Special Article
Need for Internal Medicine Subspecialists in Thailand

Amorn Leelarasamee MD, FACP*,**,***, Tanin Intragumtornchai MD, FACP*,****,
Supasit Pannarunothai MD, PhD*****, Sudsawat Laohavinij MD, PhD******,
Boonsong Patjanasoontorn MD, FACP, FCCP, FCCM*******, Surajit Suntorntham MD, MBA, FACP********,
Rungroj Krittayaphong MD, FACP**, Chureeratana Bowonwatanuwong MD, FRCPT*********
The Human Resource Working Group of the Royal College of Physicians of Thailand*

**The Royal College of Physicians of Thailand*
***Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand*
****Faculty of Medicine, Siam University, Thailand*
*****Faculty of Medicine, Chulalongkorn University, Thailand*
******Centre for Health Equity Monitoring Foundation, Thailand*
*******Rajavithi Hospital, Ministry of Public Health, Thailand*
********Department of Medicine, Faculty of Medicine, Khon Kaen University, Thailand*
*********National Health Security Office, Thailand*
********** Internal Medicine Department, Chonburi Hospital, Thailand*

Background: *Matching supply side of the Internal Medicine (IM) subspecialists to the demand for complex medical care at referral medical centers would lead to more efficient health system management and ultimately optimal clinical outcome. The second decade of the universal health coverage policy in Thailand has raised the awareness on how to reach equitable utilization goals of good quality medical services, while barriers of accession have been removed. More accurate evidence-based human resource planning is timely needed.*

Objective: *To estimate the number of the ten subspecialists in internal medicine (neurologist, cardiologist, endocrinologist, gastroenterologist and hepatologist, nephrologist, hematologist, oncologist, rheumatologist, pulmonologist, and infectious disease specialist) needed for complex medical care based on the workload in the year 2013.*

Material and Method: *The present study applied a needs assessment model with evidence-based approach. Claimed data of inpatients in the year 2013 from the three government insurance schemes (the Civil Servant Medical Benefit, the Social Security and the Universal Health Coverage schemes), and out-patient data from Universal Coverage System were used to estimate demand for subspecialists. The Human Resource Working Group of the Royal College of Physicians of Thailand agreed on the conceptual framework to estimate the need for ten subspecialists based on clinical activities of outpatient consultations, inpatient ward rounds and non-operating room procedures on medical cases of respective diagnosis related group with severe and catastrophic comorbidities and complications by the Thai-DRG version 5. Representatives from the Associations of IM subspecialties approved the lists of ICD-10 diagnosis and ICD-9-CM procedure codes specific to each subspecialist care and proposed assumptions on rates of consultations from other specialists. Surveys were done to subspecialists in 6 major provincial clusters and representatives from IM subspecialty Associations asking time spent on main activities of patient care. The number of full-time-equivalent (FTE) subspecialists needed was calculated by multiplying the clinical workloads measured in minutes spent for each activity (ward round, ward work, inpatient and outpatient consultations) to get the total time needed, then divided by the available time for clinical activity of one subspecialist.*

Results: *From 5.9 million inpatient discharges in the year 2013, primary responsibility of patients in respective severe and catastrophic DRGs related to specific subspecialist workloads were summed up for teaching hospitals and regional hospitals ranging from as lowest the 2,849 cases for rheumatology to the highest 24,610 cases for gastroenterology and hepatology. The number of inpatient non-operating room procedures by ICD-9-CM as listed by IM subspecialty Associations ranged from 8 times for endocrinologists to 22,927 times for cardiologists for the whole year. Of ten subspecialists, the estimated numbers of cardiologist, nephrologist, neurologist, gastroenterologist and hepatologist, endocrinologist, oncologist, rheumatologist, hematologist, pulmonologist and infectious disease subspecialist needed at teaching and regional hospitals were 516, 241; 345, 144; 312, 143; 195, 124; 189, 45; 137, 170; 90, 47; 96, 111; 203, 87 and; 129, 44 respectively according to the workload recorded in the year 2013. The forecast FTE found the overall gap of discrepancy at 7 percent. If the distributions of these subspecialists in public and private hospitals were taken into account, the gap of discrepancy in public hospitals increased to 47 percent.*

Conclusion: *The demand-based forecast for the number of subspecialist needed was made possible with assumptions on conceptual framework for case selection, the rates of consultation and time-spent related to activities of patient care. The*

estimated numbers of subspecialists were anticipated far from optimum since the workload in the year 2013 was derived as a consequence of pre-existing suboptimal infrastructure of healthcare system. In addition, the deficit of subspecialists may increase in the near future when highly efficient, non- or mildly invasive, time-consuming procedures of acute illness increase. Sustainable matching demand and supply of human resource for health needed further validations of these assumptions.

Keywords: *Internal Medicine subspecialists, Internal Medicine subspecialty, DRG database, demand-based forecast, human resource for healthcare system*

J Med Assoc Thai 2017; 100 (2): 239-253
Full text. e-Journal : *http://www.jmatonline.com*

Health systems have been defined by the World Health Organization[1] to cover the six inter-related building blocks from service delivery; workforce; medicine, vaccine and technology information; finance; leadership and governance. Service delivery system though significantly determined by changing patterns of burden of diseases but can be influenced by designations of jobs within various categories of workforces in particular country[2]. The dynamic call for the considerations of how to match supply side of workforces to the demand for health care of the population, not only the primary care level but also the higher levels of high cost medical services at the referral centers. Careful planning of available physicians would lead to more responsive, more equitable and more efficient health system[3].

Universal Health Coverage policy inevitably increases demand for health care hence requires higher number of workforces to respond. The first decade of Universal Health Coverage in Thailand saw a double increase in uses of outpatient and inpatient services implying better accessibility to care[4]. The second decade of the Universal Health Coverage had raised the awareness on how to reach equitable utilization goals of quality medical services while barriers of access have been removed[5]. More accurate evidence-based human resource planning is timely and Internal Medicine (IM) including IM subspecialty becomes the focus of estimation since subspecialists (from here subspecialists stands for IM subspecialists) are currently at the forefront of managing various chronic diseases and providing comprehensive and coordinated health care. Since the Royal College of Physicians of Thailand (RCPT) has not only assured quality trainings in IM and its IM subspecialty training institutes but also provides optimal numbers of physicians enrolled for higher trainings in each institute. The RCPT is particularly concerned about the supply of subspecialists in light of current increase of aging Thai population and recent availabilities of new, effective, non-invasive medical procedures such as percutaneous coronary intervention, stroke fast tract, etc. Although the consultant roles of subspecialists are well recognized, current practice shows that subspecialists commonly deliver ongoing routine care of common diseases perceived as a best care by patients. Hence, the RCPT wants to assess the current adequacy of subspecialties and gives opinion on the optimal IM subspecialty supply to meet the national health care requirement in near future.

This paper aimed to estimate demands for the ten subspecialists and to compare with the supply of corresponding subspecialists based on workload data in the year 2013.

Material and Method

The study design of subspecialist estimation was a need assessment model[6] with evidence-based approach based on clinical activities of inpatient and outpatient cares.

The framework for evidence-based data analyses was first agreed by the Researchers of the Human Resource Working Group (HRWG) appointed by the President of the RCPT. The HRWG met every two to three months since the end of year 2014 to 2016 to scrutinize the framework for needs assessment along with seeking inpatient and outpatient databases from government health insurance schemes to validate the

Correspondence to:
Leelarasamee A, The Royal College of Physicians of Thailand
7th Floor, Royal Golden Jubilee Building, 2 Soi Soonvijai,
New Petchburi Road, Huay-Kwang, Bangkok 10310, Thailand.
Phone: +66-2-7166744, +66+81-4504719, +66-89-1394555,
Fax : +66-2-7181652
E-mail: rcpt@rcpt.org; siall28945@gmail.com

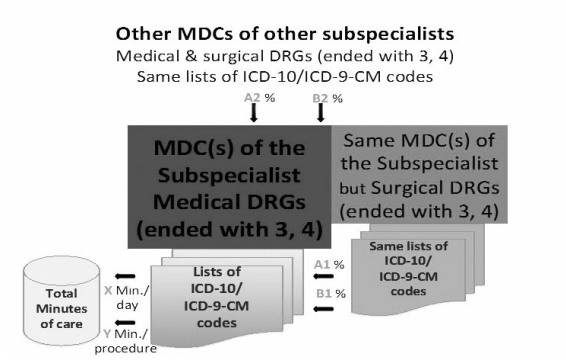

Fig. 1 Conceptual framework for estimating demand from inpatient workloads
Note: DRG – Diagnosis Related Group; ICD-10 – International Classification of Disease 10th revision; ICD-9-CM – International Classification of Disease 9th revision Clinical Modification; MDC – Major Diagnostic Category.

framework possibilities. The final conceptual framework is presented in Fig 1.

The second step was an extensive data analyses according to the agreed framework. The RCPT asked the chairs and experts of IM subspecialty Associations to review the lists of diagnoses (by International Classification of Disease 10th revision or ICD-10) and lists of procedures (according to ICD 9th revision Clinical Modification or ICD-9-CM) that each subspecialist provided care to patients. The Associations returned the lists of ICD-10 and ICD-9-CM by mid-year 2015. These lists were used to select cases that needed the subspecialty care.

Databases used to select cases according to the lists ICD-10 and ICD-9-CM of IM Subspecialty Associations were the inpatient claims data from the Thai Casemix Center that pooled data from three government health insurance schemes (the civil servant medical benefit scheme, the social security scheme and the universal health coverage scheme). Inpatient data of the year 2013 were used in the present analysis. Inpatient data allowed more accurate analysis on selecting only cases with severe and catastrophic complication and comorbidity according to the Thai Diagnosis Related Group version 5[7], with the fifth digit of 3 or 4 admitted in regional hospitals and teaching hospitals that needed care from subspecialists. Counts on number of inpatient cases and sum of hospital days by the Major Diagnostic Category (MDC) of DRG and ICD-10 were the primary responsibility of inpatient care of subspecialists in accordance with the ICD-10 lists suggested by the IM Subspecialty Associations. Within these patient groups, the number of clinical procedures according to the lists provided by the IM subspecialty Associations was summed up to be primary responsibility of inpatient care of subspecialists who perform ward works. Alternately, the number of surgical cases and other cases with related ICD-10 were likely to be consulted cases to the subspecialists and defined as secondary responsibility of subspecialists.

Outpatient data were obtained from the National Health Security Office that compiled from hospitals that provided care under the universal health coverage scheme. Outpatient data provided only ICD-10 codes for grouping of diseases by subspecialties but not

Table 1. Allocation of Major Diagnostic Category and disease and procedure codes to subspecialists

Subspecialty	MDC	ICD-10	ICD-9-CM
Neurology	01	501	5
Respiratory	04	233	36
Cardiology	05	273	86
Gastroenterology and Hepatology	06, 07	509	41
Rheumatology	08	620	18
Endocrinology	10	139	2
Nephrology	11	222	7
Hematology	16, 17	102	5
Infectious Disease	18, 25	246	19
Oncology	Carcinoma as principal diagnosis	327	6

Table 2. Time allocation (per cent or minute) to each activity in one week by subspecialists in teaching and regional hospitals.

	Teaching hospitals (n = 123)	Regional hospitals (n = 34)
Teaching	30%	17%
Research	14%	5%
Administration	13%	14%
Clinical service	43% (1,055 min)	64% (1,261 min)
Total	100% (2,398 min)	100% (1,970 min)
Inpatient care	382 minutes	489 minutes
Procedure activity	233 minutes	261 minutes
Outpatient care	440 minutes	511 minutes

Individual responses from subspecialists that could be calculated into weekly estimates

Table 3. Time (minutes) needed for subspecialist care and proportion of consultation as responded by the IM subspecialty Associations

	Inpatient						Outpatient		
			Referral from peers in surgical subspecialists		Referral from other subspecialists				
	First visit (min)	Subsequent visit (min)	% of ICD-10 (A1)	% of ICD-9-CM (B1)	% of ICD-10 (A2)	% of ICD-9-CM (B2)	First visit (min)	Subsequent visit (min)	% of ICD-10
Neurologist	45	20	By each ICD-10	By each ICD-9-CM	By each ICD-10	By each ICD-9-CM	30	15	50
Cardiologist	30	10	15	By each ICD-9-CM	15	By each ICD-9-CM	20	10	30
Gastroenterologist and hepatologist	30	15	5	10	15	80	20	10	40
Endocrinologist	30	15	80	20	80	20	30	15	5
Nephrologist	20	10	10	10	15	10	15	10*	30
Oncologist	30	15	90	90	90	90	25	10	50
Rheumatologist	50	20	8	70	8	70	30	10	30
Hematologist	30	20	90	90	90	90	30	20	90
Pulmonologist	30	15	20	90	20	90	20	10	40
Infectious disease specialist	30	15	90	30	90	30	20	10	40

A1, A2, B1, B2 were the referral or consultation rates as described in Figure 1
* 10 minutes for peritoneal dialysis or hemodialysis case of subsequent visit

ICD-9-CM on procedure codes. Cases seeking care at regional hospitals and teaching hospitals were selected to estimate demand for subspecialists with assumptions on proportion of consulted cases.

The third step was the questionnaire survey to individual subspecialists in six provinces reflecting workloads and required time (in minutes) for clinical works (ward rounds and ward works) in five regions of Thailand and Bangkok. The survey purposively selected provinces with teaching hospitals and regional hospitals to reach higher number of subspecialists. Results from the survey were scrutinized and reconciled by chair and experts from IM Subspecialty Associations. Additional questionnaire with worksheets in an Excel file was sent to IM Subspecialty Associations to list ICD-10 and ICD-9-CM codes of patients that sub-

Table 4. Clinical workloads for neurologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	18,158*	2,638**	3,152,730	865,130
Procedure on medical DRG cases	2,057	488	123,540	29,460
Surgical DRG cases	7,200	2,131	324,000	95,895
Procedure on surgical DRG cases	383	323	108,600	27,420
Procedure on other consultations	2,209	777	24,000	18,870
Related case consultations	8,395	3,259	377,755	146,675
Primary outpatient cases	565,816	248,980	7,214,154@	3,174,495@
Total	604,218	258,596	11,324,779#	4,357,945$

* Average length of stay 7.43, ** 15.15 days;@ assumed 50% of cases consulted
# divided by 1,261 min x 48 wk x 0.6 = 312, $ divided by 1,055 min x 48 wk x 0.6 = 143 neurologists

Table 5. Clinical workloads for cardiologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	18,398*	3,199**	1,426,590	374,230
Procedure on medical DRG cases	18,779	4,148	401,119	108,119
Surgical DRG cases	5,951	6,954	26,780	31,293
Procedure on surgical DRG cases	21,210	20,838	984,849	983,643.00
Procedure on other consultations	78,049	27,137	9,081,545	4,015,380
Related case consultations	132,904	55,532	598,068	249,894
Primary outpatient cases	1,217,070	305,218	6,207,057@	1,556,612@
Total	1,492,361	423,026	18,726,007#	7,319,171$

* Average length of stay 5.75, ** 9.70 days; @ assumed 30% of cases consulted
# divided by 1,261 min x 48 wk x 0.6 = 516, $ divided by 1,055 min x 48 wk x 0.6 = 241 cardiologists

Table 6. Clinical workloads for gastroenterologists and hepatologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	17,624*	6,986**	1,923,420	894,930
Procedure on medical DRG cases	3,648	1,657	134,270	69,245
Surgical DRG cases	13,678	5,718	20,517	8,577
Procedure on surgical DRG cases	6,454	2,842	35,723	14,946
Procedure on other consultations	2,882	2,168	99,748	75,856
Related case consultations	66,295	39,504	298,328	177,768
Primary outpatient cases	673,533	370,925	4,580,024@	2,522,290@
Total	784,114	429,800	7,092,029#	3,763,612$

* Average length of stay 6.28, ** 7.54 days; @ assumed 40% of cases consulted
# divided by 1,261 min x 48 wk x 0.6 = 195, $ divided by 1,055 min x 48 wk x 0.6 = 124 gastroenterologists and hepatologists

specialists provided treatment. The questionnaire asked standard time of subspecialists giving care to inpatient ward round, outpatient visit and time (in minute) of performing individual procedures (by ICD-9-CM). The questionnaire further asked the proportion of cases to be seen by subspecialists (denoted as A1, A2 for proportion of cases by ICD-10, B1 and B2 for proportion of procedures by ICD-9-CM as seen in Fig. 1).

The final step of the present study was the review meetings with representatives from IM subspecialty Associations. This was the final check whether external validity was acceptable and policy recommendations be drawn upon. The final check was completed in November 2016. The present study was originated from the policy questions of the RCPT and the study required secondary data for analysis with surveys to prominent subspecialists, therefore research ethic clearance deemed unnecessary.

Results

Expert opinion and assumption

The HRWG agreed that the estimations for the present study should adopt the needs assessment approach. The needs were estimated based on the main assumption that patients at teaching hospitals and regional hospitals either the referral cases or self-referrals with a level of clinical complexity needed care from subspecialists. The present study set detailed assumptions as follows:

a. Subspecialists were needed to provide care to patients aged 15 and above classified into DRGs in corresponding MDCs (Table 1) with severe and catastrophic complications and comorbidity (the fifth digit of Thai DRG version 5 of 3 or 4 only) for designated list of ICD-10. Ten IM Subspecialty Associations identified around 3,000 of ICD-10 codes.

b. Subspecialists were primarily responsible for daily ward round to medical patients in a. until hospital discharge.

c. Subspecialists primarily performed designated ICD-9-CM procedures to all patients in b. Ten IM subspecialty Associations identified around 200 of ICD-9-CM procedure codes.

d. Subspecialists were secondarily giving consultation services to surgical patients with designated 3,000 ICD-10 codes in a. for A1 percent of cases in the hospital.

e. Subspecialists secondarily performed procedures to surgical patients with designated 200 ICD-9-CM codes in c. but for B1 percent of the total procedures performed.

f. Subspecialists were secondarily giving consultation services to patients with designated ICD-10 of other MDCs not mentioned in a. but for only A2 percent of cases in hospital.

g. Subspecialists secondarily performed procedures to patients selected in f. with designated ICD-9-CM in c. but for only B2 percent of the total procedures performed.

h. Subspecialists provided care to only C percent of outpatients with designated ICD-10, 70 percent were new cases and 30 percent were subsequent visits.

i. Subspecialists worked on average 48 weeks in a year.

j. Assumed that actual time available for clinical activity by activity-based approach was 0.6 of the total time, as observed from previous activity-based costing methodology[8].

Time allocation to activity and consultation

A questionnaire survey aimed to ask time allocation to clinical service, teaching, administration and research of subspecialists at regional hospitals and teaching hospitals. Six provincial clusters namely: Chiang Mai, Saraburi, Chonburi, Khon Kaen, Songkhla and Bangkok with high concentration of subspecialists were selected for survey covering 22 hospitals and 862 subspecialists. By August 2015, there were 240 returned questionnaires (2 percent response rate). These were 29 nephrologists, 27 cardiologists, 24 gastroenterologists and hepatologists, 23 neurologists, 22 hematologists, 21 rheumatologists, 21 infectious disease specialists, 19 endocrinologists, 15 pulmonologists, 7 medical oncologists and others. Subspecialists at teaching hospitals contributed 30 percent of total available time for teaching, 14 percent for research, 13 percent for administrative work and 44 percent on clinical workload (Table 2).

The responses in Table 2 were further used to calculate full time equivalence (FTE) of one subspecialist working at a teaching or a regional hospital. Though subspecialists at teaching hospitals worked shorter time on clinical service but the total time for the whole work was almost 22 percent longer than subspecialists at regional hospitals. Subspecialists

at teaching hospitals spent on average 3.5 hours per working day in a 5 working weekdays on clinical service while subspecialists at regional hospitals spent 4.2 hours per working day. Most of the working time was for outpatient services (41-42 percent), with considerable proportions (21 to 22 percent) for undertaking procedures.

From survey data among IM Subspecialty Associations, most subspecialists needed 30 minutes to see the case as inpatient on the first day and reduced to 15 minutes ward round in subsequent day till hospital discharge (Table 3). In case of outpatient service, most Associations reported the longest time of 30 minutes in providing care to each new patient. The final figures in Table 3 were derived from the summary meeting with representatives from IM Subspecialty Associations at end of November 2016.

Workloads of subspecialists on clinical activities

After selecting inpatients in related MDCs with severe and catastrophic CCs, the number of cases for primary responsibility and secondary responsibility (consulting case) were counted and presented in Table 4 (for neurologists). From number of cases and procedure, minutes of time required for clinical care (in the last two columns) were calculated by multiplying number of cases with minutes required per case of ward round (first and subsequent visits), of individual particular procedures performed and of outpatient first and subsequent visits accordingly. Finally the numbers of FTE of subspecialists needed were obtained. Thus, for neurologists in Table 4 as an example for the calculation, Thailand needed 312 FTE neurologists at regional hospitals (calculated by dividing a total 11,324,779 minutes of care with the available 1,261 minutes of 1 FTE per week at regional hospital from Table 2, working for 48 weeks in a year and with 0.6 correction factor for activity-based cost methodology) and 143 FTE at teaching hospital in 2013 (calculated by dividing a total 4,357,945 minutes of care with the available 1,055 minutes of 1 FTE per week at teaching hospital from Table 2, working for 48 weeks in a year and with 0.6 correction factor of activity- based cost methodology).

Then Tables 5 to 13 present the FTE number needed for other nine subspecialists applying the same approach of calculation.

Validation of proportion of clinical workload

Table 14 validates the proportions of clinical workload from tables 4 to 13 as against the proportion calculated from the time survey (from Table 2). It is remarkable that the gap of proportion of workload on procedure from evidence-based approach was very different from the subjective approach. The highest proportions were found for cardiologists (7 to 15 percent) and pulmonologists (6 to 9 percent).

Validation of FTE number needed with existing number of subspecialists

The final step of the present study compared the numbers of subspecialists needed in public sector with the existing number of subspecialists working in public sector. Table 15 presented the responses from health resource survey (survey to public and private hospitals) by the Ministry of Public Health in the year 2014 (no data for 2013) gave detailed information on how many doctors worked full time in public and private hospitals. Only 41 percent of pulmonologists worked in public hospitals while 75 percent of hematologists worked in public hospitals. Moreover, more than one-third up to 57 percent of these subspecialists worked in Bangkok (public and private hospitals included).

Using the proportions of subspecialists working in public hospitals in Table 15 to calculate the existing number of subspecialists working in public hospitals in Table 16, the results showed that the existing number of ten subspecialists in public hospitals were on average 47 percent lower than the FTE number needed as calculated from Tables 4 to 13. The calculated FTE number of cardiologists was 757, while in 2014 there were 392 cardiologists working in public hospitals, hence represented 48% deficit of optimal number of cardiologists. The low proportions of subspecialists working in public hospitals made the problems worsen for these ten subspecialists. Optimistically, if the total existing subspecialists were working in public hospitals, the overall gap of discrepancy would be reduced to only 7 percent. The highest proportion of lacking optimal subspecialists was oncologists.

Discussion

The needs assessment model used clinical activity evidence[6,9,10] to estimate the need for subspecialty according to certain assumptions and service data. This is one choice for manpower calculation and data ob-

Table 7. Clinical workloads for endocrinologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	4,410*	690**	397,890	84,975
Procedure on medical DRG cases	4	4	90	90
Surgical DRG cases	384	354	9,216	8,496
Procedure on surgical DRG cases	-	-	-	-
Procedure on other consultations	26	90	141	525
Related case consultations	216,360	35,568	5,192,640	853,632
Primary outpatient cases	999,249	323,208	1,274,042@	412,090@
Total	1,220,433	359,914	6,874,019#	1,359,808$

* Average length of stay 5.01, ** 7.21 days; @ assumed 5% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 189, $ divided by 1,055 min x 48 wk x 0.6 = 45 endocrinologists

Table 8. Clinical workloads for nephrologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	8,317*	2,323**	698,340	295,070
Procedure on medical DRG cases	455	209	7,630	3,430
Surgical DRG cases	2,688	1,078	5,376	2,156
Procedure on surgical DRG cases	131	59	328	254
Procedure on other consultations	1,419	1,186	2,483	1,989
Related case consultations	91,934	28,747	275,802	86,241
Primary outpatient cases	365,410	157,884	11,536,841@	3,991,740@
Total	470,354	191,486	12,526,800#	4,380,880$

* Average length of stay 7.40, ** 11.70 days; @ assumed 30% of cases consulted plus 30% and 10% of 3,352,310 hemodialysis(10 minutes per visit) attended at regional hospitals and teaching hospitals respectively.

divided by 1,261 min x48 wk x 0.6 = 345, $ divided by 1,055 min x 48 wk x 0.6 = 144 nephrologists

Table 9. Clinical workloads for oncologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	10,922*	8,942**	1,509,630	1,325,685
Procedure on medical DRG cases	10,780	9,835	93,552	53,802
Surgical DRG cases	6,174	5,702	166,698	153,954
Procedure on surgical DRG cases	6,142	5,358	30,866	33,900
Procedure on other consultations	-	-	-	-
Related case consultations	15,230	15,437	411,210	416,799
Primary outpatient cases	269,439	308,923	2,761,750@	3,166,461@
Total	318,687	354,197	4,973,706#	5,150,600$

* Average length of stay 8.21, ** 8.88 days; @ assumed 50% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 137, $ divided by 1,055 min x 48 wk x 0.6 = 170 oncologists

Table 10. Clinical workloads for rheumatologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	2,200*	649**	480,880	221,450
Procedure on medical DRG cases	278	137	6,751	3,744
Surgical DRG cases	2,753	1,008	11,012	4,032
Procedure on surgical DRG cases	203	121	3,046	2,046
Procedure on other consultations	4,240	1,748	67,109	28,813
Related case consultations	13,255	6,525	53,020	26,100
Primary outpatient cases	365,668	159,390	2,632,810@	1,147,608@
Total	388,597	169,578	3,254,628#	1,433,793$

* Average length of stay 9.43, ** 15.56 days; @ assumed 30% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 90, $ divided by 1,055 min x 48 wk x 0.6 = 47 rheumatologists

Table 11. Clinical workloads for hematologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	4,800*	2,334**	1,081,380	818,760
Procedure on medical DRG cases	10,797	5,242	44,833	25,594
Surgical DRG cases	336	398	9,072	10,746
Procedure on surgical DRG cases	656	661	3,117	4,797
Procedure on other consultations	80,931	27,112	144,801	47,127
Related case consultations	7,053	9,030	190,431	243,810
Primary outpatient cases	82,821	91,539	2,012,550@	2,224,398@
Total	187,394	136,316	3,486,184#	3,375,232$

* Average length of stay 10.76, ** 17.04 days; @ assumed 90% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 96, $ divided by 1,055 min x 48 wk x 0.6 = 111 hematologists

Table 12. Clinical workloads for pulmonologists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	14,124*	3,377**	1,702,335	575,145
Procedure on medical DRG cases	7,055	2,311	166,098	50,570
Surgical DRG cases	17,498	3,246	104,988	19,476
Procedure on surgical DRG cases	34,244	6,844	466,925	104,189
Procedure on other consultations	94,806	22,918	1,205,292	304,949
Related case consultations	119,449	32,029	716,694	192,174
Primary outpatient cases	444,679	204,934	3,023,817@	1,393,551@
Total	731,855	275,659	7,386,148#	2,640,055$

* Average length of stay 7.04, ** 10.35 days; @ assumed 40% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 203, $ divided by 1,055 min x 48 wk x 0.6 = 87 pulmonologists

tained from the three health security systems are much more complete than any data we could have obtained from other sources. The approximate durations for performing each activity by subspecialists could be used for the future calculation if manpower in healthcare was needed and the result could be compared with the present study. Contrasting with crude historical approach such as bed to population ratio or the professional planning model[6], the forecast of intensivists needed for intensive care unit adopted the intensivists to bed ratio approach with justification on outcomes adjusted by detailed physiologic scores[11]. Time calculator for estimating the number of intensivists needed was simply based on a closed intensive care environments which employed different methodological approach[12]. However, since intensivists mostly work in the ICU, it could be argued that the number of intensivists the country needed should not be estimated from number of outpatients and inpatients or DRG system, but was more appropriate to roughly estimate from the population-based method or number of the current ICU beds of the hospital.

Ten subspecialists were selected in the present study because claimed databases allowed for detailed analyses on clinical activity. Our study showed that optimal and highest numbers needed for cardiologist, nephrologist and neurologist at teaching and regional hospitals are 516, 241 and 345, 144 and 312, 143; respectively according to the workload recorded in the year 2013. The numbers estimated for these subspecialties coincide with current situation where recently available, minimally invasive but highly effective interventions are becoming countrywide available namely: percutaneous coronary intervention (PCI) for acute coronary vascular disease, reimbursable hemodialysis and peritoneal dialysis service for end-stage renal disease and stroke fast track for ischemic cerebrovascular disease. Rheumatologist, hematologist, pulmonologist and infectious disease subspecialist at teaching and regional hospitals are the four subspecialties that need 90, 47; 96, 111; 203, 87 and 129, 44, respectively, and seem to be less urgently needed since the optimal numbers estimated for each specialty are not so high and not much different from the current numbers of subspecialists registered at the RCPT or Thai Medical Council.

However, proper interpretation of the results of the study needs careful consideration. The numbers of subspecialists required for each specialty in the study derived from two principal factors, one of which is the recorded workload under existing infrastructure and circumstance of health service system in the year 2013, and the other, the optimal duration of each activity obtained from the survey of subspecialists and opinions of experts in each field. Hence, the interpretation of insufficient, sufficient or over supply of subspecialists in each field is not as simple as showed in Table 16. For example, the number of neurologist seems adequate by our calculation for a workload in that year. But in fact, a subspecialty service to be performed by neurologists may not be evenly distributed even in the area where that service is strongly needed. At present, intravenous fibrinolytic therapy at the cerebral circulation dose within the first 3 hours of ischemic stroke onset offers substantial net benefits for virtually all patients with potentially disabled deficits and is accepted worldwide as a minimally invasive, highly efficient procedure. But the number of regional hospitals able to perform this highly specialized service was limited due to the need of CT scan, adequate number of nurses in addition to vascular-specialized neurologists in order to complete the procedure. Hence, the optimal operation of this procedure needs suitable infrastructure which may be limited or simply not available in the year 2013. By observation, number of beds available for hospitalization and observation of the patients after special services may be inadequate since some of the beds are occupied up to 20 percent by bed-ridden patients with cerebrovascular disease in some teaching or regional hospitals. Accordingly, the special service may be still suboptimal and hence number of neurologists calculated from the workload should be lower than optimum. If our study included data of clinical outcome of each complicated disease and compared these data among other hospitals, this method caould be used to validate or confirm the appropriate number of subspecialists in each field that was calculated from the workload. If production of subspecialty was needed, production policy to reach adequate number of subspecialists had shown success under the financing policy of the postgraduate training in the USA especially for family medicine specialists[13].

In contrast, if some interventions became nationwide applicable in the near future and were targeted to eliminate chronic or complicated illness, then the workload of related subspecialist could be reduced to

Table 13. Clinical workloads for infectious disease specialists

	Cases		Minutes of care	
	Regional	Teaching	Regional	Teaching
Primary responsibility medical DRG cases	12,499*	1,778**	1,595,640	338,835
Procedure on medical DRG cases	7,108	1,670	29,442	3,441
Surgical DRG cases	682	263	18,414	7,101
Procedure on surgical DRG cases	378	346	264	148
Procedure on other consultations	148,149	47,071	22,911	8,607
Related case consultations	35,836	10,437	967,572	281,799
Primary outpatient cases	300,925	102,374	2,046,290@	696,143@
Total	505,577	163,939	4,680,533#	1,336,075$

* Average length of stay 7.51, ** 11.70 days; @ assumed 40% of cases consulted

divided by 1,261 min x 48 wk x 0.6 = 129, $ divided by 1,055 min x 48 wk x 0.6 = 44 infectious disease specialists

Table 14 Proportion of clinical workloads from calculation compared with survey

	From survey		Neurologists		Cardiologists		GI		Endocrinologist		Nephrologists	
	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach
Inpatient	36%	39%	34%	26%	59%	64%	33%	31%	81%	70%	8%	9%
Outpatient	42%	41%	64%	73%	33%	21%	65%	67%	19%	30%	92%	91%
Procedure	22%	21%	2%	1%	7%	15%	2%	2%	0%	0%	0%	0%

Table 14 (cont.) Proportion of clinical workloads from calculation compared with survey

	From survey		Oncologists		Rheumatologist		Hematologist		Pulmonologists		Infect dis	
	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach	Reg	Teach
Inpatient	36%	39%	42%	37%	19%	20%	41%	33%	50%	41%	56%	48%
Outpatient	42%	41%	56%	61%	81%	80%	58%	66%	41%	53%	44%	52%
Procedure	22%	21%	3%	2%	0%	0%	1%	1%	9%	6%	1%	0%

Reg = regional hospital, Teach = teaching hospital, GI = gastroenterologist and hepatologist, Infect dis = infectious disease specialist

Table 15. Distribution of subspecialists in the year 2014

	Total registered to RCPT	Health resource survey	% Response rate	% in public hospitals	%in hospitals in Bangkok
Neurologists	467	288	62%	54%	51%
Cardiologists	688	498	72%	57%	43%
Gastroenterologists and hepatologists	336	268	80%	49%	47%
Endocrinologists	218	163	75%	42%	57%
Nephrologists	457	367	80%	68%	38%
Oncologists	157	118	75%	72%	46%
Rheumatologists	127	102	80%	69%	38%
Hematologists	279	174	62%	75%	37%
Pulmonologists	283	153	54%	41%	49%
Infectious disease specialist	171	118	69%	64%	42%

Calculated from data obtained from the Thai Medical Council and the Ministry of Public Health

Table 16. Number of subspecialists needed in the year 2013 from calculation compared with existing number in the year 2014

	Neuro*	Cardio**	GI	Endocrine	Nephro	Onco	Rheumato	Hemato	Pulmono	ID	Total
Regional	312	516	195	189	345	137	90	96	203	129	2,212
Teaching	143	241	124	45	144	170	47	111	87	44	1,156
Needed	455	757	319	234	489	307	137	207	290	173	3,368
Existing	467	688	336	218	457	157	127	213	283	171	3,117
Crude excess	12	-69	17	-16	-32	-150	-10	6	-7	-2	-251
% Excess	3%	-9%	5%	-7%	-7%	-49%	-7%	3%	-3%	-1%	-7%
Work in public hospital	252	392	165	92	311	113	88	160	116	109	1,797
Excess in public hospital	-203	-365	-154	-142	-178	-194	-49	-47	-174	-64	-1,571
% Excess	-45%	-48%	-48%	-61%	-36%	-63%	-36%	-23%	-60%	-37%	-47%

* estimation proportion of work by ICD-10 and ICD-9-CM ** estimation proportion of work by ICD-9-CM

greater extent in the future. For example, in the field of infectious diseases, if the current expensive, once-daily, fixed-dose combination of hepatitis C virus-specific directly acting antiviral drugs became publicly available for a 8-12 week treatment of chronic hepatitis C virus (HCV)-infected patients and eliminate the illness in more than 98 percent of the cases, then the workload of subspecialist in long-term care of these patients would have been much reduced, but unfortunately, this direct target therapy is still very expensive. Similarly, the upcoming national implementation of dengue virus vaccination among the target populations will largely reduce the future subspecialists' workload on taking care of adults with severe dengue virus infection. Even the introduction of human papilloma virus vaccine to prevent carcinoma of cervix will indirectly result in reduction of workload of oncologist and infectious disease specialist who have to deal with carcinoma of cervix with distant metastasis. However, this possible reduction of workload is now substituted by escalating activity of infection control that is not recorded in the ICD-10 or DRG system but is mandatory in the era of multidrug-resistant pathogens.

Current observation at the teaching hospitals revealed that many subspecialists also perceive themselves as primary care providers for patients once diagnosed as complicated illness and continuously need longitudinal primary care even they no longer have complicated illness.[14] This type of practice is also well accepted by the patients who want to have subspecialists as their primary physicians. This trend of health service by the patients' view suggests that there should be a better communication and health data transfer system to help avoid potential negative consequences, such as uncoordinated or fragmented care and to ensure that physicians have the communication and coordination skills necessary to provide high-quality care as key members of a broader patient care management team. If this trend of service is not reverted, then it will eventually increase the need for subspecialists in the future.

There are several limitations in our estimation. The scope of present study confined to regional and teaching hospitals to rationalize the number of subspecialists. For outpatient data, the absence or underreporting of the number of non-operating room procedures by gastroenterologist and hepatologist may be substantial when proportion of workloads by clinical activities of various subspecialists were validated. Though all assumptions were obtained from subspecialists' survey and scrutinized by experts in each field, they should be re-validated for better estimations of manpower in the future.

In conclusion, the present study accomplished estimation of subspecialists because of series of assumptions made. The data from Table 16 together with the explanations of various limitations of health service and subsequent suboptimal workload in the year 2013

call for urgent attention in the increased production of subspecialty trainings to meet future demand in particular, of recently available, highly efficient, procedural services. The size of mismatched distributions of these subspecialists also called for stronger control or better management of complex medical care markets for equity of access to good quality and efficient health care systems. Further studies should explore the appropriateness of other models together with the assumptions used in the present study and clinical outcomes to predict future needs and the capacities of training by the subspecialty Associations.

What is already known on this topic?

The estimation of number of IM Subspecialists needed for complex healthcare system has never been published before by the RCPT.

What this study adds?

The forecast FTE found the overall gap of discrepancy is 7 percent. If the distributions of these subspecialists in public and private hospitals were taken into account, the gap of discrepancy in public hospitals increased to 47 percent. The deficit of IM subspecialists may increase in near future when highly efficient, non- or mildly invasive, time-consuming procedures of acute illness become available.

Acknowledgement

The authors thank continuous participations and financial support from IM Subspecialty Associations and the Royal College of Physicians of Thailand throughout these two years, and for giving guidance and expert opinions till reaching final conclusions. Responses of subspecialists to the questionnaire surveys were highly appreciated. Our thanks also go to the National Health Security Office, the Social Security Office, the Ministry of Finance, the Central Office for Healthcare Information, the Thai Casemix Center for providing claimed data for analysis. Finally, extensive and repeated data analyses by Supakorn Klampod of the Center for Health Equity Monitoring Foundation are acknowledged.

Potential conflicts of interest

Many authors also work for the Royal College of Physicians of Thailand and IM Subspecialty Associations. The estimation of number of IM subspecialists mainly derived from the third author(SP.) who was authorized to freely design the study which was approved by the RCPT and did the estimation from the workload obtained from the three government insurance schemes (the Civil Servant Medical Benefit, the Social Security and the Universal Health Coverage Schemes) and out-patient data from the Universal Coverage System.

References

1. World Health Organization. Everybody's business--strengthening health systems to improve health outcomes: WHO's framework for action. Geneva: WHO; 2007.
2. McKee M, Dubois C, Sibbald B. Changing professional boundaries. In: Dubois CA, McKee M, Nolte E, editors. Human resources for health in Europe. Maidenhead: Open University Press; 2006: 63-78.
3. IHS Inc. The Complexities of physician supply and demand: Projections from 2013 to 2025. Prepared for the Association of American Medical Colleges. Washington, DC: Association of American Medical Colleges; 2015.
4. Tangcharoensathien V, Jongudomsuk P, Srithamrongsawat S, Patcharanarumol W, Limwattananon S, Pannarunothai S, et al. The Kingdom of Thailand Health System Review. Health systems in transition, Vol. 5 No. 5. Asia Pacific observatory on health systems and policies. Manila: WHO, Regional Office for the Western Pacific; 2015.
5. Health Systems Research Institute. Thailand's universal coverage scheme: achievements and challenges. An independent assessment of the first 10 years (2001 2010) synthesis report. Nonthaburi: HSRI; 2012.
6. Segal L, Bolton T. Issues facing the future health care workforce: the importance of demand modelling. Aust New Zealand Health Policy 2009; 6: 12.
7. National Health Security Office (NHSO), Thailand. Thai diagnosis related group, version 5. Bangkok: NHSO; 2011.
8. Phuaphanprasert B. The alternative resource allocation using Thai psychiatric casemix approach. Nonthaburi, Thailand: Health Systems Research Institute; 2006.
9. Segal L, Dalziel K, Bolton T. A work force model to support the adoption of best practice care in chronic diseases - a missing piece in clinical guide-

line implementation. Implement Sci 2008; 3: 35.
10. Hall TL. Human resources for health: a tool kit for planning, training and management. Geneva: World Health Organization; 1991.
11. Dara SI, Afessa B. Intensivist-to-bed ratio: association with outcomes in the medical ICU. Chest 2005; 128: 567-72.
12. Ward NS, Afessa B, Kleinpell R, Tisherman S, Ries M, Howell M, et al. Intensivist/patient ratios in closed ICUs: a statement from the Society of Critical Care Medicine Taskforce on ICU Staffing. Crit Care Med 2013; 41: 638-45.
13. Regenstein M, Nocella K, Jewers MM, Mullan F. The cost of residency training in teaching health centers. N Engl J Med 2016; 375: 612-4.
14. Vandergrift JL, Gray BM, Reschovsky JD, Holmboe ES, Lipner RD. The role of internal medicine subspecialists in patient care management. Am J Manag Care 2016; 22: e375-81.

จำนวนอายุรแพทย์เฉพาะทางที่ต้องการในประเทศไทย

อมร ลีลารัศมี, ธานินทร์ อินทรกำธรชัย, ศุภสิทธิ์ พรรณารุโณทัย, สุดสวาท เลาหวินิจ, บุญส่ง พัจนสุนทร, สุรจิต สุนทรธรรม, รุ่งโรจน์ กฤตยพงษ์, จุรีรัตน์ บวรวัฒนุวงศ์

ภูมิหลัง: *การมีอายุรแพทย์เฉพาะทางในจำนวนที่เหมาะสมกับความต้องการของภาระงานในโรงพยาบาลขนาดใหญ่จะทำให้ระบบการบริบาลผู้ป่วยที่มีโรคซับซ้อนทางด้านอายุรกรรมในระบบสุขภาพมีประสิทธิภาพสูงขึ้นและได้ผลการรักษาที่ดีเหมาะสมในที่สุด ระบบหลักประกันสุขภาพถ้วนหน้าในทศวรรษที่สองจะเพิ่มเป้าหมายในการให้ประชาชนเข้ารับบริการที่มีวิธีการรักษาที่ซับซ้อนและมีประสิทธิภาพสูงได้สะดวกขึ้นอย่างเท่าเทียมกัน จึงสมควรประมาณการจำนวนอายุรแพทย์เฉพาะทางที่เหมาะสมจากฐานข้อมูลภาระงานที่เชื่อถือได้และเปรียบเทียบกับจำนวนที่มีอยู่ในปัจจุบัน*

วัตถุประสงค์: *เพื่อประมาณการจำนวนอายุรแพทย์เฉพาะทาง 10 สาขาวิชาที่เหมาะสมจากฐานข้อมูลของภาระงานบริการสุขภาพในปี พ.ศ. 2556*

วัตถุและวิธีการ: *ผู้นิพนธ์ได้นำข้อมูลการบริการสุขภาพในปี พ.ศ. 2556 จากระบบประกันสุขภาพทั้ง 3 ระบบ ได้แก่ สิทธิสวัสดิการการรักษาพยาบาลของข้าราชการ สิทธิประกันสังคมและสิทธิหลักประกันสุขภาพถ้วนหน้ามาประมาณการจำนวนอายุรแพทย์เฉพาะทาง 10 สาขาวิชา และข้อมูลของภาระงานผู้ป่วยนอกของระบบหลักประกันสุขภาพถ้วนหน้า โดยนับภาระงานจากการดูแลรักษาผู้ป่วยนอก ผู้ป่วยในหอผู้ป่วย การรับการปรึกษา การทำหัตถการทางอายุรกรรมซึ่งบันทึกในกลุ่มวินิจฉัยโรคร่วมฉบับที่ 5 (diagnosis related group หรือ DRG) ที่มีภาวะโรคร่วมและโรคแทรกซ้อนสูงมาเป็นฐานในการคำนวณ คณะทำงานด้านกำลังคนของราชวิทยาลัยอายุรแพทย์แห่งประเทศไทย ได้รับรองภาระงานในรหัสวินิจฉัยโรคและรหัสหัตถการ (ICD-10 diagnosis and ICD-9-CM procedure codes) ว่าเป็นภาระงานในสาขาวิชาใดในอายุรแพทย์เฉพาะทางรวมทั้งระยะเวลาที่ใช้ในการปฏิบัติภาระงานแต่ละประเภทด้วย จำนวนอายุรแพทย์เฉพาะทางที่ทำงานเต็มเวลาที่ต้องการจะประมาณการจากระยะเวลาทั้งหมดที่ต้องใช้ในการทำภาระงานซึ่งคำนวณมาจากการคูณจำนวนภาระงานกับเวลาที่ใช้ในภาระงานแต่ละชนิด แล้วนำมาหารด้วยเวลาที่อายุรแพทย์เฉพาะทางหนึ่งคนที่ใช้ในการปฏิบัติภาระงานคลินิกชนิดนั้น*

ผลการศึกษา: *จากฐานข้อมูลในปี พ.ศ. 2556 พบว่า มีผู้ป่วย 5.9 ล้านรายที่จำหน่ายจากโรงพยาบาลทั่วประเทศและมีผู้ป่วยในจากโรงพยาบาลของคณะแพทยศาสตร์และโรงพยาบาลศูนย์ที่เข้าข่ายมีภาวะโรคร่วมและโรคแทรกซ้อนสูง โรครูห์มาโตโลยีมีผู้ป่วยจำนวนน้อยที่สุดคือ 2,849 รายจนถึงโรคทางเดินอาหารและตับที่มีจำนวนมากที่สุดคือ 24,610 ราย การทำหัตถการทางอายุรกรรมตลอดทั้งปีมีตั้งแต่ 8 ครั้งในโรคต่อมไร้ท่อไปจนถึง 22,927 ครั้งในโรคหัวใจและระบบไหลเวียน จากการประมาณการจำนวนอายุรแพทย์*

เฉพาะทางใน 10 สาขาวิชาพบว่า cardiologist, nephrologist, neurologist, gastroenterologist และ hepatologist, endocrinologist, oncologist, rheumatologist, hematologist, pulmonologist และ infectious disease subspecialist ที่ควรมีที่โรงพยาบาลของคณะแพทยศาสตร์และโรงพยาบาลศูนย์หรือประจำจังหวัดมีจำนวน 516, 241; 345, 144; 312, 143; 195, 124; 189, 45; 137, 170; 90, 47; 96, 111; 203, 87 และ 129, 44 รายตามลำดับตามภาระงานบริการที่บันทึกได้ในปี พ.ศ. 2556. ความแตกต่างระหว่างจำนวนแพทย์ที่ควรมีและจำนวนที่มีอยู่จะมีค่าขาดแคลนเฉลี่ยประมาณร้อยละ 7 ทั่วประเทศ แต่ถ้านำการกระจายของอายุรแพทย์เฉพาะทางในโรงพยาบาลเอกชนและของรัฐมาพิจารณา จะพบว่า ความแตกต่างของจำนวนแพทย์ที่เหมาะสมและจำนวนที่มีอยู่ในโรงพยาบาลของรัฐจะมีค่าขาดแคลนสูงถึงร้อยละ 47.

สรุป: *จากการประมาณการจำนวนอายุรแพทย์เฉพาะทางที่เหมาะสมในการศึกษาจากภาระงานในระบบสุขภาพทั้ง 3 ระบบในปี พ.ศ. 2556 ในอายุรแพทย์เฉพาะทาง 10 สาขาวิชาพบว่ายังขาดแคลนอยู่ประมาณร้อยละ 7 การขาดแคลนน่าจะมีมากกว่านี้เนื่องจากภาระงานในปี พ.ศ. 2556 เกิดขึ้นน้อยกว่าที่ควรเป็นเพราะมีข้อจำกัดของโครงสร้างในระบบบริการสุขภาพ นอกจากนี้การขาดแคลนอายุรแพทย์เฉพาะทางอาจจะเพิ่มขึ้นในอนาคตอันใกล้เมื่อมีวิธีการรักษาใหม่ ๆ ที่มีประสิทธิภาพสูงขึ้นและใช้เวลาในการทำหัตถการนานขึ้น ผลการประมาณจากการศึกษาครั้งนี้ควรได้รับการยืนยันถึงความถูกต้องของข้อสมมติฐานต่าง ๆ จากการศึกษาอื่น ๆ ต่อไป*