Acceptance of Virus Radar

Abstract

Communicable diseases are a perplexing problem in the operation of healthcare facilities. We outline the advantages of an automated warning system that inhibits the spread of infectious agents. The User Device is based upon Wireless Local Area Network equipped mobile telephones. Acceptability of the virus radar User Device and the associated Contagion Vigilance Service was investigated. A survey was distributed describing the Device and Service, and the functions of an operational system, including warnings of contagion risks and privacy protection methods. Fifty-nine persons, both employees and patients, indicated their willingness to pay and their status. The most representative individual was willing to pay €50 a month for the Service and €150 for the Device, out of a monthly salary of €300. Many persons with lower education/income responded inconsistently, indicating poor understanding. These persons tended to respond with lower values, which, however, still indicated a substantial willingness to pay. Thus, we conclude that acceptability will be high, particularly among those with higher education/income.

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Keywords

Preventative health services, patient data privacy, real-time systems, distributed data bases, epidemiology

“ The level of support indicated could justify a System of this type, even if the installation and operational expenses had to be supported by user payments alone. ”

1. Introduction

Healthcare Associated Infections (HAIs) are a growing global health issue. Certain resistant organisms, initially characterized in the care environment, such as Methicillin-Resistant Staphylococcus Aureus (MRSA), have become an increasing problem in the community as well. MRSA is now considered as an accelerating pandemic[1]. While healthcare environments have become breeding grounds for such resistant organisms (The proportion of Staphylococcus Aureus that is MRSA in American intensive care units increased from 2% in 1974 to 64% in 2004[2]), more effective translation of basic discoveries into clinical application could not only prevent this, but could also make these environments the first line of defense against these emerging threats. However, this requires resolving knowledge gaps in implementation. Peters[3] has pointed out that one of the unresolved questions is, "Why can't we control Hospital Associated - MRSA despite knowing how to do it?"

The proposed Vidar virus radar User Device is a cellular and Wi-Fi (Wireless Local Area Network) mobile telephone with supplementary functions. It periodically notifies a location database of its position. If its position has been marked as adjacent to a contaminated area, the user receives an alert on the phone. This permits the user to take evasive or protective actions, thereby reducing the risk of infection. Security features of the Contagion Vigilance Service make tracking of users impossible. The Vidar virus radar User Device and the associated Contagion Vigilance Service is a more advanced version of a proposed Contagion Management System[4], since it includes location-specific tracking. While this permits localization of infectious agents transmitted independently by direct person-to-person contact, it also increases privacy concerns and complicates needed security technologies. (The term "Vidar" was selected as the short name for our proposed Project, since it was a convenient contraction of "virus radar" and it was also the name of an old Nordic god.)

There is organized resistance to radio frequency identification (RFID) tracking technology among the general public. Computer users are known to limit their online purchasing activity considerably due to security and privacy concerns. On the other hand, both RFID/Wi-Fi tracking and collection of sensitive data are routine activities in some hospitals. Given the unique combination of these two technologies in the Vidar Project, it was important to estimate acceptability of the procedures and the effectiveness of our educational materials.

The objective of this study was a preliminary evaluation of acceptability of the Vidar virus radar User Device and associated Contagion Vigilance Service[5]. Subsidiary objectives were to test educational materials and gather marketing information. By estimating willingness to pay for the Device and the Service, we establish the economic feasibility of virus radar for a hospital, independent of the saving generated by preventative actions and increased awareness of infectious disease in the hospital environment. Our null hypothesis was that hospital users and personnel would not find the Vidar Project acceptable. This would be indicated by a lack of willingness to pay for the User Device and the associated Contagion Vigilance Service.

1 Peters, G. (2008, April 20). Epidemiology and resistance mechanisms of Methicillin-Resistant Staphylococcus Aureus. MRSA: the changing epidemiology of the epidemic, Pfizer Integrated Symposium. Eighteenth European Society of Clinical Microbiology and Infectious Diseases Integrated Symposia. 19-22 April 2008, Barcelona, Spain. URL: http://www.sessions2view.com/eccmid08c3_library

2 Klevens, R. M., Edwards, J.R., Tenover, F. C., McDonald, L. C., Horan, T., Gaynes, R.; National Nosocomial Infections Surveillance System. (2006, Feb 1). Changes in the epidemiology of methicillin-resistant Staphylococcus aureus in intensive care units in US hospitals, 1992-2003. Clin Infect Dis. 42(3):389-91. Epub 2005 Dec 19.

3 Peters, G. Idem

4 Stodolsky, D. S. (1997). Automation of Contagion Vigilance. Methods of Information in Medicine, 36(3), 220-232.

5 Linköping University, Institute for Social Informatics, and Stefan S. Nicolau Institute of Virology. (2007, 8 May). Virus Radar. Unpublished research proposal. Abstract, etc. available at URL: http://virusradar.org.

2. Method

2.1 Materials

An information sheet and response slip were prepared. The English version is presented in Appendix A.

2.2 Procedures

Ten survey information sheets and twenty response slips were distributed by a staff person on each of the three floors of Pavilion B2 at the Infectious Diseases Hospital, which is adjacent to the Stefan S. Nicolau Institute of Virology in Bucharest, Romania. The questionnaires were delivered between 9 AM and 12 AM and retrieved by the same person, at the same hours (9 AM to 12 AM), 24 hours later. This availability sample was taken during the week of 9 April, 2007. Each subject completed a response slip with a blue pen. All response slips were returned completed, except for one which was lost.

2.3 Results

Distribution of Respondents

Responses were highly skewed, therefore the data was log transformed to achieve a more normal distribution. This also has the advantage of transforming the data into a scale more closely corresponding to perceptual differences. That is, the distance between €30 and €40 is equal to the distance between €300 and €400 after this transformation. With a base 10 log transformation, the value 1 equals €10 ($10 = 10^1$), the value 2 equals €100 ($100 = 10^2$), etc.

We then performed an outlier analysis to trim extreme values[6]. A jackknife distance analysis revealed four persons who had responded 1€ to both questions. They were removed from the data set. Three missing values result from transforming data values of zero, which are undefined after a log transformation. Thus, we retained 52 records of transformed values. Responses remained from several employee categories [graduate nurse (20), doctor (13), nurse (7), cleaner (4), other (5)] and from patients (10).

Finally, we performed a nonparametric bivariate density plot (Figure 1, Appendix C) to identify clusters within the payment data. This plot shows the highest density at €150 per Phone ($10^{2.176}$) (range €100 to €200) and €50 per month ($10^{1.699}$) for Service (Cluster 12). A less well defined Cluster (9) appears around €50 per Phone ($10^{1.699}$) (range €50 to €250) and €10 per month (10^1) for Service. Another poorly defined Cluster (8) appears with the same value for Service, but a lower value for the Phone, €20 ($10^{1.301}$) (range €10 to 30€). Between one-third to two-thirds of the data points are visible in the graphs, because many responses had identical values thus overlapping others. A mesh plot (Figure 2) gives another view of the data, clearly showing the peak at the higher values. The Modal Clustering Table (Appendix B) shows that 11 persons are included in the high-value Cluster (12), while only 9 appear in each of the others (Clusters 8 & 9). If we are to choose a single value to exemplify our results, it would be in this higher value Cluster, since it is the largest Cluster and also the best defined one. Thus, the Graduate Nurse who appears in the center of this Cluster is our most representative individual.

6 SAS Institute. (2000). JMP (R) Version 4 (Release 4.0.4). Cary, NC.

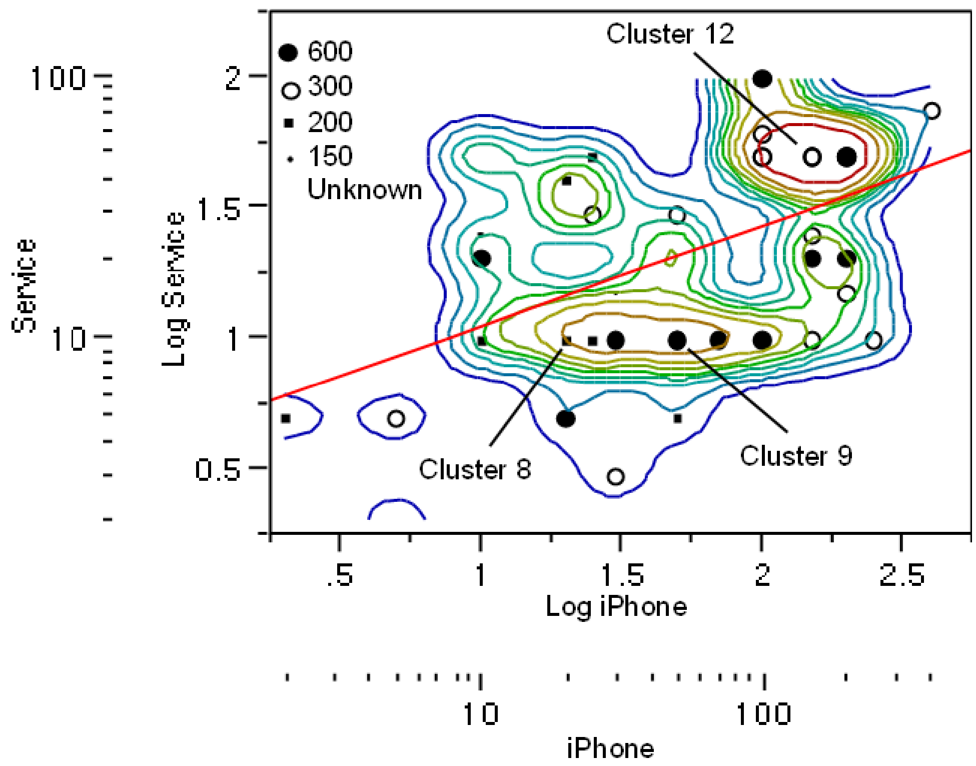

Figure 1. Nonparametric Bivariate Density Plot Showing Incomes and Cluster Centers

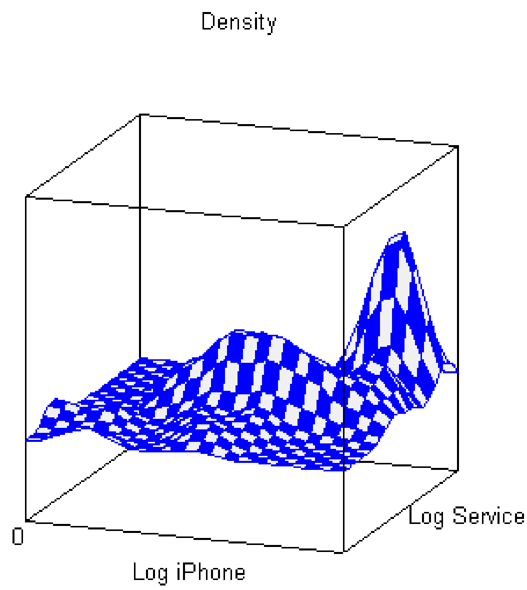

Figure 2. Mesh Plot of Densities

User Acceptance

User Acceptance was estimated based upon willingness to pay for the Vidar User Device and the Contagion Vigilance Service. A one-way analysis of variance (ANOVA) was performed upon the responses to the payment amount questions. The income data was treated as ordinal, minimizing any risk that imprecision in income estimates would effect the results (If salary levels are in the correct order, our analysis is unaffected.) Finally, power analyses to identify sample sizes needed in future studies were performed.

The mean (numerical average) response to the question "How much would you pay for a new Phone performing these functions?" was a bit over €60 ($10^{1.8}$) (Figure 3, Appendix D). The difference in payment willingness among groups was highly significant [F (3, 41) = 5.28, p < .0038] (Appendix D). The mean comparisons show that the two high-income groups (€600 [doctor] and €300 [graduate nurse] and the two low-income groups were indistinguishable (Appendix D). The lack of a difference between the highest income groups, appears to reflect a leveling off of willingness to pay with higher income. Thus, we can assume a perceived value of the Phone of about €91 ($10^{1.96}$), regardless of income, once income passes a threshold between €200 and €300. A possible confounding variable was pre-existing ownership of a mobile phone.

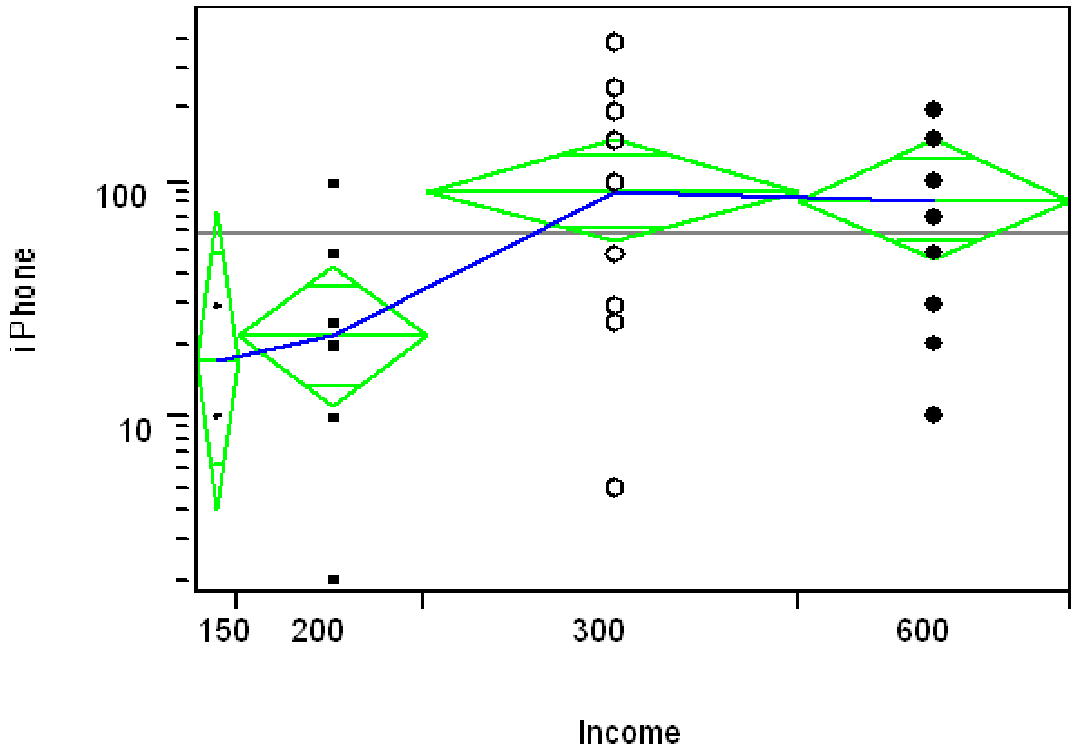

Figure 3. One-way Analysis of Log iPhone By Income

On the average, respondents were willing to pay €20 ($10^{1.3}$) per month for the Virus Radar Service (Figure 4, Appendix E). The differences among the groups are not significant [F (3, 41) = 1.5099, p < .2275] (Appendix E). However, the data again appears to reflect a leveling off of willingness to pay with higher income. Thus, we can assume that the perceived value of the Service is about €30 ($10^{1.39}$), regardless of income level, once it passes a threshold between €200 and €300. The power analysis showed that we need at minimum 76 respondents to achieve significance at the .05 level (Appendix E).

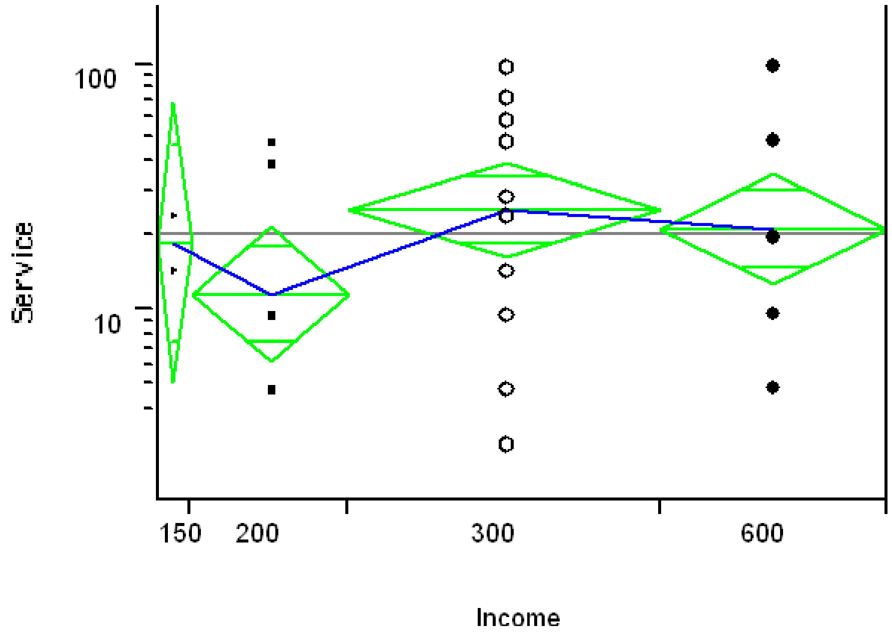

Figure 4. One-way Analysis of Log Service By Income

If we compare willingness to pay for the Service as compared to willingness to pay for the Phone, we can see (straight line in Figure 1) that these are significantly correlated (Appendix C) [maximum $R^2 = 0.54$, $p < .003$]. This supports our assertion of a similar pattern in the data for the two types of payment willingness. Thus, our estimates of a rising level of willingness to pay with income up to a threshold between €200 and €300 is supported, as is our estimate of constant perceived value above that threshold.

3. Discussion

This study investigated acceptance of both the virus radar User Device and the Contagion Vigilance Service by surveying willingness to pay for the Device and willingness to pay for the Service. While participants answered two willingness-to-pay questions, their acceptance was assessed within the context of an integrated System. The main finding was that potential users were willing to make substantial payments to achieve the protection the System provided.

There are at least two groups in terms of willingness to pay revealed by the nonparametric cluster analysis. The higher paying Cluster is well defined and tends to agree on both the value of the Service (€50) and the value of the Phone (€150). The other Cluster chooses a much lower value for Service (€10) and doesn't agree on the value of the Phone. This disagreement on the value of the Phone could indicate that individuals in this lower paying Cluster didn't understand the Survey Information. Therefore, taking an overall sample average could result in misleading values. Thus, the mean response of €60 to the question, "How much would you pay for a new phone performing these functions?" could be too low. The fact that the higher education/income groups choose the value €91, also throws suspicion on the lower value. The overall mean value for Service, €20 may also be too low, since the higher education/income groups choose €30. If we must choose one representative individual from the data set, it is the Graduate Nurse who was willing to pay €50 a month for the Service and €150 for the Phone, out of a monthly salary of only €300. Our best estimates, therefore, place the perceived value of the Phone between €91 and €150, and the perceived value of the monthly Service between €30 and €50. In terms of our application, even the lower payment values indicate a substantial willingness to pay for both the Phone and the monthly Service, considering the monthly income levels in the sample (€150 to €600).

If either the User Device or Contagion Vigilance Service was not acceptable, this would have been indicated by participants not being willing to pay for either the Device or the Service. We also asked them to indicate their patient status or personnel category, thereby permitting us to evaluate how educational background and estimated income would mediate the responses.

We attempted to counter ethical concerns about the tracking technology by explaining the anonymity of location data and alerts, and by offering compensation for possible losses associated with a potential breach of confidentiality. Similarly, we attempted to allay concerns about privacy by ensuring participants that their data remains under their control at all times and can be completely withdrawn from the experiment upon their demand. We list benefits of the Vidar technology and advantages of Internet Protocol telephony within the hospital environment, assuming a mature system. By placing the technology in an operational setting and presenting both risks and benefits, we hoped to achieve a realistic assessment of the Vidar virus radar acceptability and usability in the hospital environment. This pilot study was a test of our procedures and also permitted us to determine the sample size needed to obtain definitive results.

There are two possible explanations for the split between the main willingness-to-pay groups revealed by the analysis. One is the income level and the other is the education level. These two variables are confounded in our data, since income was estimated from employee category. Thus, it is difficult with this data set to distinguish between a failure to understand the questionnaire, due to a lack of education, and the effect of income. However, when one examines the differences in how well Clusters 12 and 9 were defined in the modal analysis (a factor of 2 versus a factor of 5 in range on the Phone values), the educational level explanation appears to be favored. This is because the lower value Cluster (9) was so divergent in terms of willingness to pay for the Phone. There is a trend in the data indicating that those with lower incomes tended to concentrate in the low value Cluster (9) as opposed to the high value Cluster (12).

Since the two monetary variables were significantly correlated, we would expect to see better defined low value Clusters if there was adequate understanding. This correlation also supports the common trend in the data concerning a rise in willingness to pay with increasing education/income up to a threshold level between €200 and €300 in monthly income.

State of the art

Real-time location systems (RTLSs) are used in hospitals now in order to reduce the amount of staff time spent locating movable equipment and to reduce equipment inventories, thereby yielding substantial savings. Movable equipment, such as wheel chairs, is often monitored with alarm systems, which have been effective in reducing equipment losses. The "[r]esearch firm IDTechEx of Cambridge has released a report on the real-time location systems (RTLS) market and its growth prospects over the next decade. They estimate that the RTLS market will explode over the next ten years, growing from an 'esoteric niche market' to one worth $2.71 billion in 2016"[7]. Thus, we expect an increasing number of healthcare facilities to have this technology installed. Our infection control strategy can then be employed with minimal additional expense.

Reminders and warnings can be automatically triggered, if a violation of a management strategy enforcing contact precautions is detected. For example, if a certain room that has been set aside

7 Rfidupdate (2006). Report: RTLS Market Worth $2.7b in 2016. URL accessed 8 Nov 2008: http://www.rfidupdate.com/articles/index.php?id=1065

for a patient known to harbor a resistant organism is approached by a user not authorized to enter that room, an alert can be issued. Failure of the person to respond to the alert could lead to a warning sounding at a nursing station, so that the situation could be immediately investigated. In this example, the surveillance system yields a second layer of protection against risky contact. This technology is now used to track patients who may become confused and leave their ward inappropriately. However, Torchia[8], in a report from the Yankee Group, stated, "Individual privacy concerns will stall human asset tracking in European markets and union-represented industries."

There is no state of the art in automated identification and management of contagious disease. However, there is prior work in syndrome identification. Typically, the first sign of an epidemiological outbreak, due to a novel agent, is a communicable syndrome. Current syndrome surveillance methods are complex manual procedures requiring highly trained persons. Delays in data collection and agent identification seriously impede the ability to control infectious agents[9]. The first steps toward automated syndrome identification have been taken, but they have been limited by manual data-collection methods[10].

Advances expected with an automated system

The failure of current HAI control methods is indicative of the unsatisfactory tradeoffs available in practice. For example, one approach to preventing the spread of resistant organisms is to test every new patient and then take contact precautions which minimize the chance of a resistant organism spreading to other patients. In many situations, however, this approach is not economically feasible. Similarly, while the hygienic procedures for controlling HAIs are well known, it has proven very difficult to maintain compliance, due to the constant educational and motivational campaigns that appear to be necessary. The introduction of an enhanced location-based services management strategy allows the alteration of the cost-benefit tradeoffs, while improving the ability to identify new agents.

Accumulated data from System operation allows for the identification of specific points of failure in current techniques and technologies. It also permits the comparison of the effectiveness of different strategies for the application of such techniques and technologies, and the optimization of such strategies. While traditional evaluation methods are typically applied to an entire ward or hospital, and have trials that may run over weeks, months, or even years, the proposed method allows greater source specificity and much better time resolution, permitting the very rapid identification and quantification of risk-related events.

Since the technology operates in real-time and can identify individual sources, patient self-management becomes possible. For example, a patient with reduced immune response could choose to avoid an area being used by other patients under treatment for infection. Similarly, if such a patient was discovered to have had such contact, a prophylactic dose of an antibiotic might be appropriate and, in fact, could be an optimal strategy for drug delivery. Similarly, this type of information facilitates dynamic risk-based surveillance and thereby optimal targeting of laboratory tests.

8 Torchia, M. (2005). RTLS Market To Exceed $1.6 Billion by 2010, URL accessed 8 Nov 2008: http://www.rfidupdate.com/articles/index.php?id=949

9 Smithson, A. E. & Levy, L.-A. (2000, October). Ataxia: The Chemical and Biological Terrorism Threat and the US Response. Washington, DC: Henry Stimson Center. URL: http://www.stimson.org/pubs/cwc/atxchapter7.pdf

10 Brossette, S. E., et al. (2002). A data mining system for infection control surveillance. Yearbook of Medical Informatics (pp. 332-9). Stuttgart, DE: Schattauer Publ. Co.
Fricker, R.D., Jr., Hegler, B.L., Dunfee, D.A. (2008). Assessing the Performance of the Early Aberration Reporting System (EARS) Syndromic Surveillance Algorithms, Statistics in Medicine, 27, pp. 3407-3429.

While discrete contact precautions are typically reserved for specific agents that can justify their added management complexity and effort, the System described here permits a graded response to the range of agents typically encountered. Thus, for example, the alerting system could warn of the type and degree of risk at a given location, thereby permitting users to respond appropriately. For example, if it was known that a specific patient was infected with an agent that could colonize a healthy person, a user might decide to use gloves to reduce the risk of contacting the infective agent. This graded range of risks would also maintain an increased awareness of the problem of healthcare associated infections and thereby ensure greater compliance levels. It could further make more effective use of facilities possible, by taking advantage of preexisting isolation options. For example, a ward could be structured so that patients known to be infected with similar agents could be placed together, reducing the risk of other patients becoming infected. Where several nurses shared responsibility for such a ward, contact with patients could be organized to minimize the inadvertent spread of an agent, by ensuring that different sets of patients were served by different nurses. Thus, the more sophisticated use of existing facilities could lead to greater patient safety with little or no additional expense.

In summary, the objective of the Vidar Project was to demonstrate the feasibility of a contagion management system based upon networked mobile devices. Information retrieval facilitates syndrome identification and the issuing of alerts to those at risk in real time. The focus is on tracking transmission within the hospital and notifying at-risk persons once an agent has been localized. State of the art is also advanced in the collection of sensitive personal data and security for mobile devices.

Analytic approach

Within the hospital environment, infectious agents are expected to be well characterized and carriers easily identifiable. When an individual's laboratory test is positive, we trace the likely source and forward transmission paths in the location database. Characteristics of different transmissible agents, and levels of immuno-competence are integrated into the analysis, as are sympoms presented by suspected new carriers. An objective is to adjust the sensitivity of the tracing algorithms so that carriers can be rapidly isolated, without excessive clinical laboratory tests.

Syndrome identification is supplementary to tracing of identified agents. In this case, data is limited to patient symptoms, immuno-competence, and other personal factors. Automated syndrome surveillance can be evaluated by its ability to identify carriers prior to the appearance of symptoms and by overall reduction of in transmission of infectious agents.

Specific Impact

The Project would employ advanced information and computer technologies to assess risks of infection and improve patient safety, without compromising user privacy. It would facilitate identification of common patterns in safety-relevant events and trigger alerts designed to stop the spread of infectious agents. This alerting and management support System incorporates new tools for prediction, detection, and monitoring of infection risks directly impacting patient safety. The solution depends on innovative data mining and integration with the present electronic health record system. It provides decision support to both users and the infection control officer, and allows prediction of adverse events.

The privacy-protection advances remove a major barrier to the deployment of real-time location systems in the multi-billion dollar European market for RTLS technology[11]. It is expected that the

11 Torchia, M. Idem.

management of contagious disease will be extended from the healthcare facility into the community, as our strategy proves its effectiveness. This is essential in the long run, since, for example, Community-Associated MRSA is becoming a widespread problem[12] and more effective hospital management of these agents requires prior knowledge of patients' exposure.

4. Conclusion

The main finding was that potential users were willing to make substantial payments to gain the protection that the proposed virus radar System provided. The most representative individual was willing to pay €50 a month for the Service and €150 for the Device, out of a monthly salary of €300. Many persons with lower education/income responded inconsistently, indicating poor understanding. These persons tended to respond with lower values, which, however, still indicated a substantial willingness to pay. Thus, we conclude that acceptability will be high, particularly among those with higher education/income. The level of support indicated could justify a System of this type, even if the installation and operational expenses had to be supported by user payments alone.

Acknowledgments

We would like to thank Andrei Popovici, MS (Stefan S. Nicolau Institute of Virology, Bucharest, Romania) for assistance in execution of this study and Christian Couppé, RPT, MSc, (Institute of Sports Medicine, Copenhagen University, Denmark) for assistance in revising this document.

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5. Appendix

Appendix A

Vidar (virus radar) Project - General Information

The principle Project objective is the protection of Hospital Personnel and Patients from Flu infections using a Phone with supplementary functions. In case of an outbreak, the Phone will sound an alert when you approach a high-risk area. One appropriate response is to avoid entering the area. Another is to wear a protective face mask and disinfect your hands after leaving the area. All measures considered can be taken at any time for protection against infections.

You will be able to use your current mobile service with the Phone. Cost-free communication with other users will be possible, while both are in the Hospital area. At the end of the three-year project, you will be able to keep the Phone or return it for a full refund.

In order to function correctly, the Phone must update your location every few seconds (location updates are a normal part of mobile phone operation). Your identity is not linked to this location information. In case of a warning being issued, it will be transmitted to all Phones. Only one Phone will be able to decode the message and sound an alert. Other Phones will silently discard the message. Therefore, other users will not be disturbed in any way by the message received.

You will receive a thousand Euro compensation payment, if any confidential information is released. If a breach of confidentiality causes greater damage, the Hospital's insurance will compensate you. You will be able to withdraw all information at any time.

You are required to participate in up to four tests of the alert system each year. The test may require you to put on a face mask and report to a Hospital laboratory. The test may require that you provide a throat swab or may use another biological sampling method. You may also be asked to load data from your Phone into a computer (this provides technical support, if it is necessary) that can transmit alerts to other users. You may refuse. No identity information is transmitted with the data. These procedures will take less than 10 minutes.

Please enter your responses:

:How much would you pay for a new Phone performing these functions?

(0 - 500 Euro) ___________________

:How much would you pay for the Service, assuming it protects you from some communicable diseases? (0 - 100 Euro / month) ___________________

I am a (check one) Doctor _ , Graduate Nurse _ , Nurse _ , Food Service Worker _ , Patient _ , Cleaning persons _ , other _.

Observations ___________________

Appendix B

Largest Modal Clusters including Most Representative Members

Category	Count	iPhone	Service	Income	Log iPhone	Log Service	Cluster
graduate nurse	11	150	50	300	2.17609	1.69897	12
doctor	9	50	10	600	1.69897	1	9
nurse	9	20	10	200	1.30103	1	8

Appendix C

Nonparametric Bivariate Density

Variable	Kernel Std
Log Phone	0.135664
Log Service	0.107032

Linear Fit

Log Service = 0.6612939 + 0.3841518 Log Phone

Summary of Fit

RSquare	0.237088
RSquare Adj	0.22183
Root Mean Square Error	0.364822
Mean of Response	1.311088
Observations (or Sum Wgts)	52

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	13	2.6693707	0.205336	1.9063
Pure Error	37	3.9853995	0.107713	**Prob > F**
Total Error	50	6.6547702		0.0621
				Max RSq
				0.5431

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2.0680872	2.06809	15.5384
Error	50	6.6547702	0.13310	**Prob > F**
C. Total	51	8.7228574		0.0003

Appendix D

Oneway Analysis of Log Phone By Income, including Means Comparisons and Power Analysis

Oneway Anova

Summary of Fit

Rsquare	0.294544
Adj Rsquare	0.23885
Root Mean Square Error	0.446578
Mean of Response	1.783501
Observations (or Sum Wgts)	42

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Income	3	3.164157	1.05472	5.2886	0.0038
Error	38	7.578410	0.19943		
C. Total	41	10.742567			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
150	2	1.23856	0.31578	0.5993	1.8778
200	9	1.34410	0.14886	1.0428	1.6455
300	18	1.96275	0.10526	1.7497	2.1758
600	13	1.92334	0.12386	1.6726	2.1741

Std Error uses a pooled estimate of error variance

Appendix E

Oneway Analysis of Log Service By Income, including Means Comparisons and Power Analysis

Oneway Anova

Summary of Fit

Rsquare	0.10651
Adj Rsquare	0.035971
Root Mean Square Error	0.396524
Mean of Response	1.314818
Observations (or Sum Wgts)	42

Analysis of Variance

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**	**Prob > F**
Income	3	0.7122301	0.237410	1.5099	0.2275
Error	38	5.9747763	0.157231		
C. Total	41	6.6870064			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
150	2	1.28702	0.28038	0.7194	1.8546
200	9	1.07766	0.13217	0.8101	1.3452
300	18	1.41952	0.09346	1.2303	1.6087
600	13	1.33830	0.10998	1.1157	1.5609

Std Error uses a pooled estimate of error variance

Means Comparisons

Dif=Mean[i]-Mean[j]

	300	600	150	200
300	0	0.08122	0.13251	0.34186
600	-0.08122	0.00000	0.05129	0.26064
150	-0.13251	-0.05129	0.00000	0.20935
200	-0.34186	-0.26064	-0.20935	0.00000

Alpha=0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*
2.68648

Abs(Dif)-LSD

	300	600	150	200
300	-0.3551	-0.3065	-0.6615	-0.0930
600	-0.3065	-0.4178	-0.7578	-0.2013
150	-0.6615	-0.7578	-1.0653	-0.6234
200	-0.0930	-0.2013	-0.6234	-0.5022

Positive values show pairs of means that are significantly different.

Power Details

Test

Income

Power

Alpha	Sigma	Delta	Number	Power	AdjPower	LowerCL	UpperCL
0.0500	0.396524	0.130222	42	0.3662	0.1279	0.0500	0.9885

Least Significant Number

Alpha	Sigma	Delta	Number(LSN)
0.0500	0.396524	0.130222	75.98967