

Disclosure

46th Symposium on Clinical Pharmacy, Heidelberg

Relevant Financial Relationships

Novartis, Merck Group Google, Samsung, Quantac, HealBe, Amazfit / Huami, Withings (Nokia), Basis (Intel)

Off-Label Investigational Uses NONE









More than 200 Million Google Searches By The End Of My Talk



Back to Health ...

Actual Causes of Death in the United States, 2000

All H. Marshell, PhD: Janves R. Marke, MD, MPH, Darme T. Steinig, PhD, MSE, Julie L. Garberchig, MD, MPH (H) Aufter APDiations

JAMA 2004 291/02/1230-0245 Jan 18 1801(pers.29110.1238) Teat Data A. A. A

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ABSTRACT

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Content Haddhelis Salawiaral this harms are inding source of neurality in the United Basins. Quartifying these will provide singled into the offsets of meant transls and the traditionions of extand presentation operated into

Objectives To identify and quantify the leading masses of survivity in the United States.

Design Competencies MEDLDNI means of lingbits large-spir articles that identified optimizing ind, disting, and historenery studies listing sets behaviors and rearrially. The second was initially marined in articles published during or after applicate we have included released articles published in typic to Description galaxies. Providence and relative relative exclusion of released articles published in typic to become for galaxies. Providence and relative relative exclusion of the relative exacts, but used means marrially data separate the fact Content for Dissour Content and Provention to identify the means and marriants of duals. The anticance of concer of duals were compared by randinghing estimation of the concesion-financial markets of generative duals with the topic market playing and and the market

Main Datesme Measures Aduat sums of douby

Results The leading causes of death in parts over tainees (agg) state deaths: (0.1% of bank UI deaths), poor this and physical headshift parts use databa, 56.5%), and deaths in secure prior (0) you deaths, p.3%). Other actual means of data's wave variabal agency (7) works that agency (2) prior), notice values of causes and





Challenge Today

Imprecision medicine = *Population health* & *average patient*

Personalized medicine: Time for one-person trials

20 April 2018

Precision medicine requires a different type of strong high that tosaes on individual, set average, responses to therapy, expenditories 2. Scherk.

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Bubject larres: Center / Drug destroy / Medical research - Health center



Top 10 Drugs Our Patients Do Not Respond To (US)



nature

Drive Big All costs incu	Medicare Bi]] 195	Estimated Waste	Res	ponse Rates
Nexium	Heartburn	\$2.53	\$2.42	100	
Advair Diskus	Asthena	2.26	2.15		**********
Crestor	Cholesterol	2.22	2.10	-	
Abilify	Antipsychotic	211	1.69		*********
Cymbalta	Antidepressant	1.96	1.76	-	
Spiriva	Asthma	1.96	137	****	*********
Namenda	Dementia	1.56	156	****	*********
Januvia	Diabetes	146	1.02		
Lantus Solosta	r Diabetes	1.37	27	**	******* ******
Revlimid	Cancer	135	.54	INFECTORIA	MEDICINE
Source Contars for THE WALL STRE 1 May 2015	Medicare and Medicaid S ET JOERNAL Tot	anices al \$18.8B	\$14.9B	natu	TC 30 April 2015

Imprecision medicine *Population*, *average patient*,







Precision medicine

[Personalized, Preventative, Proactive, Participatory]

- Average is over: patient_i
- POC is where the patient is
- Toolbox is expanded beyond a stethoscope and a pill
- Approach to health is holistic



















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is targeted the same viral epitopes.

science associate



Detection of Circulating Tumor DNA in Early- and

Late-Stage Human Malignancies Teleto Regional, "London Human, "La Base 1, Long C, Jose Marci, Tonan Marg, Minard Agenced, "General Extend", National Region, "Instant Mark, "Longer Mark, Mark Research, Nation S, Kang, C, Marris, Base 1, Cong, Mark, Mark, Tonan JM, Markan C, Sangerov, Tank, Kang, C, Mark, C, Mark, J, Kang, C, Mark, Mark, Tonan JM, Markan C, Sangerov, Mark, Markan K, Sang, C, Kang, C, Mark, Yang, Kang, Y, Yang, Kang, Y, Kang, K, Sangerov, Tang, K, Sangerov, Sangerov, Sangerov, Sangerov, Canada, C, Kang, Y, Sangerov, Tonas Jan, Human K, Lander J, Markan L, Marken T, Sangerov, Tanas J, Likev C, Zangerov, Basedon T, Markan K, Baserov, Tan, Sangerov, La Kang, Kang, Markin K, Likev C, Zangerov, Baserov, Wang, Markan K, Baserov, Tan-C, Markan Sangerov, Markin K, Likev C, Yang, Sangerov, Markan M, Kangerov, J, Katerov, King, J, Markanna Kang, J, Shanakanan, Y, Anada Hu, Y, Markan J, Kangerov, Kang, Katerov, Kang, J, Katerov, King, J, Ka

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Science Translational Medicine









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Fully integrated wearable sensor arrays for multiplexed in situ perspiration analysis

Wal Dec. Sem Emerinejad, Hinin Yin Yin Nyein, Samyukitsa Challa, Kanin Chen, Aladin Peck, Hossian M, Fahad, Hineki Ota, Hineki Shiraki, Dalauke Kiriya, Der-Helen Lien, George A. Brocks, Romald W. Davis & All Javey

Affiliations | Contributions | Corresponding author

Assure 529, 506–614 (28 January 2016) | doi:10.1036/nature16521 Received 26 June 2016 | Accepted 23 November 2016 | Published online 37 January 2016

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Waarable sensor technologies are essential to the realization of parsonalized medicine through continuously monitoring an individual's state of health?. 8, 8, 4, 8, 8, 9, 9, 11, 12 Sampling human awaat, which is rich in physiological information¹³, could enable noninvasive monitoring. Previously reported sweat-based and other nan-invasive biosensors either can only monitor a single analyte at a time or lack on-eite signal processing circuitry and sensor calibration mechanisms for accorate analysis of the physiological state^{14, 15, 16}, 17, ¹⁶, Oven the complexity of aveat secretian, simultaneous and multiplexed screening of target biomericers is critical and requires full system integration to ensure the occuracy of measurements. Here we present a mechanically flexible and fully integrated (that is, no external analysis is needed) sensor array for multiplexed in alto perspiration analysis. which simultaneously and selectively measures aweat metabolites (such as glucose and lastate) and electrolytes (such as sodium and potassium ione), as well as the shin temperature (to calibrate the response of the sensors). Our work bridges the technological gap between eignal transduction, conditioning (amplification and filtering), processing and wireless transmission in wearable biosensors by merging plastic-based sensors that interface with the skin with silicon integrated sircuits consolidated on a flexible arouit board for complex signal processing. This application could not have been realized using either of these technologies alone owing to their respective inherent instations. The wearable system is used to measure the detailed sweat profile of human subjects engaged in protonged indoor and outdoor physical activities, and to make a real-time assessment of the physiological state of the subjects. This platform enables a wide range of personalized dic and physiological monitoring applications.



Sweat Analysis



Sweat metabolites (glucose and lactate) Electrolytes (sodium and potassium ions) Skin temperature



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Excess Fluid in Heart Failure (toSense)



Heart Rate Resp Rate

Thoracic Fluid Stroke Volume Cardiac Output **Physical Activity**

Tattoo-Based Noninvasive Glucose Monitoring: A Proof-of-Concept Study

Amay J. Bandodkar,[†] Wenzhao Jia,[†] Ceren Yardimci,[†] Xuan Wang, Julian Ramirez, and Joseph Wang*

Department of NanoEngineuring, University of California, San Diego, La Jolla, California 92093, United Status

O Supporting Information

ABSTRACT. We prement a preved economyt demonstration of an all printed transportery tation-based glazene issues for matiovating the sense composition of the fort example device and the sense response to be and the fort example device and the sense response to be and the sense response with the of a commonian deconstration of the sense response with the of a commonian deconstration of the sense response with the of a commonian deconstration of the sense response with the of a commonian deconstration of the sense response to the sense ABSTRACT: We present a proof-of-concept demonstration of an all-



Dislates is one of the most veldely agread modern lifestyle descases affecting headeds of nillices of people and is among the leading causes of deaths globaly.¹¹ Propose mentioning of glocome is sociatili for optimal management of the disease and avoiding its associated purblems.¹ Transare research has lead to the hirrodoction and widependiture of self-insting blocal glasmes meters.¹ However, such adfensing methods will on inconvenient and patietal blocal sampling free the finger to that composition and subsecting optimal lifers aread at addressing this drawback lasse resulted is several commissional continuous glacome mostering epitems. These enzyme-based microscella results are interesting land (1971) that ¹⁰ Such microscella results are interesting dual (1971) that ¹⁰ Such microscella results are interesting and (1971) that ¹⁰ Such microscella results are interesting and (1971) that ¹⁰ Such microscella patients and blocal sampling free distributions between glassone levels in the DSF and



cathods. During this ISP flow, gluinne is also toward the cathodic. Thus, this technique can be narrianxaive manifering of ISP glucose levels.¹¹ H device was later discontinued as patients capani irritation. This limitation has been addressed of employing a lower current density for the glacose connection to new nontrocave revenue iontophor sensors.¹¹⁻²¹ However, these postcools have either out under in vitro conditiona^{10,11} or require eff-



analytical chemistry













Blow (on) Your Phone: Lung Performance (SpiroSmart)

Tracking Lung Health With a Cell Phone



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Breatheirs, breathe out, Distancirepost.

January 15,2013



developed emotional connection with your gadget. But day those sight could tip off your doctor to a latent su cornering king condition.

A group at the University of Waihington, in collaboration with S Children's Hospital, to developing a way in check how healthy yo large are when you breaths out at your emertphone.

- For patients with conditions like asthma, chronic lavachitis, or o filmosis doctors sound out their pipes using a spirometer, a devimeasures volumes of air breathoil in and out. The enhaled volum indicates if the potient's air passages are clogged and leading to difficulty breathing.
- Scentrily, a group at Streetak Patela Ide at the University of Washington figured out how to measure exhaled breaths using microphone on a smartphone.

The dpirofreart upp estimates the volume of siz exhaled by the es recorded as you heathe out. The goal was to creste a home larg



Patel explained in a press 48, the system second reliable







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Where is Your Tricorder? In the Patient's Pocket.



Wearable Wireless Waterproof Multipurpose Unobtrusive Fashionable Long battery lifetime

Further: Non-contact, Ingestible, Bio-degradable, Injectable



You can't list your iPhone as your primary-care physician



Where is the evidence? 'in the making' Star Trek state of mind

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Many Mobile Health Appe Target High-Need, High-Cost Populations, But Gaps Remain Authors

es Web First

Abetract

With neing amarphone ownership, mobile health applications (mirksalth apps) have the potential to support high-need, high-cost populations in managing their health. While the number of available infinitial apps has grown autoitantially, no clear strategy has emerged on how providers alroad worksals and incommend auch apps to patients. Key atakaholden, including medical problemonal accientse, insurant, and poling makes, have langing worked formally sectometricing apps, which forma patients to obtain incommendiation from clear strategy and the based at a poline concerns the based and the same strategy and the patients based at a poline concerns the based and the same strategy apps. We evaluated 137 patient-lacing mither the same strategies to execute the same strategy apps.

necommended by separate and that languted high-need, high-ocel populations. We know could benaft the most, We also found that companying instings were poor index patientially damperous haufth information. Going forward, data privacy and security v

High-need high-cost populations. Patient engagement. Mobile health. Chronic I

PUBLIC BRUNDE # OCT (21%)

The Lancet Diabetes & Endocrinology: Even with charity or cash incentives, activity trackers do not appear to improve health THELANDE

East interclass beyond movaale exercise lowers at 6 interchs, but you wrough to benefit head? and 90% of participants stopped using the devices into incentives stagged

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Repularly using an activity tracker (or performance) that maintain and provides feedback on articular activity data net increase activity levels arough to be with health, man with the centrie of a financial research according to a randomized trial involving \$22.54 mms orbits, published in the Leners Database & Outputschedage

Deer the source of the pear story pluck, veterinests whereas the activity tradem recorded to drange in their may your that made story because their ground of an size activity by an average of 18 minutes provident, manyor, we found no wedence that the device promoted weight was or improved broad process or conducting or conducting formers, within with an without Numerical Incomisent, explains lead author Mydocoor Dri, Steatstains from Duke MAS Wedool Street in Singapano, "While there are conter progress early on, once the incomines were stopped, solutions dol worse that if the intentions had sever been effered, and may



pulmentary reliabilitation, and activity coanselling in diabetic patients, among others. Undertainedly, the data generated by wear-tile devices is selden integrated into programmath self-management chrons discuss regimens. In addition, there is lack of evidence supporting sortained use or effects on health extremes, as studies have primarily focused on establishing the feasibility of monitoring activity and the association of measured activity with short-term benefits.





ANALYSIS

Accelerated clinical discovery using self-reported patient data collected online and a patient-matching algorithm

Paul Wicks, Timothy E Vaughan, Michael P Massagli & James Heywood

patientslikeme^{*}

Patients with serious classes may experiment with drugs that have not received regulatory approval. Online patient communities structured annuml quantitative estimates data have the patiential to provide an observational environment to montro such drugs magin and the companyeous. Here we describe an analysis of data reported on the website Patiental.kelle by patients with arrypotopic laberal colorasis (ALS) who experimented with lithium carbonale treatment. To notice patiential bias owing to lack of randomization, we developed an algorithm to market 148 treated patients to multiple controls (447 briat) based on the programmend that disease course. All 12 months after treatment, we found no affect of lithicen on disease progression. Althrough observational studies using unbilined data are not a substitute for doubleblied nanodmized control triats, this study reached the same conscision as subsequent randomized triats, suggesting that data respected by patients: even the interact marks be used for

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to investigate the real abarrantive medicine. Addata reported by patients over the internet may be useful for accelerating clinical discovery and evaluating the effectiveness involution structure of drugs already in use.

Time, it is important scientific iteracy. Second, there is an obligation to collect data on the safety of add-experimentator. Unprove treatments might have subtrastial address of take to patients may be increased subtrast a way to report adress increased subtrast a way to report adress increased subtrast a way. In origination, and take to patients may be increased subtrast a way to report adress increased subtrast a way to report adress increased subtrast as well to report the subtrast of the subtrast of the definitions. Reading to further study. Als to a coefficient over the the randomized trials and merand-

ALS is a condition where both randomized trials and nutrino domined clinical studies have yet to provide an effective thereing. It is a crual and rapidly fatal recorders much a studies causing prograsice wishcress and records attrophy: another studies and the protocol studies of the studies of the studies of the protocol difficult of think that of the source of the programs of ALS in a small, studies that the souldcal constanting ¹⁰, source ALS patients were estimatic divided at the source of the protocol of the source of the studies of the source of the studies of the source of the source of the studies of the source of the source of the source of the source of the studies of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of the source of the source of the source of the spectra of the source of



The big medical data miss: challenges in establishing an open medical resource

Eric J. Topol

Nature Reviews Genetics 16, 253-254 (2015) | doi:10.1038/rrg3943 Published online: 17 April 2015

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Abstract

American - References - Author Information - Related links

I call for an international open medical resource to provide a database for every individual's generate, metabolanis, microbionis, appendice and almost information. This resource is needed in order to tainfille generatio disposes and transform medical tain.

Subject terrer: Canalic database - Medical generates - Personalized medicine -Predictive medicine

PROCESS INCOME

Laute Becklund was a noted journalist who died in February 2015 at age 60 from these cancer. Soon thereafter, the Line Angeles Times published har op-eet antitied "An Loy dying" (2011). Sine serenced. "We are each, in effect, one-periori

clinical thats. Yet the invertedge generated horn three blats will de with un because there is no comprehensive database of metastatic toreast cancer patients, their interactivities and what treatments did and clich? help them?. She went on to assent that, in the end of big date, the lack of auch a research is "criminal", and whi is abackfully right.

Internet of DNA

Around the same time of this important op-ed, the MIT Technology Review published their issue entitled "10 Breakthrough Technologies 2015" and on the list was the "Internet of DNA" (Ref. 2). While we are other remoted that the world we live in a becoming the "Internet of Tricings", I have ind seen this terminology applied to DNA before. The ancient on the "Internet of CDA" decised, "the unideding coamity is grownics in their a great deal of the service information, though attending and/dding coamity is grownics in their a great deal of the service information, though attending and the service of the service of the service information through attending and the service of the service of the service information through attending and the service of the service of the service information through attending and the service of the service of the service information.



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"a massive, open, online medicine resource ... would help to quickly identify the genetic cause of the disorder"

Projects & Initiatives

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The Challenge (One of Many): **PRIVACY**

News

Anonymizing patient records for genomics

New method for concealing identity could open up more data for science.

Dartiel Cresses:

Combining genetic information with existing medical records could allow researchers to rapidly identify genes linked to disenses. But bringing together disposable and genetic information in ane place risks compromising the confidentiality of patients.

Now a team from Vanderbilt University in Nailwille, Tannesse, has developed a method they say can anonymize electronic medical records, eliminating the risk of individual patients being identified while preserving the ability of researchers to do such work.

There is a huge push under way in the United States and elsewhere to create and exploit electronic medical records (see 'Clinical epidemology: Anthread answers'). Combining the diagnosis codes that is a patient's conditions in

these records with genetic information from the patient could save time and money in genome-wide esociation studies, which seek to link genetic variations with diseases.

Diagnestic data held in medical records could be very useful to geneticists.

DNYSQ/Slockptum

If their new approach is adapted it could open up vast new amounts of data for researchers to crunch while keeping patient data enorymous, the team say,

There are lots of different types of information that exist within medical records. In the pipe, it has been shown that demographic information is readily inkable to public information that could lead to the short that the short the short that the short the study. Main





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The Future



Precision medicine [Personalized, Preventative, Proactive, Participatory] Average is over: patient_i POC is where the patient is Toolbox is expanded beyond a stethoscope and a pill Approach to health is holistic

Connect with Me to Design *Your* Next Tricorder! (& research the PROs)

Prof. Katarzyna Wac ^{1,2} & QoL Team & Funding Agencies Supporting The Research

¹ Human-Centric Computing, University of Copenhagen, Denmark ² Quality of Life Technologies lab, University of Geneva, Switzerland

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