Alice Magaw: A Model for Evidence-Based Practice

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The model of evidence-based practice (EBP) of Alice Magaw places the practice of nurse anesthesia as an early pioneer in patient safety and is prophetic to the aims of the Institute of Medicine (IOM). In its 2001 report, Crossing the Quality Chasm, the IOM identified 6 aims essential to improving the delivery of care. These aims include safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. Magaw used her vast expertise in anesthetic administration to develop protocols and a body of knowledge that could be used as a template for practitioners near and far. This early use of EBP principles places nurse anesthesia at the forefront of the model and the movement to provide high-quality care. Practitioners sought her practice model out as she demonstrated her techniques to visiting providers as well as through her published ideal anesthetics in the literature. She wrote, "Pioneers are noted for building upon a body of knowledge, establishing a model for continuous improvement, and exemplifying notable methods of research with subsequent documentation of their findings." Magaw exemplified the EBP model.

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"Every anesthetist should bear in mind that to administer an anesthetic properly is enough responsibility for one individual. No person can learn to be a surgeon while administering an anesthetic, therefore one should entertain no other care at this time."[1]

Alice Magaw, born in November 1860, is often referred to as "The Mother of Anesthesia".[2] Magaw entered the Women's Hospital of Chicago School of Nursing with her longtime friend, Edith Graham, in 1887. This training was credited with establishing her with the necessary skills to make her mark on her future role as a nurse anesthetist. After the opening of St Mary's Hospital in Rochester, Minnesota, her classmate, Edith Graham, would initially serve to provide general surgical office duties as well as the administration of anesthesia for William and Charles Mayo. After the marriage of Edith to Charles Mayo, Magaw would be persuaded to move from Chicago, to replace her fellow classmate and friend as the primary anesthetist for physicians Charles and William Mayo at St Mary's Hospital.[1]

While Magaw was perfecting the art of nurse anesthesia for the Mayo brothers, the specialty of surgery and anesthesia itself was in a state of flux. The model of surgical training in the early 1900s included a surgical trainee administering the anesthetic while the surgeon performed the procedure. This model proved dangerous for the patient. Instead, the delivery of anesthesia recommended by the Mayo brothers highlighted a design that emphasized the need for the anesthetist to be a constant, reliable member of the team whose only role was to provide anesthesia to the patient. This design would be embraced throughout the nation's new hospitals as practitioners flocked to the Midwest to observe the Mayo physicians' growing surgical practice and their anesthetists. Magaw understood the level of dedication necessary to make anesthetics successful.

This historical review describes and analyzes the origin of nurse anesthesia in the United States, specifically identifying the impact of Magaw on the medical community of surgery and anesthesia from 1893 to 1908. It addresses how Alice Magaw, as a nurse anesthetist, pioneered not only the practice of nurse anesthesia but also an evidence-based practice (EBP) that incorporated sound principles of anesthesia practice and patient safety and how she had an impact on the medical and surgical community worldwide then and now.

Evidence-Based Practice

The EBP of Magaw places the practice of nurse anesthesia as an early pioneer in the model of patient safety and is prophetic to the aims of the Institute of Medicine (IOM). The IOM, in its 2001 report, *Crossing the Quality Chasm*, identified 6 aims essential to improving the delivery of care.[3] These aims include safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity.[3,4] To begin to embark on the changes needed in the current healthcare delivery system, the industry must recognize that adverse outcomes are the result of poor design of the industry and cannot alone be attributed to the healthcare worker.

Changes are necessary throughout the continuum of the delivery system, which includes 4 levels: patients, microsystems, healthcare organizations, and healthcare

environments.[4] The microsystem, according to Berwick,[4] is the heart of where delivery of healthcare occurs. For improvement of microsystems, a redesign is needed. Change at this level relies on incorporating EBP and not the age-old practice of habit. Each patient brings unique characteristics that influence care received. The result is an individualized care package based on the evidence, which focuses on the physical and psychosocial needs of the patient and addresses the aims as established by the IOM.[3,4] In addition, EBP relies on improved collaboration among specialties as providers examine the science to incorporate an individualized plan of care directed at the characteristics of the patient, his or her comorbidities, and the physical findings.[5] Evidence-based practice guides providers to seek out, in the literature, the information necessary to provide an appropriate plan of care that avoids adverse outcomes. Magaw used her vast expertise in anesthetic administration to develop protocols and a body of knowledge that could be used as a template for practitioners near and far. This early use of EBP principles places nurse anesthesia at the forefront of the model and the movement of patient safety. Practitioners sought her practice model out as she demonstrated her techniques to visiting providers as well as through her published ideal anesthetics in the literature.[6-8]

The Changing Hospital

In the last half of the 1800s, the specialty of surgery in the United States was increasing rapidly, with the introduction of chloroform in the 1850s, the practice of ether anesthesia shortly thereafter, and the subsequent discovery of the germ theory. In 1870, Joseph Lister's germ theory would have a major impact on the field of surgery, in which mortality due to surgical infections in Europe ranged from 26% to 66% following surgery.[9] The sterility for surgical procedures, the use of sutures, wound preparation, and the need for the skills that nurses could provide to wound care added to the advancing practice.[9] "Applying principles of asepsis and antisepsis in surgery, they [surgeons] could perform a great many more operations than formerly, especially in the internal cavities of the abdomen, chest and skull. The application of these principles increased the time and effort of the operating room for surgery. A nurse indeed could be of great assistance."[10] The overall death rates related to surgery and risks of surgical infection were diminishing.[9]

Healthcare was being reformed through the increasing use of technology. There also was an increase in the number of hospitals opening throughout the country between 1880 and 1920.[11] In a census of hospitals in 1873, there were 178 hospitals with a total patient capacity of approximately 50,000, and this number increased to more than 4,000 hospitals by early 1920.[12] Hospitals became the setting for the delivery of care not only for the poor and destitute but also for the upper and middle class. Medical records evolved from the concept of a single-page narrative to include standardized forms with objective data, which contained essential information, detailed records of visits, and narrative notes to reflect all medical and nursing providers.[13] Surgeries were moved from being performed on the kitchen table to the operating room table, and hospitals went to great lengths to offer the surgeons the necessities to enhance the delivery of surgery.[13] The sterile efficient environment of the hospital persuaded patients to use hospitals for treatment.[13] According to Howell,[13] surgery was moved to a centralized location, elevating surgical practice. These factors, coupled with the inception of trained nurse anesthesia providers and the opening of an increasing number of hospitals throughout the country, greatly affected the number of surgeries nationwide. With improvements in the delivery of anesthesia and the assignment of a primary provider in the delivery of anesthesia, surgeons could focus on the technical aspects of surgery. Advancements in technology would further improve the surgical advancement and include the use of dressings for wounds, improved lighting and electricity, investment in equipment such as that used for radiography, and laboratory standardization.[13]

The Mayo Brothers and Collaboration

"The most unique elaborate and scientific clinic in the history of medicine"[14]

The creation of St Mary's Hospital in 1889 in Rochester, Minnesota, allowed William Mayo Sr and his sons, William Jr and Charles, to move their surgical practice from their private residence to a hospital-based practice, which would encompass greater than 4,000 surgeries annually with a mortality rate of less than 2%.[13] Education was essential to the Mayo philosophy and practice.[11] The Mayo physicians gained notoriety and came to be known as expert surgical resources throughout the country. Many patients sought after their services. The Mayos kept detailed records of what they encountered and encouraged those involved in their team, including Magaw, to take time to advance the knowledge of their specialty and to keep journals of what they observed, including patient outcomes. This became a basis for scientific literature in the field of surgery and anesthesia. This practice mirrored the essentials from the St Paul Medical Society, as quoted by Harris[2]: "The cultivation of science and art of medicine, the interchange of professional experience, the encouragement of professional zeal and the promotion of a friendly feeling among its members.…While few of us who are engaged in active private practice can find time to engage in scientific research, we can very profitably interchange our medical experiences, and by keeping careful and accurate records of interesting cases make valuable contributions to medical literature. The object

of the society should be first of all educational." The Mayos' reputation brought patients to St Mary's Hospital to benefit from the expertise of not only the famous surgeons but also Magaw, a nurse anesthetist on whom they relied heavily.

To explain the workings of the practice and its surgical success, historian Fye[14] quotes William Mayo's address to the medical college at Rush University in 1910:

> The best interest of the patient is the only interest to be considered, and in order that the sick may have the benefit of advancing knowledge, union of forces is necessary. The first effort made to meet the situation was in the development of clinical specialties. Man was divided for treatment into parts, as a wagon is divided in the process of manufacture. Each part of a man was assigned to those who could devote special attention to their particular portion, giving the benefit of superior skill in treatment. Unlike a wagon, man could not be treated in parts but as a whole … [so] it became necessary to develop medicine as a cooperative science; the clinician, the specialist, and laboratory workers uniting for the good of the patient, each assisting in the elucidation of the problem at hand, and each dependent upon the other for support.

This collaboration translates to the contemporary design of interdisciplinary medicine.

The Mayos and their counterparts in practice were acutely aware of their impact on healthcare and education. They desired to share their expertise with those who would visit St Mary's Hospital to view their techniques and surgical theater firsthand.[14] For those who could not visit, they provided a lens to their practice through their medical publications.[14,15] Because of their desire to share the successes of their practice, they maintained a strong commitment to the medical literature. In fact, much of the renown of their practice was attributed to their commitment to publications from not only the Mayo surgeons but also their chief anesthetist, Magaw. These publications were being used by professionals worldwide and would serve to give instruction about their techniques' failures and successes.[11,14] This model is another evidence of EBP.

Open-Drop Method

In 1885, Dr James Moore, a surgeon, went to Germany to study the use of chloroform. Dr Moore returned to the states with a German "anesthetizer" (anesthetist) to teach this method to the surgeons and the nurse anesthetist of St Mary's Hospital.[16] The German anesthetizer would describe this new technique for administering anesthesia, as quoted by Keeling[16]: "He recommended the gradual administration of chloroform and/or ether by using a wire frame covered with gauze, which was placed over the patient's mouth and nose. The anesthetizer would slowly place drops of the anesthetic agent on the cloth until the patient lost consciousness. This method, soon labeled the open-drop method, prevented the anesthetist from giving large quantities of the agents too rapidly."

Nurse Anesthesia Specialty Is Pioneered

Pougiales[10] quoted Dr Charles Mayo's 1905 article in which he described his satisfaction with and reliance on nurse anesthetists: "The question of anaesthesia is a most important one. We have regular anaesthetists [on] whom we can depend so that I can devote my entire attention to the surgical work."[10] The training of Magaw would prove crucial to the development of the model for education for future nurse anesthetists and consisted of both apprenticeship and didactics.[16] Magaw[7] is quoted as saying, "in giving an anesthetic remember that you are, as it were, carrying the patient along the edge of the precipice, and while there is no need of going over you must watch not to get too close to the edge". Nelson and Wilstead[17] quote Clapesattle, in a reference to Magaw: "Alice Magaw provided such leadership in that new field that her work drew more widespread attention than that of any other member of the Rochester group apart from the Mayo brothers themselves." Magaw became adept at the administration of open-drop ether. Although she did not create the design method for its administration, Magaw perfected the technique and was frequently observed in its administration by visiting physicians. She described the technique in depth in her address:

> The inhaler used is improved Esmarch mask, with two thickness of stockinette, and we always have both ether and chloroform ready to give whichever is indicated by the condition of the patient. In administering ether, we commence with the drop method as carefully and with as much air, as though it were chloroform, until the patient's face is flushed, when we have a large piece of surgeon's gauze of several thickness convenient and keep adding a few more layers of the gauze and giving ether a trifle faster until the patient is asleep, then remove the gauze and continue with the same covering as at the start and by the drop method. Should it produce difficult breathing, profuse secretions of mucus, or cough, or should the muscles be slow to relax, change to chloroform.[8]

The Mayo physicians preferred that their patients receive ether unless there was an alternative indication. Magaw further noted, "As it requires very little ether to keep a patient surgically etherized, one can change to the smaller dropper during the operation. A much deeper narcosis is required to start an operation or to make an incision than later on, when the operation is in progress. It is useless to touch the cornea, as so many advocate, as

it tells us nothing and is unscientific. Only the inexperienced take the pulse and touch the conjunctiva when giving ether."[8]

Many visiting physicians observed her administration of open-drop ether, and Magaw[6] would further discuss this technique at a Missouri Medical Society meeting. This detailed description of Magaw's techniques would benefit the anesthesia community and serve as a practice standard for the new evolving specialty. Magaw would proceed to document more than 14,000 anesthetics without an anesthetic-related death.[8] Her published work served as body of evidence for practicing anesthesia providers worldwide.

Promoting Safety

"Assure your patient that he is in safe hands and need not be afraid, at the same time be firm, especially with the hysterical. In fact, try to gain the confidence of the patient as much as possible before administering the anesthetic"[1]

Magaw demonstrated the ability to disseminate the ideal anesthetic techniques for other nurse anesthetists and physicians alike. As doctors from around the world were observing the Mayo physicians, the attention also gave Alice Magaw an audience of doctors and nurses near and far. The ease with which Magaw administered anesthetics in the surgical theater was noted by visiting physicians, and it became a template and practice model for surgeons. She was known to administer smooth anesthetics and had experience in more than 10,000 cases with ether.[2]

Magaw as Patient Safety Advocate

"The dangers of general anaesthesia depend more on the lack of experience and incompetency of the anesthetist than on the drug itself"[8]

Magaw's publications on her practice and the outcomes she shared helped to preserve and advance the practice of nurse anesthesia. As the primary anesthetist for the Mayo surgeons from 1893 until 1908, Magaw set a precedent for the practice through her involvement in the training of nurses and physicians as well as through her dissemination of publications and research and through speaking engagements at numerous meetings she attended during her tenure with the Mayo physicians. Magaw was forward thinking in setting the expectations necessary for successful administration of anesthetic. She recognized the need for preanesthetic review, documentation, record keeping, evaluating outcomes, nurse to patient communication, patient-specific plans, and early patient safety goals—all necessary components to EBP. She discussed these expectations in her address to the Olmsted County (Minnesota) Medical Society, where she concluded the importance of a thorough preoperative visit; physical examination of the heart, lungs and kidneys; and advice to abstain from food the morning of surgery.[7] The Mayo surgeons preferred the administration of ether for their cases, but Magaw emphasized a more patient-specific approach, as evidenced in her speech to the Minnesota Valley Medical Center in 1901, "The Administration of Anesthetics"[1]: "[T]he anesthetist should understand which circumstances make either choice better for the patient and the importance of standard of care and formulating a patient specific anesthetic plan and when she states; It is a duty we owe the patient to become an expert in its use.… [W]hen a patient must have an operation he is usually able to have some kind of anesthetic and we feel sure that the mortality can be decreased by a careful selection of the anesthetic in each case."[18]

Magaw further identified patient concerns and safety considerations for improvement in care during her address to the Missouri Medical Society by acknowledging the risks to the patient regarding nerve and eye injury.[8] She noted the need to address safety, commenting that the nurse anesthetist should make adequate preparation for cases, complete a preoperative baseline observation, and maintain thorough periodic observational skills for the anesthetized patient.[7,18] In fact, Magaw set a precedent regarding patient monitoring, noting that observation of vital signs, which included respiration, pulse, and skin color was essential.[10] To bolster her commitment to delivery of safe anesthetics, she noted in her speech the necessity to have ongoing assessment of the airway and to know how to handle emergencies should they arise:

> Respiration is often interrupted with the obstruction caused by the tongue falling back and depressing the epiglottis.… Should any of these symptoms arise during the administration of an anesthetic that has been given slowly and carefully all that is needed as a rule is to raise the lower jaw up and forward and instead of using tongue forceps, catch the tongue with a piece of gauze and draw it up and out.… No anesthetist should form the habit of using the gag or tongue forceps; both are cruel and seldom needed. It is of far more importance that the anesthetist should become skillful in watching for the symptoms and preventing them, than to become proficient in the use of a certain gag, tongue forceps or use of artificial respiration.[1,6,8,18]

Keeling[16] described the importance of observation: "Observing the patient closely was key to successful anesthesia delivery, and the surgeons recognized that trained nurse anesthetists observed the patient more closely than did medical students and interns, "whose attention was more often directed to the operation." Magaw had acute skills in observation, and this helped her maintain excellent patient outcomes. In fact, with

more than 3,500 cases, there was not a single death related to the anesthetic.[7] She proceeded to give her audience advice on the necessary observation skills used by the anesthetist to prevent danger to the patient as well as encouraging the anesthetist to remain engaged in the anesthetic's delivery.[7]

Magaw was very concerned with patient outcomes and patient satisfaction. In her 1900 report on anesthesia with nitrous oxide and ether, she reports on the findings of patients and nurses and uses these to further support her own patient specific–designed anesthetic plan.[18] Koch[19] describes Magaw's vigilance during the administration of anesthesia. In preparation for the administration of the anesthetic, "Magaw notes in her initial contact with the patient, one must be quick to notice the temperament, and decide which mode of suggestion will be most effective in the particular case: the abrupt, crude, and very firm, or the reasonable, sensible, and natural.… The subconscious or secondary self is particularly susceptible to suggestive influence; therefore, during the administration, the anaesthetist should make those suggestions that would be most pleasing to this particular subject. Patients should be prepared for each stage of anaesthesia with an explanation of just how the anaesthetic is expected to affect him.

Harris[2] refers to Magaw's scientific success by noting the fact that Magaw was frequently quoted in medical texts. Magaw's anesthetic techniques were directed toward providing the patient an individualized plan. In her address to the Minnesota State Medical Association, Magaw[6] shared observations on 11,000 anesthetics administered. "During the administration of either ether or chloroform prepare the patient by explaining just how you expect the anesthetic to affect him, and go through each stage, giving him your undivided attention. In fact, talk him to sleep, with the addition of as little anesthetic as possible. It is surprising how much comfort and help this little attention is to the majority of cases, and how quickly they submit, doing away with that horrible anxiety and fear."[6] Magaw[8] kept thorough records of her cases and recorded these anesthetics. In her publication reviewing more than 14,000 surgical anesthetics, Magaw indicates she successfully provided anesthesia without an anesthetic-related death.[8] Magaw describes in another article, "Observations on 1092 Cases,"[20] her administration of anesthetics: "We have administered an anesthetic 1,092 times; ether alone 674 times; chloroform 245 times; ether and chloroform combined 173 times. I can report that out of this number, 1,092 cases, we have not had an accident".[7]

Magaw's records and outcomes created a legacy defining that the delivery of anesthesia by nurses would serve the surgical community without increasing the risks to patients. In fact, Magaw's outcomes would eclipse those of practitioners today. The model of teaching the practicing nurse anesthetist was evolving from merely sitting on the stool next to the elder Mayo as he taught the steps to performing an anesthetic to the more concrete model involving a combination of theory and practical experience. Magaw's legacy and publications would serve as a strong support for advanced-practice nursing in the legal challenge that would unfold against the specialty of nurse anesthesia.

Early Documentation of Outcomes

"One death is one too many."[20]

Magaw's publications were used as defense in favor of the nurse's ability to successfully administer anesthesia in the landmark *Chalmers-Francis v Nelson* (1936) lawsuit in California, which challenged the practice of nurse anesthetists. This case would go to appeal 3 times. Each appeal used the outcomes-driven data supplied by the publications of Magaw, "The Administration of Anesthetics" (1902) and "A Review of over Fourteen Thousand Surgical Anaesthesias" (1906), to challenge the claims that nurses' outcomes were less desirable than those of physicians.[1,8,16] Nelson and Wilstead[17] describe the publications of Magaw as a "standard for safe, research-based anesthesia delivery. Her publications embodied practice principles that other anesthesia providers would reference in their desires to become more proficient in their own practice.… Magaw's documentation was used as indispensable evidence to validate the decision by the court in a landmark case that challenged the nursing scope of practice with regard to the administration of anesthetics. The court assessed that the knowledge of administering anesthetics was not exclusively with the province of medicine; that when [a] nurse administered anesthesia, she was practicing nursing."[17]

Alice Magaw, Model for the Future

Alice Magaw clearly earned the title of "Mother of Anesthesia." Magaw published 6 articles outlining the events, outcomes, and expectations that would serve as a model for practice with practitioners nationwide. She was also invited to speak before medical society meetings, something unheard of for nurses at that time. Magaw's successful anesthetic techniques included the open-drop method, skills in observation, assessment of the depth of anesthesia, airway resuscitation, preoperative assessment analysis, and patient-specific anesthetic plans. Only a practitioner with experience would have the knowledge to engage in this level of skill. Magaw encouraged other anesthetists to do the same. Magaw's model of anesthesia encouraged the nurse anesthetists to embrace and possess the skills of observation, practice within standards of care, and formulate a patient-specific plan well before the profession understood the importance of incorporating this as a baseline to practice. These skills

are now considered hallmarks of practice and standards as set by the American Association of Nurse Anesthetists (AANA). Magaw's accurate reporting of cases and outcomes helped shape the development of safe anesthesia practice, and her record keeping allowed the anesthetist to follow steps of safe practice long before the nation would embrace these standards of care. Her relationship with the Mayo physicians served as an impetus for her to excel in practice. Magaw's practice and training model conceived the birth of other training programs to begin to graduate nurse anesthetists with similar practice styles that would eventually become ancestry to the AANA. Her publications of best practice models and outcomes helped disseminate the evidence of effective practice to all anesthetists and established her as an authority for the practice of anesthesia (medical and nursing) and the surgical community.[6]

As patient advocates, we have a duty to protect patients from harm. The IOM has written: "The best care results from the conscientious, explicit, and judicious use of current evidence and knowledge of patient values by well-trained experienced clinicians."[3]

Nelson and Wilstead[17] wrote: "Pioneers are noted for building upon a body of knowledge, establishing a model for continuous improvement, and exemplifying notable methods of research with subsequent documentation of their findings." Alice Magaw exemplifies this EBP model.

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