not given	—	(0.0)	5	(8.5)	5	(4.4)
Worksite	Hospital	2	(3.6)	4	(6.8)	6	(5.3)
	Health center	41	(74.5)	35	(59.3)	76	(66.7)
	Dispensary	12	(21.8)	20	(33.9)	32	(28.1)
Overall		55	(100.0)	59	(100.0)	114	(100.0)

Notes: IMCI-WHO = standard course; IMCI-CBT1 = computer course

B. Data Collection

Several instruments were used to collect data on providers' IMCI knowledge, skill, and performance.

Knowledge. To assess knowledge of IMCI, providers were asked to take a self-administered paper test consisting of 20 multiple-choice questions scored at five points each. The test measured trainees' knowledge of how to: (a) correctly assess, classify, and treat sick children; (b) identify need for vaccinations and Vitamin A; and (c) counsel caretakers. The number of questions per subject area corresponded to the weight assigned to the topic by the Ugandan MOH. The weights were as follows: assessment 40 percent, classification 15 percent, prescription 15 percent, counseling 15 percent, immunization 10 percent, and vitamin A 5 percent. A score of 70 or above was considered passing. This test was administered to all trainees before training, at the end of training, and three to four months after training.[4] The instrument had been pre-tested with a group of nurses in another IMCI training course. The test took approximately 30 minutes to complete.

Skill. To assess providers' case management skill in IMCI, an instrument had been developed for

[4] Two trainees in the first round of standard training missed the pre-test because they arrived a day late.

facilitators to evaluate trainees' case management skills and compliance with the IMCI guidelines. The facilitators were all experienced Ugandan clinicians or pediatricians who had completed an IMCI training course and WHO's five-day facilitation course. The instrument was an observation guide for all major steps of the IMCI guidelines: danger signs assessment, symptom assessment, classification of symptoms, treatment, identification of vaccinations, and counseling. The guide had space for the facilitator to record the provider's classification and treatment plan, as well as what determinations the facilitator would have made. If the child would have been harmed by the providers' treatment plan (or lack of treatment), the facilitator would intervene, take the child and caretaker aside, and give them the alternate diagnosis and treatment. Providers were observed managing two sick children at the end of training, after two weeks, and after three to four months. After completing the observation guide, the facilitator would record whether the provider had followed the IMCI order. A composite skill score was determined by summing all steps correctly followed and determinations correctly made, then dividing them by the total steps and determinations possible. To obtain a final skill score on a 0–100 scale, this score was multiplied by 100. Separate skill scores were also calculated for assessment, classification, treatment, and counseling.

Performance. It is impossible to know with certainty whether providers routinely perform IMCI when not being observed. However, facilitators did try to make a subjective determination of whether they thought that the provider was regularly applying the IMCI guidelines. They based this determination on providers' ease of use of the IMCI chartbook, whether they followed the IMCI order, their recall of the basic steps, time spent, anxiety, and other indicators.

Cost. The costs of each round of training were tabulated. Costs included allowances, transport refunds, accommodations, and meals for participants and facilitators, fuel expenditures, stationery, and photocopying. Excluded were: costs that were the same for both training groups, such as follow-up visits; paper modules and chartbooks supplied by UNICEF; costs associated with developing the software and outfitting and maintaining the computer laboratory; and the opportunity costs associated with removing health workers from their normal duties.

C. Data Analysis and Interpretation

Data were entered into a computer using Epi Info Version 6 and analyzed using SPSS software. Comparisons were made using chi-square for categorical data, ANOVA for continuous data, Pearson correlations, and paired t-tests.

IV. Findings

A. Knowledge of IMCI

Both types of training led to significant and sustained improvements in participants' knowledge of effective case management of sick children. No difference was observed in composite knowledge of trainees by course type either at the end of training or three to four months later (see Table 3). Nor was a difference

Table 3
Average IMCI Composite Knowledge Score, by Course Type over Time

		Pre-Test		End of Training		After 3–4 Months	
		IMCI-WHO (n=52)	IMCI-CBT1 (n=59)	IMCI-WHO (n=54)	IMCI-CBT1 (n=59)	IMCI-WHO (n=47)	IMCI-CBT1 (n=55)
District	Mpigi	36.8	33.7	75.8	75.0	71.8	75.6
	Kampala	27.4	32.4	75.5	74.0	71.9	70.5
	Luwero	35.0	37.4	82.0	84.2	71.9	75.1
Cadre	Clinical officer	35.4	41.5	79.9	84.5	72.4	79.3
	Registered nurse	35.5	36.8	77.0	75.4	75.9	75.4
	Enrolled nurse	30.1	29.9	77.0	74.7	70.7	70.6
Sex	Male	33.2	38.4	77.4	86.1	68.4*	83.6*
	Female	32.3	33.7	78.0	75.9	73.0	72.1
Age	21-29	34.2	35.9	81.7	78.3	73.3	73.0
	30-39	33.3	33.2	76.2	77.9	74.7	74.5
	40-52	28.7	35.1	75.0	75.9	65.4	67.4
Overall		32.5	34.5	77.9	77.8	71.9	73.8

Notes: IMCI-WHO = standard course; IMCI-CBT1 = computer course. Knowledge scores were on a scale of 1–100. *Significant difference between course types ($p<.05$).

found when knowledge scores were stratified by district, cadre, or age. However, a significant difference did emerge after three to four months among male providers, 18 (out of a total of 19) of whom were clinical officers. Male computer trainees had considerably better composite knowledge than male standard trainees (83.6 versus 68.4, F=7.0, p<.017). There was no significant difference by course type among females. Interestingly, gender seems more important than cadre for explaining difference. Female clinical officers trained on computers actually had somewhat lower knowledge at three to four months than those trained with lectures (74.4 versus 89.4, F=2.2, p<.184).

Among trainees from both course types, the percentage that passed the exam with a score of 70 or higher dropped significantly over time. At the end of training, 77.5 percent passed the knowledge exam (76.6 percent standard versus 78.2 percent computer), but only 53.9 percent (51.1 percent standard versus 56.4 percent computer) passed it three to four months later. There was no significant difference by course type. It is worth noting that only 31.8 percent of older providers aged 40–52 passed the exam after three to four months. Knowledge deteriorated the most among older clinical officers aged 40–52 in both courses: their average knowledge dropped from 83.3 percent (end of training) to 57.9 (after three months). In contrast, the knowledge of younger clinical officers only fell from 84.7 to 80.3. Nurses' age did not seem to have an effect on knowledge decay.

When looking at specific areas of IMCI knowledge after three to four months, again no differences were detected by district, age, cadre, or overall. However, male computer trainees scored significantly better on assessment and somewhat better on all other areas (see Table 4). On the other hand, female computer trainees scored significantly worse on classification and equivalently in all other areas except Vitamin A.

Table 4

Average IMCI Specific Knowledge Scores after 3–4 Months, by Course Type and Gender

	Males		Females		Total	
	IMCI-WHO (n=11)	IMCI-CBT1 (n=8)	IMCI-WHO (n=36)	IMCI-CBT1 (n=47)	IMCI-WHO (n=47)	IMCI-CBT1 (n=55)
Assess	73.8*	90.6*	76.4	75.0	75.8	77.3
Classify	60.6	75.0	81.5*	69.5*	76.6	70.3
Treat	72.7	81.3	73.6	78.7	73.4	79.1
Counsel	75.7	79.1	65.7	68.0	68.1	69.7
Immunize	54.5	81.2	73.6	73.4	69.1	74.5
Vitamin A	45.4	75.0	38.9	53.2	40.4	56.4

Notes: IMCI-WHO = standard course; IMCI-CBT1 = computer course. Specific knowledge scores are on a scale of 1–100. *Significant difference between course types (p<.05).

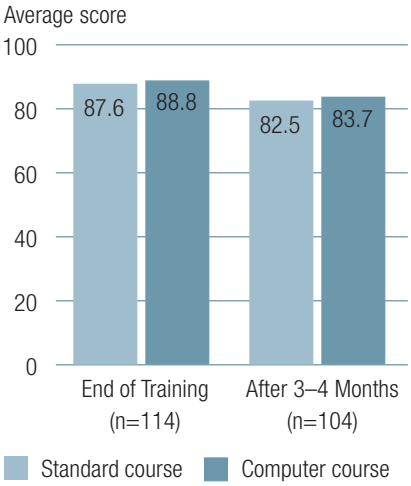
B. Skill in Case Management

Participants trained in either course type demonstrated similar skills in managing sick children, both at the end of training and three to four months later (see Figure 1). The decay over time in average case management skills was identical across both training types, declining 5.1 percentage points. Composite knowledge and skill scores were highly correlated (Pearson correlation .400, sig.= .000) at three to four months after training. Male computer trainees did demonstrate significantly higher skills than standard trainees at the end of training (92.2 versus 84.4), but the difference diminished over time and was no longer significant (90.8 versus 81.9). No other significant differences by course type were discerned.

Regarding decay in case management skills over time, for the most part both courses showed similar patterns, except in Kampala district and in the 30–39 age group. Significant deterioration occurred among enrolled nurses (all of whom were female) and female providers in general from both course types. The district with the lowest case management skills after three to four months was Luwero (79.4), where trainees had no two week follow-up visit. Older providers aged 40–52 trained with the standard course showed the lowest case management skills over time (77.9). The best score after three to four months was

Figure 1

Average IMCI Composite Case Management Skill Score over Time, by Course Type



obtained by the male computer trainees (90.8)

Case management skills for IMCI are usually reported in four main categories: assessment, classification, treatment, and counseling. The two course types are compared for these specific skills over time in Table 5. While no differences were noted between trainees from the two courses either at the end of training or after three to four months, significant decay was found in standard trainees' assessment skills. For computer trainees, all skills seemed to decline similarly over time in percentage points. Correct classification seemed to decline somewhat more among computer trainees, although the difference was not significant.

For both course types and in both time periods, assessment and counseling skills were considerably weaker than classification and treatment. Trainees typically took shortcuts in assessing the child, such as not performing the nutritional assessment or failing to count respirations. Trainees also often skipped certain counseling messages, such as telling the caretaker when to return or how to feed correctly. After three to four months, more than a fourth of trainees failed to tell the caretaker what was wrong with the child, and nearly half did not check whether the caretaker understood. Discussions with trainees suggest that they found it contrary to Ugandan culture to ask a caretaker to repeat information. While assessment and counseling were insufficient by IMCI standards, informal discussions with caretakers at facilities found increased satisfaction with IMCI-trained providers. Caretakers felt these providers gave more thorough examinations and better counseling.

C. Regular Performance of IMCI

Because trainees knew that their IMCI performance was being assessed, virtually all of them used their IMCI chartbooks and tried to follow the guidelines when an observer was present. However, the observers noted that a number of providers had to hunt for the chartbook, spent many minutes searching for information in the chartbook, did not follow the IMCI order, asked questions of the observer, and seemed to lack confidence in performing an IMCI assessment and arriving at classifications.

The facilitators determined that only four in ten trainees were performing IMCI regularly after three to four months (see Table 6). This may be a conservative estimate, because the ten trainees not found at their

Table 5

Percentage of Trainees Who Demonstrated Specific IMCI Case Management Skills, by Course Type over Time

	End of Training		After 3–4 Mos.		Change over Time (Percentage Points)	
	IMCI-WHO (n=55)	IMCI-CBT1 (n=59)	IMCI-WHO (n=47)	IMCI-CBT1 (n=57)	IMCI-WHO	IMCI-CBT1
Completely assessed child[1]	45.4	49.2	25.5	36.8	-19.9*	-12.3
Correctly classified child[2]	81.8	79.7	80.9	68.4	-0.9	-11.3
Correctlytreated child[3]	74.5	66.0	66.0	57.9	-8.5	-8.1
Gave sufficient counseling[4]	38.2	42.4	27.7	31.6	-10.5	-10.8

Notes: IMCI-WHO = standard course; IMCI-CBT1 = computer course. *Significant difference over time within a course type (p<.05). [1] Performed all assessment tasks required by the IMCI algorithm. [2] Classified all symptoms correctly. [3] Prescribed correct drugs in correct dosages for all classifications noted. [4] Gave all counseling messages in the IMCI algorithm and checked caretaker's understanding.

Table 6

Percentage of Trainees Implementing IMCI Regularly after 3–4 Months, by Course Type and Trainee Characteristics

		IMCI-WHO		IMCI-CBT1		Total	
		n/N	Percentage	n/N	Percentage	n/N	Percentage
District	Mpigi	5/11	(45.5)	11/20	(55.0)	16/31	(51.6)
	Kampala	5/18	(27.8)	9/18	(50.0)	14/36	(38.9)
	Luwero	6/18	(33.3)	5/19	(26.3)	11/37	(29.7)
Cadre	Clinical officer	6/12	(50.0)	7/17	(41.2)	13/29	(44.8)
	Registered nurse	3/6	(50.0)	2/7	(28.6)	5/13	(38.5)
	Enrolled nurse	7/29	(24.1)*	16/33	(48.5)*	23/62	(37.1)
Sex	Male	4/11	(36.4)	4/10	(40.0)	8/21	(38.1)
	Female	12/36	(33.3)	21/47	(44.7)	33/83	(39.8)
Age	21-29	7/15	(46.7)	7/16	(43.8)	14/31	(45.2)
	30-39	7/20	(35.0)	13/26	(50.0)	20/46	(43.5)
	40-52	2/12	(16.7)	2/10	(20.0)	4/22	(18.2)#
	Not given	—	—	3/5	(60.0)	3/5	(60.0)
Overall		16/47	(34.0)	25/57	(43.9)	41/104	(39.4)

Notes: IMCI-WHO = standard course; IMCI-CBT1 = computer course. *Significant difference between course types (p<.05). # Significant difference within category. (p<.05) n= number implementing regularly. N = number trained who were assessed after 3–4 months.

worksite were probably less likely to be performing IMCI regularly. Trainees from Luwero, who missed the two-week follow-up visit, seemed to be performing IMCI the least. Interestingly, fewer than one in five older providers (40–52) were perceived to be performing IMCI regularly. As might be expected, not performing IMCI regularly was correlated with weaker case management skills overall (Pearson correlation .467, sig.=.000), decreasing IMCI knowledge over time (Pearson correlation .252, sig.=.011), and spending more time per case (Pearson correlation .316, sig.=.001). Three to four months after training, those providers determined not to be applying IMCI regularly were observed spending on average eight minutes more per sick child.

In general, providers who had the computer training seemed somewhat more likely to be performing IMCI regularly (44 percent versus 34 percent), but the difference was not significant. The only significant difference by training type occurred among enrolled nurses: twice as many who were trained on computers seemed to be implementing IMCI regularly.

D. Cost

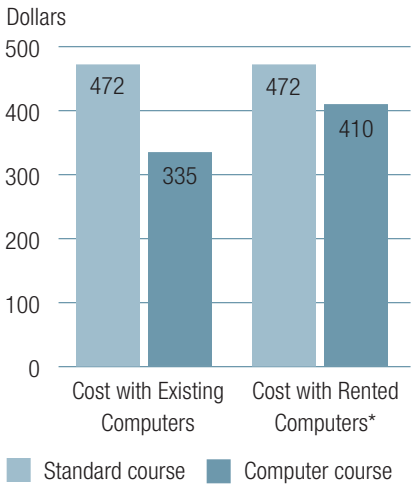
Because the computer course took less time and required fewer facilitators to administer, it cost considerably less than the standard course. The total cost for three rounds of the computer course was 23 percent less than the standard course. Since more participants in the computer course completed the training, calculating the cost per trainee yields an even larger saving: the cost per trainee was 29 percent less in the computer course. The IMCI course cost about $472 per standard trainee and $335 per computer trainee. Even if computers had had to be rented from a private firm in Kampala, using the CBT would still have saved 13 percent (see Figure 2). Had the opportunity costs of trainees' time been included in the calculations, using computers for training would have accrued 4–5 percent in additional savings.

E. Comments on the Computer Course

In mid-2000, after the training and both sets of visits had been completed, the research team sought to visit ten standard trainees and ten computer trainees to obtain their

Figure 2

Comparison of Costs per Trainee by Course Type



*Based on cost in May 2000 of renting 10 computers for 8 days from a private firm in Kampala.

views on the course and to find out how they were faring in their performance of IMCI. Trainees were randomly selected from the 104 who had been found during the three- to four-month assessment visits. Of the 20 trainees the team tried to locate, only four were on duty and seeing sick children at the time of the visit. Some nurse trainees reported that they currently were not able to use IMCI because only clinical officers and medical assistants were permitted to classify and treat sick children in their facility. Many trainees noted that IMCI was too time-consuming to perform with every child. Several did not have the IMCI chartbook at the worksite.

The computer trainees were asked to give their impressions of the computer course and whether they would have preferred being trained with lectures. Trainees were aware that the standard course ran for an additional two days, which meant that they would have received an additional two days of allowance (per diem). Nevertheless, all computer trainees reported that they enjoyed learning by computer and would choose that approach if given an option. Some of their comments were:

- "I prefer the computer course because everything is easier and smoother with it. You can revise quickly, then go ahead to the next section."
- "The computer is advantageous because you can really take your time to learn. You can go slower and more carefully."
- "The computer is just like a teacher. It is even more than a teacher, because it gives you a remark, such as 'well done,' after every answer you give."
- "With computers, you can't go wrong. The computer immediately tells you the right answer. Facilitators can forget something."

V. Discussion

The results of this study suggest that there would be no significant difference between the effectiveness of computer-based and standard training in imparting IMCI knowledge and skills to nurses and clinical officers in a developing country. Even without prior exposure to computers, the trainees still performed well and reported having a positive experience with computers. Both course types seemed to have equivalent impact on knowledge and skill retention. Computer trainees may be somewhat more likely to perform IMCI regularly over time, although the majority of trainees from both courses appeared to be implementing IMCI rarely if at all after three to four months. Interestingly, males who took the computer course appeared to have achieved better knowledge and skill, even after controlling for age, cadre, and previous computer use. It is possible that males found using computers to be more stimulating or more suitable for independent study. There seemed to have been no effect of the computers on females, except for a negative impact on classification knowledge over time. Because the computer course was significantly less expensive, it was more cost-effective than the standard course.

These results complement similar studies that found no significant difference between learning outcomes and performance of participants using either standard or computerized training. In a review of studies in the medical field comparing computer training with other forms of training, Knebel (2000) noted that trainees using CBT performed better or equally well in 18 of 19 studies. This CBT study in Uganda addressed several gaps left by previously published studies, such as the effectiveness of computers for in-service training of providers in a developing country setting and the effect of computer training on knowledge and skill retention. The results can be considered robust because similar content was provided to computer and standard trainees, the trainees were randomized, and the training location and course directors were the same for both course types.

IMCI-CBT1 is a "first generation" product that does not have the interactivity and other programming advances available in more recent computer courses. Even without these more modern features (such as branching, online help, search function, video clips, photographs, etc.), IMCI-CBT1 appeared to be as effective as standard training. The QA Project's IMCI-CBT2 will offer greater interactivity and functionality, including an updated interface, more tutorials, several case studies, a glossary, and a library. It may prove more effective than the standard course.

Although this study demonstrated that a CBT program could be effective for IMCI training, the trend toward decentralization of IMCI training to districts poses constraints to scale-up. At present, most districts in Uganda and elsewhere in Africa do not have the resources for setting up computer laboratories or renting computers. Even if computers were supplied by

an external donor or the MOH, power outages, maintenance, and hardware security would be ongoing concerns.

While in-service IMCI training using computers may not be feasible at this time, the computer course still could have important applications. Wherever computer laboratories already exist or could be set up to serve multiple purposes—such as in medical or nursing schools—using computers for IMCI training could lead to considerable cost savings. Moreover, pre-service IMCI training with computer modules would reduce the time demands placed on instructors and/or free up their time for clinical supervision. In Uganda, the computer course is used to teach IMCI to medical students when they rotate on the diarrhea treatment unit of Mulago Hospital.

The IMCI computer course could also play an important role in refresher training and in reaching private practitioners. If the program were installed on all existing computers in a district's headquarters, the district could offer individualized IMCI refresher training at low cost.

For reaching private practitioners, an MOH could make arrangements with newly emerging for-profit computer centers to train individuals on various computer software packages. For a small fee, private practitioners could take the course at a computer center during times convenient to them and receive a provisional IMCI certificate. To obtain full IMCI certification, the private practitioner would need to be supervised performing IMCI with 15 to 20 sick children.

VI. Conclusions

Classroom-based, lecture-led training has been the standard approach for educating health providers. However, in view of the high costs associated with this type of training, its limited effect on some trainees, and the rise of innovative technology, many educators have been exploring new ways to educate and reinforce health providers in developing countries. This study demonstrated that computer-based training of IMCI can be as effective as standard training, yet considerably less expensive. Given that each country implementing IMCI needs to train all providers seeing sick children, training costs are substantial. Introducing IMCI in pre-service training and conducting refresher training after one or two years for trained providers would require further financial outlays. With resources limited in most developing countries, a training program that achieves comparable results at three-fourths the cost is worth considering.

As the price of computer hardware falls, more developing countries are setting up computer laboratories—particularly in medical and nursing schools. These laboratories could be cost-effective venues for introductory or refresher IMCI training. Moreover, private or office computers could serve as occasional sites for continuing education of professionals, as now occurs in developed countries. Having multiple approaches for imparting knowledge and skills to health workers is advantageous in view of the growing complexity and constant changes in the medical field.

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