4G Health- The Long Term Evolution of m-health

Robert S. H. Istepanian

Professor of Data Communications, Kingston University, London

Mobile Information and Network Technologies Research Centre
Faculty of Computing,Information Systems and Mathematics
Kingston University, London, UK
E-mail: r.istepanian@kingston.ac.uk

MINT Research Centre

Summary

- 4G Technologies
- LTE v/s WiMAX
- Evolution of m-health and defining ‘**4G – Health**’
- Diabetes in the Middle East.
- M-health for Diabetes Management and clinical trials
- Potential of m-health for Diabetes in the middle East
- Future trends

History of radio/wireless technology and healthcare

In 20th Century the invention
Of the ‘ Radio’ or wireless
made a major paradigm shift
in healthcare

KINGSTON UNIVERSITY

4G Technologies and Future Networks

The two main candidates of the 4G Systems are :

-WIMAX Technology based on the IEEE802.16 standards
-The Third Generation Partnership Project's (3GPP) Long Term Evolution (LTE)

These to be most likely to be endorsed by the ITU-R and IMT – Advanced systems

On the 8th of January the Global Certification Forum announced that it is on course to deliver a complete LTE device certification scheme before the end of 2010.

REF: 3GPP A GLOBAL INITIATIVE

4G Technologies and Future Networks

IMT – Advanced specifies among other parameters:

- All IP packet switching
-Peak download data throughpouts of at least 1Gbit/s (low mobility) and 100 Mbits/s (high mobility)
-The use of OFDM digital modulation

Neither WiMAX nor LTE support today these throughputs.

However, although both technologies have somewhat different designs, there are many concepts, features to meet common requirements and expectations in both:

For example:
1- **Physical layer**: Both systems use OFDMA with MIMO configuration and fast link adaptation
2- **MAC layer** : Both systems support multicarrier operation and heterogeneous networks of cells (macro, femto and relay nodes) for supporting wide range of applications and mobility challenges, traffic management

	HSPA	mWiMAX	LTE
Peak Data Rate	Useful: 10.8 / 4.3 Mbps	Useful: 42 / 14 Mbps	Useful: 75 / 37.5 Mbps
Spectral Efficiency	Useful: 2.16 / 0.86 bps/Hz	Useful: 3.15 / 2.1 bps/Hz	Useful: 3.75 / 1.88 bps/Hz
VoIP Performance	• 12 concurrent users/cell/MHz** • 430 km/h with guaranteed QoS*	• 16 concurrent users/cell/MHz** • Focus on nomadic mobility, also vehicular speeds up to 120 km/h	• 24 concurrent users/cell/MHz** • 350 km/h target speed

Source: *Huawei Technologies, **PA Consulting

4G: LTE v/s WIMAX

		HSPA	mWiMAX	LTE
1	Capacity	◑	◕	●
2	Coverage	◑	◔	●
3	Complexity	◔	◑	◕
4	Cost	◑	◔	◕

Source: *Huawei Technologies, **PA Consulting

Push/ Pull of Telecom industry v/s healthcare trends

Shift to home care demands

Quality of life

Home care

Residential care

Acute care

$$

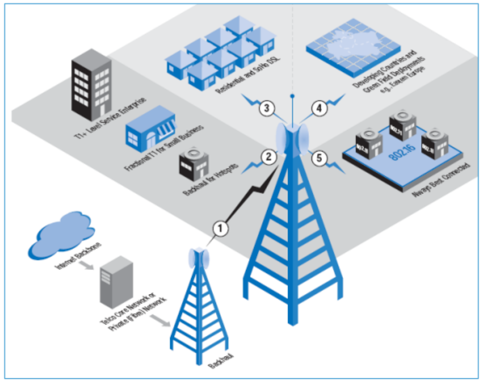
Mobility in Healthcare

Work flow Optimisation

Improved clinical outcomes

Cost

Wireless and IP based Infrastructure Growth



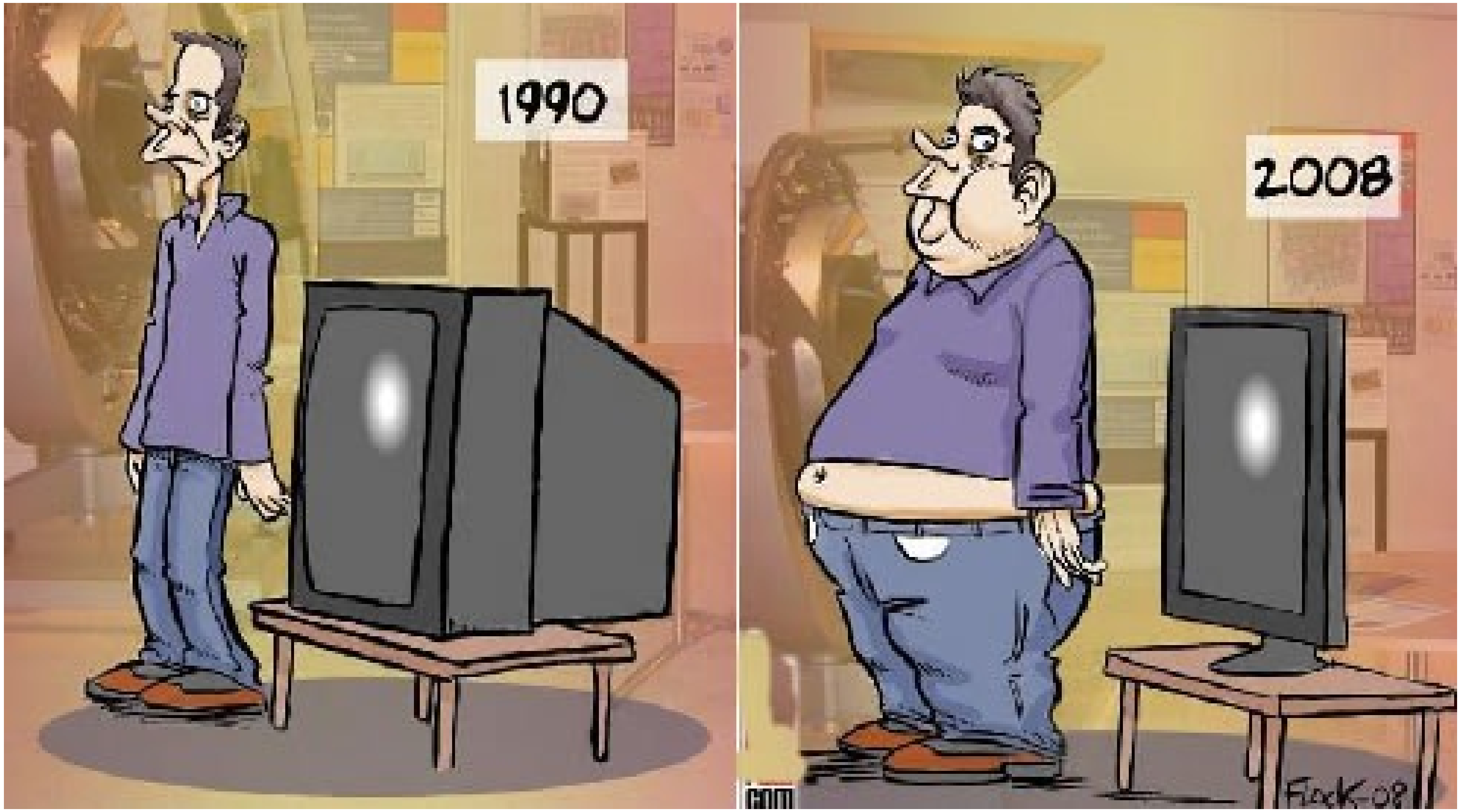
Advances in mobile and medical Devices

KINGSTON UNIVERSITY

MINT Research Centre

Global Diabetes and Obesity

It takes 10-12 years for the HbA1C in the body to become or start becoming higher than the normal levels



M-health Evolution: 1997-2003

194 IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 4, NO. 3, SEPTEMBER 2000

Guest Editorial
Special Issue on Mobile Telemedicine and Telehealth Systems

Design of a Telemedicine System Using a Mobile Telephone

B. Woodward, *Member, IEEE*, R. S. H. Istepanian, and C. I. Richards

Abstract—This paper describes the design of a prototype integrated mobile telemedicine system that is compatible with existing mobile telecommunications networks and upgradable for use with third-generation networks. The system, when fully developed, will enable a doctor to monitor remotely a patient who is free to move around for sports medicine and for emergency situations.

Proceedings of the 25th Annual International Conference of the IEEE EMBS
Cancun, Mexico • September 17-21, 2003

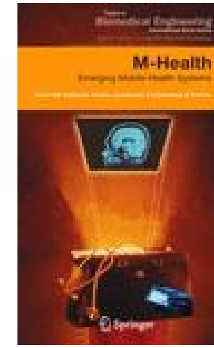
Emerging Mobile Communication Technologies for Health: Some Imperative notes on m-health

Robert S. H. Istepanian[1] and Jose C. Lacal[2]
[1]Mobile Information & Network Technologies Research Center; Kingston University (UK)
[2]Tele-Health Solutions; Motorola / iDEN Subscriber Group (USA)

KINGSTON UNIVERSITY

MINT Research Centre

m-Health Defined



Mobile Health Care (m-Health)

Emerging Mobile Communications ,Network and Sensor Technologies For Healthcare Systems and Applications'

Istepanian (*etal*.), 'm-health: Beyond Seamless Mobility for Global Wireless Healthcare Connectivity ', *IEEE Trans. Information Technology in Biomedicine*, Vol. 8, 4, pp. 405-412, 2004.

IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 8, NO. 4, DECEMBER 2004 405

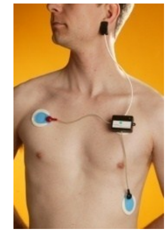
Guest Editorial
Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-Care Connectivity

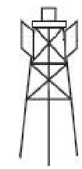
KINGSTON UNIVERSITY

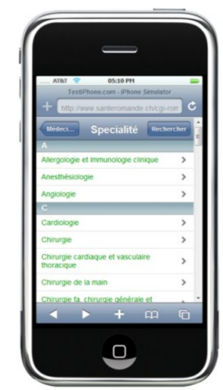
MINT Research Centre

Mobile HealthCare (M-Health)

Wearable and Sensors
(BAN, PANs etc.)

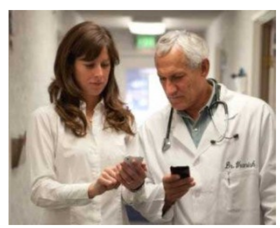




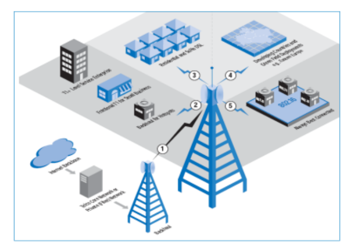


Computing and Internet Technologies

M-health



Information and Communication Systems



Istepanian etal. 2004

KINGSTON UNIVERSITY

MINT Research Centre

Long Term m-health Evolution

Some Interesting ‘ Google’ Statistics:

Google Search- April 2010:

- ‘m-health’ > 212,000,000 Hits
- ‘ wireless healthcare’> 5,830,000 Hits
- ‘mobile Diabetes Management’ > 1,910,000 Hits
- Personalised healthcare > 4,870,000 Hits

Mobile Healthcare Industry Summit 2010

21-22 September 2010

Radisson Blu, London

Opportunities in the global mobile healthcare market are estimated to be worth between $50bn and $60bn in 2010

Source: McKinsey & Company-2010

Examples of global m-health Industry

O2 debuts mHealth division

O2 looks to develop opportunities in healthcare sector with new mHealth unit

Source: mobile news
The UK's leading mobile industry news source

2010

Qualcomm, AT&T Move in on 'M-Health'

The smartphone boom has tech giants and health-care companies eyeing demand for wireless gadgets and software that can deliver health services

Source: Bloomberg Businessweek

2010

intel

MOBILE CLINICAL ASSISTANT

What is it?

Nurses and physicians need better access to patient information at the point of decision to provide quality care more efficiently. The Intel® Mobile Clinical Assistant (MCA) reference architecture was designed in collaboration with healthcare professionals to better access up-to-date patient care records at the point of care and to enable documentation of a patient's condition in real time. The MCA is built for the rigors of the clinical environment and with appropriate software the MCA helps to reduce transcription and medication administration errors, enhance clinician workflows, and enable more informed decisions at the point of care.

KINGSTON UNIVERSITY

Source: Intel

4G Health- The Long Term Evolution of m-health

Interim Definition:

‘The evolution of m-health towards targeted personalised medical systems with adaptable functionalities and compatibility with the future 4G networks’

IEEE TRANSACTIONS ON
INFORMATION TECHNOLOGY IN BIOMEDICINE
A publication of the IEEE Engineering in Medicine & Biology Society
Technically co-sponsored by the IEEE Computer Society

CALL FOR PAPERS: Special Issue on

4G Health
The Long Term Evolution of m-Health

Examples of m-health services In the Middle East

mHealth UPDATE

[Etisalat brings mHealth to UAE (http://www.mhealthupdate.com/?p=1376)]

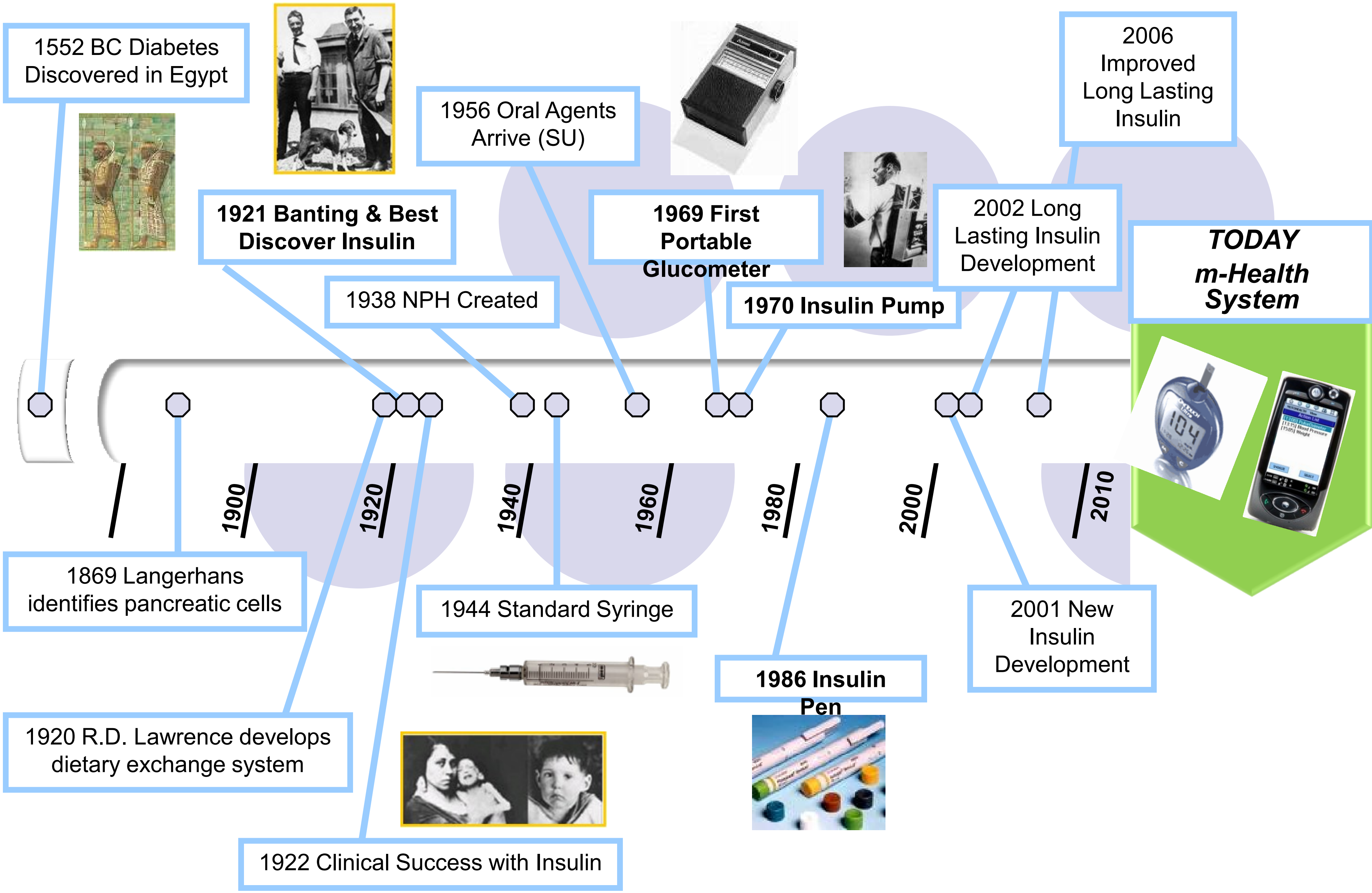
By
Mark
– October 19, 2010**Posted in:** **Product News** (http://www.mhealthupdate.com/?cat=422), **Uncategori:** (http://www.mhealthupdate.com/?cat=1)

UAE-based telecoms provider **Etisalat** (http://www.etisalat.ae/) unveiled a new mobile health service at **GITEX 2010** (http://www.gitex.com/) in Dubai this week. The service will use mobile technology to provide users with personalised and relevant health information via their mobile devices.

KINGSTON UNIVERSITY

MINT Research Centre

Evolution of Diabetes Care



Prevalence in Diabetes in Middle East 2010-2030

	Prevalence (%) adjusted to				Numbers of adults with diabetes (000s)		Mean annual increment (000s)
	World population		National population		2010	2030	
	2010	2030	2010	2030			
Middle-East Crescent							
Afghanistan	8.6	9.9	6.6	7.0	856	1,726	43
Algeria	8.5	9.4	7.4	9.3	1,632	2,850	61
Egypt	11.4	13.7	10.4	12.8	4,787	8,615	191
Iran (Islamic Rep. of)	8.0	9.8	6.1	9.3	2,872	5,981	155
Iraq	10.2	12.0	7.8	9.3	1,176	2,605	71
Kazakhstan	5.8	7.0	5.6	7.1	584	843	13
Morocco	8.3	9.8	7.6	9.7	1,513	2,589	54
Pakistan	9.1	10.5	7.6	9.3	7,146	13,833	334
Saudi Arabia	16.8	18.9	13.6	17.0	2,065	4,183	106
Sudan	4.2	5.2	3.3	4.0	675	1,367	35
Syrian Arab Republic	10.8	13.2	8.3	11.0	974	2,099	56

REF: Diabetes Res & Clini. Prac, 87,2010.

WORLD **DIABETES** FOUNDATION

KINGSTON UNIVERSITY

Diabetes prevalence in the Middle East is among the highest in the world.

MINT Research Centre

Diabetes Expenditure and Prevalence 2010-2030

US dollars (USD)

% of health expenditure

Health expenditure for diabetes in 2010 ('000)

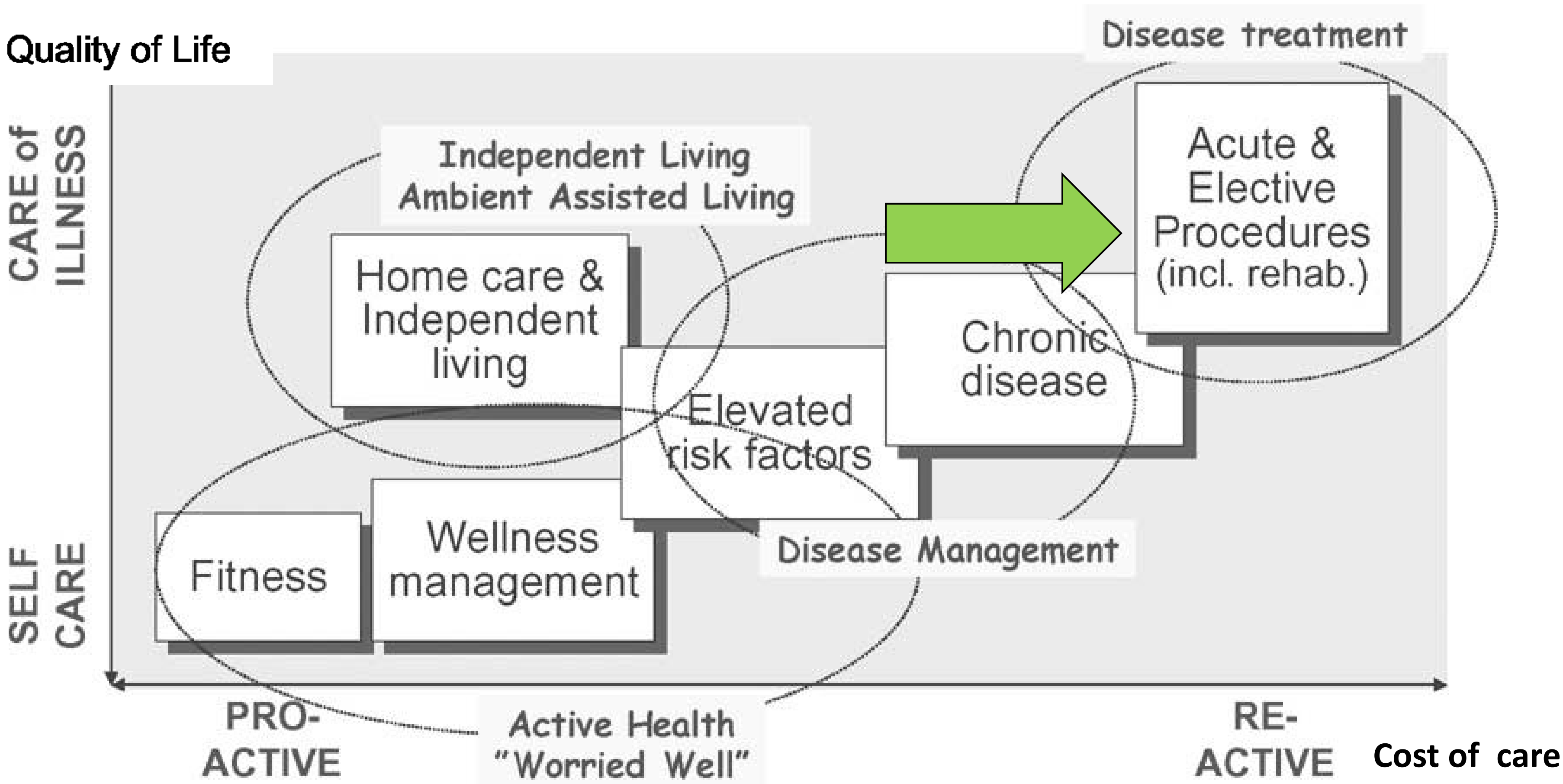
Middle-East Crescent					
Afghanistan	28,625.01	48,537.01	37,212.51	63,098.11	11
Algeria	264,177.99	455,675.29	428,066.19	738,362.75	11
Egypt	557,078.45	936,606.64	1,992,626.78	3,350,169.90	16
Iran, Islamic Republic of	1,048,047.21	1,829,836.94	3,346,829.99	5,843,394.38	11
Iraq	112,917.24	189,086.82	248,800.70	416,631.97	13
Kazakhstan	124,544.95	221,440.09	257,505.10	457,842.36	8
Morocco	206,626.45	358,324.56	598,984.55	1,038,738.60	12
Pakistan	172,512.83	293,537.06	563,541.92	958,887.74	12
Saudi Arabia	1,409,561.98	2,246,478.24	1,793,415.91	2,858,242.41	21
Sudan	34,794.99	63,104.72	64,790.66	117,505.35	6
Syrian Arab Republic	100,497.58	172,057.88	181,225.15	310,268.30	14
Tunisia	138,376.55	238,390.34	417,757.05	719,697.41	12

Health expenditure for diabetes in 2030 ('000)

33.42	43.45	57,170.69	96,398.56	74,321.90	125,318.12
161.86	262.27	461,074.27	803,885.69	747,111.09	1,302,592.56
116.37	416.25	993,584.17	1,673,524.58	3,553,974.13	5,986,068.69
364.98	1165.52	2,186,953.76	3,827,378.56	6,983,809.87	12,222,336.24
96.03	211.59	251,459.85	421,711.11	554,064.07	929,193.97
213.20	440.80	180,564.52	323,799.57	373,329.36	669,477.50
136.59	395.96	356,397.11	623,753.16	1,033,151.18	1,808,183.31
24.14	78.86	332,612.23	566,773.86	1,086,533.27	1,851,461.29
682.50	868.35	2,989,442.48	4,836,078.04	3,803,531.72	6,153,045.73
51.53	95.95	69,958.46	126,256.32	130,267.47	235,097.97
103.22	186.13	220,411.08	377,176.42	397,462.61	680,154.20
229.94	694.18	245,444.05	424,646.87	740,992.48	1,282,003.51

REF: Zhang, P. Etal. : Diabetes Res. And Clin. Pract. , 87,2010

The healthcare continuum and the middle east

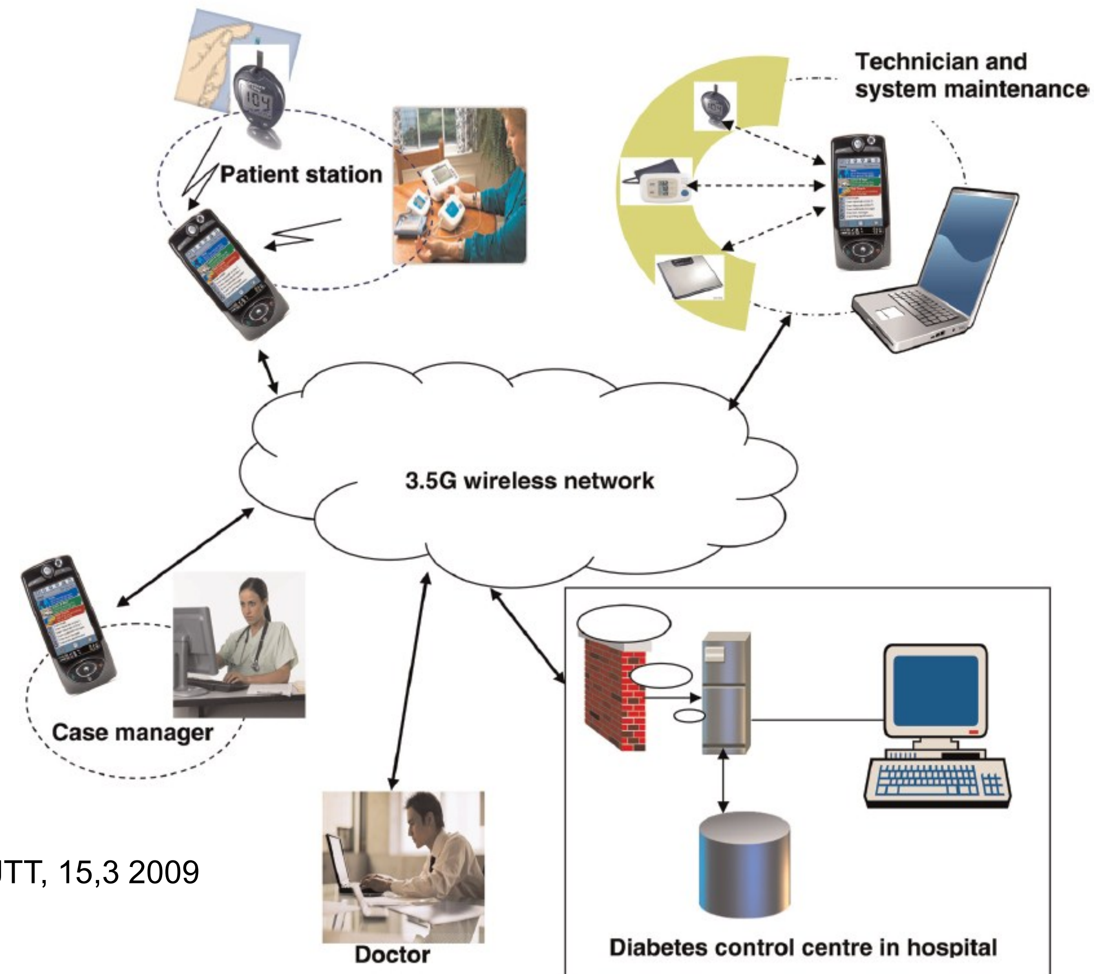


There is urgent need on the use of innovative technologies to alleviate the Healthcare burdens of chronic diseases in the ME region

KINGSTON UNIVERSITY

MINT Research Centre

3G-based m-health Diabetes Management System



Ref: Istepanian etal, JTT, 15,3 2009

KINGSTON UNIVERSITY

Effectiveness of Diabetes Management using Cellular Phone Technologies

Author/ year	Study design	Sample age	Duration in months	Clinical area	Control	Intervention	Measures	Results C vs I or pre–post
Benhamou, *et al.*, 2007	RCT, crossover	30, 41.3 years	12	Type 1 diabetes	No weekly SMS support	Weekly clinical support via SMS	HbA1c SMBG QOL score Satisfaction with life Hypoglycemic episodes No. of BG tests/day	+0.12 vs -0.14%, $P < 0.10$ +5 vs -6 mg/dl, $P = 0.06$ 0.0 vs +5.6, $P < 0.05$ -0.01 vs + 8.1, $P < 0.05$ 79.1 vs 69.1/patient, NS -0.16 vs -0.11/day, NS
Hurling, *et al.*, 2007	RCT	77, 40.4 years	4	Healthy	Verbal advice, during clinic visit, no phone support	Cell phone support, i.e., exercise plan, PA charts, reminders, tailored advice	Change in: PA overall, MET min/week PA leisure time, MET min/week Hours sitting: overall Hours sitting: weekday Hours sitting: weekends Accelerometer epochs BMI Lost % body fat BP, diastolic BP, systolic Perceived control Intention to exercise Internal control External control	 4.0 vs 12, NS -5.5 vs 4.1, $P < 0.05$ -0.17 vs -2.18, $P < 0.05$ 1.4 vs -5.9, $P < 0.05$ -0.2 vs -5.2, NS 208.7 vs 218.5, $P < 0.05$ 0.10 vs -0.24, NS -0.17% vs -2.18%, $P < 0.05$ 0.73 vs 0.69, NS 0.41 vs 0.13, NS -0.37 vs 0.57, $P < 0.01$ -0.01 vs 0.45, $P < 0.01$ 5.85 vs 7.24, $P < 0.001$ 5.33 vs 6.38, $P < 0.01$
Kim, 2007	RCT	51, 47 years	3	Type 2 diabetes	Standard care during clinic visit	Weekly BG-based optimal recommendations via SMS	Group 1: <7%, pre–post: HbA1c FPG levels mg/dl 2HPMG Group 2: ≥7%: HbA1c FPG levels mg/dl 2HPMG	 0.53 NS vs -0.21, $P < 0.05$ -5.8 NS vs -13.4, $P < 0.05$ -3.1 NS vs -56.0, $P < 0.05$ 0.22 NS vs -2.15, $P < 0.05$ 14.5 NS vs -3.3 NS 24.8, NS vs -115.2, NS

REF: Krishna etc. , J. Diabetes Science and Technology, 2,3, 2008

Author/ year	Study design	Sample, age	Duration in months	Clinical area	Control	Intervention	Measures	Results C vs I or pre–post
Kim, 2007 Kim and Jeong, 2007 Yoon and Kim, 2007	RCT	51, 47 years	3 6 12	Type 2 diabetes	Usual care and support	Weekly patient input of SMBG, medication details, diet, and exercise and optimal advice from a nurse via SMS or the Internet	3 months: HbA1c FPG levels mg/dl 2HPMG 6 months: HbA1c FPG levels mg/dl 2HPMG 9 months: HbA1c FPG levels mg/dl 2HPMG 12 months: HbA1c FPG levels mg/dl 2HPMG 3-, 6-, 9-, 12-month change in: total cholesterol triglycerides HDL	0.07 vs -1.15%, $P < 0.05$ 5.4 vs -8.0, NS 14.7 vs -85.1 mg/dl, $P < 0.05$ 0.11 vs -1.05%, $P < 0.05$ 7.3 vs -5.8, NS 13.8 vs -63.6 mg/dl, $P < 0.05$ 0.33 vs -1.31, $P < 0.05$ 12.2 vs -10.5, NS -17.4 vs -66.8, $P < 0.05$ 0.81 vs -1.32, $P < 0.05$ 27.7 vs -10.7, NS 18.1 vs -100, $P < 0.05$ NS NS NS
Franklin , *et al.*, 2006	RCT	92, 8–18 years	12	Type 1 diabetes	CIT- Grp1	CIT+ST - Grp2, IIT+ST- Grp3	HbA1c Self-efficacy Adherence	10.3 vs 10.1 vs 9.2%, $P < 0.01$ 56.0 vs 62.1, $P < 0.01$ 70.4 vs 77.2, $P < 0.05$
Rami *et al.*, 2006	RCT	36, 15.3 years	6,3-month cross-over	Type 1 diabetes	Conven-tional support and paper diary	Monitoring and support by SMS	HbA1c change 3 months HbA1c change 6 months	+1.0 vs -0.15 +0.15 vs -0.05
Kim *et al.*, 2006	Pre–post	45, 43.5 years	3	Type 2 diabetes	N/A	Educational messages	HbA1c Diabetic diet Exercise Medication Foot care	-1.1%, $P < 0.01$ -0.8, days/week, NS 0.9 days/week, $P < 0.05$ 1.1 days/week, $P < 0.05$ 1.1 days/week, $P < 0.05$

Summary of the cellular phone for Diabetes Management

- 18 Studies of the use of cellular phone for Diabetes and Obesity Management.

- 9 out of 10 studies reporting on the HbA1c reported significant improvement among patients receiving education and care support.

- Text messaging provided improved clinically outcomes and increase self management behaviour and self-efficacy.

REF: Krishna etc. , J. Diabetes Science and Technology, 2,3, 2008

Examples of UK Clinical Studies on m-health Diabetes

Evaluation of a mobile phone telemonitoring system for glycaemic control in patients with diabetes

Robert SH Istepanian*, Karima Zitouni*, Diane Harry†,
Niva Moutosammy†, Ala Sungoor*, Bee Tang* and Kenneth A Earle†

*Mobile Information and Network Technologies Centre, Kingston University, London; †St George's Hospital NHS Trust, London, UK

Journal of Telemedicine and Telecare Volume 15 Number 3 2009

Mobile Telemonitoring for Achieving Tighter Targets of Blood Pressure Control in Patients with Complicated Diabetes: A Pilot Study

Kenneth A. Earle, M.D.,[1,2] Robert S.H. Istepanian, Ph.D.,[3] Karima Zitouni, Ph.D.,[1,2]
Ala Sungoor, Ph.D.,[3] and Bee Tang, M.B.A.[3]

DIABETES TECHNOLOGY & THERAPEUTICS
Volume 12, Number 7, 2010

Clinical Results: Baseline demographic, clinical and biochemical data of patients with diabetes randomised to the telemonitoring (TM) intervention or usual care (UC) control group

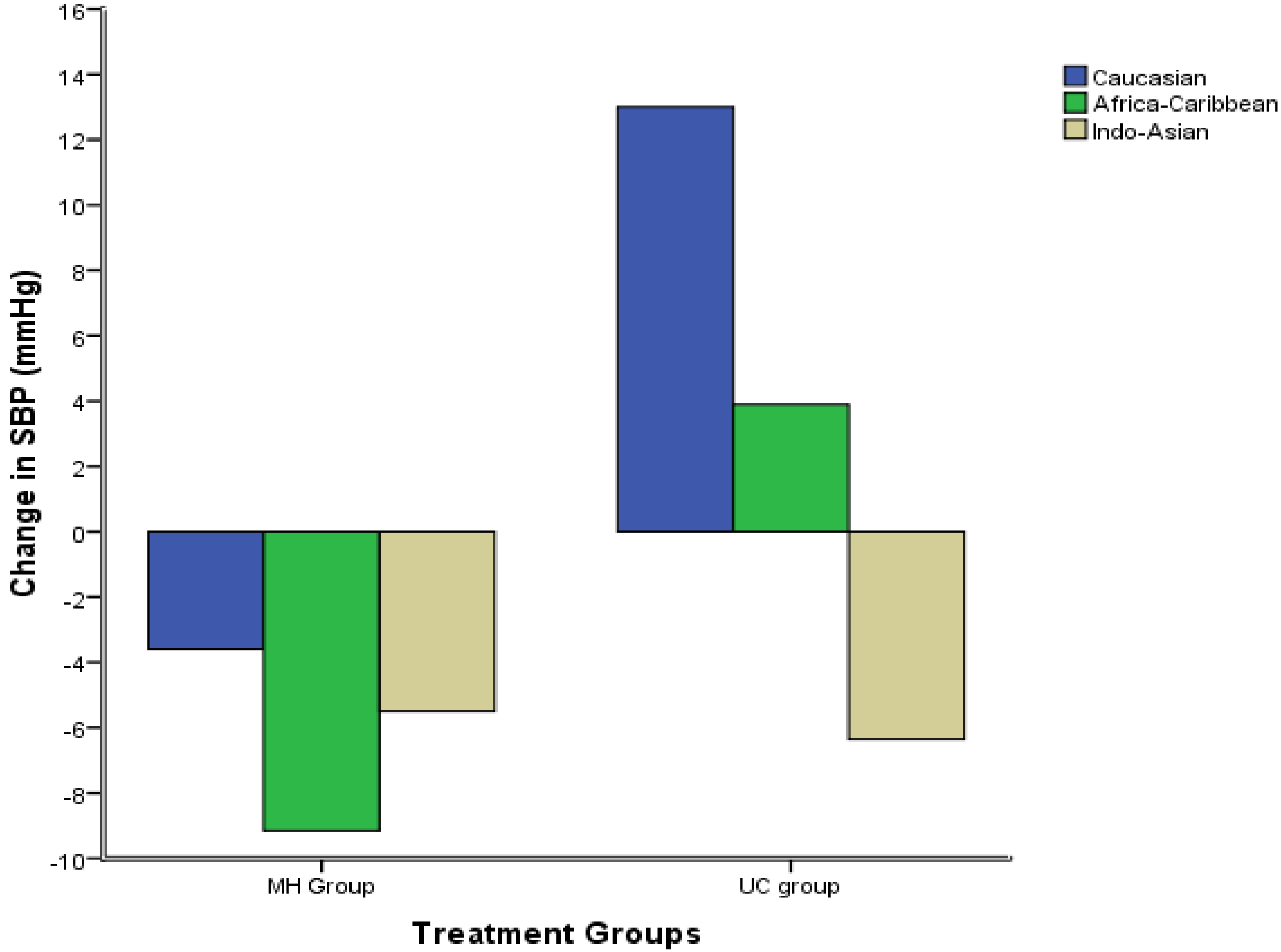
	TM	**UC**	p
N (Total=137)	72	65	
Age (years)	59.6 (12.0)	57.1(13.0)	0.25
Duration of diabetes	13.3 (8.6)	11.7 (8.0)	0.27
Type 1 diabetes *n* (%)	6 (8)	5 (8)	0.85
Type 2 diabetes *n* (%)	66 (92)	60 (92)	
Weight (kg)	79.7 (17.9)	80.1 (20.1)	0.91
Ethnic group *n* (%) :-			
Caucasian	26 (36)	21 (32)	0.79
African-Caribbean	24 (33)	18 (28)	
Indo-Asian	21 (29)	21 (32)	
Other	1 (1)	5 (7)	
HbA1c (%)	7.9 (1.5)	8.1 (1.6)	0.40
Total cholesterol (mmol/l)	4.3 (1.1)	4.4 (1.2)	0.76
Total triglycerides (mmol/l)	1.5 (0.8)	2.1 (2.7)	0.10
HD-cholesterol	1.2 (0.4)	1.2 (0.4)	0.81
LD-cholesterol	2.5 (0.9)	2.5 (0.9)	0.92
Plasma creatinine (µmol/l)	111.1 (102.1)	93.0 (43.1)	0.21
Systolic blood pressure (mmHg)	130.5 (15.1)	131.8 (19.7)	0.67
Diastolic blood pressure (mmHg)	76.9 (9.4)	76.6 (11.3)	0.82

KINGSTON UNIVERSITY

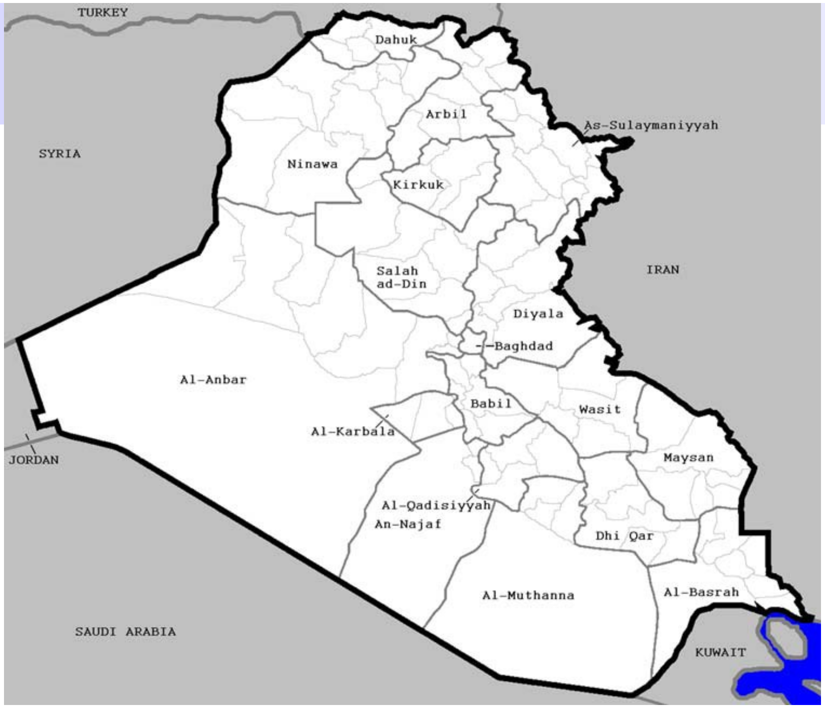
MINT Research Centre

REF: Earle, K. , Istepanian, R., etal., Diabetes Technology and Theraputics, 12,7, 2010

The mean decrement in SBP



REF: Earle, K. , Istepanian, R., etal., Diabetes Technology and Theraputics, 12,7, 2010



E-health Technology for Improving Medical Education and Healthcare Research in Iraq 2010-2012

cara
council for assisting refugee academics

DelPHE Iraq

BRITISH COUNCIL

KINGSTON UNIVERSITY

CARDIFF UNIVERSITY

Baghdad University Medical School
Basra University Medical School

MINT Research Centre

There is urgent and major need for m-Health in Iraq

M-health

Modern Mobile Technologies

m-health Issues and challenges in the ME Region

1- Currently most of the likely m-health applications in ME should focus on the ‘ Process’ of adopting m-health in the region.

2- Clinical ‘ buy in’ is critical and the technology is the enabler not the solution.

3- Define the clinical priorities and Iraqi patients population needs .

4- Engage the governments in the region to educate them on the benefits of the m-health sector for the economy and for the perspective national healthcare systems

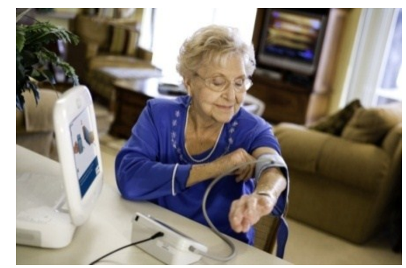
5- Engage the also understand and define the relevant stake holders roles, Teleco operators and interested private sector players.

6- Pilots in the region need to be based on more on evaluating the impact of m-health for best healthcare outcomes and less on user (patients doctors, nurses etc.) satisfaction.

Future 4G-health Platforms for Diabetic care

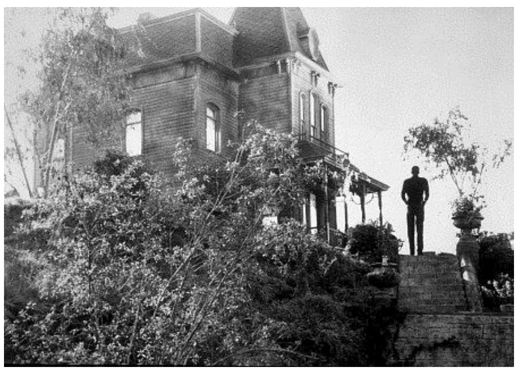
- **4G-Health (Future network Technologies)**
- 4G Health Information systems
- **Medication Optimization**

- Remote Patient Monitoring
- **Innovative Assistive Technologies**



- Remote Training and Supervision
- Cognitive Fitness and Assessment
- Diabetes Social Networking concepts

Finally!



The length of a film should be directly related to the endurance of the human bladder.

- Alfred Hitchcock

MOMED

THANK YOU

Robert S. H. Istepanian
r.istepanian@kingston.ac.uk

http://cism.kingston.ac.uk//mint

KINGSTON UNIVERSITY

MINT Research Centre