

HUMS Ohidas Toolkit, the PHC, and HUMS *Tanya Pakar*: A multi-level, vertically integrated digital health Promotion, Primary Prevention and telemedicine provision programme

Nicholas Pang¹, Helen Benedict Lasimbang^{1*}, Mohd. Hanafi Ahmad Hijazi², Mohd Nizar Bin Hamild¹, Mohd Azhar Bin Dris¹, Wendy Shoesmith³, Rafiqul Islam Maruf⁴, Naoki Nakashima⁴, Yokota Fumihiko⁴

Hospital Universiti Malaysia Sabah, Universiti Malaysia Sabah, Malaysia¹
Pusat Pengurusan Data dan Maklumat, Universiti Malaysia Sabah, Malaysia²
Fakulti Perubatan dan Sains Kesihatan, Universiti Malaysia Sabah, Malaysia³
Medical Information Centre, Kyushu University Hospital, Kyushu University, Japan⁴

Corresponding Author: 1*



Keywords:

ohidas, wellness, telemedicine, smart health, PHC

ABSTRACT

Digital health has become an increasingly salient point in today's ever-changing healthcare landscape. At the same time, the Internet is democratising information related to healthcare, as a quick search about simple healthcare conditions will yield hundreds of thousands of healthcare-related search results. UMS University Hospital (HUMS) was established and is poised to become the first Smart Hospital in the State of Sabah. As part of the overall branding and implementation of HUMS as a smart hospital, an app was conceptualized called OHIDAS ("health" or "wellness" in the local Kadazan language). OHIDAS is a mobile application that will serve two major objectives namely promoting healthy lifestyle practices among the community and advocating for health screening prior to illness to maintain health and well-being in our communities and prevent illness caused through NCDs. There are four stages of OHIDAS; health promotion and primary prevention, telemedicine, capturing of patients' bioinformatics, and full integration of clinical care with mobile application. OHIDAS has been integrated with the Portable Health Clinic of Kyushu University and a proprietary telemedicine system established by HUMS, which were both developed and expedited in view of the Covid-19 pandemic. In conclusion, OHIDAS will help to reinforce HUMS's corporate identity through HUMS's core values of "compassionate" and "empowering". OHIDAS has the potential to become a highly effective tool for health promotion and primary prevention.



This work is licensed under a Creative Commons Attribution Non-Commercial 4.0 International License.

Digital health has become an increasingly salient point in today's ever-changing healthcare landscape. With the advent of personalised Information and Communication Technology in everyone's pocket via the advent of smartphones, healthcare is becoming ubiquitous and not trapped behind the cloistered walls of hospitals. However, in Malaysia and in lower and middle-income countries (LAMICs) in general, there is a lack of smartphone related applications that have a specific purpose in increasing health promotion and assessing related bioinformatics. This is a waste of potential, as modern smartphone processing power and capacities, including simple cameras and motion sensors, are sufficient to fulfil the role of many proprietary devices, potentially providing a valuable Internet of Things (IoT) solution [1]. There are many reasons this could be so, including but not limited to: the high cost of producing comprehensive healthcare related applications and the limited potential of revenue without a large-scale subscription model and pool of potential customers; the lack of backing from a large-scale hospital, be it a private or ministry of health-related facility; and the lack of ethics or medicolegal guidelines regarding such applications [2].

Moreover, Internet information bases may be convenient but they remain generic. Each illness presents in each unique individual with specific illness profiles, including but not limited to unique symptoms, functional impairments, specific side effects to treatments, and very different subjective illness experiences and psychological sequelae. Hence, there is high importance in providing targeted illness health advice and personalised treatment plans, as it will increase adherence levels [3].

Universiti Malaysia Sabah (UMS) is the only comprehensive public university in the state of Sabah on Borneo Island, Malaysia. As part of its plans to be a healthcare provider and contribute to the state of Sabah, the UMS University Hospital (HUMS) was established and is poised to become the first Smart Hospital in the State of Sabah. In this day and age, a hospital needs to diverge from the traditional model of hospital providership, where patients come to hospitals to seek care on a one-off or as needed basis, then have a long hiatus till the next encounter. This does not serve to reinforce health-promoting behaviours and reduces the sense of collaboration and partnership with hospitals, instead leaving the hospital and patient in a paternalistic model. Also this model is not suitable for chronic illnesses e.g. hypertension and diabetes, which rely on patients making incremental steps for behavior change and adoption of medication adherence behaviours and healthy lifestyles in the long run, rather than single interventions in hospitals that can excise or limit the illness [4]. Much of this can be countered by creating a mobile application. Instead of putting patients in hospitals, we are essentially able to put hospitals into patients' pockets. There will be continuous care provided in both directions envisioned: from hospital to patient (via health promotion and primary prevention information), from patient to hospital (via bioinformatics), and most importantly, collaboratively with patient and hospital (through personalized care plans and their implementation via direct contact with clinical care teams in-app). As part of implementation of HUMS as a smart hospital, an app was conceptualized called OHIDAS ("health" or "wellness" in the local Kadazan language). OHIDAS is a revolutionary idea in the creation of a SMART HUMS, as it will be a ground-breaking mobile application that will serve two major objectives, namely to promote healthy lifestyle practices among the community, and to advocate for health screening prior to illness to maintain health and well-being in our communities and prevent illness caused through NCDs.

In the "new normal" espoused by Covid-19 and its multiple ramifications on social distancing, transformation of healthcare norms, and decongestion of hospitals and healthcare facilities, OHIDAS has an even more integral role. By uberising healthcare and transforming primary prevention and healthcare promotion from a face-to-face activity performed in mass gatherings or in classroom settings, all heavily proscribed under current lockdowns and new norms, into an activity easily performed in the comfort of one's home, village or location with the aid of one's smartphone, it allows healthcare to proceed

relentlessly. Moreover, as OHIDAS includes in its mid-level implementations telemedicine facilities, it will allow people with chronic health issues who are hampered from movement and health-seeking behaviours due to lockdowns equitable access to tertiary healthcare providers via telemedicine software, remote dispensing, and judicious use of online monitoring systems.

1.1 Theoretical Framework for OHIDAS

OHIDAS is strategically poised to directly affect the way patients think, feel and behave in terms of their health, thus its foundations have to be established with firm support. To that length OHIDAS is not a flight of fancy but is grounded in theories of health behaviour – self determination theory [5]. [6] describe 3 basic psychological needs that are central to the model of self-determination: autonomy (feeling of being the origin of one’s behaviours), competence (feeling effective), and relatedness (feeling understood and cared for by others). These three needs represent “psychological nutrients that are essential for ongoing psychological growth, integrity, and well-being” [6]. Support and subsequent satisfaction of these needs provides a higher quality of psychological energy that is predicted to, and has been empirically confirmed to, motivate the initiation and long-term maintenance of health behaviors [5]. This leads to better mental and physical health [7]. Meta-analytic level evidence suggests statistically significant positive relationships between the two pillars: psychological need satisfaction and autonomous motivation to beneficial health outcomes [5]. Hence the activities and tools that propose to be made available in the OHIDAS toolkit will ideally be able to incorporate principles and aspects of SDT on top of the values HUMS espouses.

1.2 Focus on Primary rather than Tertiary Prevention

One paradigm shift in terms healthcare behaviours is a move away from tertiary prevention and towards primary prevention [8]. Provision of tertiary prevention, i.e. reduction of symptoms or morbidity when illness has already begun, is expensive, usually intractable with difficult symptoms to treat, and causes high level of risk, side effects and morbidity [9]. Primary prevention on the other hand, where we take active steps to prevent illness from beginning by promoting wellness behaviours, e.g. diet, lifestyle, exercise, provision of good mental health, and tackling burnout and stress management, is by and large more cost-effective from a public health point of view, and has minimal or manageable risk and side effect profiles [10].

This is because staying “in wellness” involves sustainable behaviours of eating, living, and exercising well. Hence, they are easier to maintain as a “lifestyle” rather than tertiary interventions which are “firefighting” in nature. This increases self-determinism in terms of relatedness and competence. Patients who feel they have mastery about their own health behaviours and feel more related to primary teams when they provide higher levels of primary prevention advice, are more likely to then behave self-deterministically.

One major obstacle to delivering healthcare, that afflicts both low and middle-income countries (LAMICs) and developed nations alike is continuity of care [11]. Due to increasing consumerization of healthcare, mobility of individuals for employment in a globalised world, and lack of a continuous general practitioner to attend, populations falling ill tend to doctor-shop and attend multiple practitioners [12]. Hence many people do not have a centralised file in one place, have multiple records in multiple centres, and do not know what illness they have, what medications they are on, or what treatments they have undergone. Hence different centres are forced to repeat different investigations unnecessarily, at great cost and potential risk to the patients. OHIDAS increases self-determinism in terms of autonomy. By patients knowing they have control over storage, transmission, and communication to other parties of their own health information, rather than waiting for a doctor or a centralised filing system to do so, people start behaving in more self-deterministic ways with regards their healthcare.

Another issue is the lack of reliable healthcare information provided to the patient [13]. Patients frequently use Google but may yield non-evidence-based or circumstantial literature. Moreover, medicine is an inexact science; scientifically based healthcare advice that is relevant to a “textbook presentation” of asthma may not be relevant to the vast majority of individuals who have presentations dissimilar to the norm. Targeted healthcare related advice that is directly relevant to patients’ presentations and illness patterns is far more useful than delivering generic healthcare advice.

In reflecting HUMS’s corporate values, targeted healthcare advice can be integrated to the “collaborative” and “empowering” core values that our HUMS requires. Targeted advice also will provide patients with the relatedness that self-determinism needs. When people are given more accurate feedback from their healthcare providers that directly relate to what they have, they will then behave more self-deterministically towards good health.

In an unreleased report commissioned by HUMS for the value proposition of its new hospital, 14.4% of Sabahan hospital readmissions have been found to be avoidable for NCDs eg diabetes. In an ideal world, 24-hour home-based nurses tending to post-discharge patients with home-care teams would perform necessary monitoring, deliver relevant healthcare advice, and provide essential preventative care that would reduce readmission. However, due to logistics, transport availability, and shortage of staff, this is not feasible without huge structural changes at national level to healthcare HR budgets. Part of this can be delegated to the Internet and healthcare applications.

2. Methods

The implantation of this application was planned to be carried out in multiple stages. This is because of various reasons. Firstly, there are few medicolegal guidelines on how to implement an application that collects patient data, and this has implications in both emergencies and in terms of improper use of big data with regards research ethics. The only recent guidelines from the WHO mainly target digital interventions, but mainly focusing on child, maternal, and reproductive health interventions [14]. Secondly, it is envisioned the project will be sustainable and organic as per HUMS’s five key core values, and instead of implementing an application straight up without any process of self-correction through negative feedback, it would be better to allow an app to evolve from simple to complex levels, while taking into account user feedback along the way on what works and what does not.

The four stages are hence as follows. The first stage will be an OHIDAS mobile app focusing predominantly on health promotion and primary prevention. The second stage will feature telemedicine functionality, the third stage will add on bioinformatics directly linked to the OHIDAS application, whereas the fourth and final stage will involve direct communication both verbally and bioinformatically with live clinical teams.

In the first stage, the OHIDAS app aims to promote healthy lifestyle practices among the community, and advocate for health screening prior to illness to maintain health and well-being in our communities and prevent illness caused through non-communicable diseases (NCDs). Medications, diagnoses, previous procedures, or imaging done will be recorded directly in the OHIDAS. If this information is from HUMS, it will be directly downloaded from the existing Total Hospital Information System. For non-HUMS information, e.g. patient visits to private GPs or district hospital, there will be a mechanism developed to capture the encounter. We envision a simple drop-down form with typing capabilities which will allow doctors out of HUMS to capture the basic information as above. For imaging or complex information like blood result panels, we envision a simple camera-phone “scrapbook” which can take picture of that

information and append it to the drop-down form as an attachment.

Also, adherence to medications and treatments is one of the most difficult parts of healthcare delivery; studies estimate that between 60% of patients with chronic illness are unable to adhere to the complex schedules available [15]. This especially concerns individuals on polypharmacy and individuals on mixed oral and injectable schedules. Hence medication aid systems are an integral part of OHIDAS. There will be a “virtual” Dosette box screen with information about medications due and doses, and a reminder will be integrated into the phone, either through Google or via a propriety app reminder. This reminder can be not merely text-based but also pictorial, to cater for less educated or those with more visual intelligence. This also reinforces names of medications.

Also, incorporated in the first stage is shared decision making (SDM) and collaborative care. Patients and healthcare providers will discuss risks and benefits of treatments and other associated care plans as equals, and patients and doctors will come to a consensus [16]. OHIDAS is a valuable vehicle in making SDM happen. The app will provide visual aids for various illnesses, e.g. diagrams, charts, risk/benefit tables, and latest evidence base summarized into easily digestible charts, that will allow patients to truly be empowered to make shared decisions. Subsequently, shared care plans can be integrated into the app, and patients can review them at their leisure. After discussing aspects of care plan, this can be documented into OHIDAS and intelligently linked via clickable icons to healthcare information.

It can be also valuable at the point of end of life or loss of capacity. Advance directives are important to document what emergency interventions should be denied due to cultural or religious reasons. One more important form of advance directive comprises of care plans in the event of loss of capacity that suggest “how an individual would have wanted to be treated”, e.g. choices of medications, physical or biological therapy, patients’ own perceptions of what works and what has not, and patients’ ideas, concerns and expectations. Do not resuscitate (DNR) requests, allergies and other relevant pertinent information can all also be recorded.

To aid knowledge retention, gamification will be incorporated. The app will feature simple computer games eg identifying symptoms, quizzes, which will facilitate learning about targeted disease. Research has shown gamification to facilitate learning and expedite retention of information compared to didactic methods or in-hospital lectures or psychoeducation [17]. At the same time, gamification can be extended to availability of in-app mindfulness exercises and recordings in multiple languages and also regular simple DASS screenings for depression, anxiety and stress, which can be recorded serially. Emergency linkages will also be available in-app via a GPS tracker which alerts users to nearest healthcare facilities. OHIDAS aims to incorporate virtual worksheets targeted to illness and severity, eg depression worksheets can focus on CBT or mindfulness and can incorporate aspects of gamification as below. Other things are electronic mood diaries, which can be useful for both mental health disorders and general stress management. They allow people to record mood changes and immediate stressors, to see patterns and determine modifiable factors if recorded in diary repeatedly.

To cater for the wide cultural landscape of Sabah, English and Malay/Kadazandusun resources will be available from onset depending on patient’s preferred language setting, will provide relevant resources. Also, for a lot of these locally available materials, they will be curated by app content creators rather than downloaded or syndicated from other sources, but appropriate citations will be provided where necessary.

3. Results

Initially, it was anticipated that the OHIDAS platform would need to be carefully curated and would need extensive levels of ethical clearance before proceeding, as there are still no telemedicine guidelines that have been clearly drawn up in this region other than Malaysian Medical Council preliminary guidelines. However, due to the necessity to expedite provision of telemedicine during the unanticipated and sudden Covid-19 societal lockdown and restriction of movement, a system called *Tanya Pakar* HUMS (Ask the Specialist, HUMS) was developed.

This system was set up to provide telemedicine consults in various branches of medicine, including internal medicine, paediatrics, psychiatry, public health, pain management, and addiction medicine. To overcome privacy concerns, the system uses the university proprietary Miruba internal video conferencing software, as there have been multiple cyber-security complaints with other publicly available software. The system has been highly relevant, as it has reduced barriers to access telemedicine and conventional medicine, increased the catchment of patients for Hospital UMS, and also provided increased visibility for our services especially less-known services like pain management and addiction services.

At the same time, HUMS has collaborated with a team from Kyushu University which have developed a highly viable rural medicine toolkit called the Portable Health Clinic (PHC) [18], [19], which has been demonstrated to be instrumental in South Asian countries in reducing the treatment gap between the urban areas and rural areas distant from traditional medication provisions [20]. The PHC will be rolled out in 5 villages in the Kudat district, 3 hours drive from a specialist tertiary hospital, and has received the blessing and collaboration of the Health Department of Kudat district. It will be a highly innovative project, allowing provision of specialist quality healthcare services to people in rural areas off the grid. The PHC intends to train up community health representatives (CHRs) in each village involved. Their roles will be as follows: to provide access to high quality specialist healthcare services to remote rural villages via teleconsultation, to provide access and linkage to local medication dispensaries and health facilities, to reduce the treatment gap in common non-communicable diseases, to provide training to other relevant villagers eg church/mosque leaders in essential psychological interventions, to participate in local health clinic team meetings about their village's healthcare, and discuss indicated individuals with difficult health concerns.

Their terms of reference of the CHRs will then be as follows. Firstly, they will be dealing with gatekeeping, and will be trained to use IT facilities to access *Tanya Pakar* HUMS, which will be used to contact a specialist or medical officer via telemedicine. Secondly, they will be able to interpret common results such as blood pressure, pulse, sugar, and pick up common signs and symptoms. Moreover, they will also be upskilled in basic life support skills (BLS), hence all CHRs will be expected to be trained in BLS by the UMS rural medicine clinic in Kudat (RMEC) and updated periodically. Importantly too, they will become part of formalised referral pathways, as they will be trained to triage patients with the help of the PHC, to know which patients to refer to Hospital Kudat, which patients just need RMEC consultation, and which patients can be seen by themselves and dispensed basic medications. Last but not least, they will participate in team meetings, as there will be a monthly (or as indicated) team meeting with the doctors and healthcare staff at RMEC Kudat, where they will be able to bring up their concerns about particular members of their community, and discuss common issues. As one last value added proposition, they will be involved in delivering psychological interventions as part of a Train the Trainer system where over time, they will learn Ultra Brief Psychological Intervention skills adapted from Shoemith and James's 2018 module [21], and slowly train other key workers in the village. Anything beyond their capability will be referred to see a psychiatry trained doctor at RMEC by appointment, who will then refer on to Hospital Kudat for admission if indicated. From a logistics point of view too, in order to facilitate village residents, they will be in charge of logistics in terms of sending people to certain designated pharmacies or health clinics to collect

medications, for patients who have been suitably consulted on telemedicine

The Portable Health Clinic will hence clearly be synergistic and augmented with the *Tanya Pakar* interface. Hence, this will represent an exciting new collaboration between Kyushu University and Hospital UMS. The existing PHC system, as hardware and infrastructure, will be augmented with the software and expertise of having potentially 120 experts in various branches of medicine from the Faculty of Medicine and Health Sciences available on *Tanya Pakar* UMS on teleconferencing, direct to the most rural of villages in Sabah.

In the long run, for this model to be viable, *Tanya Pakar* HUMS will be widened at hospital level to patients having reasonable video connections and reasonable levels of insight into illness with documented logistical or disability issues, they can begin telemedicine consults. This would be more restricted to patients who are well and may just need long-term dispensation of medications, strokes, diabetes or endocrine illness, and perhaps for lower-grade complaints. To corroborate on the history and for general examination purposes, for future reference, it is suggested community nurses would be the port of call, who are trained up in the relevant speciality examinations. If community nurses feel there are any points of discrepancy, then they would request for a referral back to the hospital for clarification.

Stage 3: Incorporation of Bioinformatics

This stage will incorporate a consented form as “big data” is potentially being collected. Patients’ pulse, oxygen saturations, number of steps walked per day can be automatically monitored via the app. They can also personally use it to take certain recordings: perhaps input “food eaten” via pictorial methods or smart searches for the app to automatically calculate number of calories eaten, record units of alcohol taken (again via the app’s smart pictorial methods), or track self-monitored BP or glucose at home. This can then be integrated with the above health promotion and primary prevention methods.

Also, should the above be linked to the HUMS central systems, it can become part of overall monitoring patterns for when patients come for appointments. It can be directly integrated into the patient’s “home notes” when they come for visits. So, instead of relying on individual agency to bring bits of home scrawled paper, or printed worksheets/serial charts which tend to get torn, allowing data to be incorporated directly from a patient’s bedside will allow clinic reviews to not be based on one cross-sectional review.

4. Discussion

Various ethical pitfalls need to be ironed out especially at the later stages of the project. As researchers at the same time, there is big data involved which is valuable as most Sabahan data has been captured on small unrepresentative sample populations or from statistical surveys from healthcare sites, without individual data points. However, this is a repository of big data that can allow us to do the same kind of large scale retrospective studies that have sufficient power. Hence patients need to be adequately consented before embarking on this kind of data collection venture. Also, there is a high possibility of data breaches and hacking therefore highly secure biometric security systems need to be installed from the onset.

Moreover, patients who are unwell according the app may fail to respond or are unresponsive to our reminders and attempts to contact. There is a risk of potential litigation so early measures need to be put in place for that. Also, there are patients deliberately withholding certain aspects of vital medical history as this app is an “opt-in” application hence only aspects patients intend to divulge should be divulged.

4.1 Potential rights to devolve to family

There is potential of family rifts and disharmony if certain confidential information is revealed from inadvertent unlocking of app, hence a protection clause against HUMS needed at onset. Also, there is a potential need for family member to unlock app if individual is comatose or has no capacity and is in non-HUMS hospital. They will need to have named biometric assistant or emergency authentication measures at onset

5. Conclusion

OHIDAS has the potential to become a highly effective tool for health promotion and primary prevention. This is because it is poised to be a few things that others are not. It can be highly tailored to patients' illnesses, personalised care plans, ideas, concerns and expectations, which is very different from generic care plans that may be downloaded from other more mass-market apps. Also, it has a high level of ethnic and cultural sensitivity, as there will be a large team of content curators to provide Malay language content, and in the future, other ethnic languages. Moreover, OHIDAS can allow our branding to permeate the local market before the official launch of HUMS. It will allow our potential customers to absorb our culture and ethos, which will be very different from existing paternalism-oriented approaches. Instead, there will be a shared care, collaborative model which empowers, connects, and makes patients autonomous from the onset. At the same time, with the integration of collaboration from Kyushu University's PHC system to facilitate rural teleconsultation, and HUMS's very own Tanya Pakar system to link up rural areas to the specialists in the academic side of the university, OHIDAS can take on a more ubiquitous, multifarious and omnipresent role, as it is able to provide healthcare in many different dimensions of the technological sphere.

Importantly, HUMS OHIDAS has to be economically and financially sustainable. Hence, it will be crucial to conduct research regarding the health economics of OHIDAS to establish what whether using OHIDAS has financial ramifications in preventing or delaying the onset of a certain number of non-communicable diseases. Hence, a pilot trial of intervention versus control groups for a small group of patients in the university health care system, and in the long run, there will be big data collected from the application that will be available for good quality retrospective studies of colossal sample sizes. However, all this will require a solid medicolegal base, and more focus groups will be crucial in determining the direction OHIDAS is going to take in the context of the university hospital ecosystem.

Acknowledgements

We acknowledge all the healthcare workers who have been or are in the process of being trained for the PHC and the team behind the telemedicine project.

Compliance with Ethical Standards

There are no potential conflicts of interest.

6. References

- [1] Michie S, Yardley L, West R, Patrick K, Greaves F. Developing and evaluating digital interventions to promote behavior change in health and health care: recommendations resulting from an international workshop. *J Med Internet Res*. 2017;19(6):e232.
- [2] Labrique A, Vasudevan L, Weiss W, Wilson K. Establishing standards to evaluate the impact of integrating digital health into health systems. *Glob Heal Sci Pract*. 2018;6(Supplement 1):S5--S17.
- [3] Fisher WA, Fisher JD, Harman J. The information-motivation-behavioral skills model: A general

social psychological approach to understanding and promoting health behavior. *Soc Psychol Found Heal Illn.* 2003;82:106.

[4] Phillips LA, Cohen J, Burns E, Abrams J, Renninger S. Self-management of chronic illness: The role of 'habit' versus reflective factors in exercise and medication adherence. *J Behav Med.* 2016;39(6):1076–91.

[5] Ng JYY, Ntoumanis N, Thøgersen-ntoumani C, Deci EL, Ryan RM, Duda JL, et al. Self-Determination Theory Applied to Health Contexts : A Meta-Analysis. 2012;

[6] Deci EL, Ryan RM. The " what" and " why" of goal pursuits: Human needs and the self-determination of behavior. *Psychol Inq.* 2000;11(4):227–68.

[7] Ryan RM, Patrick H, Deci EL, Williams GC. Facilitating health behaviour change and its maintenance: Interventions based on self-determination theory. *Eur Heal Psychol.* 2008;10(1):2–5.

[8] Jacka FN, Mykletun A, Berk M. Moving towards a population health approach to the primary prevention of common mental disorders. *BMC Med.* 2012;10(1):149.

[9] Health MI of P. National Health and Morbidity Survey 2015. 2015.

[10] Maciosek M V, Coffield AB, Edwards NM, Flottemesch TJ, Goodman MJ, Solberg LI. Priorities among effective clinical preventive services: results of a systematic review and analysis. *Am J Prev Med.* 2006;31(1):52–61.

[11] Cheng S-H, Hou Y-F, Chen C-C. Does continuity of care matter in a health care system that lacks referral arrangements? *Health Policy Plan.* 2010;26(2):157–62.

[12] Wang M-J, Lin S-P. Study on doctor shopping behavior: insight from patients with upper respiratory tract infection in Taiwan. *Health Policy (New York).* 2010;94(1):61–7.

[13] Gottlieb S. Health information on internet is often unreliable. *BMJ.* 2000;321(7254):136.

[14] Organization WH, others. WHO guideline: recommendations on digital interventions for health system strengthening: web supplement 2: summary of findings and GRADE tables. 2019.

[15] Dunbar-Jacob J, Mortimer-Stephens M. Treatment adherence in chronic disease. *J Clin Epidemiol.* 2001;54(12):S57--S60.

[16] Barry MJ, Edgman-Levitan S. Shared decision making—the pinnacle of patient-centered care. *N Engl J Med.* 2012;366(9):780–1.

[17] Nevin CR, Westfall AO, Rodriguez JM, Dempsey DM, Cherrington A, Roy B, et al. Gamification as a tool for enhancing graduate medical education. *Postgrad Med J.* 2014;postgradmedj--2013.

[18] Ahmed A, Inoue S, Kai E, Nakashima N, Nohara Y. Portable Health Clinic: A pervasive way to serve the unreached community for preventive healthcare. In: International Conference on Distributed,

Ambient, and Pervasive Interactions. 2013. p. 265–74.

[19] Ahmed A, Rebeiro-Hargrave A, Nohara Y, Kai E, Ripon ZH, Nakashima N. Targeting morbidity in unreached communities using portable health clinic system. *IEICE Trans Commun.* 2014;97(3):540–5.

[20] Hossain N, Yokota F, Sultana N, Ahmed A. Factors influencing rural end-users' acceptance of e-health in developing countries: a study on portable health clinic in bangladesh. *Telemed e-Health.* 2019;25(3):221–9.

[21] Nicholas P, Ping T, S WD, Sandi J, Melissa N, H N, et al. Ultra Brief Psychological Interventions for COVID-19 Pandemic : Introduction of a Locally-Adapted Brief Intervention for Mental Health and Psychosocial Support Service. 2020;27(2):51–6.