Nursing Informatics Research *Two* Years in Review

November 16, 2021

NENIC
New England Nursing Informatics Consortium
Nurses Transforming Healthcare Through Informatics

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Conflict of Interest

Have no real or apparent conflicts of interest to report.

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Learning Objectives

- Evaluate themes that impact nursing informatics.
- Identify gaps in nursing informatics research.
- Generate logical next steps in advancing nursing informatics research.

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Methods – Scoping Study

Arksey and O'Malley[1]

- Step 1 – Identify the Research Question
- Step 2 – Identify Relevant Studies
- Step 3 – Study Selection (Iterative process which can change over time)
- Step 4 – Charting the Data
- Step 5 – Collating, summarizing, and reporting the results
- Step 6 – Consultation – This is you guys

[1]Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International journal of social research methodology, 8*(1), 19-32.

Step 1: Research Question

- What trends and themes emerge from a survey of the published literature in the area of nursing informatics during the past year(s)
- Make meaning of current and past themes – historical context.

Step 2: Identify Relevant Studies

- Search Strategy
  - Databases: PubMed and CINAHL
  - Search terms
- ((“nurse” or “nursing”) AND “informatic*”) OR “nursing informatic*”
- Publication Dates 3/1/2019 – 2/28/2021

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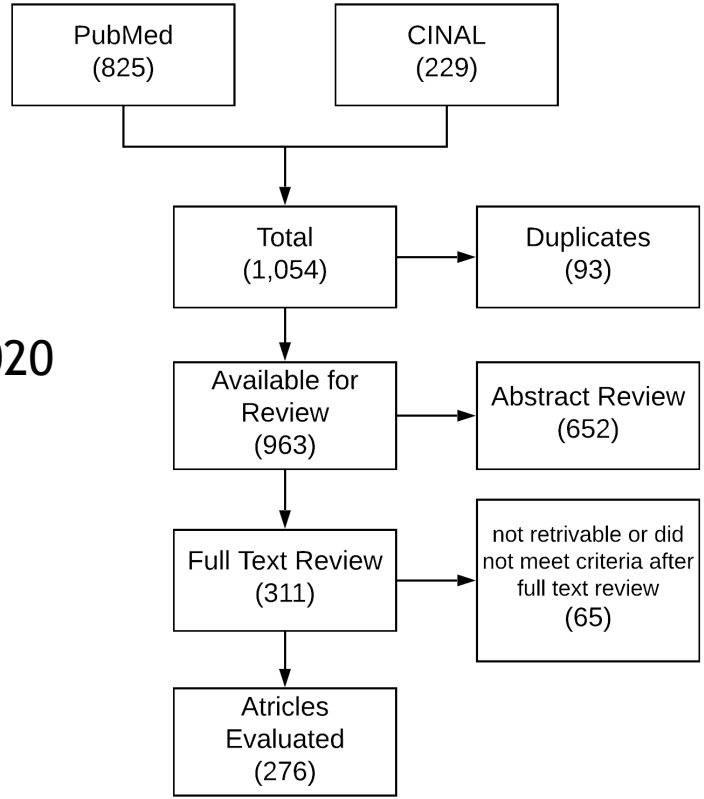
Step 3: Study Selection

Inclusion and Exclusion Criteria

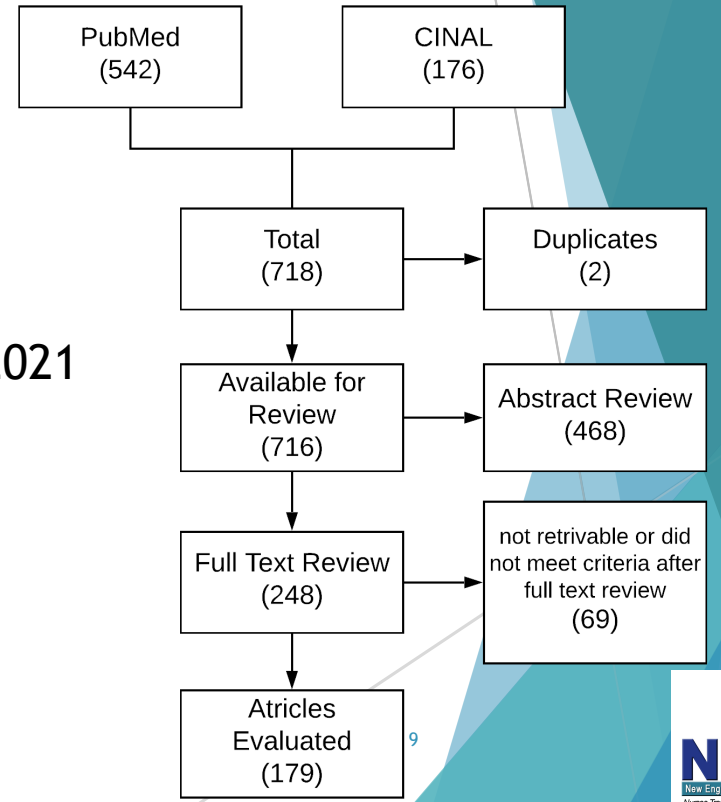
- Inclusion criteria: Research, contributes to nursing informatics knowledge base, prototype development and testing, clinical care delivery focus; informatics
- Exclusions: Articles that focused on informatics education programs, nursing education, nursing students

Search Results (2020 and 2021)

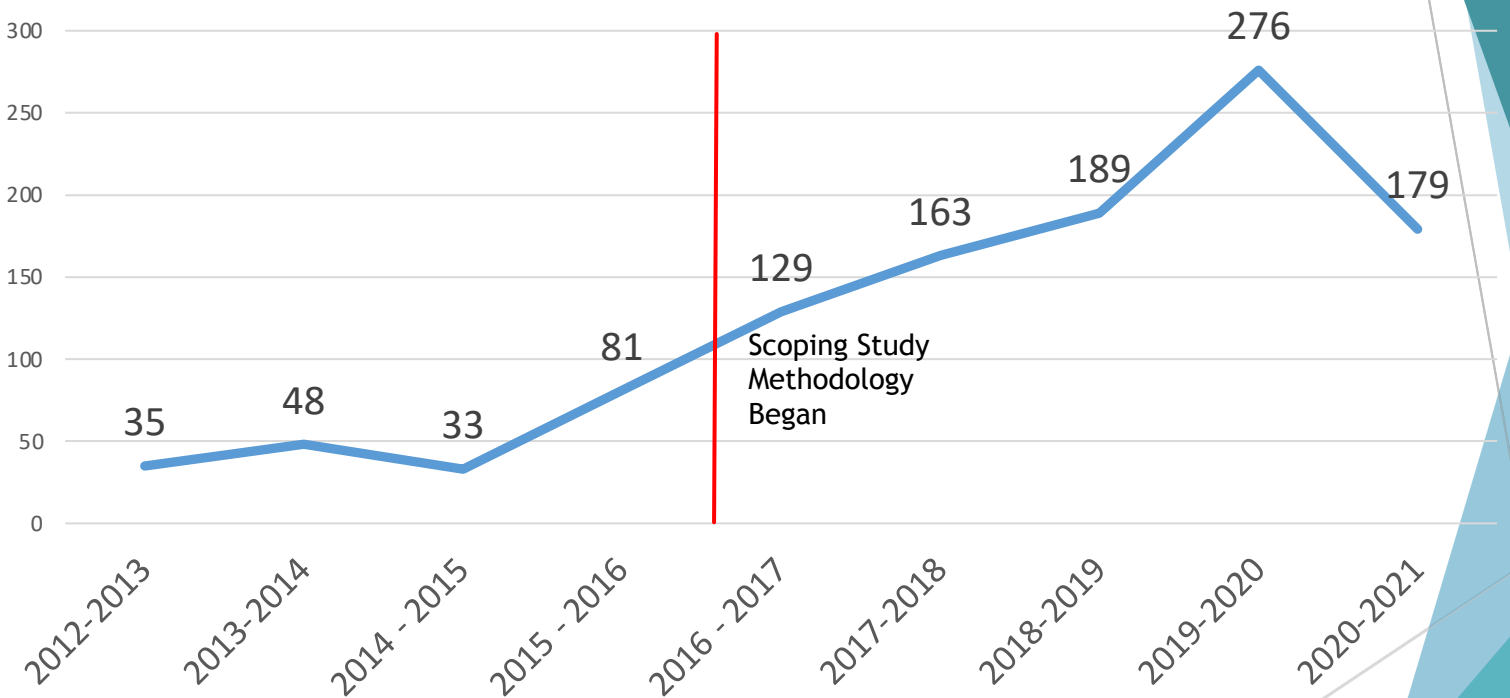
2020



2021



Articles Included in Evaluation



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Step 4: Charting the Data

Where is the research?

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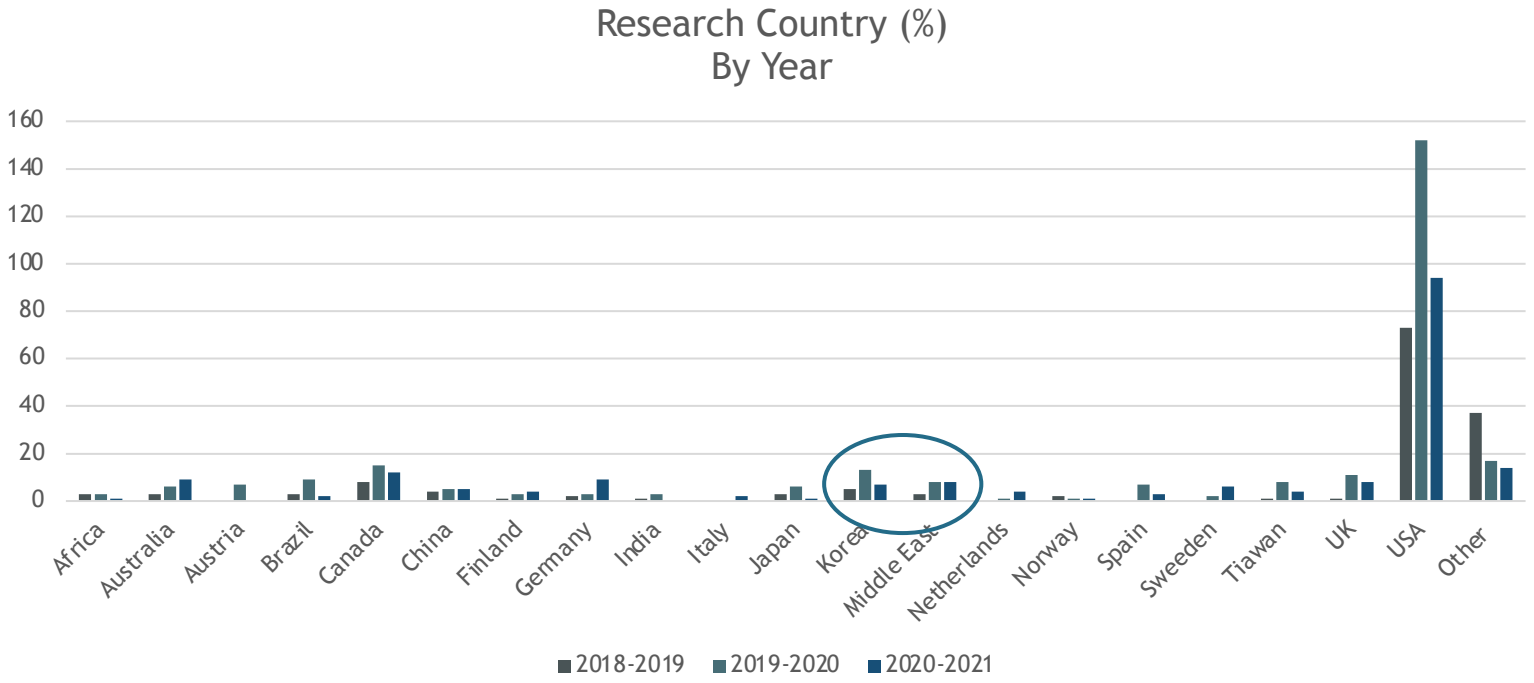
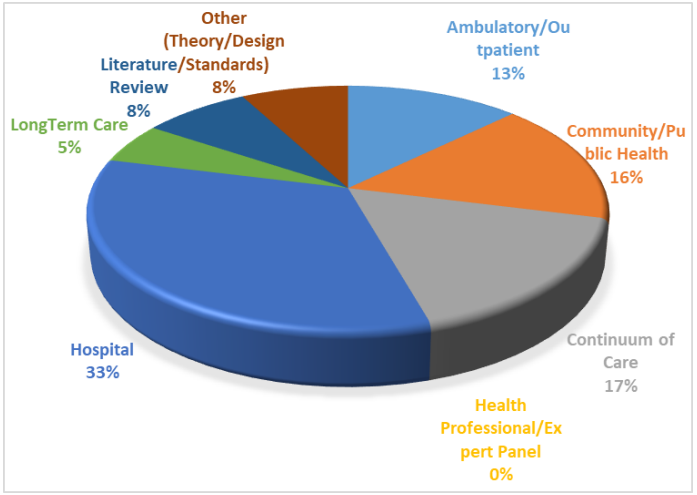
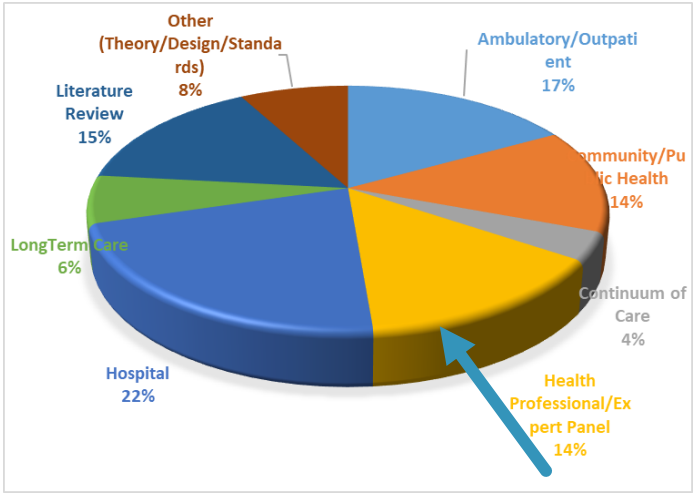

Research Country (%)
By Year
160
140
120
100
80
60
40
20
0
Africa
Australia
Austria
Brazil
Canada
China
Finland
Germany
India
Italy
Japan
Korea
Middle East
Netherlands
Norway
Spain
Sweeden
Tiawan
UK
USA
Other
2018-2019
2019-2020
2020-2021

Research by Setting

2019-2020



2020-2021



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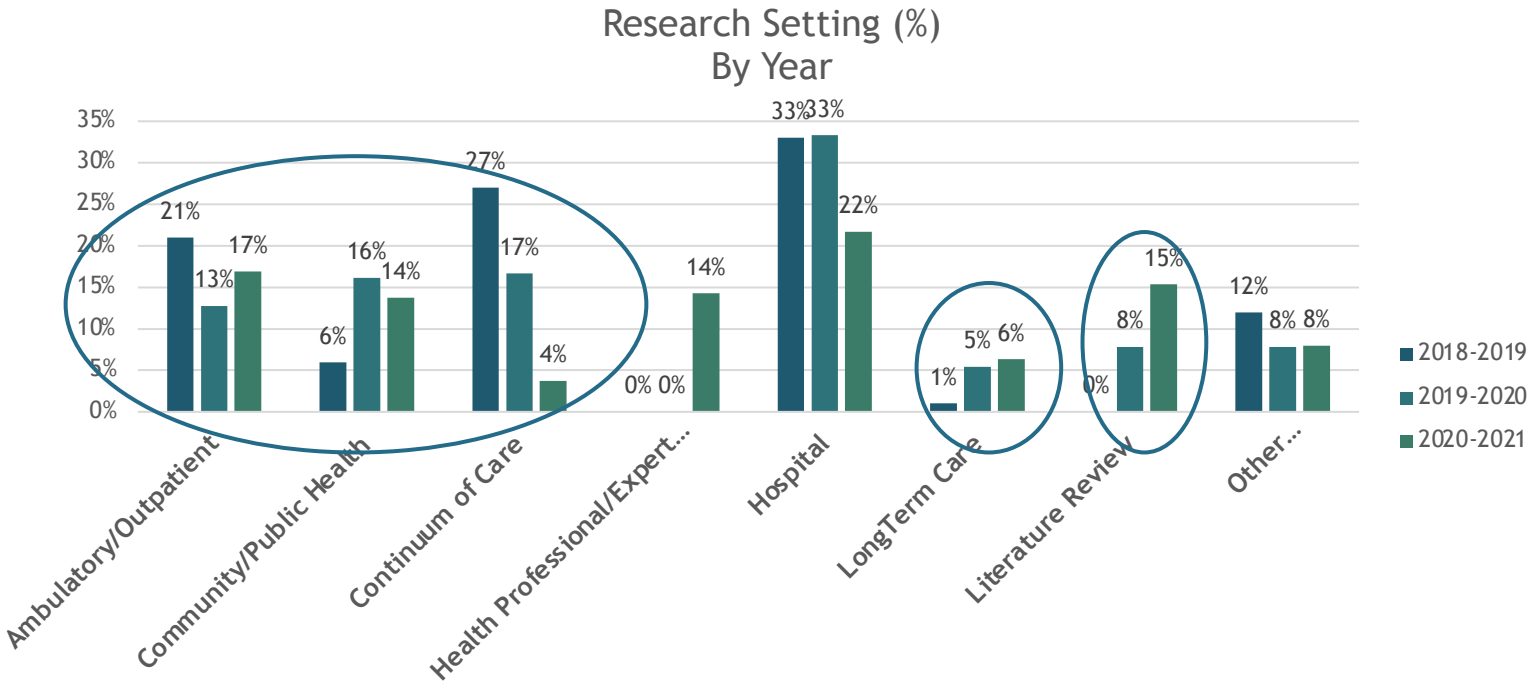
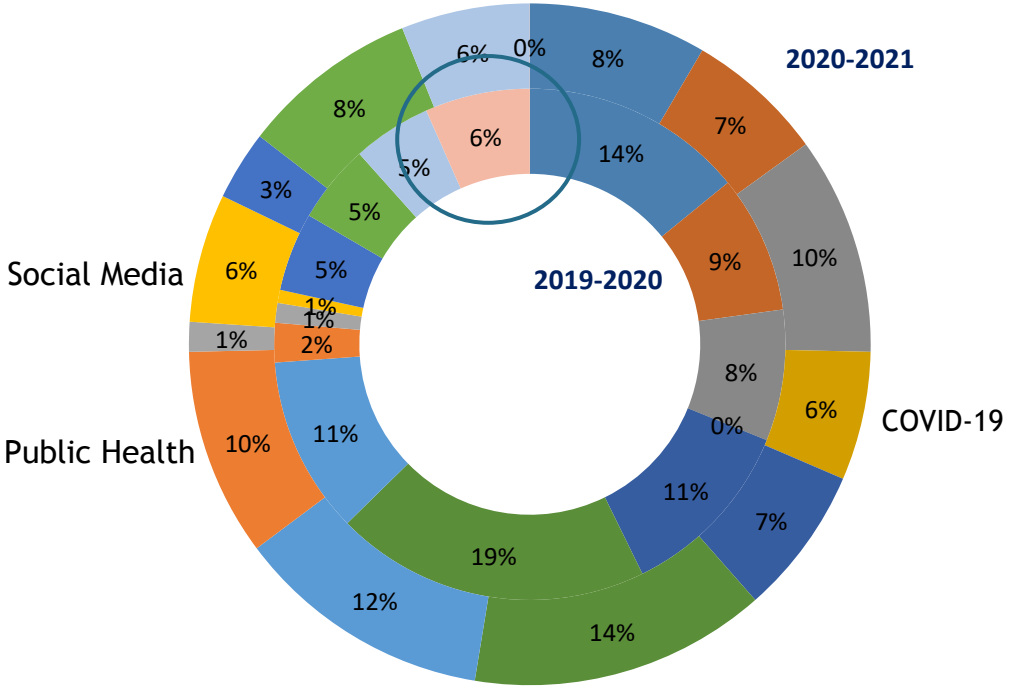
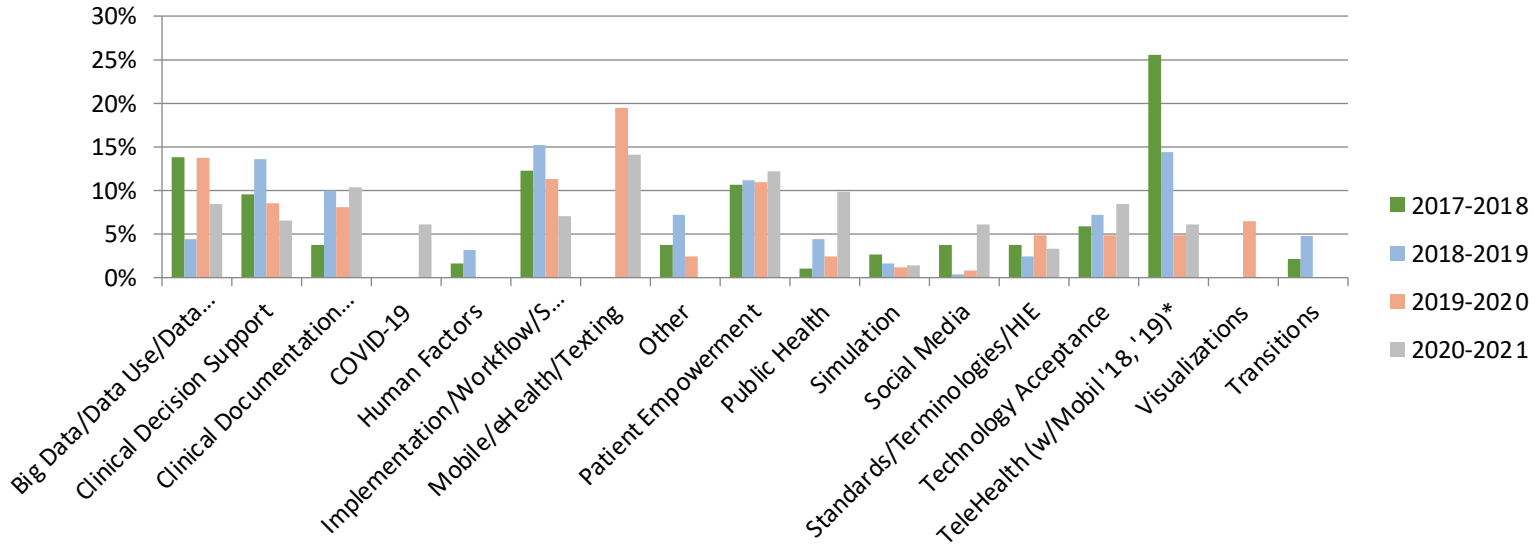

Research Setting (%)
By Year
35%
30%
25%
20%
15%
10%
5%
0%
21%
13%
17%
6%
16%
14%
27%
17%
4%
0%
0%
14%
33%
33%
22%
1%
5%
6%
0%
8%
15%
12%
8%
8%
Ambulatory/Outpatient
Community/Public Health
Continuum of Care
Health Professional/Expert...
Hospital
LongTerm Care
Literature Review
Other...
2018-2019
2019-2020
2020-2021

Topics by Year



Topic (%) by Year



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Step 5 – Collating, summarizing, and reporting the results

Themes Identified (2019-2020)

1. Population Health/Disparities
   - Use of telehealth technology to address health equity
   - Mobile apps for patient behavioral change
2. Documentation Burdon
   - Importance of nursing note and data contained in it
3. Older populations
4. Aging Adults
5. Patient directed technology
   - Social Media vs. eHealth → need to research information needs
   - Text messages
   - Information needs visualization
   - Patient generated data (wearables/smart watches)
6. Machine Learning/AI predictive models
   - Big Data <→ Population Health
   - AI/ML and clinical documentation
   - Interconnected use of big data to evaluate diseases and develop interventions and patient tools
7. Technology Acceptance – still an issue (patient and clinician)
8. Soooo many lit reviews at some point we need new research to support them ☺
9. School nurses

Representative Citations

Gopalan, A., Shaw, P. A., Lim, R., Paramanund, J., Patel, D., Zhu, J., ... & Buttenheim, A. M. (2019). Use of financial incentives and text message feedback to increase healthy food purchases in a grocery store cash back program: a randomized controlled trial. BMC public health, 19(1), 1-10.K

Kang, M. J., Dykes, P. C., Korach, T. Z., Zhou, L., Schnock, K. O., Thate, J., ... & Rossetti, S. C. (2020). Identifying nurses' concern concepts about patient deterioration using a standard nursing terminology. *International journal of medical informatics*, *133*, 104016.

Khairat, S., Haithcoat, T., Liu, S., Zaman, T., Edson, B., Gianforcaro, R., & Shyu, C. R. (2019). Advancing health equity and access using telemedicine: a geospatial assessment. *Journal of the American Medical Informatics Association*, *26*(8-9), 796-805.

Korach, Z. T., Cato, K. D., Collins, S. A., Kang, M. J., Knaplund, C., Dykes, P. C., ... & Zhou, L. (2019). Unsupervised machine learning of topics documented by nurses about hospitalized patients prior to a rapid-response event. *Applied clinical informatics*, *10*(05), 952-963.

Phillips, C. A., Hunt, A., Salvesen-Quinn, M., Guerra, J., Schapira, M. M., Bailey, L. C., & Merchant, R. M. (2019). Health-related Google searches performed by parents of pediatric oncology patients. *Pediatric blood & cancer*, *66*(8), e27795.

Reading Turchioe, M., Grossman, L. V., Myers, A. C., Baik, D., Goyal, P., & Masterson Creber, R. M. (2020). Visual analogies, not graphs, increase patients' comprehension of changes in their health status. *Journal of the American Medical Informatics Association*, *27*(5), 677-689.

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- Objective: The HealthyFood (HF) program offers members up to 25% cash back monthly on healthy food purchases. In this randomized controlled trial, **we tested the efficacy of financial incentives combined with text messages in increasing healthy food purchases among HF members**.
- Methods: The HealthyFood (HF) program offers members up to 25% cash back monthly on healthy food purchases. In this randomized controlled trial, we tested the efficacy of financial incentives combined with text messages in increasing healthy food purchases among HF members.
- Results: Of the members contacted, 20 opted out, and 2841 met all inclusion criteria. There were no between-arm differences in the examined outcomes. The largest mean (standard deviation) difference in percent healthy spending was between Arm 1 (24.8% [11%]) and Arm 2 (26.8% [13%]), and the largest mean difference in percent unhealthy spending was also between Arm 1 (24.4% [20%]) and Arm 2 (21.7% [17%]), but no differences were statistically significant after correction for multiple comparisons.
- Conclusions: **None of the tested financial incentive structures or text strategies differentially affected food purchasing.** Notably, more than doubling the cash back amount and introducing a financial disincentive for unhealthy purchases did not affect purchasing. These findings speak to the difficulty of changing shopping habits and to the need for innovative strategies to shift complex health behaviors.

RELATED: Korach, Z. T., Cato, K. D., Collins, S. A., Kang, M. J., Knaplund, C., Dykes, P. C., ... & Zhou, L. (2019). Unsupervised machine learning of topics documented by nurses about hospitalized patients prior to a rapid-response event. *Applied clinical informatics*, *10*(05), 952-963.

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- Objective: Nurse concerns **documented in nursing notes are important predictors of patient risk of deterioration**.
- Methods: Group consensus meetings with nurse SMEs were held to identify nursing concerns by grading Clinical Care Classification (CCC) system concepts based on clinical knowledge.
- Results: A total of 29 CCC concepts were selected as reflecting nurse concerns. From these, 111 entities and 586 seed terms were generated into a fundamental lexicon. Nursing concern concepts differed across settings (intensive care units versus non-intensive care units) and unit types (medicine versus surgery units).
- Conclusions: **The fundamental lexicon offers more granular terms that can be identified and processed in an automated fashion**.

RELATED: Korach, Z. T., Cato, K. D., Collins, S. A., Kang, M. J., Knaplund, C., Dykes, P. C., ... & Zhou, L. (2019). Unsupervised machine learning of topics documented by nurses about hospitalized patients prior to a rapid-response event. *Applied clinical informatics*, *10*(05), 952-963.

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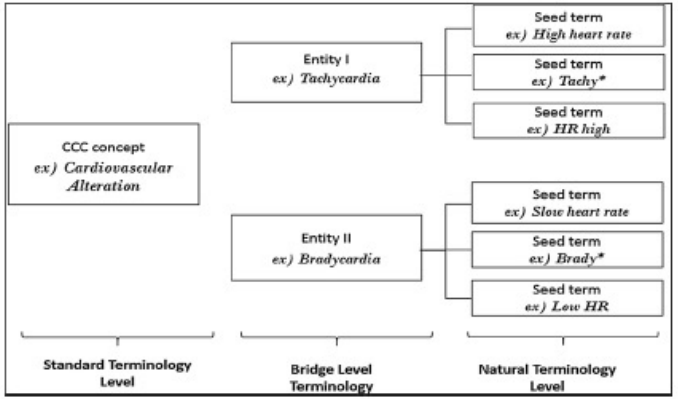

Fig. 1. Structure of terminology set used in research.

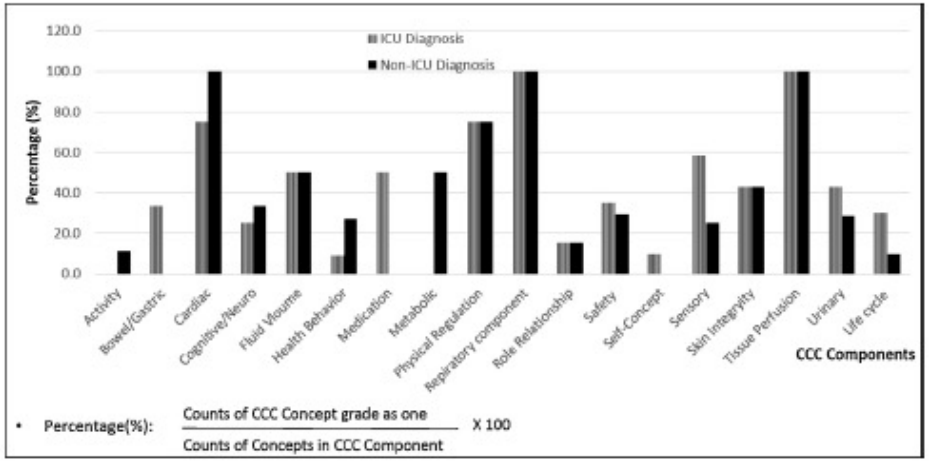

Fig. 2. Nursing concern scores for CCC concepts stratified by setting.

Khairat, S., Haithcoat, T., Liu, S., Zaman, T., Edson, B., Gianforcaro, R., & Shyu, C. R. (2019). Advancing health equity and access using telemedicine: a geospatial assessment. Journal of the American Medical Informatics Association, 26(8-9), 796-805.

- Objective: Evaluates the **reach and context of a virtual urgent care (VUC) program** on health equity and accessibility with a focus on the rural underserved population.
- Methods: Studied a total of 5343 patient activation records and 2195 unique encounters collected from a VUC during the first 4 quarters of operation. Zip codes served as the analysis unit and geospatial analysis and informatics quantified the results.
- Results: The reach and context were assessed using a mean accumulated score based on 11 health equity and accessibility determinants calculated for each zip code. Results were compared among VUC users, North Carolina (NC), rural NC, and urban NC averages
- Conclusions: **The study concluded that patients facing inequities from rural areas were enabled better healthcare access by utilizing the VUC**. Through geospatial analysis, recommendations are outlined to help improve healthcare access to rural underserved populations.

Table 2. NC, NC rural, and the NC rural with at least 1 VUC encounter zip codes as a measure of the program's service reach within each inequity component

Inequity factor	Rural VUC zip codes	NC zip codes	NC rural zip codes
American Indian	6	35 (17.14)	33 (18.18)
African American	32	164 (19.51)	140 (22.86)
In poverty	99	524 (18.89)	388 (25.52)
Single-female HH with children receiving food stamps	51	265 (19.24)	183 (27.87)
>60 years of age receiving food stamps	67	368 (18.21)	296 (22.64)
Medicare	85	493 (17.24)	411 (20.68)
Medicaid	81	414 (19.57)	317 (25.55)
Health services access	88	457 (19.26)	431 (20.42)
Road access	97	527 (18.41)	430 (22.56)
Broadband access	81	371 (21.83)	325 (24.92)
No vehicle	46	260 (17.69)	181 (25.41)

Values are n (%).
HH: household; NC: North Carolina; VUC: virtual urgent care.

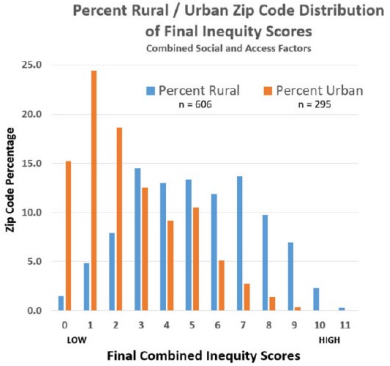

Figure 4. Rural (blue) vs urban (orange) percentages of zip codes by final combined inequity score across North Carolina.

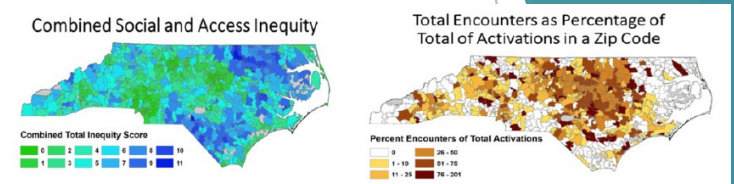

Figure 6. Combined social inequity and health services access: accumulation of inequity.

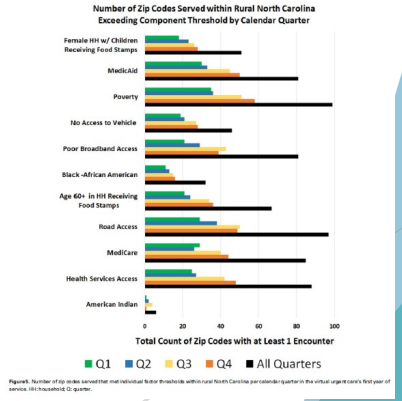

Figure 5. Number of zip codes served that met individual factor thresholds within rural North Carolina per calendar quarter in the virtual urgent care's first year of service. HH: household; Q: quarter.

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Phillips, C. A., Hunt, A., Salvesen-Quinn, M., Guerra, J., Schapira, M. M., Bailey, L. C., & Merchant, R. M. (2019). Health-related Google searches performed by parents of pediatric oncology patients. Pediatric blood & cancer, 66(8), e27795.

- Background: Little is known about the specific **information parents of children with cancer search for online**. Understanding the content of parents' searches over time could offer insight into what matters most to parents and identify knowledge gaps that could inform more comprehensive approaches to family education and support.
- Methods: **We describe parents' health-related Google searches starting six months before cancer diagnosis and extending through the date of study enrollment**, which was at least one month after initiating cancer treatment. Searches were obtained retrospectively and grouped into health-related and non-health-related categories.
- Results: **Parents searched for health-related topics more frequently than the general population (13% vs 5%).** Health-related searches increased in the months preceding the child's cancer diagnosis and most commonly pertained to symptoms and logistics, "directions to hospital." Health-related search volume peaked about a month after cancer diagnosis when general health-related searches were present in addition to cancer-specific searches. Eighteen percent of health-related searches were cancer specific, and of these cancer-specific searches, 54% pertained to support, for example "cancer quote for son.“
- Conclusions: Google search content offers insight into what matters to parents of cancer patients. Understanding search content could inform more comprehensive approaches to family education and support initiatives.

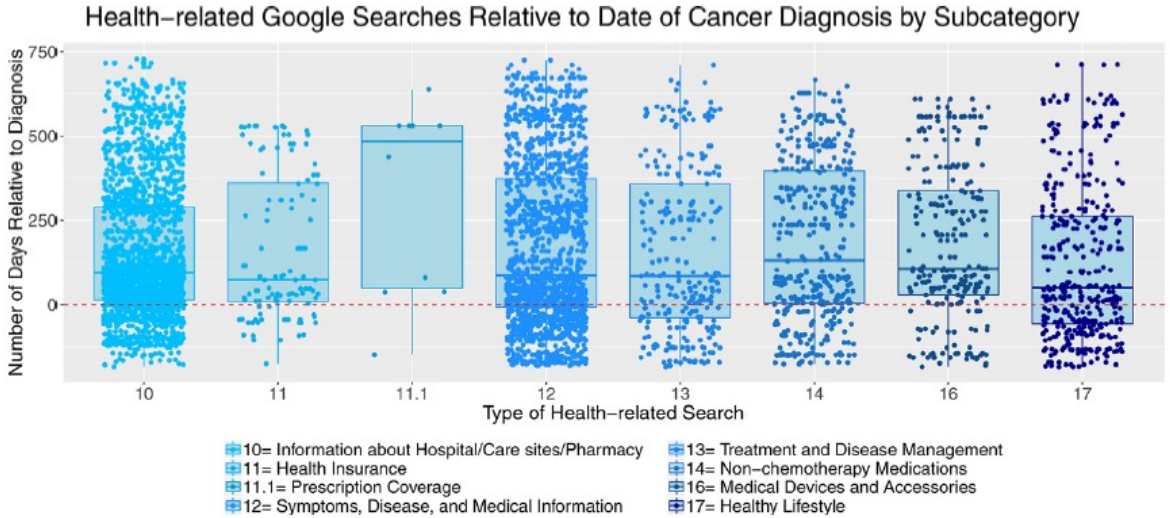

FIGURE 2 General health-related Google searches relative to the date of cancer diagnosis. General health-related Google searches are shown by subcategory (x-axis) from six months prior to diagnosis through two years after diagnosis (y-axis). Parents primarily search for symptoms and logistical information prior to a cancer diagnosis. Searches for health insurance cluster around the time of cancer diagnosis

Reading Turchioe, M., Grossman, L. V., Myers, A. C., Baik, D., Goyal, P., & Masterson Creber, R. M. (2020). Visual analogies, not graphs, increase patients' comprehension of changes in their health status. Journal of the American Medical Informatics Association, 27(5), 677-689.

- Objective: Patients increasingly use patient-reported outcomes (PROs) to self-monitor their health status. Visualizing PROs longitudinally (over time) could help patients interpret and contextualize their PROs. The study sought to assess hospitalized patients' objective comprehension (primary outcome) of text-only, non-graph, and graph visualizations that display longitudinal PROs
- Methods: We conducted a clinical research study in 40 hospitalized patients comparing 4 visualization conditions: (1) text-only, (2) text plus visual analogy, (3) text plus number line, and (4) text plus line graph. Each participant viewed every condition, and we used counterbalancing (systematic randomization) to control for potential order effects. We assessed objective comprehension using the International Organization for Standardization protocol. Secondary outcomes included response times, preferences, risk perceptions, and behavioral intentions.
- Results: Overall, 63% correctly comprehended the text-only condition and 60% comprehended the line graph condition, compared with 83% for the visual analogy and 70% for the number line ($P = .05$) conditions. Participants comprehended the visual analogy significantly better than the text-only ($P = .02$) and line graph ($P = .02$) conditions. Of participants who comprehended at least 1 condition, 14% preferred a condition that they did not comprehend. Low comprehension was associated with worse cognition ($P < .001$), lower education level ($P = .02$), and fewer financial resources ($P = .03$)
- Conclusions: The results support using visual analogies rather than text to display longitudinal PROs but caution against relying on graphs, which is consistent with the known high prevalence of inadequate graph literacy. The discrepancies between comprehension and preferences suggest factors other than comprehension influence preferences, and that future researchers should assess comprehension rather than preferences to guide presentation decisions.

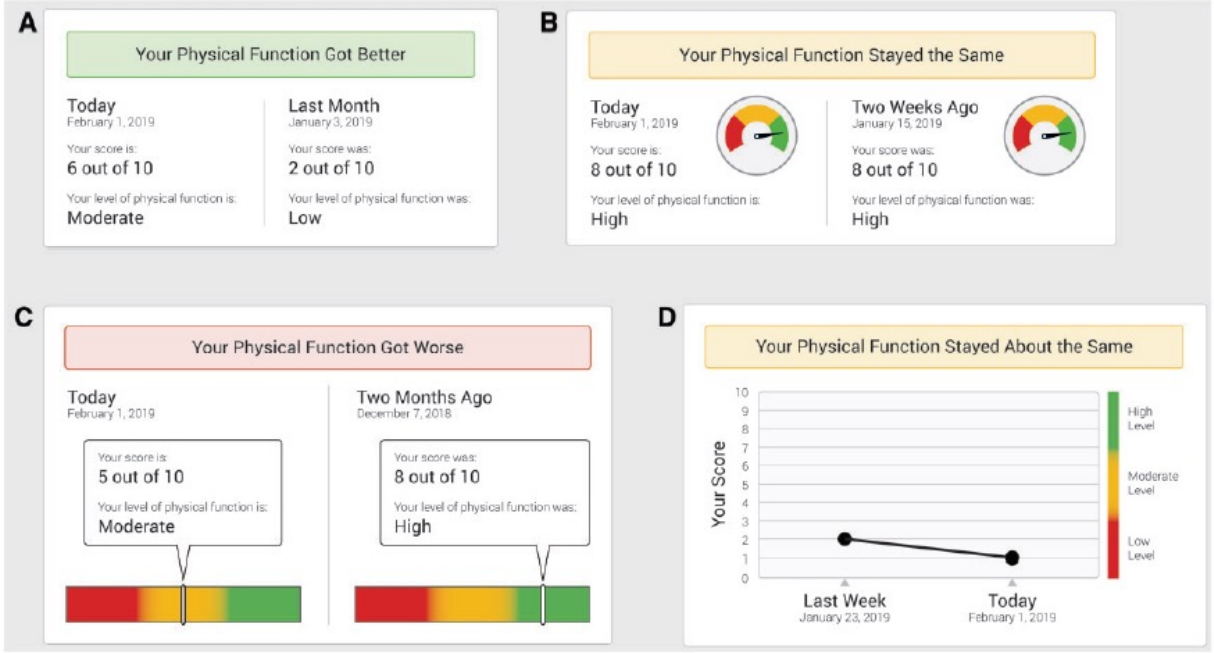

Figure 1. Visualization conditions: (A) text-only; (B) text plus visual analogy; (C) text plus number line; (D) text plus line graph.

Themes Identified (2020-2021)

1. Nursing Workload
2. Use of Machine Learning and AI Algorithms (risk factors – predictive models)
3. Older adult use of E-health (information literacy)
4. Information resources/self-management (apps)
5. Assessment Tools
6. EHR Adoption in more places (International)
7. Initial mentions of COVID-19 (expect more next year)
8. Education articles down
9. Florence Nightingale
10. Informatics has become very broad Should we redefine it?
11. Where are security issues???

Representative Citations (2020-2021)

Fu, H. N., Rizvi, R. F., Wyman, J. F., & Adam, T. J. (2020). Usability evaluation of four top-rated commercially available diabetes apps for adults with type 2 diabetes. *Computers, informatics, nursing: CIN*, *38*(6), 274.

Hyun, S., & Cooper, C. (2020). Application of Text Mining to Nursing Texts: Exploratory Topic Analysis. *CIN: Computers, Informatics, Nursing*, *38*(10), 475-482.

Lin, C. T., Bookman, K., Sieja, A., Markley, K., Altman, R. L., Sippel, J., ... & Pell, J. (2020). Clinical informatics accelerates health system adaptation to the COVID-19 pandemic: examples from Colorado. *Journal of the American Medical Informatics Association*, *27*(12), 1955-1963.

Moore, E. C., Tolley, C. L., Bates, D. W., & Slight, S. P. (2020). A systematic review of the impact of health information technology on nurses' time. *Journal of the American Medical Informatics Association*, *27*(5), 798-807.

Yen, Po-Yin, et al. "Nurses' stress associated with nursing activities and electronic health records: Data triangulation from continuous stress monitoring, perceived workload, and a time motion study." *AMIA Annual Symposium Proceedings*. Vol. 2019. American Medical Informatics Association, 2019.

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Foreign Studies

- Iran – Nurses adoption of health information technology, Attitudes toward telenursing and telehealth, nursing informatics competencies
- Germany – Health technology literacy
- Brazil – Sepsis detection algorithm
- Kenya – Social factors in the adoption of electronic health records
- Turkey - Nursing informatics competencies
- Korea – Adopting and implementing SNOMED, mobile personal health systems
- Greece – Perceptions about Big Data technology
- Finland – Roles of healthcare leaders

Fu, H. N., Rizvi, R. F., Wyman, J. F., & Adam, T. J. (2020). Usability evaluation of four top-rated commercially available diabetes apps for adults with type 2 diabetes. Computers, informatics, nursing: CIN, 38(6), 274

- Background: Despite the many diabetes applications available, the rate of use is low, which may be associated with design issues. This study **examined app usability** compliance with heuristic design principles, guided by the Self-determination Theory on motivation.
- Methods: Four top-rated commercially available apps (Glucose Buddy, MyNetDiary, mySugr, and OnTrack) were tested for data recording, blood glucose analysis, and data sharing important for diabetes competence, autonomy, and connection with a healthcare provider. Four clinicians rated each app's compliance with Nielsen's 10 principles and its usability using the System Usability Scale.
- Results: All four apps lacked one task function related to diabetes care competence or autonomy. Experts ranked app usability rated with the System Usability Scale: OnTrack (61) and Glucose Buddy (60) as a "D" and MyNetDairy (41) and mySugr (15) as an "F." A total of 314 heuristic violations were identified. The heuristic principle violated most frequently was "Help and Documentation" (n = 50), followed by "Error Prevention" (n = 45) and "Aesthetic and Minimalist Design" (n = 43).
- Conclusions: **Four top-rated diabetes apps have "marginally acceptable" to "completely unacceptable."** Future diabetes app design should target patient motivation and incorporate key heuristic design principles by providing tutorials with a help function, eliminating error-prone operations, and providing enhanced graphical or screen views

Hyun, S., & Cooper, C. (2020). Application of Text Mining to Nursing Texts: Exploratory Topic Analysis. CIN: Computers, Informatics, Nursing, 38(10), 475-482.

- We applied **topic modeling** to the nursing free texts in ICU nursing progress notes in order to explore the content of nursing narratives and to determine whether this text mining approach is suitable to gain a meaningful summary from them. Forty topics (themes) were discovered. Methods:

Table 1. Topics and Their Frequent Collocation Terms

Topic	Frequent Collocation Terms
Topic 1: Airway	secretions, rehab, pm, tf, trach, tube, suctioned, care, airway, suctioning, sputum, suction, cough, back, mouth, peg, protect_risk, aspiration_altered_gag_airway, airway_inability
Topic 2: Cognitive	monitor, alert, oriented, lethargic, awake, administered, oriented_x3, throughout_shift, administer, voice, sleeping, commands, following_commands, vitals, assessment_alert, arousable
Topic 3: Myocardial infarction	ccu, cath, chest_pain, cp, groin, ekg, hematoma, lad, asa, stent, cath_lab, ck, rca, troponin, echo, mi, teaching, myocardial, ntg, trop
Topic 4: Renal	hd, labs, renal, urine, uop, cr, monitor, elevated, catheter, uo, dialysis, renal_failure_acute, baseline, urine_output, acute_renal_failure_arf_assessment, creat, fluid, creatinine, bun
Topic 5: Mixed monitoring	monitor, tylenol, na, tachycardia, ew, ivf, labs, fever, monitoring, urine, tachycardic, sodium, max, plan_monitor, wnl
Topic 6: History	htn, hx, chronic, acute, management, pmh, significant, worsening, hpi, pmhx, cad, normal, setting, chf, baseline, chief_complaint, tx, ef, secondary
Topic 7: Nausea/vomiting	nausea, symptoms, zofran, vomiting, ra, ns, feeling, diarrhea, felt, denied, mild, nausea_vomiting, dizziness, chest_pain, episodes, complaints, er, abdominal_pain, vitals
Topic 8: Laboratory	hematocrit, reactions, temperature_arterial, insp_heart_rate, chloride_meq, non-invasive_bp, potassium_meq, surgery_procedure, bp_respiratory_rate, creatinine_dl, co2_meq, bun_dl, lab_results_sodium_meq, o2, money_wallet, glucose_dl, precautions, bpm_heart_rhythm_sinus_rhythm
Topic 9: Skin	skin, wound, applied, dressing, back, impaired_skin_integrity_assessment, coccyx, red, dsg, areas, intact, dry, rash, monitor, turned, pink, bed, skin_care, turn, stage
Topic 10: Hospice	family, bedside, care, morphine, comfort, support, comfortable, cmo, expired, family_members, discussed, family_meeting, emotional_support, decision, death, comfort_measures, wishes, unresponsive, dnr_dni, declined
Topic 11: General cardiac care	k, monitor, episodes, repleted, placement, pacer, potassium, vt, rhythm, ccu, bradycardia, bp, labs, paced, icd, kcl, electrolytes, ep
Topic 12: Postsurgery care	cough, encouraged, coughing, chest, activity, oob, deep_breathing, tolerated, overnoc, improved, turning, pain_control, db, movement, increase, rest, turns, deep_breath

Lin, C. T., Bookman, K., Sieja, A., Markley, K., Altman, R. L., Sippel, J., ... & Pell, J. (2020). Clinical informatics accelerates health system adaptation to the COVID-19 pandemic: examples from Colorado. Journal of the American Medical Informatics Association, 27(12), 1955-1963.

- Objective: Large health systems responding to the coronavirus disease 2019 (COVID-19) pandemic face a broad range of challenges; we describe 14 examples of innovative and effective informatics interventions.
- Methods: A team of 30 physician and 17 nurse informaticists with an electronic health record (EHR) and associated informatics tools.
- Results: To meet the demands posed by the influx of patients with COVID-19 into the health system, the team built solutions to accomplish the following goals: 1) train physicians and nurses quickly to manage a potential surge of hospital patients; 2) build and adjust interactive visual pathways to guide decisions; 3) scale up video visits and teach best-practice communication; 4) use tablets and remote monitors to improve in-hospital and posthospital patient connections; 5) allow hundreds of physicians to build rapid consensus; 6) improve the use of advance care planning; 7) keep clinicians aware of patients' changing COVID-19 status; 8) connect nurses and families in new ways; 9) semi-automate Crisis Standards of Care; and 10) predict future hospitalizations
- Conclusions: During the onset of the COVID-19 pandemic, the UCHealth Joint Informatics Group applied a strategy of "practical informatics" to rapidly translate critical leadership decisions into understandable guidance and effective tools for patient care. Informatics-trained physicians and nurses drew upon their trusted relationships with multiple teams within the organization to create practical solutions for onboarding, clinical decision-making, telehealth, and predictive analytics.

Moore, E. C., Tolley, C. L., Bates, D. W., & Slight, S. P. (2020). A systematic review of the impact of health information technology on nurses' time. Journal of the American Medical Informatics Association, 27(5), 798-807.

- Objective: Nursing time represents one of the highest costs for most health services. We conducted a systematic review of the literature on the **impact of health information technology on nurses' time**.
- Methods: We followed PRISMA guidelines and searched 6 large databases for relevant articles published between Jan 2004 and December 2019. Two authors reviewed the titles, abstracts, and full texts. We included articles that included a comparison group in the design, measured the time taken to carry out documentation or medication administration, documented the quantitative estimates of time differences between the 2, had nurses as subjects, and was conducted in either a care home, hospital, or community clinic.
- Results: We identified a total of 1647 articles, of which 33 met our inclusion criteria. Twenty-one studies reported the impact of 12 different health information technology (HIT) implementations on nurses' documentation time. Weighted averages were calculated for studies that implemented barcode medication administration (BCMA) and 2 weighted averages for those that implemented EHRs, as these studies used different sampling units; **both showed an increase in the time spent in documentation (+22% and +46%). However, the time spent carrying out medication administration following BCMA implementation fell by 33% (P < .05).** HIT also caused a redistribution of nurses' time which, in some cases, was spent in more "value-adding" activities, such as delivering direct patient care as well as inter-professional communication.
- Conclusions: Most of the HIT systems increased nursing documentation time, although time fell for medication administration following BCMA. **Many HIT systems also resulted in nurses spending more time in direct care and "value-adding" activities.**

Yen, Po-Yin, et al. "Nurses' stress associated with nursing activities and electronic health records: Data triangulation from continuous stress monitoring, perceived workload, and a time motion study." AMIA Annual Symposium Proceedings. Vol. 2019. American Medical Informatics Association, 2019.

- As health IT has become overloaded with patient information, provider burnout and stress has accelerated. Studies have shown that EHR usage leads to heightened cognitive workload for nurses, and increases in cognitive workload can result in stronger feelings of exhaustion and burnout. We conducted a **time motion study** in an oncology division to examine the relationships between nurses' perceived workload, stress measured by blood pulse wave (BPw), and their time spent on nursing activities, and to identify stress associated with EHR use. We had a total of 33 observations from 7 nurses. We found that EHR-related stress is associated with nurses' perceived physical demand and frustration. We also found that nurses' perceived workload is a strong predictor of nurses' stress as well as how they spent time with their patients. They also experienced higher perceived mental demand, physical demand, and temporal demand when they were assigned to more patients, regardless of patient acuity. Our study presents a unique data triangulation approach from continuous stress monitoring, perceived workload, and a time motion study.

	Mean	SD	Min	Max
C_patient	28.07	16.44	5.18	83.55
C_RN	24.41	13.52	7.22	53.80
C_family	6.15	5.47	0.57	20.48
C_call out	4.10	3.43	0.00	16.10
C_call in	2.35	2.33	0.00	8.92
H_EHR	45.54	17.42	18.27	95.92
H_direct_medication	15.17	8.12	3.85	32.00
H_direct_procedure	7.68	9.77	0.00	50.95
H_indirect_get med	6.43	4.07	0.82	17.02
H_handoff_rounding	5.18	7.04	0.00	24.40
L_own_pt_room	84.18	29.29	32.02	160.58
L_rn station	80.44	38.63	12.10	175.47
L_med_supply room	14.53	8.79	0.37	38.23
L_travel walking	14.31	4.01	7.13	23.87
L_unit secretary	10.65	16.17	0.00	66.70

C = communication; H = hands-on tasks; L = location

Step 6 – Consultation

Feedback and Professional Input…