

## The Digital Enterprise: Redefining How Data is Changing Surgery

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### Contributors

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*“There can be no denying that the rise of the digital era has effectively pulled into play a modern set of guidelines and principles that effectively elevate practically every aspect of life...Look around you; the changes are evident from all angles. We live in a vastly different world than the one we were navigating twenty, even ten years ago. And the advancements keep on coming.” (1)*

—— IUtech ——

This digital transformation has created incredible opportunities for change, especially within the field of healthcare. From the digitization of academic print materials that has created a surge of instantly accessible evidence to the vast data mines that now power big data and machine learning processes, this digital era is continuing to transform the way we interact with information and push the limits of what we can do with it. However, this process takes time, innovation, and most importantly – the breaking of old habits. In this OE Insight, we explore both the challenges and opportunities that have risen from this new abundance of online information and what this means for our pursuit of evidence-based medicine in surgery.

*“Every technology follows a similar path of discovery, engineering, and transformation. In the case of electricity, Faraday uncovered new principles, but no one really knew how to make them useful. They first had to be understood well enough that people such as Edison, Westinghouse, and Tesla could figure out how to make things that people would be willing to buy. However, creating a true transformation takes more than a single technology. First, people need to change their habits, and then secondary innovations need to come into play. For electricity, factories needed to be redesigned and work itself had to be reimaged before it began to have a real economic impact. Then household appliances, radio communications, and other things changed life as we knew it, but that took another few decades.” (2)*

————— Satell G (2018) —————

## Insights

- Academic print materials, such as textbooks and journals, are undergoing a digital transformation.
- This transformation means that more and more evidence is becoming available electronically, placing it at the fingertips of medical practitioners worldwide.
- Readily available data is cutting down on costs, creating new possibilities for data mining, making information more secure, and improving data sharing.
- However, the sheer volume of data is making it increasingly difficult to navigate.
- Technological factors can also affect a physician's ability to access this information which is further compounded by time constraints, limited knowledge of research methodology, limited context-specific research, and experiences with a textbook-based residency curriculum.
- It is becoming increasingly important to make high-quality evidence more accessible, convenient and timely in order to make the overall practice of translating research into clinical practice more efficient.
- Evidence-based summaries can provide the type curated data clinicians need to help guide clinical decision making at the point-of-care.

- There is currently a limited number of evidence-based resources available for surgical subspecialties.
- This has highlighted a need for evidence-based resources that are more easily accessible, recent, transferable, implementable, and especially in the case of surgical subspecialties like orthopedics, more specialized.
- To fill the evidence gap, OrthoEvidence has grown its digital enterprise to one of the largest, providers of evidence-based reports worldwide.

## Are Academic Print Materials Truly A Thing of The Past?

*“The nature of discovery is changing. I think the digital revolution and the use of digital resources in general is really the beginning of a change in the way humanity thinks and represents itself.” (3)*

———— Hafner K (2004) ————

A 2019 study by Kheterpal et al. found that, of the 44 orthopedic surgeons who were surveyed on their use of medical literature, 75% reported that they accessed medical literature online while only 39% of respondents said they read paper journals. (4) However, 73% said they used textbooks. (4) Another survey conducted at Stanford University surveyed 20 graduating medical students on their top medical book read recommendations. Surprisingly, the top four recommendations were not textbooks at all, but instead, were two banks of questions, a review book and a pocket handbook (the Medical Knowledge Self-Assessment Program (MKSAP) question book, the United States Medical Licensing Examination (USMLE) World question bank, the Step Up To Medicine review book, and Pocket Medicine). (5) When it comes to where medical learners and professionals turn for information, whether it is online or print, textbook or question bank, it seems there may be a generational shift affecting the “academic diet” of 21st century learners. (5)

“The recent explosion of printed and digital resources offers students alternatives to the classic texts that previous generations swore by. As a result, medical tomes are no longer the primary means by which students learn medicine, but just one piece of an increasingly complex puzzle.” (5)

Gupta M (2014)

**The Problem With Textbooks:** The thing with textbooks is that they are familiar and convenient, but the information presented in them can be limited or lack an evidence-basis. (6) In certain rapidly advancing fields, information that is provided is already outdated at the time of publishing. (6) In a 2019 Annual Letter, Bill and Melinda Gates note that “thanks to software, standalone textbooks are becoming a thing of the past.” (6) A sentiment shared by many, as it has been widely thought that this new, technology-driven generation (who are often blamed for killing many other industries such as print news and the music industry) would quickly adopt digital textbooks and render print textbooks a thing of the past. (7)(8)

However, an EdSurge article argues that these predictions have been greatly exaggerated, asserting that “even as many traditional textbook providers are transitioning to digital formats, paper and ink have proved stubbornly resilient.” (8) For example, a 2018 survey of college students reported that 75% of students preferred print textbooks and felt that print books were easier to read. (9) This is compared to just 12% of students who preferred e-books and 20% who had no preference. However, the survey also found that 66% of all students agreed that e-books were more convenient to get than print books and 45% preferred e-books for research, citing that up to date information, e-references, the ability to copy and paste, and simplified navigation that allowed the jump to specific pages made e-books particularly helpful. (9)

The industry does show signs of change. In 2015, physical textbooks made up 45% of higher education courseware in the United States, down from 50% the year before. (9) Digital-only textbooks made up 29% and digital and print bundles made up 26%. (9) However, fast forward to 2019 and digital sales now make up more than half of annual revenues for big publishers such as Pearson. (10) According to Pearson CEO John Fallon, “we are now over the digital tipping point” which means Pearson will “flick the switch in how we primarily make and create our products” by making the move to encourage students to buy e-books. (10) However, this “print-to-digital transition is not as clean-cut and immediate as some are led to believe” and for now, it seems we are stuck somewhere in the middle, which may also explain why blended bundles of print and digital offerings are still a popular option. (9) Bill Gates also reflects on the industry's slow momentum but adds that “in the meantime, I haven't heard from anyone who misses their heavy, expensive textbooks.” (4)

**The Future of Academic Journals:** Academic journals, especially those in Science, Technology and Medicine (STM), were the first major scholarly publications to become available online. (11)(12) According to an Atlantic article entitled *The Scientific Paper is Obsolete*, the biggest issue with academic journals isn't that they haven't committed to transforming their content to digital, it's that they aren't embracing everything this new digital format has to offer. (13)



*“Scientific methods evolve now at the speed of software...And yet the basic means of communicating scientific results hasn't changed for 400 years. Papers may be posted online, but they're still text and pictures on a page...What would you get if you designed the scientific paper from scratch today?”*

*“This is, of course, the whole problem of scientific communication in a nutshell: Scientific results today are as often as not found with the help of computers. That's because the ideas are complex, dynamic, hard to grab a hold of in your mind's eye. And yet by far the most popular tool we have for communicating these results is the PDF—literally a simulation of a piece of paper. Maybe we can do better.” (13)*

—— Somers J (2018) ——

According to Bret Victor, former researcher with Apple, this incomplete transformation is similar to the evolution of the book following the invention of the printing press, “there was this entire period where they had the new technology of printing, but they were just using it to emulate the old media.” (13) Scholastica outlines three main areas where the digitization of print journals has fallen short:

**1. Decentralized processing systems.** Submissions are often accepted on one platform, peer reviewed in a second, and finally, published once again in another. Since information is being moved so frequently between platforms, it also changes formats quite often. Overall, technology has presented an opportunity to centralize this entire process, however in many cases the opportunity to use technology to cut out this manual work has been missed. (14)

**2. Publishing articles as PDFs.** PDFs were traditionally used as the standard format for print and to this day contain the same layout. PDFs do not support embedded multi-media, have a poor layout for online and mobile reading, do not allow for easily clickable references within the text, and are not search-optimized for online browsers. (14) Instead, other methods could be adopted for presenting research. One other method is the use of computational notebooks, which allow for interactive diagrams to be worked in with the text. (13) These diagrams would not only provide access to the data behind them but would allow the reader to see and interact with it. (13)

**3. Waiting to publish articles in issues.** The issue-based publishing model means that journals can sometimes take weeks to years to compile enough content for an entire issue. For more time sensitive research articles, this time intensive process can make a big difference to its real-world value. (14) In our current day-in-age where information has the capacity to become available so quickly, it is easy to see why this slow dissemination of evidence has become an issue.

## Digitization Has Created the Desire (And Need) for Curated Data



*“Information is relatively easy to come by in the electronic age. In principle, nearly all of the world's information is available instantly. The opportunities are almost limitless. [But] the sheer volume of easily accessed information creates a new challenge: keeping up with new information and finding the best available answers to specific questions amidst all the other information.” (4)*

————— Kheterpal et al. (2019) —————

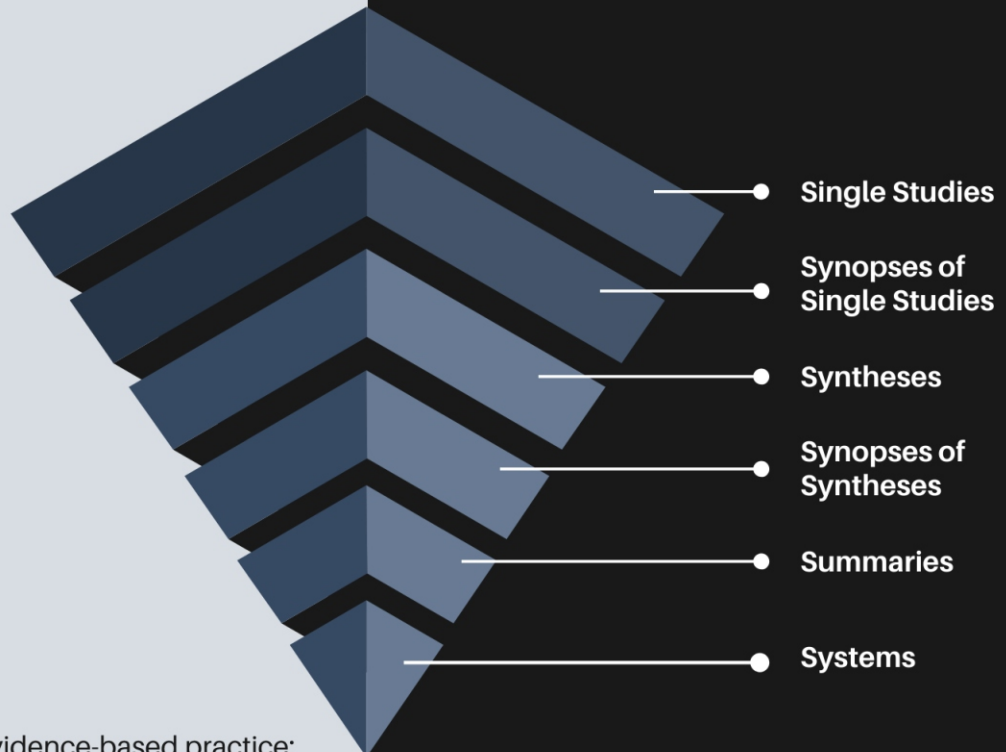
The abundance of evidence available digitally means that we now have vast amounts of information at our fingertips. This readily available data is cutting down on printing and library costs, creating new possibilities for data mining, making information more secure, and improving data sharing. (12) However, the convenience of having so much evidence available is making it increasingly difficult to navigate. In addition to the difficulties that arise from the sheer volume of evidence, this digitization also presents a series of other challenges. For example, just because the information is online does not mean that it is easily accessible. Kheterpal et al. (2019) found that for the orthopedic surgeons who were surveyed, internet connection and minimal access to medical journals had an impact on their ability to access relevant literature. (4) In addition, time constraints, limited knowledge of research methodology, limited context-specific research, and a textbook-based residency curriculum all added to a decreased incentive to stay up to date. (4)

With clinicians increasingly required to use evidence in addition to expertise to make clinical decisions, it is becoming very important to make high-quality evidence more accessible, convenient and timely – making the overall practice of translating research into clinical practice, or evidence-based medicine (EBM), more efficient. (4) Enter the evidence-based summary (also referred to as a point-of-care resource) – a thoughtful summary of available evidence that provides the type of curated data clinicians want and need. With limited time available day to day, this type of curated information can help clinicians to make the best possible decisions for the care of patients at the point-of-care while also increasing workflow. (16) Exhibit 1 outlines the six types of resources for evidence-based practice. (17) With each new layer, or when moving towards the peak of the pyramid, the resource becomes less specific and more filtered, but increases in its ability to guide clinical action. (18)

*“Over the last several years the concepts and ideas attributed to and labeled collectively as EBM have become a part of daily clinical lives and clinicians increasingly hear about evidence-based guidelines, evidence-based care paths and evidence-based questions and solutions. The controversy has shifted from whether to implement the new concepts to how to do so sensibly and efficiently.” (19)*

——— Bhandari et al. (2007) ———

## THE 6S PYRAMID



**Exhibit 1.** Resources for evidence-based practice; the six layers of the 6S pyramid. (17)

Exhibit 2 describes each resource type and provides examples of existing resources. (18) The search for this filtered or “pre-appraised” information should begin at the peak of the pyramid, or the systems layer. If that resource does not exist for a given topic, the search should continue by moving down through the layers. (17) The Systems layer therefore represents the ideal source of information for clinical decision making as it “integrates and concisely summarises all relevant and important research evidence about a clinical problem, is updated as new research evidence becomes available, and automatically links (through an electronic medical record) a specific patient's circumstances to the relevant information.” (17) This process is facilitated through the use of computerized decision support systems (CDSSs) which unfortunately make the Systems layer feel less familiar due to their overall lack of availability. (17)



	Description	Example Resource(s)
Single Studies	Unique research conducted to address specific clinical questions.	CINAHL, OVID databases (e.g. Medline, EMBASE), PubMed
Synopses of Single Studies	Summarize the evidence from high quality studies.	ACP Journal Club, OrthoEvidence
Syntheses	A comprehensive summary of evidence surrounding a specific research question (systematic review).	Cochrane Library, Cochrane Collaboration, OrthoEvidence
Synopses of Syntheses	Summarize the information found in systematic reviews.	Cochrane Evidence Summaries, ACP Journal Club, OrthoEvidence
Summaries	Clinical guidelines or textbooks that integrate evidence-based information for specific clinical problems.	NICE, ClinicalKey, DynaMed, UpToDate, BMJ Best Practice
Systems	Integrate information from all lower levels with individual patient records; the ideal source of information for clinical decision making.	No resources available yet.

**Exhibit 2.** Description and example resources for each of the six layers of the 6S pyramid. (18)

*“Processing single studies into synopses, syntheses, and summaries takes time, and therefore, the current best evidence may not always be available in a pre-appraised resource as quickly as we would like. Indeed, there is no guarantee that high-quality evidence exists for the clinical problem of interest or that the patients studied are sufficiently similar to the patients to whom we hope to apply the results. Thus, users always must retain responsibility for use of evidence in a given clinical decision. The orderly use of current evidence-based resources, however, will often make the burden of this decision much lighter.” (17)*

— DiCenso et al. (2009) —

## Addressing the Evidence Gap for Surgical Subspecialties

To evaluate the evidence-based resources available to practitioners within surgical fields, a 2013 study by Turvey et al. quantified the available surgical and orthopedic content from five evidence-based medicine resources. (20) The resources examined were DynaMed (EBSCOhost), Clinical Evidence (British Medical Journal), UpToDate (Wolters Kluwer Health), PIER (American College of Physicians) and First Consult (Elsevier). (20) The study found that surgical content ranged from 9.5% (UpToDate) to 28% (First Consult and PIER) of total content. For orthopedics, this ratio decreased drastically ranging from 0.2% (UpToDate) to 4% (First Consult). (20) Although there is more coverage of general surgical content compared to more specialized fields such as orthopedics, there is still a limited number of surgical evidence-based resources available relative to total content. This broad range of content makes finding evidence for specific interventions of interest to surgical subspecialties particularly challenging. This has highlighted the need for more surgical subspecialty focused resources. A more specific range of evidence may also continue to help EBM become an integral part of surgical practices. (20)

## OrthoEvidence: Better Evidence, Better Analytics, Better Decisions

To fill the evidence gap, OE has grown its digital enterprise to one of the largest, providers of evidence-based reports worldwide (20). With a searchable database of several thousand reports of randomized trials, the promise of data is being realized in its Machine Learning Insights Database (OE M.I.N.D.). With over 80 million datapoints from published research trials, OE's analytics platform has moved from an individual research paper to real time analyses that change as new data is added to the system. Meta-analyses of trials which once took months, now take minutes. These digital tools now can unveil insights like never before.

*“Data is the differentiator in surgery. Without it, the loudest voice often wins, and patients often lose. We have built a sustainable, fast-growing repository of the best evidence in our field with an analytics platform that unleashes it's full potential to empower better surgical decision-making, and better patient outcomes.”*

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## Contributors



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