Research Trends

Volume 1
Issue 34 *Topics in Medical and Health Research*

Article 2

9-1-2013

Military medicine and its impact on civilian life

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Section 1: Research Trends

Military Medicine and its impact on civilian life

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It has long been said that "necessity is the mother of invention", which means that when the need for something becomes imperative, you are forced to find ways of getting or achieving it (1). What can be a better example of this saying than inventions conceived in times when human lives were at stake and circumstances were of the most challenging nature?

In a comprehensive article published by the Phoenix Patriot (2), the authors Keely Grasser and Teresa Bitler examined some of the medical innovations that grew from military medical research and were widely adopted by civil medicine later on. These innovations were born from the need for quick and efficient medical care for soldiers in the battle field as well as ongoing rehabilitation care later on. Some of the examples given by the authors include advanced prosthetics and reconstructive surgery methods. In an overview, Teresa Bitler lists six medical innovations that were conceived during times of war and several decades later had become widely adopted in civilian medicine (see Image 1).

In this article we examine these innovations from the scientific output perspective in order to trace their development through the years. Each of these products and methods were searched on in Scopus and the results were analyzed and discussed from several perspectives:

a. Growth over time: tracing the number of articles discussing these applications through the years.
b. Regional contributions: where are these articles published, by country.
c. Affiliations: what type of affiliations are publishing articles on these topics.
d. Collaborations: mapping the collaborations between army or government institutions and civilian institutions such as universities or hospitals.

In order to create the maps, we limited the data to publications that have at least one instance of collaboration with an army institution, and presented the main links between them.

The topics in this article are traced backwards in time by counting the number of publications indexed in Scopus that contain a concept term in the article title or abstract. Scopus contains about 24 million records with references back to 1996, and 20 million records pre-1996 which go back as far as 1823. It must be noted that Scopus has full coverage of source journals from the publication year 1996 onwards; prior to 1996 Scopus' journal coverage is more limited, but large enough to obtain an indication of the trend in the number of articles containing a particular term. Since a significant expansion of coverage took place in 1996, the best way to read the trend figures presented in this paper is by splitting the curves into a pre-1996 part and a post-1996 part, and to identify trends within each part rather than across parts.

Triage

As mentioned in Bitler's overview (see Image 1), triage has been used since World War I as a process of determining the priority of

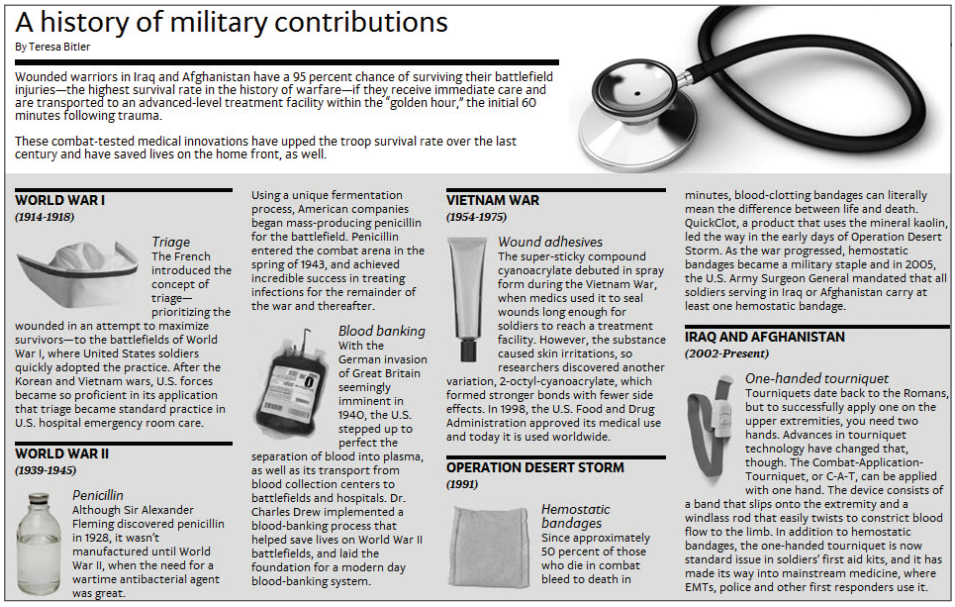


Image 1: A History of Military Contributions. Source: The Phoenix Patriot, Winter 2012 http://phoenixpatriotmagazine.com/article/winter12/a-history-of-innovation/

patients' treatment based on the severity of their condition. This rations treatment efficiently when there are insufficient resources to treat everyone immediately (3). As can be seen in Figure 1, there is a steady growth of articles discussing triage evident from the 1970s onward. This phenomenon can be explained by the fact that this method was not only widely adopted in civilian medicine internationally, but was also further developed into several sub-methods and specific applications in different countries, where each country adjusted it to fit specific workflow methods. In addition, advanced technology has introduced new ways to prioritize patient injury levels (4).

An overview of countries with at least 100 scientific articles about this topic shows high output from North America, China, India, Australia, and Brazil, and from the UK, Germany, France, Italy, Sweden and the Netherlands in Europe. Israel should also be noted here with over 100 articles on the subject (see Image 2).

Finally, an examination of affiliations which published at least 80 articles on the subject not surprisingly shows that both military institutions and hospitals are among the top scientific publishers of articles on this topic, followed by medical schools at universities (see Figure 2, p.5).

The collaboration patterns between military and civilian institutions coincide with the patterns found in the affiliations identification over all (see Image 3, p.6). In this map, the military affiliations are highlighted in red and the universities in blue. The size of the circles and the width of the lines indicate prolific publication rates and strong collaborations respectively. The US Army Institute of Surgical Research has a central role in the network. It collaborates with medical universities and hospitals mainly in the USA but also in Canada. Other military institutions seen on the map are The Walter Reed Medical Center, The National Navy Medical Center, The US Navy, The Brooke Army Medical Center, and others. As can be seen in the network, the role of the universities as research collaborators is fundamental. The Uniformed Services University of the Health Sciences, the University of Miami and the Medical College of Georgia are among the main co-publishers of triage related research collaborating with military research institutions.

Penicillin

The discovery of Penicillin traces back to 1928 and saw mass production and use in the 1940s during World War II.

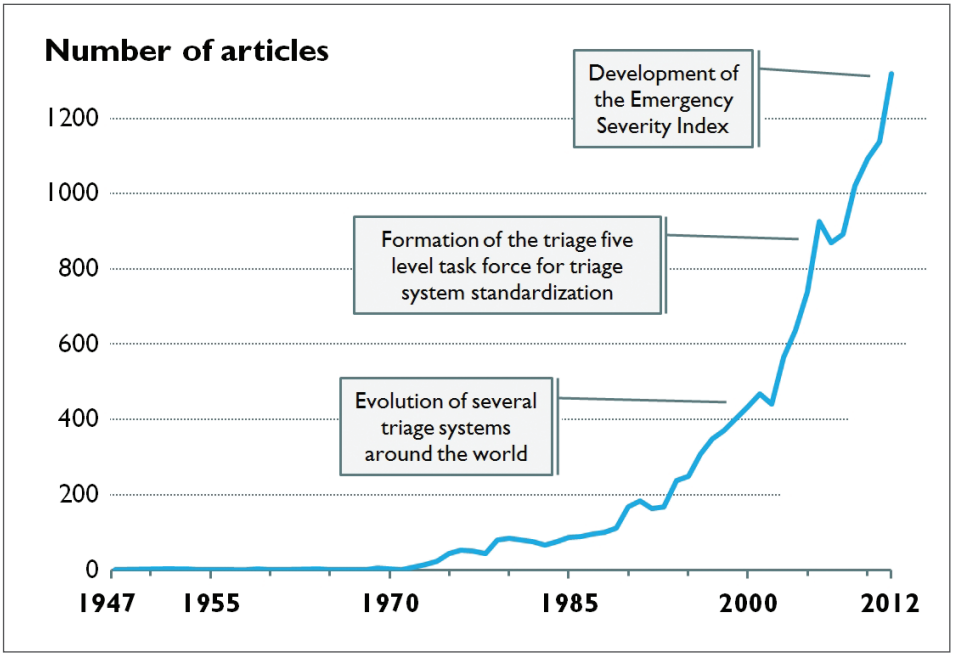


Figure 1: Publications on triage over the years (1947 – 2012)

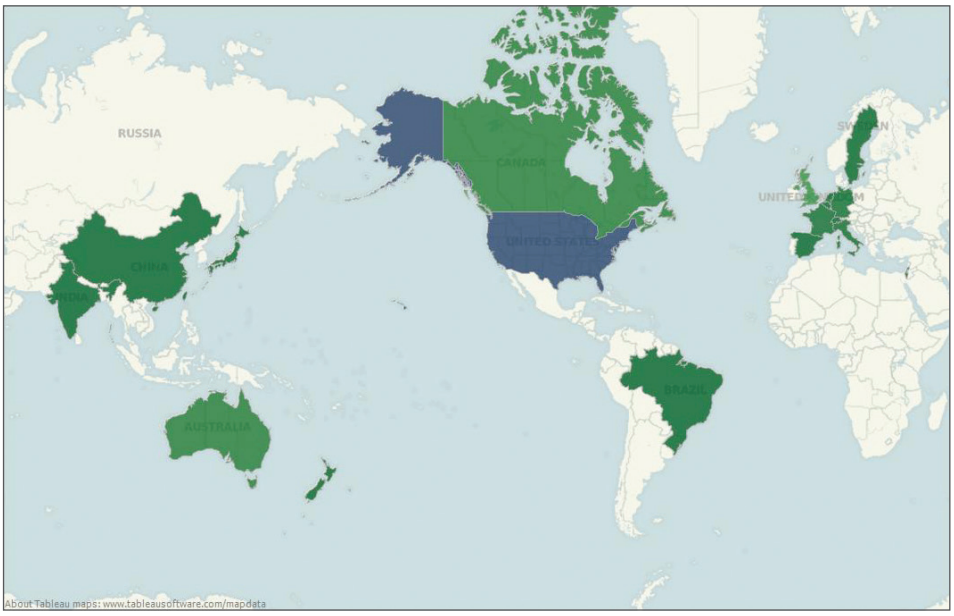
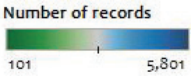


Image 2: Overview of scientific publications on triage by author country



An examination of scientific articles on the topic produced almost 150,000 articles, with the first publication in 1927 followed by a varied pattern over the years (see Figure 3, p.5). It should be noted that years with a peak in publications regarding penicillin are also war time years.

The regional output for countries with at least 100 publications on this topic shows the United States, Canada, United Kingdom, Germany, France, Spain, Italy, Japan and India as top publishers of scientific research in this area (see Image 4, p.6). Penicillin, as well as antibiotics in general, including its development, production and effects on both humans and animals, is an ongoing research topic in many countries; this is due to the increasing numbers of penicillin (and other antibiotic) resistant diseases, and the increased use of antibiotics on animals and in agriculture (5).

Figure 2: Top affiliations publishing on triage

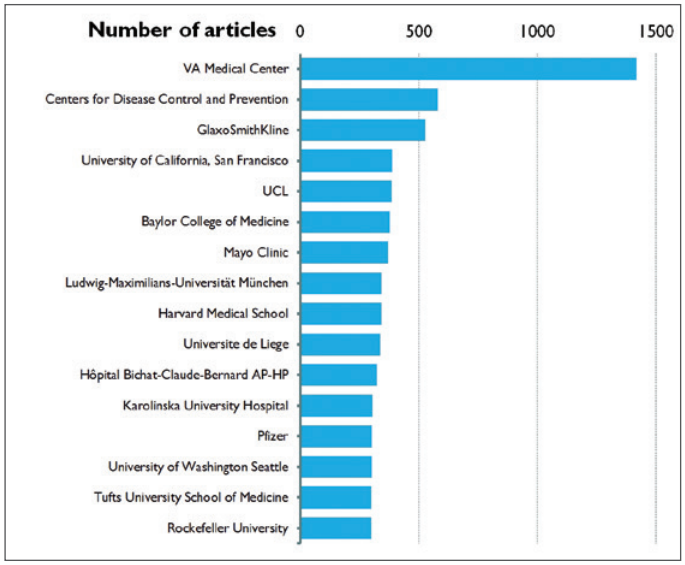


Figure 4: Top affiliations publishing on penicillin

Figure 6: Top institutions publishing on blood banking

Figure 3: Publications on penicillin over the years (1927 – 2012)

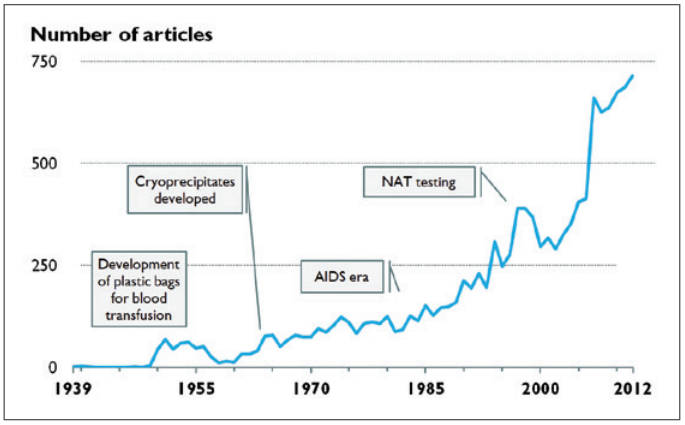


Figure 5: Publications on blood banking over the years (1939 – 2012)

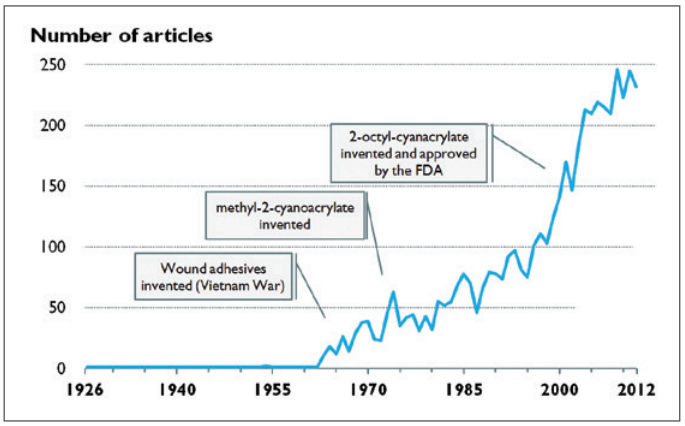


Figure 7: Publications on wound adhesives over the years (1926 – 2012)

Due to the large number of articles, we chose to display an overview of affiliations that have at least 300 publications on this topic. It shows the VA Medical Center and the Center for Disease Control, which are both government institutions, at the top of the list followed by the pharmaceutical company GlaxoSmithKline. Universities' medical schools and departments take a major role in this research arena (see Figure 4, p.5).

The collaborative network for penicillin related research is enormous (see Image 5, p.7) due to the sheer numbers of publications. For the collaborative network depiction we highlighted the main military institutions in red and the universities and hospitals in blue. What is evident from the map is the vast majority of academic and hospital research depicted by the blue areas on the map. Yet, despite the sheer size of the network, the VA Medical Center emerges as one of the major affiliations to publish on the subject and has a complex network of collaborations and co-authorships, both domestic and international.

Blood Banking

As mentioned in the Phoenix Patriot article, blood banking was conceived in the 1940s. A look at the first publications on this topic shows that the first two articles appeared in 1939 (see Figure 5, p.5).

Several discoveries and developments in this field are seen on the publication curve. The first peak in publications is seen in the 1950s when plastic bags for containing collected blood were developed. Following is the 1960s development of cryoprecipitate, which is a high Factor VII deposit created from slowly thawed frozen plasma that was found to have greater clotting capacity. AIDS research in the 1980s shows an increase in publications, followed by the NAT testing, which allowed for better detection of the HIV and Hepatitis B virus in donated blood (6). Nowadays, blood banks are an integral part of many countries' healthcare system. An overview of countries where at least 100 articles were published shows certain global concentrations of research on the topic, mainly in North America, Europe, India, Australia and Brazil (see Image 6, p.8).

An affiliation examination of the top institutions publishing research on this topic shows that a large portion of the research is produced by blood service institutions such as the Red Cross, and other national blood institutes (see Figure 6, p.5).

The collaborative network in Image 7 (on p.8) shows the Walter Reed Army Institute,

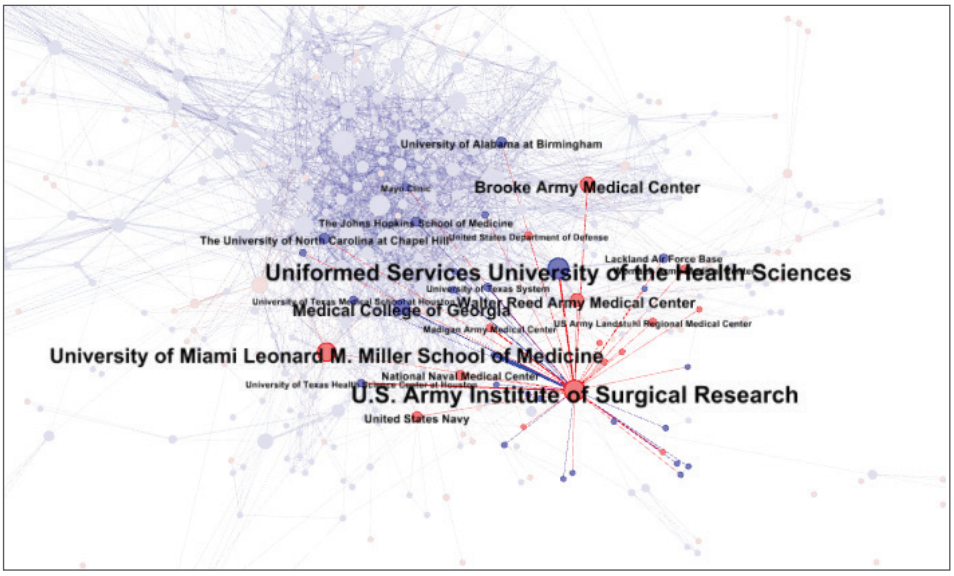


Image 3: Collaborative network of triage related publications

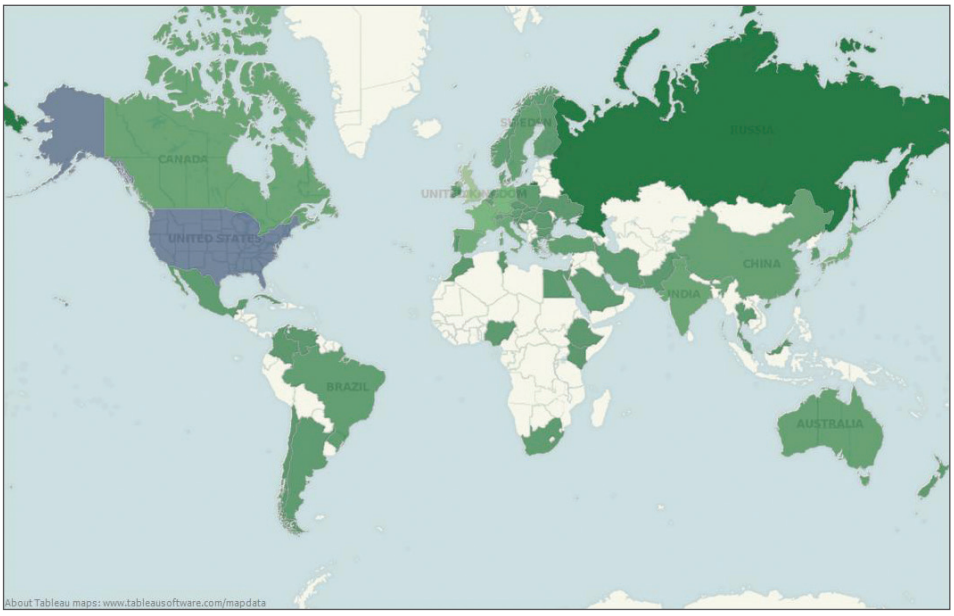


Image 4: Overview of scientific publications on penicillin by author country

Number of records
110 32,248

the US Army Institute of Surgical Research and the VA Medical Center as the main army branches publishing on this subject. The collaboration network demonstrates the major role of the global Red Cross and its branches as researchers in this field. This international organization collaborated with universities and hospitals around the world.

Wound Adhesives

Wound adhesives are a type of glue which can be used as first aid wound treatment. The time line of the research output focusing on wound adhesives or forms of cyanoacrylate shows the first article to be published in 1962. In the 1970s the N-butyl-2-cyanoacrylate was developed. This was the first adhesive to be less toxic yet still have strong bonding qualities. However, this material was still fragile and suffered from cracking. In the late 1990s a new bonding agent called 2-octyl-cyanoacrylate was invented. This compound causes less skin irritation and has improved flexibility and strength. As a result, the FDA approved 2-octyl cyanoacrylate for use on patients (see Figure 7, p.5).

An overview of the country output shows that research on this topic is led by the USA with

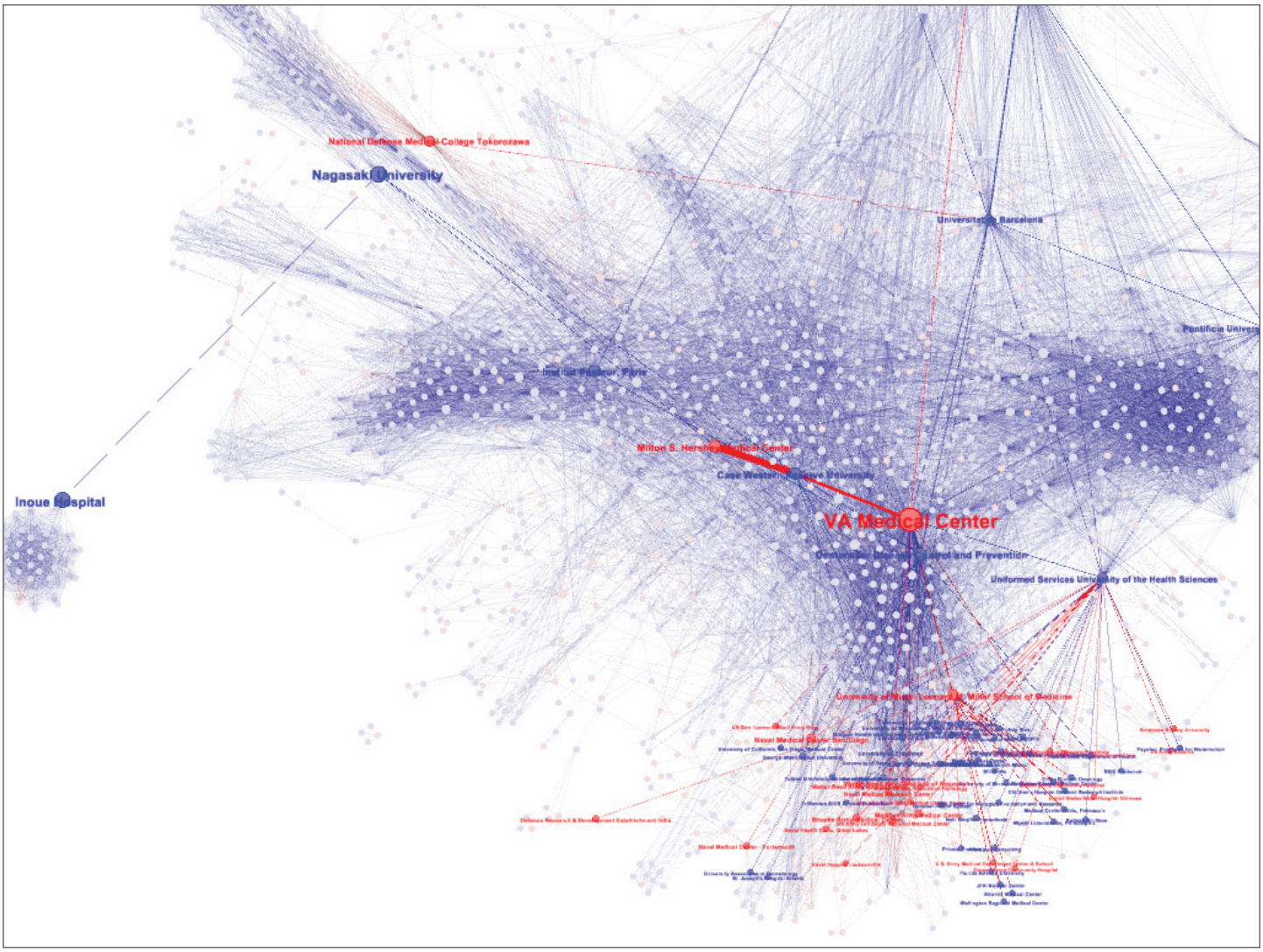


Image 5: The overall collaborative network of penicillin related publications

double the amount of articles compared to other countries. Research is also conducted in Japan, China and India as well as several European countries such as the UK, Germany and France. It should be noted that Turkey is also one of the main contributors to this research topic with over 100 articles on the subject (see Image 8, p.8).

Because of the large amount of data, we chose to display institutions with at least 15 articles on the subject. Figure 8 (on p.8) shows that the top producing institutions publishing on this subject are universities rather than any other institutions.

The collaborative network in the area of wound adhesives shows that publications on this subject are carried out by the VA Medical Center, the Brook Army Medical Center and the US Army Institute of Surgical Research (see Image 9, p.8). The University of Texas Health Science Center has an interesting role as it appears to connect between research carried out by the VA and the US Army Institute of Surgical Research which forms a cluster with the Brook Army Medical Centre.

Conclusions

Our analysis of the publication trends in triage, penicillin, blood banking and wound adhesives shows that these developments do begin in times of war. Military related events could be seen as triggers to the development of these medical inventions, which is clearly illustrated by the trend figures that tend to show peaks in years that can be linked to particular wars, such as World War II, the wars in Vietnam, and even in Afghanistan and Iraq.

It can also be seen how in later years these inventions enter the medical research arena and how major discoveries create peaks in publications through the years. Therefore we could trace a close connection between military medicine and civilian medical research. Many of the researching institutions are medical universities and hospitals which developed the initial findings into medicines and systems that were adopted on national levels. Medical military innovations are developing over time thus progressing science and human health care. This is seen clearly in the cases of wound adhesives and penicillin development.

Military methods, especially those related to trauma care, are being adopted by civilian hospitals and becoming a part of mainstream emergency health care. This phenomenon is seen in the development of triage systems and blood banking all over the world.

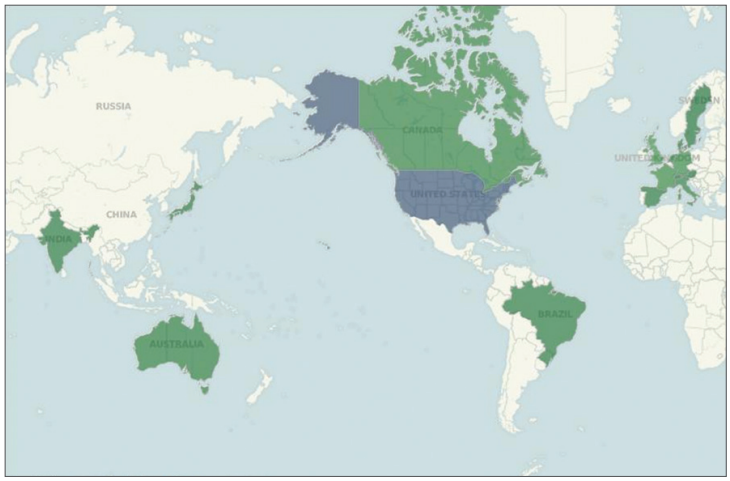


Image 6: Overview of scientific publications on blood banking by author country

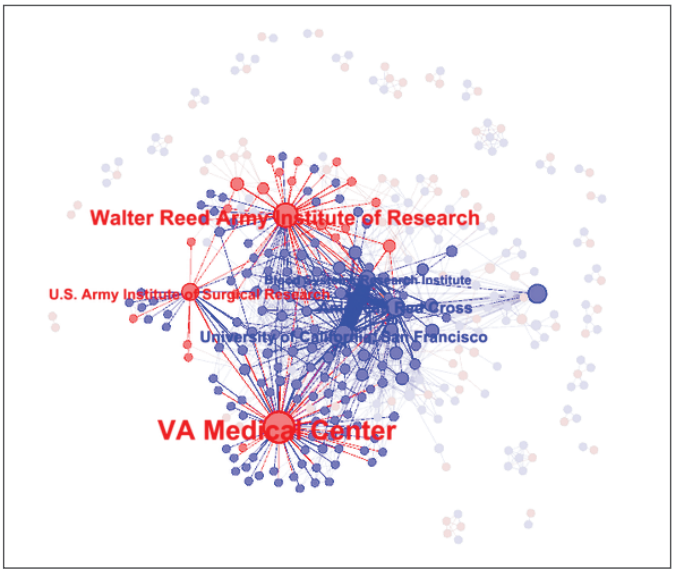


Image 7: Collaborative network of blood banking related publications

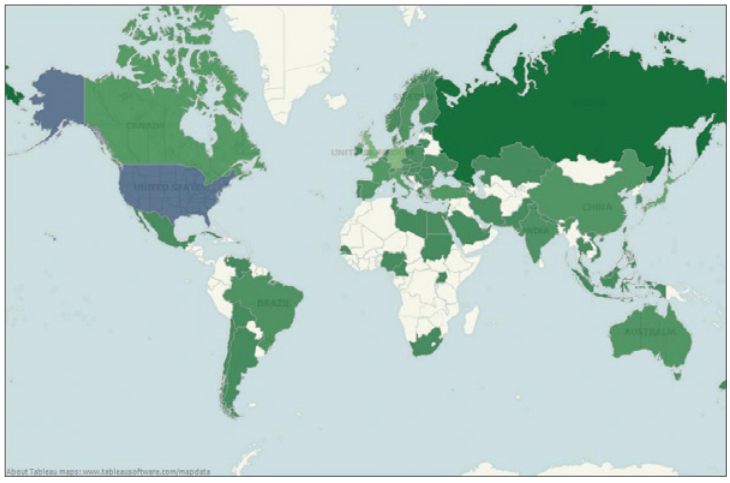


Image 8: Overview of scientific publications on wound adhesives by author country

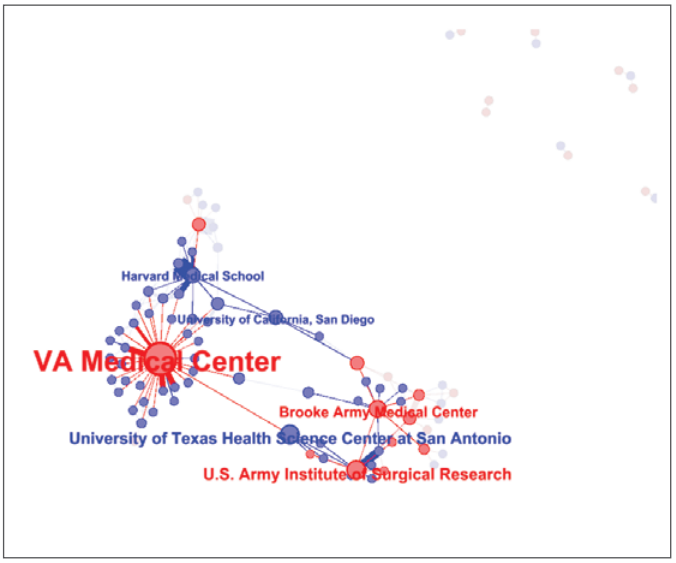


Image 9: Collaborative network of wound adhesives related publications

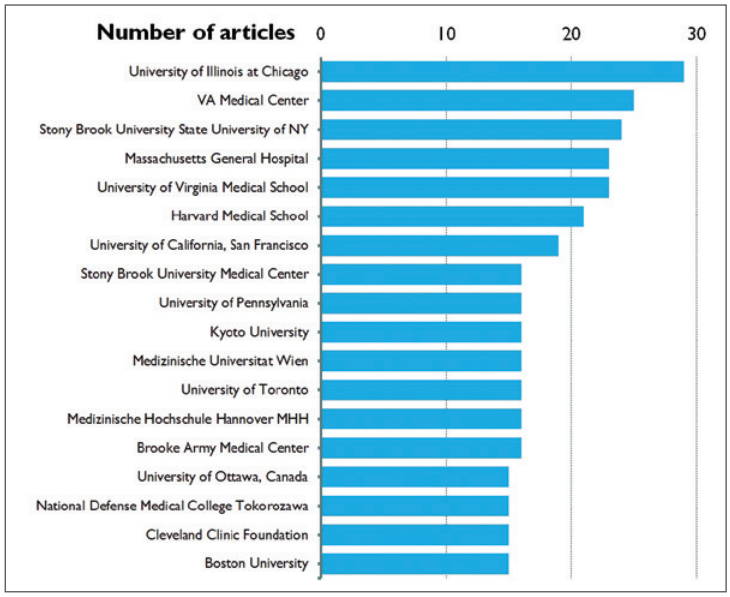


Figure 8: Top institutions publishing on wound adhesives

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