



REMEDY

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Greetings!

Welcome to the inaugural edition of the *BHSU Remedy Scholarship Journal*.

Remedies rise from research. Solutions spring from scholarship.

The *BHSU Remedy Scholarship Journal* is a free, open-access journal in which Baptist University undergraduate and graduate students address issues of historical and contemporary concern to the healthcare and health sciences community. The journal aims to present well-researched scholarship, information, and perspectives in a style suitable for all readers. The university's undergraduate Honors Program facilitates the journal as one of many efforts to fulfill the program's Scholarship & Research Advancement Initiative.

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This inaugural edition showcases some of the research completed in undergraduate programs at the University in the last four years.

Remedy will be published each Fall term to complement our *Elevate Student Research Symposium* held each Spring term.

We hope you will find something useful and helpful as we celebrate the achievements of our students.

Thank you for your kind consideration.

To the advancement of scholarly research...

Best Regards,

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Methods Used to Diagnose Acute Myeloid Leukemia

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Program: Honors Medical Laboratory Sciences

Faculty Reviewer(s): Dr. Darius Wilson

Acute Myeloid Leukemia (AML) is a quick progressive cancer of the blood and bone marrow. In this disease, the hematopoietic normal tissue is replaced with neoplastic tissue. It is characterized by the overproduction of immature cells from the myeloid lineage in the bone marrow before proceeding to present in the peripheral blood. It is more common in adults rather than children, and the symptoms present suddenly.

When leukemia is suspected, the first thing conducted by the physician is a physical examination. The patient may present with symptoms such as fever, night sweats, fatigue, easy bruising, recurrent infections, easy bleeding, sudden weight loss, short breath, organomegaly, and pale skin. The reason these symptoms induce suspicion of AML is due to the nature of the disease. The fever and night sweats can be the body's response to try and get rid of the malignant cells, but it can also be a response to an acquired infection. The recurrent infections are due to the inadequate white blood cells (WBCs) seen in AML, so there is not a proper response against pathogens. Fatigue and pale complexion are caused by AML disrupting proper hematopoiesis, which can result in anemia because of the reduced amount of red blood cell (RBC) production compared to the overwhelming amount of immature myeloid cells. Anemia also causes shortness of breath due to less oxygen being distributed throughout the body, so short breath is the body's way of trying to compensate for the lack of oxygen. The easy bruising and bleeding are caused by thrombocytopenia, which is low platelet levels, so the patient has issues with blood clotting. Two factors that influence weight loss are loss of appetite and excess energy used to produce the malignant cells. The overproduction of immature cells uses up a large amount of energy, which causes the body to use up the stored energy, or fat, to try to compensate for the low number of normal cells. The organomegaly of the spleen, liver, and/or lymph nodes is due to extramedullary hematopoiesis. To try and compensate for the lack of adequate blood cells produced in the marrow, the body will begin producing blood cells in those other organs.

One of the first tests performed to diagnose Acute Myeloid Leukemia (AML) is to examine the patient's blood by performing a complete blood count (CBC) and making a peripheral blood smear. The CBC is usually an automated method used to evaluate the amount of blood cells that are in the patient's circulation. By doing this, the laboratorian will have an indication of the RBC, WBC, and platelet count as well as hemoglobin (Hgb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW) and WBC differential. Patients with AML have an increased WBC count and decreased RBC and platelet count. The RBC indices are normocytic and normochromic, but the Hgb and Hct will be decreased.

A peripheral blood smear is performed to confirm the findings of the CBC. It is prepared by spreading a drop of blood on a glass slide and then fixing it with a stain. The blood can then be analyzed microscopically by a laboratorian. It will analyze and compare results from the abnormal automated CBC and look for immature cells in the population. Next, if there is a confirmed abnormality, the bone marrow will be collected and analyzed under the microscope. A diagnosis of AML is considered if a certain percentage of immature cells are seen. For the World Health Organization (WHO) classification, a diagnosis of AML is considered when there are 20% or more blasts in either the peripheral blood or marrow. For the French-American-British (FAB) classification, a diagnosis is when there are 30% or more blasts in the cell

population. It should be noted that bone marrow aspirate is the preferred choice when looking for neoplastic cells. The laboratory personnel performing these tests need to have at least a bachelor's degree that involves laboratory science. It is also preferred that the individual is certified and possesses sufficient laboratory experience.

“Immunohistochemistry (IHC) combines anatomical, immunological and biochemical techniques to image discrete components in tissues by using appropriately-labeled antibodies to bind specifically to their target antigens in situ.” (ThermoFisher, para.1). For immunohistochemistry, the tissue is first fixed with formalin, which is used to preserve cell morphology. The fixed tissue is then embedded in paraffin as a way to keep the tissue's natural shape to assist with sectioning and storage. The formalin-fixed and paraffin-embedded tissue is then sliced into thin sections and mounted onto a slide. Next, the section being tested must be de-paraffinized, and the antigen needs to be retrieved. Xylene is used to de-paraffinize the tissue, and antigen retrieval is done afterward by either boiling the section in buffers or enzyme treating the section. A blocking method is then performed to prevent false positives due to nonspecific binding. Incubating the slide in a blocking buffer would reduce nonspecific binding. Next, a blocking buffer is used to prevent false positives due to nonspecific binding. Finally, either an indirect or direct method is used to visualize the reaction. With the indirect method, two different antibodies are used to help detect the antigen. A primary antibody is used to initially attach to the antigen, and then a secondary antibody with a label is added. The secondary antibody will attach to the primary antibody. The label allows the antigen to be visualized. With the direct method, only the primary antibody is used, and the label is attached to it. The labels can be visualized with a fluorescent microscope, and the ones seen represent that specific antigen.

Another method that can be used to detect markers for AML is flow cytometry. Immunophenotyping using this method can differentiate AML from acute lymphocytic leukemia (ALL) and determine the subtype of AML. The sample is first prepared into a single-cell suspension from bone marrow tissue. This involves mincing the tissue before breaking down the tissue with enzymes diluted in PBS buffer. It is then filtered into another tube before being centrifuged. After centrifugation, a cell pellet forms at the bottom of the conical tube, and the liquid portion is poured off. The pellet is resuspended with PBS before being centrifuged again, this process is performed twice. The cell pellet is finally resuspended with a staining buffer, making it a single-cell suspension. The suspension is then stained with antibodies linked to fluorochromes, which are fluorescent dyes. The antibodies are specific to markers found on the desired cell's surface based on the cell lineage and stage in maturation. For instance, CD-13 is a marker for myeloid cells that can be targeted during testing. However, multiple markers with their corresponding antibodies are needed in order to properly diagnose AML. A flow cytometer possesses three components needed for analysis: fluidics, optics, and electronics. With the fluidics, cells or particles travel individually through a flow cell, a narrow pathway. Each cell or particle is then examined individually as it passes through the laser, which is part of the optic system. As cells pass through the laser, their traits are measured. This provides forward-scattered laser light (FSC) and side-scattered laser light. “The larger the cell, the greater is the FSC signal, and the more internal complexity or granularity, the greater the SSC signal.” (Harmening, 2009, pg.887, para.2). The laser will also trigger fluorescence by exciting the fluorophores on the antibodies that attached themselves to the cell. For the fluorophore to be excited and emit light, a laser needs to be at a specific wavelength. “As signals are emitted from the cell, the optical system separates and routes the different colored light to the appropriate photodetector using strategically placed optical filters and mirrors” (Harmening, 2009, pg.887, para.3). These photodetectors can then convert the light signals to pulses, which are the electrical signals used in the electronic system. The electrical component is used to save and analyze the given results.

With both immunohistochemistry and flow cytometry, the laboratorian will be able to detect specific cell markers that will assist in the identification of that cell. Cells in AML have common markers that help differentiate them from cells from ALL. Some common cell markers used for AML include CD13, CD33, CD11c and CD117. These antigens are not present on cells from lymphoid lineage, and examples of

lymphoid antigens include CD3 and CD7. Another common myeloid marker is MPO, but it will be discussed later on in the paper.

There are several molecular methods that can be used to help diagnose AML. One method is karyotyping. “Karyotyping is the direct observation of metaphase chromosome structure by arranging metaphase chromosomes according to size.” (Buckingham, 2019, pg.186). In most cases, bone marrow is the desired specimen because living cells are required for testing. The cells are cultured in a special media, so there are enough cells to analyze. Mitogen can be used to promote cell division. Since chromosomes are the most visible in metaphase, colcemid is used to prevent the cells from dividing further. After that, the chromosomes need to be released from the cell and stained. The cell bursts after being treated with a hypotonic buffer and chromosomes are stained with Giemsa dye. Finally, the chromosomes are visualized under a microscope to look for chromosomal abnormalities. Mutations that can be visualized while karyotyping include: translocations, deletions, inversions, duplications, and isochromosomes. However, AML is mostly known for having mutations related to translocations.

Another molecular method that diagnoses at a molecular level is fluorescence in situ hybridization (FISH). With FISH, specific genetic sequences are targeted by using complementary nucleic acids called probes. “Probes are designed to be complementary to a particular chromosome or chromosome locus so that the image under the microscope will correlate with the state of that chromosome or locus.” (Buckingham, 2019, pg.191, para.2). The sample, which is typically bone marrow, is prepared by using protease to destroy cytoplasmic proteins that might cause unnecessary binding. Next, formaldehyde is used to preserve the morphology. 70% formamide is then used to denature chromosomal DNA at 70C for 2 minutes. The mixture containing the probes is applied to the slide before the incubation step, which will take 6 to 12 hours from 37C to 42C. Since AML is mostly caused by translocations, probes with different colored signals are used to pick up on translocations. After the probes are hybridized, any unbound probes are washed off, and the slide is ready to be visualized using a fluorescence microscope. A translocation is visualized when two probe colors are combined rather than separated. For instance, t(8;21) can be visualized when the two probe colors overlap.

Another method that can be utilized is polymerase chain reactions (PCR). PCR is used to amplify a specific sequence of DNA to better analyze if there are genetic abnormalities. This is done by replicating the template DNA in a matter of hours versus days in vivo. In order to execute PCR, a template, nucleotides, primers, polymerase, and buffer is required. PCR begins with the denaturation step to separate the two strands of DNA. This process takes place at 90C to 96C within a 20-60 second timeframe. The once double helix is now two individual strands. The next step in the process is known as annealing, which is when the primers hybridize into complementary sequences on the template strand. Primers are the components that decide what part of the DNA is amplified. Annealing occurs at a temperature of 50C to 70C for 20-90 seconds. The final step of PCR is extension, which uses DNA polymerase to extend the 3' end of the primer. Extension takes place at a temperature between 68C and 75C for up to a minute. Once all three steps are finished, it marks the end of one cycle. The newly replicated DNA is then used to begin another cycle. This will help detect low levels of the DNA by copying it. The person has AML if replication of the abnormality occurs.

Finally, cytochemical stains can be used to determine the chemical constituents in the cell. The chemical composition of cells in AML can assist in diagnosing the condition depending on the stain. It can also be used to rule out certain subtypes of AML and ALL. It should be noted that this methodology focuses on morphological features, and it aligns more with the FAB classification rather than the well-known WHO classification. However, WHO does include some of the terminology from the FAB in regard to AML. There are several cytochemical stains, but there are four main ones that can be used to help visualize AML in accordance with FAB classification. One stain that can be used is the myeloperoxidase (MPO) stain. The MPO stain is used to detect the peroxidase in primary granules of cells from myeloid lineage, and it is typically reactive in AML subtypes M1, M2, M3, M4, M4Eo, and occasionally(or weakly) in M5. Another

stain is the Sudan Black B (SSB) stain, and the lipids in granulocytes and monocytes are stained. The positive staining reactivity in SBB mirror those of MPO. Specific esterase is another that possesses staining patterns similar to MPO and SBB. Naphthol-AS-D chloroacetate reacts with the specific esterase enzyme that resides inside of granulocytes which then reacts with diazonium salt. Due to this, specific esterase has the abbreviation of CAE. A stain that is specific for monocytes is the nonspecific esterase (NSE) stain. The principle is that NSE enzymes hydrolyze aliphatic and aromatic esters then the addition of alpha-naphthyl butyrate (substrate) with hexazonium pararosaniline (coupler) causes a visible stain to be seen in monocytes. NSE staining is more specific for AML M4, M5 and occasionally (or weakly) in M3, M6 and M7. Other stains such as periodic acid-schiff (PAS) and cyanide-resistant peroxidase (CrP) have been useful in diagnosing subtypes of AML. PAS stain can be helpful in visualizing AML M6 and AML M7, also known as erythroleukemia and, but it is also seen in other cell lineages and is not reliable for differentiating between AML and ALL. CrP stain can be used to attempt to visualize AML M4Eo, which is characterized by eosinophilia. These two methods are not ideal, so they are rarely recommended.

In conclusion, all of the methods mentioned are useful in identifying and diagnosing AML. Despite knowing that the disease is acute myeloid leukemia, it is important to note that not every AML case is treated the same way. Using the information obtained from testing, the physician is able to come up with a prognosis and decide the best course of treatment for that patient.

References

- BioRad. (n.d.-a). 5 Easy Steps for Successful Flow Cytometry. Retrieved from <https://www.bio-rad-antibodies.com/blog/5-steps-successful-flow-cytometry-results.html>
- BioRad. (n.d.). Flow Cytometry Sample Preparation Protocols - Flow Cytometry Guide. Retrieved from <https://www.bio-rad-antibodies.com/flow-cytometry-sample-preparation.htm>
- BioRad. (n.d.-b). Preparation of Peripheral Blood Protocol - Flow Cytometry. Retrieved from <https://www.bio-rad-antibodies.com/preparation-of-cells-for-flow-cytometry-preparation-of-peripheral-blood-mononuclear-cells.html>
- Biosciences, I. (2021, July 19). Immunohistochemistry Basics: A Helpful Guide to the 4 Main Immunohistochemistry Steps. Retrieved from <https://bitesizebio.com/20929/getting-started-with-immunohistochemistry/>
- Boster Biological Technology. (n.d.-a). Flow Cytometry Fundamental Principle. Retrieved from <https://www.bosterbio.com/protocol-and-troubleshooting/flow-cytometry-principle>
- Boster Biological Technology. (n.d.). Flow Cytometry Sample Preparation. Retrieved from <https://www.bosterbio.com/protocol-and-troubleshooting/flow-cytometry-sample-preparation>
- Buckingham, L. (2019). *Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications* (Third ed.). Philadelphia, PA: F.A. Davis Company.
- Cancer.Net. (2017, June). Leukemia - Acute Myeloid - AML - Subtypes. Retrieved from <https://www.cancer.net/cancer-types/leukemia-acute-myeloid-aml/subtypes>
- eBioscience. (n.d.). Cell Preparation for Flow Cytometry. Retrieved November 23, 2021, from http://www.flowlab-childrens-harvard.com/yahoo_site_admin/assets/docs/cell-preparation-for-flow-cytometry_by_ebio.289171034.pdf

- Fergus, K. (2020, January 4). The Purpose and Steps Involved in a Karyotype Test. Retrieved from <https://www.verywellhealth.com/how-to-how-is-a-karyotype-test-done-1120402>
- Harmening, D. (2009). *Clinical Hematology and Fundamentals of Hemostasis 5th (fifth) edition* (5th ed.). Philadelphia, PA: F.A. Davis Company.
- Leukemia and Lymphoma Society. (n.d.). Diagnosis | Leukemia and Lymphoma Society. Retrieved from <https://www.lls.org/leukemia/acute-myeloid-leukemia/diagnosis>
- Mayo Clinic College of Medicine and Science. (n.d.). Molecular Genetics Technologist - Explore Health Care Careers - Mayo Clinic College of Medicine & Science. Retrieved from <https://college.mayo.edu/academics/explore-health-care-careers/careers-a-z/molecular-genetics-technologist/>
- Narayanan, D., & Weinberg, O. K. (2020). How I investigate acute myeloid leukemia. *International journal of laboratory hematology*, 42(1), 3–15. <https://doi.org/10.1111/ijlh.13135>
- Ouyang, G., Xu, Z., Jiang, D., Zhu, H., Wang, Y., Wu, W., Sun, Y., Sheng, L., Xu, K., Lou, Y., Mu, Q., Zhang, Y., Wu, N., Cheng, J., & Duan, S. (2019). Clinically useful flow cytometry approach to identify immunophenotype in acute leukemia. *The Journal of international medical research*, 47(4), 1483–1492. <https://doi.org/10.1177/0300060518819637>
- Shakoori A. R. (2017). Fluorescence In Situ Hybridization (FISH) and Its Applications. *Chromosome Structure and Aberrations*, 343–367. https://doi.org/10.1007/978-81-322-3673-3_16
- ThermoFisher. (n.d.). Overview of Immunohistochemistry | Thermo Fisher Scientific - NL. Retrieved from <https://www.thermofisher.com/nl/en/home/life-science/protein-biology/protein-biology-learning-center/protein-biology-resource-library/pierce-protein-methods/overview-immunohistochemistry.html>

Surgical Time-Outs in the Operating Room

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Program: Honors Nursing

Faculty Reviewer(s): Dr. Cheryl Johnson-Joy

The surgical time-out is part of the Universal Protocol developed in 2003 by the Joint Commission on Accreditation of Healthcare Organizations (The Joint Commission, 2022b). The Universal Protocol, designed to ensure that the correct procedure is conducted on the correct site and the correct patient, consists of three steps: (a) conducting a pre-procedure verification process, (b) marking the site, and (c) performing the time-out (Joint Commission on Accreditation of Healthcare Organizations, [JCAHO] 2003.) The Universal Protocol applies to all accredited hospitals, ambulatory care, and office-based surgical facilities (JCAHO, 2006). A time-out procedure is used in the operating room where the operative team, at a minimum, properly identifies the patient, procedure, and operative site (The Joint Commission, 2021b). Surgical time-outs are an important aspect of surgery to reduce operating room errors and enhance patient safety. While the literature indicates that surgical time-outs have positively impacted patient outcomes through a reduction of wrong-site, wrong-procedure, and wrong-person surgeries, errors still do occur. The focus of this project is to explore the time-out procedure, including the literature addressing patient outcomes and procedure compliance.

Purpose of a Time-Out

Before any surgery, a member of the operative/surgical team conducts a time-out using a pre-operative checklist. The World Health Organization (WHO) developed a surgical safety checklist in support of the Universal Protocol to help ensure patient safety regarding operative procedures and prevent errors (WHO, 2009). As noted above, the Universal Protocol consists of three (3) steps: (a) the pre-procedure verification, (b) marking the operative site, and (c) conducting the time-out. The WHO, responding to the Universal Protocol, developed the surgical safety checklist that incorporated these steps. The three steps are also included in the Joint Commission's (2021a) National Patient Safety Goals Effective January 2022 for Hospital Programs. The pre-procedure verification is an ongoing information-gathering process that precedes the time-out and involves the patient, when possible, to address any missing information, including documents and equipment, before the procedure. Marking the operative site is conducted by a team member prior to the procedure, and the patient should be included when possible. While the team member marking the site is most likely the surgeon, the Joint Commission (2021a) does not dictate a specific person only that it should be the person who knows the most about the procedure. The last of the three steps, the time-out, is the most publicized and well-known. According to The Joint Commission (as cited in Pelligrino, 2017), a time-out is defined as "an immediate pause by the entire surgical team to confirm the correct patient, procedure, and site" (para. 1). This time-out is conducted in the operating room (i.e., OR) before starting the procedure. It has also been suggested that this time-out should also involve the patient and, therefore, be conducted prior to anesthesia induction. The Joint Commission (2021a), in the National Patient Safety Goals, also does not limit the number of time outs that can be implemented. However, the time out prior to the incision (the focus of this project) is required. The WHO (2009) provides three (3) time-outs in their surgical safety checklist: (a) before induction of anesthesia prior to entering the OR, (b) before the skin incision (in the OR), and (c) before the patient leaves the OR. Checklists are based on the WHO criteria and are usually standardized and unique to each facility. The time-out protocol provides a time for team members to state their concerns regarding the patient's safety or procedure. Furthermore, the checklist prevents undesired or dangerous actions by ensuring accurate identity, site, and plan by all team members involved.

Team Member Involvement

Getting the patient ready for surgery can be chaotic, increasing the chance of error. A time-out allows the team members to focus on patient safety and the procedure to prevent negative patient outcomes and errors. To effectively perform a time-out, all surgical team members must be present and actively listening. Team members include the circulating nurse, surgeon, anesthesiologist/nurse anesthetist, scrub technician, and any ancillary staff present during that specific case (O'Connor, 2018). It is usually the circulating nurse or surgeon who conducts the time-out procedure. In a poll conducted by O'Connor asking who initiates the time-out, 79% of respondents answered the circulating nurse. In comparison, 10% indicated the surgeon and another 10% stated that it varied between the nurse, surgeon, and anesthesiologist. According to O'Connor, "the circulator confirms the patient's identify by the name tag on his wrist, and all verbally state confirmation. The nurse calls out the correct site and procedure, and all again orally confirm" (para.2). Active participation during a time-out means confirming orally, not just mindlessly nodding, that the information stated is correct.

Effect on Patient Outcomes

Surgical time-outs were designed to protect patients during a surgical procedure. Utilizing a time-out in the operating room creates a safe patient environment and reflects on the organization's culture. In other words, the organization's behavior is aimed at a commitment to the patient's safety (The Joint Commission, 2021a). A time-out is meant to increase situational awareness during the procedure to prevent wrong-site, wrong-person, or wrong-procedure surgeries. According to a study conducted by Kozusko (2016) involving surgical checklists and time-outs, "since 2011, 4,453 procedures have used the preoperative and pre-incision time-outs. Of those, 988 used all three when we added the postoperative component. Since the implementation of the checklist, there have been zero discrepancies between team members and zero wrong-site, wrong-side, or wrong-patient surgeries" (p. 620). Miller and Wagner (2020) report that "wrong-site surgeries occur between 1,300 and 2,700 times a year in the United States. This equates to physicians still performing surgery on the wrong part of the body, performing the wrong procedure, or operating on the wrong patient altogether roughly 40 times a week" (para. 2). Wrong-site surgeries can have a considerable effect on the patients as well as the organization or hospital. Vance et al. (2021) stated that "wrong-site surgery can have a major effect on patient outcomes, length of stay, and hospital costs. Third-party payers in the United States spent an estimated \$1.3 billion on malpractice payments for surgical never events" (p. 637). When a step-by-step checklist is performed accurately with all team members during time-outs, inaccurate procedures can be considerably reduced.

Compliance and Misuse of Time-Out

Croke (2019) reported that "according to the most recent Joint Commission sentinel event data, there were more than 3,300 sentinel events from 2015 to 2018; 440 were wrong-site surgeries" (para.1). The updated Joint Commission's (2021b) Summary Data on Sentinel Events reflects over 2,400 sentinel events from 2018 to 2020 with over 280 being wrong-site surgeries (including wrong patient, procedure, implant, and site). The number of wrong-site surgeries includes 110 in 2018, 83 in 2019, and 95 in 2020. While there has been some decrease in numbers, it is evident that wrong-site surgeries still occur. The Joint Commission's (2022a) General Information and 2021 Update reports a slight uptick of 113 wrong-site surgeries. The leading causes of wrong-site surgeries reported in the 2021 Update, occurring specifically in the OR, include:

- lack of intraoperative site verification when the same provider performs multiple procedures
- ineffective hand-off communication or briefing process
- primary documentation not used to verify patient, procedure, site
- site markings removed during patient prep
- rushing/distractions occurring during time-out
- time-out conducted before staff members are ready or without full participation

A study conducted by Vance et al. (2021) identified similar causes for time-out noncompliance that included:

- failure to stop other activities
- failure to use two (2) patient identifiers
- failure to use the consent as the primary source document
- lack of active surgeon engagement

Complying with a time-out is important. A time-out has been shown to be effective in having successful patient outcomes; nevertheless, if certain team members are not proactive or do not participate in the time-out, mistakes can be easily made. Croke (2019) recommended that “all perioperative team members should participate in the time-out, confirming at least the correct patient, surgical site, laterality if appropriate, and procedure; introducing themselves and explaining their roles; and discussing patient safety concerns” (para. 2). According to the Guideline for team communication (as cited in Croke), “all extraneous activities and conversations should be stopped when the time-out is called and until it is completed, and the time out should be documented in accordance with facility policy after completion” (para. 2). There is a need for teamwork in the prevention of surgical errors. Vance et al. (2021) stated, “perioperative nurses should speak up when they identify concerns about any activities occurring in the perioperative environment that may result in patient safety events (e.g., wrong-site surgery). Such concerns may include the use of outdated policies that do not support best practices and current regulations, as well as personnel being inattentive during procedural steps designed to protect patients” (p. 5). Staff/team members are responsible for advocating for the patient's safety. If misuse of the time-out is noticed, staff/team members should take action to fix the issue.

Case Examples

The following cases are the worst, most shocking surgical errors made that could have been prevented if a surgical time-out had been performed adequately. The three worst surgical cases, as reported by Miller and Wagner (2020), include (a) operation on the wrong side of three different patients' heads, (b) transplanted organs with the wrong blood type, and (c) removal of the wrong leg. The outcome of the first case resulted in two survivors and one death. Although the organs were transplanted in the second case, the patient did not survive. In the third case, the patient lost both lower extremities.

The examples above suggest that if the time-out had been performed, or even performed correctly, these devastating tragedies could have been averted. Utilizing a time-out procedure before surgery begins has the potential to dramatically change the patient's outcome. By reinforcing the details of the procedure before the incision is made, patient safety and the success of the procedure will be substantially enhanced. Patient safety should be the number one priority of healthcare providers. Therefore, taking a pause to confirm patient identifiers should be a matter of most significant importance.

Conclusion

Initiating a surgical time-out prior to beginning the procedure has increased positive patient outcomes as evidenced by the statistics listed previously. A time-out allows the surgical team to identify the patient, procedure, site, and other important information before the incision is made. This procedure has substantially reduced wrong-site, wrong-procedure, and wrong-person incidents. However, as noted above, devastating accidents can happen when or if the time-out procedure is not performed correctly. All team members should actively participate in the time-out procedure to ensure patient safety. As the patient is the priority, staff/team members should act against any misuse of the time-out procedure. Overall, the use of surgical time-outs results in an increase in the quality of care and safety of the patient as well as enhances surgical team performance.

References

- Croke, L. (2019). Updated statistics underscore the importance of the surgical time out Special focus issue]. *AORN Journal*, 109 (6), P5. <http://doi.org/10.1002/aorn.12731>
- Joint Commission on Accreditation of Healthcare Organizations (2003). *Universal protocol for preventing wrong site, wrong procedure, wrong person surgery*TM.
<https://www.ncbi.nlm.nih.gov/books/NBK2678/box/ch36.box1/?report=objectonly>
- Joint Commission on Accreditation of Healthcare Organizations (2006). *Universal protocol for preventing wrong site, wrong procedure, wrong person surgery*.
<https://psnet.ahrq.gov/issue/universal-protocol-preventing-wrong-site-wrong-procedure-wrong-person-surgery#:~:text=The%20Universal%20Protocol%20applies%20to,risk%20of%20wrong%2Dsite%20surgery>
- Kozusko, S.D., Elkwood, L., Gaynor, D., & Chagares, S. A. (2016). An innovative approach to the surgical time out: A patient-focused model. *AORN Journal*, 103 (6), 617-622.
<http://dx.doi.org/10.1016/j.aorn.2016.04.001>
- Miller, D. K., & Wagner, R. S. (2020). *Is the universal protocol working?* <https://www.miller-wagner.com/articles/the-universal-protocol/>
- O'Connor, D. (2018). *Your attention, please: Time for a time-out*. <https://www.aorn.org/outpatient-surgery/articles/outpatient-surgery-magazine/2018/december/your-attention-please-time-for-a-time-out>
- Pellegrini, C. A. (2017). *Time-outs and their role in improving safety and quality in surgery*.
<https://bulletin.facs.org/2017/06/time-outs-and-their-role-in-improving-safety-and-quality-in-surgery/#:~:text=A%20time%2Dout%2C%20which%20The,Wrong%20Site%2C%20Wrong%20Procedure%2C%20and>
- The Joint Commission. (2021a). *National patient safety goals® effective January 2022 for the hospital program*. Retrieved May 21, 2022, from https://www.jointcommission.org/-/media/tjc/documents/standards/national-patient-safety-goals/2022/npsg_chapter_hap_jan2022.pdf
- The Joint Commission. (2021b). *Summary data of sentinel events reviewed by The Joint Commission*. Retrieved May 21, 2022, from <https://www.jointcommission.org/-/media/tjc/documents/resources/patient-safety-topics/sentinel-event/summary-se-report-2020.pdf>
- The Joint Commission. (2022a). *Sentinel event data: General information & 2021 update*. Retrieved May 21, 2022, from <https://www.jointcommission.org/-/media/tjc/documents/resources/patient-safety-topics/sentinel-event/sentinel-event-general-information-and-2021-update.pdf>
- The Joint Commission. (2022b). *The Joint Commission history timeline* [PowerPoint slides]. Retrieved May 21, 2022, from <https://www.jointcommission.org/about-us/facts-about-the-joint-commission/history-of-the-joint-commission/>
- Vance, M. E., Proctor, T., & Schmidt, K. A. (2021). Using performance improvement to enhance time-out compliance and prevent wrong-site surgery. *AORN Journal*, 113(6), 635-642.
<http://doi.org/10.1002/aorn.13413>
- World Health Organization. (2009). *Implementation manual: WHO surgical safety checklist 2009*.
https://apps.who.int/iris/bitstream/handle/10665/44186/9789241598590_eng.pdf?sequence=1&isAllowed=y

An Analysis of the Relationship Between PCOS and Cardiovascular Disease

Lula Boone

Submitted: February 22, 2022

Program: Honors Biomedical Sciences

Faculty Reviewer(s): Dr. Lilian Nyindodo

Background

Polycystic Ovarian Syndrome (PCOS)- less commonly referred to as hyperandrogenic anovulation (HA) or Stein-Leventhal syndrome¹- is an endocrine disorder that affects women of reproductive age. PCOS was first clinically acknowledged in a 1935 report by doctors Irving Freiler Stein and Michael Leventhal that detailed the correlation between the presence of ovarian cysts and oligo/amenorrhea (irregular/absent menstruation)². The disorder is characterized by ovarian dysfunction that results in hyperandrogenism, or the excessive production of male sex hormones like testosterone, dehydroepiandrosterone sulfate (DHEAS), and androstenedione. The exact mechanism of ovarian dysfunction is not yet known. Still, it leads to clinical manifestations of hirsutism (thick, dark patches of hair presenting on the face, neck, back, and/or chest), oligo/amenorrhea, the development of ovarian cysts, and infertility as a result of failed follicular maturation. It is important to note that while these manifestations are the most consistent, there is no universal appearance for PCOS, and common clinical symptoms are not present in all patients¹. Other manifestations of PCOS include mood disturbances (heightened feelings of anxiety and/or depression), fatigue, acne, sudden weight changes, and brittle/thinning hair.

Diagnosis

Currently, there are 3 potential sources of diagnostic criteria for PCOS, all of which require the exclusion of other disorders related to androgen excess, such as Cushing syndrome, thyroid disorders, adrenal hyperplasia, and idiopathic hyperandrogenism. The most common diagnostic prerequisite- the Rotterdam criteria- also requires patients to have hyperandrogenism, clinically manifesting in hyperandrogenemia and/or hirsutism, and/or ovarian dysfunction, clinically manifesting in chronic ovulatory irregularity and/or the presence of ovarian cysts³.

2003 Rotterdam Criteria
1- Exclusion of other disorders related to androgen excess
AND
2- <i>Hyperandrogenism: hyperandrogenemia and/or hirsutism</i>
OR
3- Ovarian Dysfunction: polycystic ovaries and/or oligo/anovulation

Table: Rotterdam Criteria for Diagnosis of PCOS⁴

Genetic Factors

It is worth noting that PCOS is a multifactorial disorder, and while the exact genetic component is not fully understood, researchers have noted an increased likelihood of PCOS incidence in diagnosed patients' primary relatives, i.e., their mothers, daughters, and sisters. This is likely due to abnormalities on

chromosomes 2 and 9, which show significant single nucleotide changes present in PCOS genotypes. Two genes of interest- thyroid adenoma-associated protein (THADA) on chromosome 2 and DENN domain-containing protein 1A (DENND1A) on chromosome 9- have been observed at higher concentrations in PCOS patients compared to non-PCOS control patients, and the overproduction of these genes is believed to lead to the development of a PCOS phenotype⁵. Further research is needed to state that these genes are recognized PCOS biomarkers conclusively, but they are promising candidates for discovering PCOS's pathogenic mechanism.

Prevalence

PCOS affects 4-20% of reproductive-age women, making it the most common endocrine disorder in this global population. In the United States, there is an estimated prevalence of 6-12%, with nearly half of these cases occurring in the Southeastern US^{6,7}. There is an increased rate of PCOS diagnosis in high-income communities, compared to those of lower income levels. This difference is largely due to the increased likelihood for those of higher socioeconomic status to have adequate access to medical care and should not be misunderstood as a lower disease prevalence in underprivileged regions⁷. It was also noted that Hispanic women are more likely to have more aggressive PCOS phenotypes, and white women were shown to have the least aggressive PCOS phenotypes. This difference is largely due to the combination of both genetic and socioeconomic factors, since it has been noted that white women were most likely to receive PCOS education from healthcare providers, whereas Hispanic women were the least likely to receive these resources, even when controlled for income⁸.

Complications of PCOS

PCOS patients are more likely to have a higher distribution of fat in their upper bodies- especially around the abdominal region- and obesity is a potential result. Insulin resistance (IR) often develops as the result of an insulin receptor/insulin receptor substrate (IRS)-1 defect that causes metabolic signaling errors, causing many PCOS patients to present with hyperinsulinemia, a condition in which there is a higher-than-normal amount of insulin circulating in the blood. Consequently, these patients are also at a greater risk for the development of type II diabetes mellitus (DM) because pancreatic beta (β) cells of PCOS patients show greater potential for defects and lowered glucose tolerance, compared to patients without PCOS⁹. Moreover, inadequate metabolism of insulin coupled with abnormally high androgen levels- namely testosterone- has the potential to cause thickening of blood vessel walls, resulting in elevated blood pressure levels and the presence of a prehypertensive state in patients without diagnosed hypertension. Another common complication of PCOS is diminished lipid metabolism corresponding with IR and high androgen levels¹⁰. Apolipoproteins (Apo) A and C have also been observed at varying levels in these patients, with protective ApoA-I appearing at lower levels and plaque-forming ApoC-I being reported at higher levels in PCOS patients, increasing the patients' potential for atherosclerotic lesion (plaque) formation in blood vessels. Likewise, high serum levels of low-density lipoproteins (LDLs) and triglycerides alongside low serum concentrations of high-density lipoproteins (HDLs) correspond to hypercholesterolemia in PCOS patients¹¹.

Cardiovascular Disease

Cardiovascular disease (CVD) is a group of disorders that affect the function of the heart and surrounding blood vessels. Coronary artery disease (CAD), in which the main vessels supplying the heart become damaged, is the most prevalent CVD. Much like PCOS, CVD is multifactorial, so one's risk for development relies on the interplay of genetics and lifestyle¹². CVD is often linked to atherosclerosis, and it has consistently been the leading cause of global mortality, causing around 660,000 US deaths in 2019¹³. Among the greatest biological risk factors for CVD are hypertension and elevated LDL levels, as these pathologies impair the heart's ability to efficiently provide the body with adequate blood supply. In addition to this, increased cardiovascular risk is attributed to elevated levels of C-reactive protein (CRP)- an inflammatory biomarker- and homocysteine (Hcy)- an amino acid that has the potential to damage arterial

walls^{14,15}. Cardiovascular risk factors can be mediated with the implementation of a low-cholesterol/high-folate diet and regular physical activity, but lifestyle modifications will not eliminate the risk of CVD.

PCOS & CVD

PCOS patients are more likely to develop conditions that constitute metabolic syndrome. Metabolic syndrome is a group of interconnected conditions (obesity, elevated TG/low HDL, hypertension, and hyperglycemia) that significantly increase one's risk for the development of diseases like type II DM and CVD¹⁶. Furthermore, PCOS patients present with greater blood levels of CRP and Hcy, indicating plausible vascular inflammation and damage^{14,15}. These findings would suggest that PCOS patients are at a greater risk for the development of CVD, but, given the complicated nature of both disorders, there has not been substantial data proving a direct explanation of the relationship between the two. Here, there is a correlation between PCOS and CVD risk markers, but there is no definite incidence of causation. There is a need for further study of long-term PCOS patients that independently observe their cardiovascular health, but such a study would be difficult to complete due to the prevalence of external factors like one's lifestyle, genetic background, and preexisting health conditions¹⁷.

Conclusion

PCOS patients present with higher risk factors for CVD than non-PCOS control patients; however, there has not been a conclusive study to demonstrate the direct contributory effect that PCOS has on CVD when independent of other health conditions. Given the high prevalence of PCOS, it is necessary to make resources available to ensure that patients can recognize potential symptoms of the disorder when they arise so they can mitigate its effects. This also emphasizes the importance of routine medical screenings and examinations as well as the value of understanding one's medical background as it pertains to family history and predisposition to disease. Although there was no presence of a statistically significant relationship between PCOS and a patient's likelihood of developing CVD, it is of utmost importance that these patients take necessary actions such as the addition of physical activity, dietary modifications, and pharmaceutical therapeutics- to manage their condition and prevent further complications.

References

1. El Hayek S, Bitar L, Hamdar LH, Mirza FG, Daoud G. Poly Cystic ovarian syndrome: An updated overview. *Frontiers in Physiology*. 2016;7. doi:10.3389/fphys.2016.00124
2. Azziz R, Adashi EY. Stein and Leventhal: 80 years on. *Am J Obstet Gynecol*. 2016;214(2):247.e1-247.e11. doi:10.1016/j.ajog.2015.12.013
3. Sirmans SM, Pate KA. Epidemiology, diagnosis, and management of polycystic ovary syndrome. *Clin Epidemiol*. 2013;6:1-13. Published 2013 Dec 18. doi:10.2147/CLEP.S37559
4. Azziz R, Carmina E, Dewailly D, et al. Criteria for defining polycystic ovary syndrome as a predominantly hyperandrogenic syndrome: An androgen excess society guideline. *The Journal of Clinical Endocrinology & Metabolism*. 2006;91(11):4237-4245. doi:10.1210/jc.2006-0178
5. Chen ZJ, Zhao H, He L, et al. Genome-wide association study identifies susceptibility loci for polycystic ovary syndrome on chromosome 2p16.3, 2p21 and 9q33.3. *Nat Genet*. 2011;43(1):55-59. doi:10.1038/ng.732
6. Deswal R, Narwal V, Dang A, Pundir CS. The Prevalence of Polycystic Ovary Syndrome: A Brief Systematic Review. *J Hum Reprod Sci*. 2020;13(4):261-271. doi:10.4103/jhrs.JHRS_95_18
7. Rao M, Broughton KS, LeMieux MJ. Cross-sectional study on the knowledge and prevalence of PCOS at a multiethnic university. *Progress in Preventive Medicine*. 2020;5(2). doi:10.1097/pp9.0000000000000028

8. Engmann L, Jin S, Sun F, et al. Racial and ethnic differences in the polycystic ovary syndrome metabolic phenotype. *Am J Obstet Gynecol*. 2017;216(5):493.e1-493.e13. doi:10.1016/j.ajog.2017.01.003
9. Palomba S, Santagni S, Falbo A, La Sala GB. Complications and challenges associated with polycystic ovary syndrome: current perspectives. *Int J Womens Health*. 2015;7:745-763. Published 2015 Jul 31. doi:10.2147/IJWH.S70314
10. Dunaif, A., 2006. Insulin resistance in women with polycystic ovary syndrome. *Fertility and Sterility*, 86, pp.S13-S14.
11. Kim JJ, Choi YM. Dyslipidemia in women with polycystic ovary syndrome. *Obstet Gynecol Sci*. 2013;56(3):137-142. doi:10.5468/ogs.2013.56.3.137
12. Nabel EG. Cardiovascular disease. *New England Journal of Medicine*. 2003;349(1):60-72. doi:10.1056/nejmra035098
13. Heron M. Deaths: Leading causes for 2019. National Vital Statistics Reports; vol 70 no 9. Hyattsville, MD: *National Center for Health Statistics*. 2021. DOI: <https://dx.doi.org/10.15620/cdc:107021>
14. Maleedhu P, M V, S S B S, Kodumuri PK, Devi D V. Status of Homocysteine in Polycystic Ovary Syndrome (PCOS). *J Clin Diagn Res*. 2014;8(2):31-33. doi:10.7860/JCDR/2014/7070.3999
15. N. Boulman, Y. Levy, R. Leiba, S. Shachar, R. Linn, O. Zinder, Z. Blumenfeld, Increased C-Reactive Protein Levels in the Polycystic Ovary Syndrome: A Marker of Cardiovascular Disease, *The Journal of Clinical Endocrinology & Metabolism*, Volume 89, Issue 5, 1 May 2004, Pages 2160–2165, <https://doi.org/10.1210/jc.2003-031096>
16. Paul L. Huang; A comprehensive definition for metabolic syndrome. *Dis Model Mech* 30 April 2009; 2 (5-6): 231–237. doi: <https://doi.org/10.1242/dmm.001180>
17. Richard S. Legro, Polycystic Ovary Syndrome and Cardiovascular Disease: A Premature Association?, *Endocrine Reviews*, Volume 24, Issue 3, 1 June 2003, Pages 302–312, <https://doi.org/10.1210/er.2003-0004>

Automatic Exposure Control Misusage

Sondos Hamadneh

Submitted: November 29, 2021

Program: Honors Medical Radiography

Faculty Reviewer(s): Professor Thomas Wolfe

Background

Medical radiography students have rotated through many clinical facilities where x-ray technologists use the automatic exposure control (AEC) system to make exposures. The AEC contains radiation detection devices that transform energy into electrical current. It is part of the x-ray equipment that allows for more consistent exposures and reduces radiation exposure to the patient. It has many advantages, such as improving the consistency of radiographic exposures, reducing retakes, and minimizing patient dose, but it is not optimal for every procedure. Preprogrammed exposure controls need to be adjusted for unusual exams, such as those with anatomy that is too small, peripheral, or contain large artifacts. Technologists should be able to recognize these unusual circumstances and determine what technique is appropriate. Many technologists use the AEC when it should not be used, directly resulting in an increased patient dose and images with overexposure or underexposure.

This paper serves to educate and inform future and current radiologic technologists about appropriate use of the AEC, and when it becomes harmful to the patients being examined. Technologists are taught the principle of 'ALARA,' which stands for 'as low as reasonably achievable.' This principle also applies to misusing equipment during exams, causing patient doses to be much higher than necessary.

Lab Description

I first determined how many of my classmates understood the advantages of the automatic exposure control system, as well as its limitations. I designed a lab that highlighted the basic parts of the AEC. It included radiographs that were either overexposed or underexposed due to AEC misusage. The students needed to describe which limitation caused the over or under-exposure. I also had them decide which configuration is appropriate for specific exams when manually selecting the detector cells. Finally, I asked them to explain the relationship between the exposure index values and the amount of radiation the patient is receiving. I added a copy of the AEC lab at the end of the thesis for reference.

Mr. Ben Roberts suggested making a pre and post-survey that students fill out to indicate how much they have learned from the lab activity. They circled a number from 1 to 10 in response to each statement. 1 means complete strongly disagree and 10 represents strongly agree. The statements on the survey were the following:

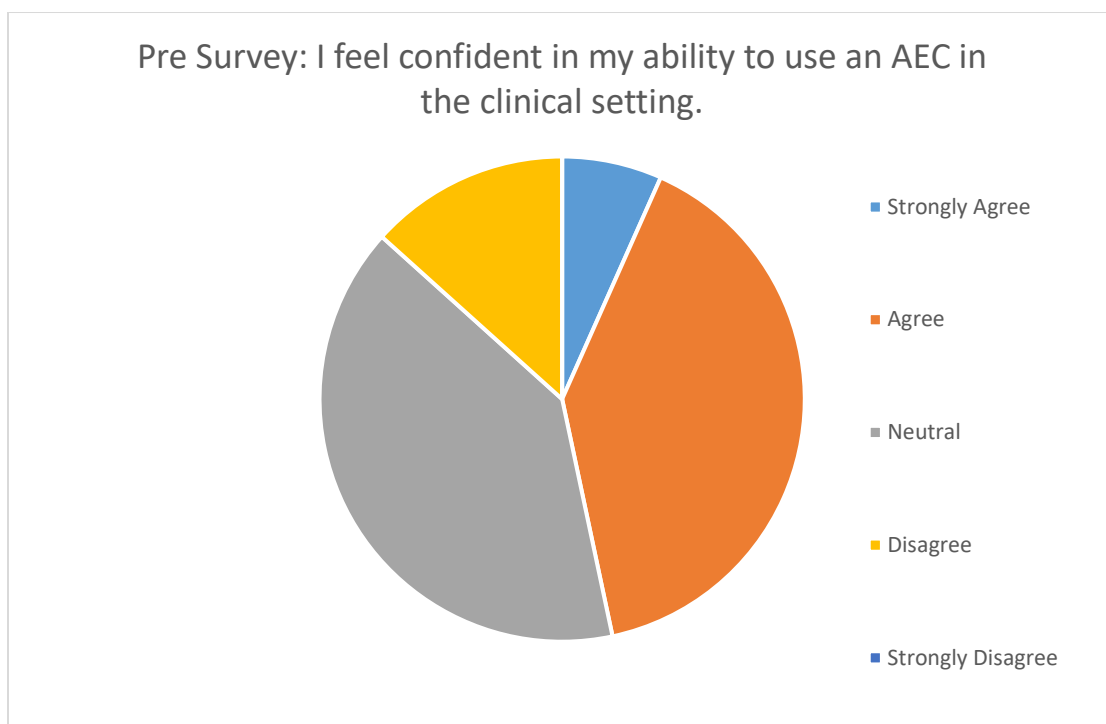
1. I feel confident in my ability to use an AEC in the clinical setting.
2. I understand how the AEC works.
3. I can diagnose errors in AEC usage.
4. If I were given test questions about the AEC, I feel confident I could answer them correctly.
5. I have additional questions about how to use an AEC.

The goal was that the students rate themselves more comfortable with the AEC after the lab was presented. Data will be gathered from the pre and post-surveys.

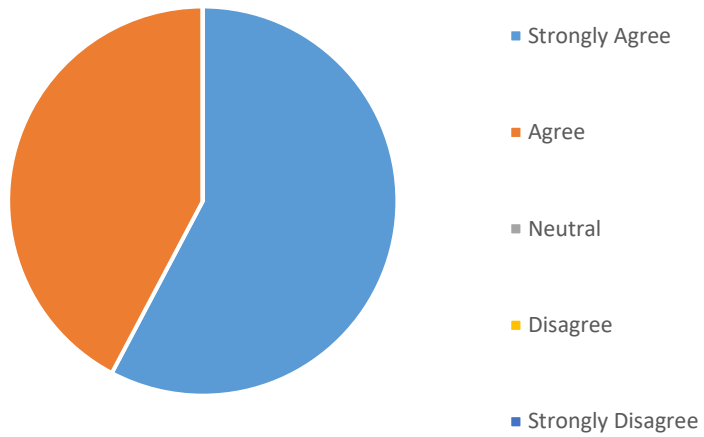
Timeline

The lab took a month to design, but it was presented to the students in one class period. The instructor already covered the AEC chapter in the textbook, so the students had basic knowledge about it. The students completed the pre-survey, then the lab, and then the post-survey followed. All the data was collected from answers to the surveys.

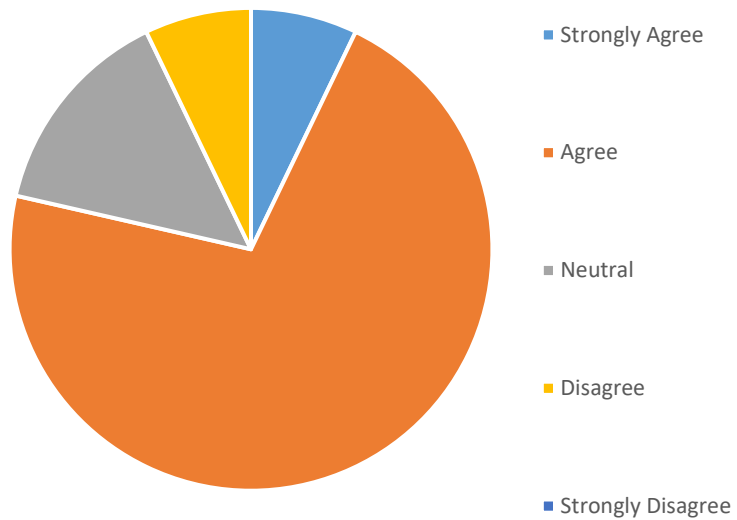
Results



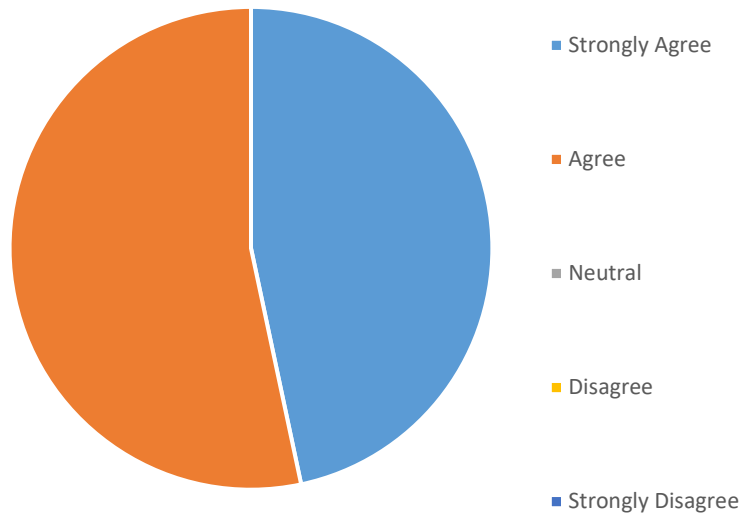
Post Survey: I feel confident in my ability to use an AEC in the clinical setting.



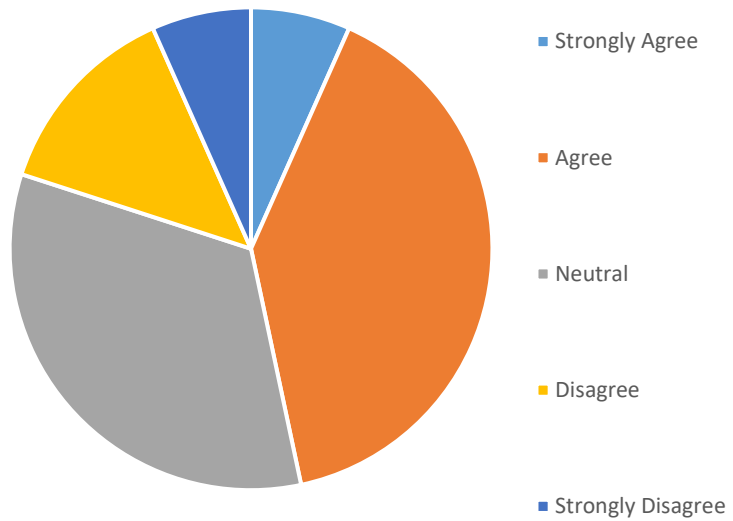
Pre Survey: I understand how an AEC works



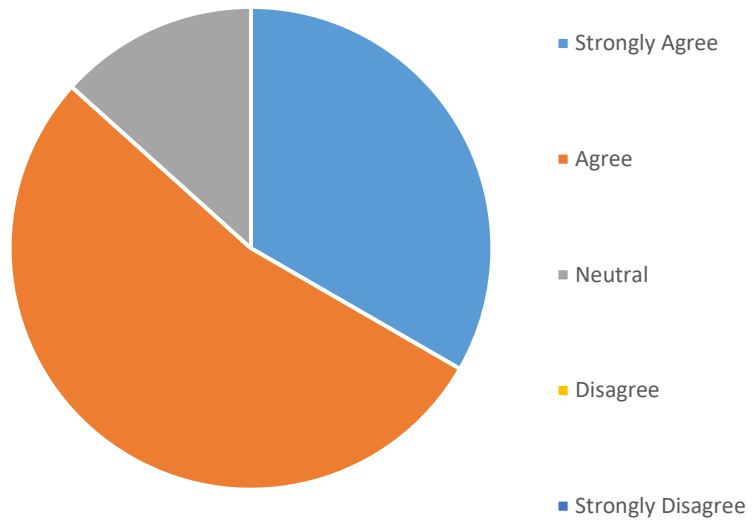
Post Survey: I understand how an AEC works.



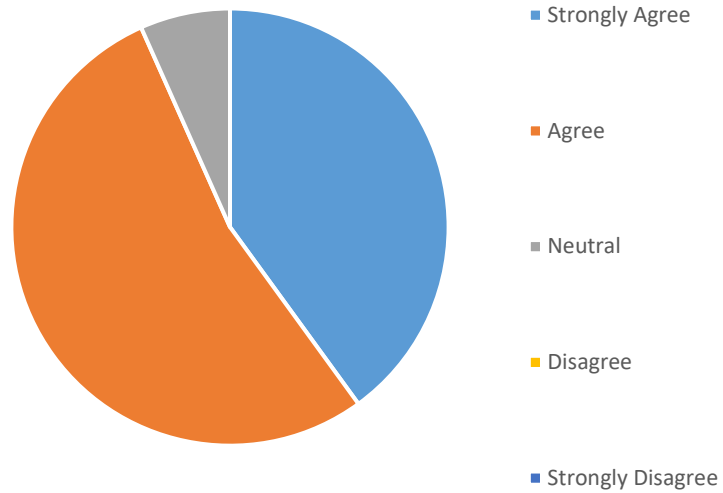
Pre Survey: I can diagnose errors in AEC usage.



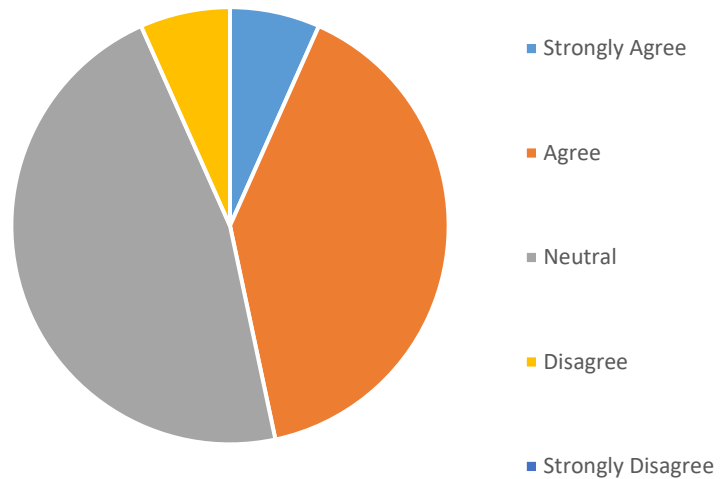
Post Survey: I can diagnose errors in AEC usage.



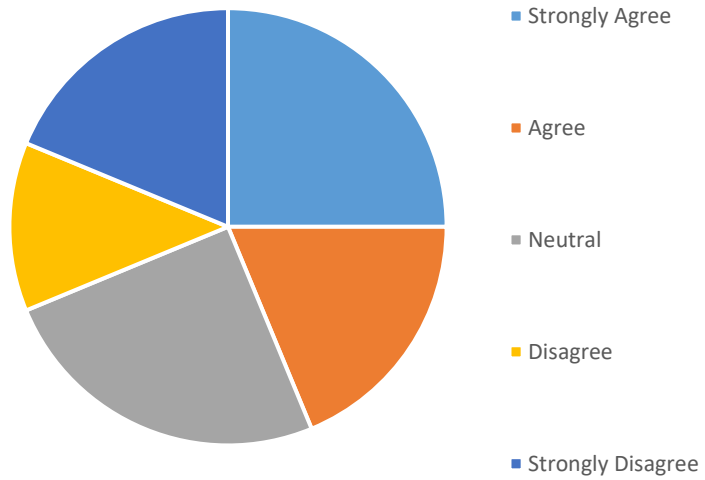
Post Survey: If I were given test questions about the AEC, I feel confident I could answer them correctly.



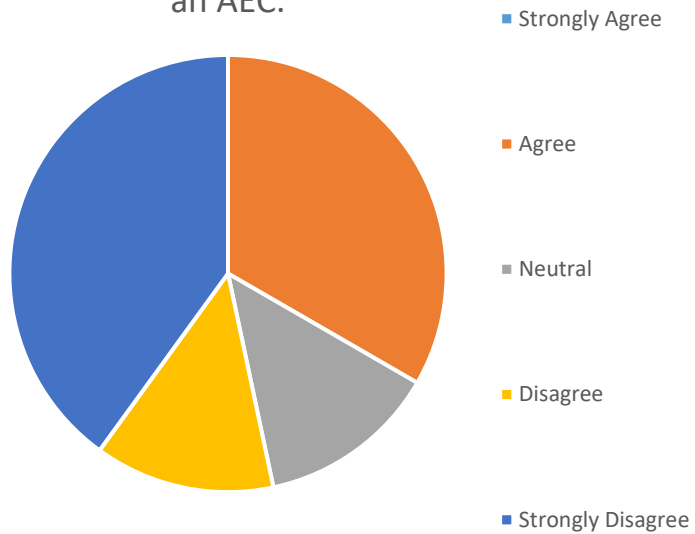
Pre Survey: If I were given test questions about the AEC, I feel confident I could answer them correctly.



Pre Survey: I have additional questions about how to use an AEC.



Post Survey: I have additional questions about how to use an AEC.



Resources & Literature

The information from the lab I created mostly came from information in our textbook used in our Image Production class. It is called *Radiography in the Digital Age*, and it has an entire chapter including information an x-ray technologist should know about the automatic exposure control system. The remaining information has been collected through my clinical experiences as a medical radiography student.

Significance of the Research

This research highlights how well the radiography students understand how to use the automatic exposure control system. If they are not appropriately using the AEC, the patient's dose can dramatically increase or decrease. If the quality of the image is not diagnostically acceptable a repeat image may be required, which will increase the patient's dose even more. By educating those who are directly working with x-rays in patient care, I hope to help decrease patient radiation exposure.

Students in clinical rotations gain experiences from the technologists they are working with. As much as we learn in class, we remember much more from clinical situations we've been in ourselves. If the technologists we are working with do not understand why what they are doing is wrong, they will continue to make wrong decisions that can influence the students around them.

Future Research

The research collected during this project was solely done on the senior medical radiography students at Baptist University. This project can be extended by gathering data from radiology students in other schools, and even by collecting data on how much technologists in the work field know about the AEC system. Gathering data to see how much the technologists know will be much more difficult. I anticipate it taking about a year; this time frame allows for information to be gathered from different technologists in a variety of departments and hospitals.

AEC Lab (Answer Key)

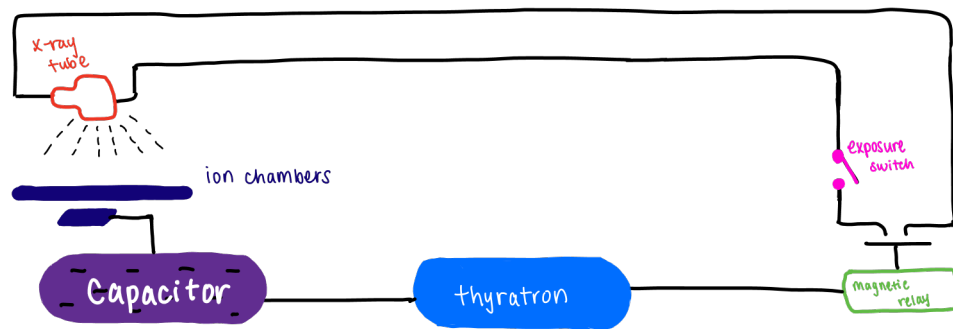
Learning Objectives:

After completing the AEC lab, the student should:

1. Be able to select the best configuration of the three detector cells for a specific radiographic exam
2. Accurately identify 4 out of 5 of the major limitations of AEC
3. Be able to state the relationship between exposure index values and patient exposure
4. Identify at least 3 causes of overexposure and underexposure using the AEC

Automatic Exposure Control Circuit

Illustrate the AEC circuit below using your textbook as a reference. Be sure to label the X-ray tube, ion chambers, capacitor, thyatron, magnetic relay, and exposure switch.



Explain what each part of the x-ray circuit does.

- Ion chambers

The ion chamber induces an electrical current when the gas atoms are ionized by radiation, freeing electrons from the gas atoms. These electrons are then attracted to and strike a positively charged anode plate at one end of the chamber. They flow out of the anode plate down a very thin wire, becoming electrical current.

- Capacitor

Electrical charge from the induced current is stored up on an electric capacitor until it reaches a preset threshold amount corresponds to the ideal amount of radiation exposure.

- Thyatron

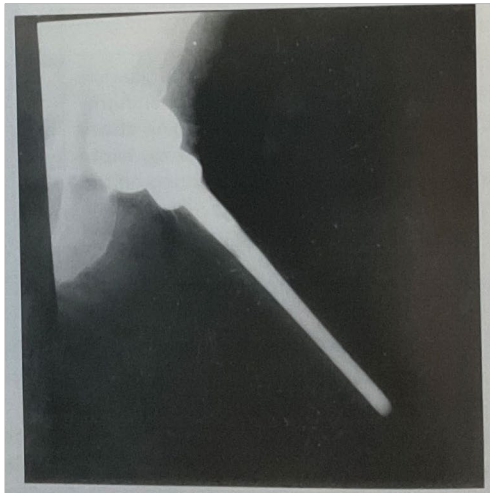
The thyatron in the circuit releases the charge and a surge of electricity that is used to activate an electromagnet, which pulls open the exposure switch terminates the exposure.

Limitations of the AEC

1. AEC should never be used on anatomy that is Smaller than at least one detector cell.
2. Anatomy that is peripheral results in underexposure of the image, because it is too close to the edge of the body.
3. When using the AEC, positioning and centering must be perfected. The tissue of interest, not just anatomy, must cover most of the detector cells used.
4. The x-ray field must be well collimated to the anatomy of interest, to prevent scatter radiation from shutting off the AEC prematurely.
5. The AEC should never be used when radio opaque (metal) artifacts cannot be removed from the anatomy of interest.

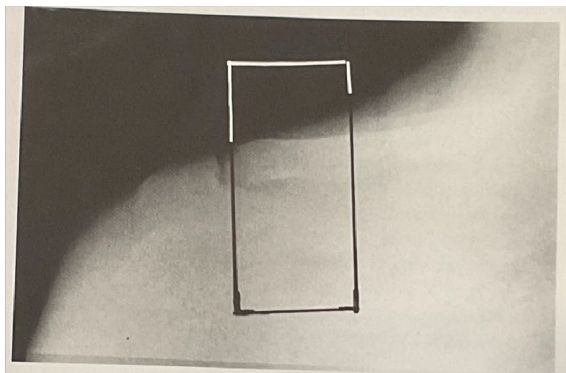
Radiographs

What caused the images below to be overexposed or underexposed? Be sure to refer back to the limitations listed above in your explanations.



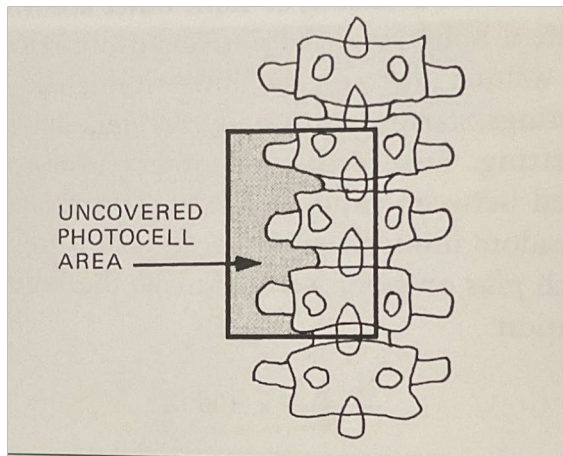
Frog lateral hip projection

The hip pin is a large radiopaque artifact. The AEC detector cell is not receiving any exposure, so the exposure time will be extended. Overexposure will result at the receptor plate & to the patient.



The clavicle is peripheral, so the detector cell extends above the anatomy. The AEC shuts off prematurely, so the image is underexposed.

AP clavicle projection

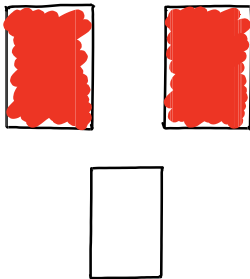


Off-centering of the spine places the detector cell outside the area of interest. The AEC will shut off too soon, and underexposure is the result.

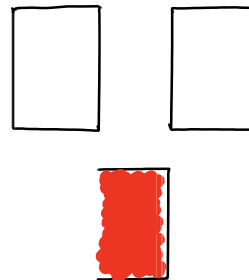
Oblique spine projection

Detector Cells

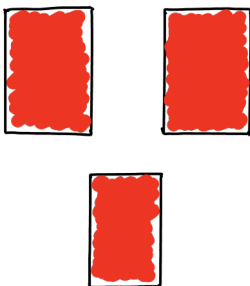
Shade in the appropriate detector cell configuration for the specific exam given.



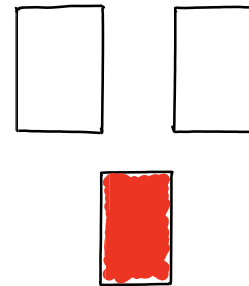
PA Chest



Lateral Chest



Abdomen



Spine

Deviation / Exposure Index

Circle the correct answer.

Deviation Index	% of Target
3	~100% too high
2	~58% too high
1	~26% too high
0	Correct
-1	~21% too low
-2	~37% too low
-3	~50% too low

Exposure Index

Fuji (S Number)	Indication & Action
>1000	Repeat
601-1000	Underexposed QC exception
301-600	Underexposed QC review
150-300	Acceptable
75-149	Overexposed
<50	Repeat

With the deviation index, as the value increases the exposure **increases** / decreases, and as the value decreases the exposure increases / **decreases**.

With the exposure index, a higher S number means the image will be overexposed / **underexposed**. A lower S number means the image will be **overexposed** / underexposed.

References

- Carroll, Q. B. (2018). *Radiography in the digital age : physics, exposure, radiation biology* (3rd ed.). Charles C. Thomas, Publisher, Ltd.
- Ehrlich, R. A., & Coakes, D. M. (2021). *Patient care in radiography: With an introduction to medical imaging*. Elsevier.
- Seibert, J. A., & Morin, R. L. (2011). The standardized exposure index for digital radiography: an opportunity for optimization of radiation dose to the pediatric population. *Pediatric radiology*, 41(5), 573–581. <https://doi.org/10.1007/s00247-010-1954-6>

ICU Liberation as a Precedent for Innovation in Healthcare

Grayson Landers

Submitted: February 22, 2022

Program: Honors Health Administration

Faculty Reviewer(s): Dr. Briana Jegier and Dr. Jan Hill

Introduction

A million-dollar question has puzzled leaders in every industry for centuries—namely, “How can we keep improving?” This constant search for betterment has inspired speeches, music, and slogans, not to mention hundreds of books. The need for progress in medicine reached a new stage in 1999 when a report by the Institute of Medicine showed that nearly 100,000 Americans die every year from medical errors alone (Rangachari, p. 2). In a 2016 study, that figure increased to 250,000 Americans per year (Daniel, par. 1). Yet another sobering reality is that even in high-income countries, one in ten patients suffer serious physiological and mental harm as a result of their treatment (“Patient Safety,” par. 1)—whether it was faulty or simply not in their best interest.

Indeed, a quarter million preventable deaths is a staggering statistic, and many long-accepted protocols for patient care inflict more harm than it seems at first glance. It is worth the time and effort for administrators and caregivers alike to ask themselves the same question: “How can we keep improving?” Healthcare organizations often resemble the United States Congress in terms of difficulty in implementing change. Physicians are stereotyped for their resistance to change (Gupta, Boland, & Aron, p. 1), and when this resistance truly occurs, entire hospitals are impeded from improving themselves and the way they care for patients.

Consider the part of a hospital where the most targeted and aggressive treatment occurs—the intensive care unit (ICU). The volatility and (per its name) intensiveness of this ward make it uniquely difficult to “think outside the box” to improve patient outcomes. Nonetheless, the ICU has been the focus of a major innovation since 2000 (Ely, p. 3), and one of the products of that focus is the initiative of ICU Liberation. Unbeknownst to most, patients often suffer long-term complications stemming from their ICU treatment, specifically long-term sedation, ventilation, and isolation (“About ICU Liberation,” par. 2). Hospitals around the United States have launched a joint effort to improve the quality of care and patient outcomes in the ICU (par. 9). In an era where the ICU and healthcare organizations (HCOs) alike are experiencing ever-growing demand, improvements in safety, quality, and efficiency are vital. Not only is ICU Liberation a necessary and beneficial change, but its successful implementation also sets an example for all hospitals to follow when attempting their own innovations.

Purpose, Methods, and Uniqueness

ICU Liberation has gained momentum around the United States’ healthcare system over the last decade. Its pioneers were remarkably effective at phasing it in despite the logistical and medical challenges it has faced. To provide insight and inspiration for other healthcare innovators, this paper will review the literature surrounding the implementation of ICU Liberation to ascertain specific actions taken by its founders. Furthermore, this paper will also explore the characteristics of the HCOs themselves that have enacted ICU Liberation.

The objectives of this paper are:

1. Conduct a review of the literature pertaining to ICU Liberation to synthesize the lessons that may be drawn from its enactment as they relate to the logistical, organizational, and medical challenges overcome during the implementation process.
2. Pinpoint actions and characteristics that improve the innovation process in patient care.
3. Demonstrate the necessity of institution-wide buy-in for changes to be successful.

Methods

Because this paper is a literature review, it will consult various works related to ICU Liberation and healthcare innovation in general. Since ICU Liberation was first conceptualized in 2013, this review will only consult works from that year or later when discussing specific advancements and trends in healthcare. Most of the research for this review took place through the databases PubMed, Medline, and the National Institutes of Health. Special emphasis was given to studies authored by Ely, Balas, Barr, Barnes-Daly, Morandi, Pun, and others actively involved in executing or studying ICU Liberation since its inception.

The end goal of this project, however, is not just to demonstrate the benefits of ICU Liberation, as the advantages speak for themselves. Rather, this project will investigate how these hospitals achieved innovative and arguably radical changes. For example, how have ICU Liberation hospitals garnered buy-in from their teams? How did they allocate their resources? How did they navigate unforeseen challenges to these changes? The main purpose of this paper is to demonstrate how the precedent set by ICU Liberation may serve as an example for other hospitals to make their own innovations, whether derived from ICU Liberation or unique to a given hospital.

Uniqueness

Notably, this paper will focus considerably more attention on the organizational attributes of hospitals seeking to enact changes, as opposed to the medical nature of a given change. The paper takes this approach for two reasons. First, most of the studies on ICU liberation and other medical advancements emphasize the science behind them, leaving a larger gap in the literature on how those advancements were made logistically. Additionally, while medicine directly influences patient care, no clinical improvements can be sought without proper mechanisms for enacting them. This is significant because, as Elmore (1980) explains:

Analysis of policy choices matters very little if the mechanism for implementing those choices is poorly understood. In answering the question, “What percentage of the work of achieving a desired governmental actions [sic] done when the preferred analytic alternative has been identified?” [Political scientist Graham] Allison estimated that, in the normal case, it was about 10 percent, leaving the remaining 90 percent in the realm of implementation. (p. 605)

That is, ninety percent of the process of policymaking is implementation. This theory does not just apply to public policy. Consider healthcare: a revolutionary drug makes no difference for patients if a hospital does not allocate funding to purchase it and establish protocols for how and by whom it is administered. In other words, advances are worthless if they are not effectively enacted. This paper aims to analyze the actual enactment of ICU Liberation to identify how its success can be replicated elsewhere in the medical field.

What Is ICU Liberation?

Origins and Background

To an unfamiliar reader, the term “ICU Liberation” likely makes little sense. Even for many healthcare professionals, it remains an unfamiliar concept—the ICU Liberation initiative is less than a decade old. In 2013, the Society for Critical Care Medicine (SCCM) launched the ICU Liberation Collaborative, which aimed to free or “liberate” intensive care patients from the long-term degenerative effects of treatment in

the ICU. Collectively referred to as “PostIntensive Care Syndrome” (PICS), these effects are abbreviated with the term “PADIS,” which stands for pain, agitation, delirium, immobility, and sleep disruption (“About ICU Liberation,” n.d., par. 2-3). The ICU Liberation Collaborative established six guidelines to reduce the impact of PICS on ICU patients. Another term for ICU Liberation is the ABCDEF Bundle, as the six guidelines are laid out alphabetically by their initials. The ABCDEF Bundle (ICU Liberation) consists of the following elements:

- A. Assess, Prevent, and Manage Pain
- B. Both Spontaneous Awakening Trials (SATs) and Spontaneous Breathing Trials (SBTs)
- C. Choice of Analgesia or Sedation
- D. Delirium: Assess, Prevent, and Manage
- E. Early Mobility and Exercise
- F. Family Engagement and Empowerment (“ICU Liberation Bundle A-F,” n.d., par. 4).

Medical Rationale for ICU Innovation

Singer (2019) highlights the importance of focusing on the way ICU patients are treated in addition to treating their illness itself: “The consistent decrease [in] in-hospital mortality achieved over the past years has yielded a threefold increase in ICU survivors with PICS requiring rehabilitation for decreased functional status” (p. 1).

True to its name, the intensive nature of care in the ICU takes a significant toll on patients who are already critically ill. Mechanical ventilation, long-term sedation, and catabolism often wreak havoc on patients’ bodies even after their survival and discharge from the hospital. Examples of commonplace ICU treatments that disrupt post-ICU recovery abound:

- Mechanical ventilation with an endotracheal tube detrimentally impacts nutrition. In this circumstance, patients can only be nourished with fluids, which are usually delivered through a nasogastric tube. One study found that in most ICUs, it takes a week for a given patient to reach a 1,500 kcal intake—the average daily suggestion for normal caloric intake is around 2,000 kcal per day (Singer, 2019, p. 2). As a result, ICU patients are uniquely vulnerable to malnutrition and catabolism.
- Even after extubation, up to sixty percent of post-ICU patients experience dysphagia (difficulty swallowing) that also undermines their ability to regain energy, muscle volume, and mobility (Singer, 2019, p. 3).
- Prolonged sedation impacts brain function, and the isolation many patients experience in the ICU exacerbates that neurological and mental toll (Fernandez-Gonzalo et al., p. 115).

The combination of these and many other factors create a perfect storm for ICU patients, “leading to decreased energy, micronutrient, and protein intake, as well as increased rates of pneumonia, reintubation, and mortality” (Singer, 2019, p. 3). These issues also call attention to the need for nutritional follow-up after patients return home. Still, the detrimental impact of long-term traditional ICU treatment—and the need for innovation to reduce harm to patients— is undeniable.

Proliferation of ICU Liberation

ICU Liberation seeks to both free patients from these life-altering long-term effects and facilitate interprofessional communications among caregivers (“About ICU Liberation, n.d., par. 12). As previously mentioned, the first national effort to attempt the ABCDEF Bundle was the ICU Liberation Collaborative, which was organized by SCCM and sponsored by the Gordon and Betty Moore Foundation. This collaboration included 76 hospitals—67 adult and 9 pediatric institutions (Ely, 2017, p. 1). The pioneers of this initiative understood that, like every other ward, every ICU patient is different and dynamic. Ely (2017) explains, “ICU Liberation is not a static construct or cook-book medicine or a set of protocols to be rigidly

applied” ... “The idea in ICU Liberation is to generate a framework that is updated in real-time as new data emerge, adapted to individual, institutional preferences and needs and implemented globally” (p. 4). Like any innovation, ICU Liberation is built on consistency, communication, and continuous improvement. The investment has paid off. As such, it is worth the attention of caregivers and administrators alike. Balas et al. (2019) observe:

ABCDEF Bundle implementation often requires ICUs to fundamentally transform practice and patient care in a number of ways. This Bundle requires effective interprofessional team communication, collaboration, and care coordination among all ICU team members; engagement with ICU patients and families to appropriately prioritize patient care goals; and use of data to drive decision-making and care processes. Once ICUs have undergone this transformation, the hierarchical and siloed approach to ICU patient care that has been standard practice for decades often dissipates. (p. 55)

Indeed, hospitals that effectively implement one of the most significant overhauls to ICU practice ever attempted will have lessons to share with the medical community, where innovation remains difficult.

Organizational Characteristics of ICU-Liberating Hospitals

The ICU focuses on treating patients clinging to life; it is inherently dynamic and volatile. As such, the intensive care unit is one of the most difficult wards in a hospital to enact significant innovations, especially as they relate to patient care. ICU Liberation is a drastic change in scope and impact, as it is a long series of adaptations that usually takes the effort of an entire hospital and months, if not years, to implement. Multiple studies (Balas, Barnes-Daly, Barr, Pun, and others) have been conducted to evaluate hospitals that have participated in the ICU Liberation Collaborative since its inception. Organizational change is a thoroughly researched aspect of leadership. The businesses that last the longest and the leaders that succeed the most are astute in the behaviors of problem-solving and innovation. It may be argued that four key elements are needed to facilitate innovation in a hospital.

Innovation Behavior Element 1: Persistence

Winston Churchill is credited with coining the phrase, “Perfection is the enemy of progress.” Despite this, results-driven leaders often face the temptation to pursue perfection and consider anything less than that to be missing the mark. This all-or-nothing approach makes statistical sense on paper, but it does not often prove effective in practice. At a large healthcare system in the southeastern United States (unspecified by the author), Gabbard (2021) details that an all-or-nothing approach failed to maximize ICU Liberation's benefits. Originally, for any unit in this system to receive credit for compliance with the ABCDEF Bundle, every component of every element had to be accomplished. For example, if a patient had seven chances for an SAT assessment, all seven assessments must be completed and documented for credit to be granted. Any misstep resulted in zero credit for that element. Naturally, compliance scores and the team's morale were very low. The entire healthcare system then shifted to an opportunity-for-success approach, which focused on what was done correctly and celebrated each achievement while pursuing continuous improvement (paras. 13–15).

This anecdote is reflected in multiple other instances, each pointing to the benefit of prioritizing persistence over perfection. It bears repeating that ICU Liberation—and arguably most new approaches to patient care—is a significant and challenging change. No hospital will hit every mark, especially at the beginning. The hospitals that have demonstrated the greatest success in implementing the ABCDEF Bundle and generate the most buy-in from their team are those that focus on continuous improvement—persistence over perfection.

Innovation Behavior Element 2: Organization

Just as buildings require blueprints, Broadway plays involve rehearsals, and major public events are planned months in advance, institutional innovation requires careful planning and execution. This is also true in the

case of ICU Liberation. Barr et al. (2020) studied ABCDEF Bundle implementation in the State of Michigan and investigated, among other things, the execution that characterized each participating hospital's efforts (p. 1). The study surveyed staff from all seventy-two hospitals with adult ICUs in the state. Michigan was selected as the state of interest because of its hospitals' uniquely successful history of transforming clinical evidence into practice. More than fifty of the studied hospitals have enacted ICU Liberation to some degree. None have reached full Bundle compliance—in fact, most elements are engaged by fewer than half of the participating hospitals. The highest level of compliance is found in Michigan ICUs' implementation of element B (Both SATs and SBTs): sixty percent of the hospitals have fulfilled this component. Only thirty-six percent have implemented element A (pp. 5–6).

While these statistics may sound underwhelming, they, in fact, highlight why organization is necessary for successful innovation. For each hospital that enacted any part of the ABCDEF Bundle, overall patient outcomes (survival rates, length of stay, and readmission rates) improved. Specifically, every ten percent increase in Bundle compliance improved survival and freedom from delirium by fifteen percent (Pun et al., p. 9). This also reinforces the benefit of persistence, as mentioned in the previous point. Furthermore, each of these high-performing ICUs shared other practical tools that they have utilized. These include goals-of-care checklists to facilitate team communication and patient care, electronic health records (EHR) use, and standardized procedures that every caregiver knows how to follow. Each of these tools was significantly associated with Bundle implementation. In other words, when caregiving staff are united in setting goals for each patient's care, monitoring that care, and delivering it consistently and approved, any innovation becomes easier to execute.

It is important to note that the sequence of these actions is not interchangeable. That is, establishing goals and processes must precede any innovation being attempted. In this case, each ICU team knew how they wanted to leverage each element of the Bundle to their patients' benefit before attempting it.

Innovation Behavior Element 3: Communication

Barr et al. (2020) further emphasize organizational characteristics that influenced Bundle compliance in Michigan ICUs. First, daily conduction of interprofessional team (IPT) rounds that included at least a physician, nurse, pharmacist, and respiratory therapist bore a strong association with Bundle implementation—73 percent of hospitals implementing element A conduct IPT rounds daily, as opposed to only 27 percent rounding less often (p. 6). This is a crucial mechanism for ensuring sufficient communication. IPT rounds involve staff that affect multiple aspects of a patient's care; additional perspectives naturally aid a team's ability to determine how to apply each Bundle element to their unique patient. Still, effective Bundle implementation (as well as any other change in approach to patient care) also requires ongoing communication outside IPT rounds (pp. 5–6).

The second organizational characteristic related to communication closely follows: hospitals and ICUs classified as a collaborative work environment (CWE) were also more likely to implement any part of ICU Liberation. CWE was measured to include the traits of staff accessibility, trust, value, and leadership. As summarized by Barr et al. (2020):

ICU team members who value one another, who are accessible to each other, and who can predict each other's behavior are more likely to collaborate and perform Bundle elements in a correct and timely fashion, suggesting that team member communication and care coordination around the Bundle is critical. (p. 8)

No aspect of a hospital's operations is as dynamic as patient care. One action (or inaction), drug dose, or treatment can considerably influence a patient's prognosis. Any time a hospital seeks to implement a quality improvement initiative to better patient outcomes, it must ensure that every care team member is “on the same page,” communicating and working together.

Innovation Behavior Element 4: Culture

The presence of a culture of safety was yet another major influence on Bundle execution in the Barr et al. study. Each of the previously mentioned characteristics combined to impact culture. This makes logical sense: a hospital without standard procedures for patient care, communication, or interaction between caregivers will be riddled with medical errors and preventable deaths. The Hippocratic principle of “First, do no harm” speaks to the truth that safety should be the highest priority for any hospital. Stronger cultures of safety lead to greater trust in leaders, fewer errors, and both lower fall and mortality rates (Barr, et al., 2020, p. 7). Ultimately, “a strong safety culture may help to align bundle implementation efforts around the overarching goals of improving patient safety and reducing harm in the ICU” (p. 7).

This element also goes hand-in-hand with the pursuit of persistence over perfection. Caregivers and their teams will be burned out if their superiors mark them off for every misstep. While there is no room for compromise with regard to patient safety, healthcare leaders will generate more buy-in if their teams are assured that every win will be celebrated rather than overshadowed by missing a point in an elective initiative such as ICU Liberation. Appropriate and focused staffing, employee recognition, and constructive coaching will substantially help cultivate morale and a more positive culture among caregiving teams.

Challenges in Implementing Meaningful Change

Any time a hospital seeks to implement a change in its approach to patient care, it is sure to encounter practical questions rooted in the medical consequences of a change. Many of the authors cited in this thesis (including, among others, Balas, Pun, Devlin, Barr, Barnes-Daly, and Ely), collaborated on a short piece (Balas et al., 2019) to address seven concerns frequently voiced about the ABCDEF Bundle by ICU staff around America. Six of the seven points addressed were directly related to the medical aspects of ICU Liberation (as opposed to logistical or organizational issues). Examples of these concerns include:

- How can sedation assessments be minimized at night to maintain healthy sleep/wake cycles?
- How quickly should physical activity be attempted for critically ill patients?
- What kind of physical activity is acceptable for “critical” illness? (Balas et al., 2019, p. 7)

This reinforces a key lesson: every innovation in patient care will and ought to be challenged with medically relevant questions. The authors, in this case, answered every concern with clinically sound advice. This also raises another pressing question: how can hospital leaders prepare to handle challenges to significant innovations? Three observations may be made in response:

Observation 1: Executive and leadership involvement is critical

It is the responsibility of a hospital’s leaders to stay abreast of every significant event that occurs within their institution. While it is not necessarily crucial that every executive sign off on minor changes, such as the frequency of rounding between patients or the number of staff on the schedule, they should be aware and engaged with changes in structure or approach to patient care.

Engagement and support.

Many hospital administrators are not medical professionals. In many ways, this is an asset since hospitals largely function as businesses and need leaders who are trained accordingly. However, ICU Liberation demonstrates the necessity for even non-caregiving executives to have at least a cursory understanding of the science behind the policy change. Ely (2017) summarizes this idea: “ICU Liberation is not a situation where one set of people think they know better than others—excellent quality improvement engages all members of an interprofessional team” (p. 4). Administrators ought to engage and collaborate with caregivers when beneficial ideas are presented. Ignorance of the medical aspects of a hospital’s operations and advancements can blind leaders to potential logistical and legal disasters. Executives and caregivers work on the same team; as such, they should support each other in pursuing what is right for the patient.

Alignment of divisional goals with organizational goals.

Hospital leaders also bear the responsibility of framing the mission and vision of their organization. The mission establishes why a hospital exists and the goals it pursues every day; the vision directs how the hospital and its employees will accomplish that mission from a practical standpoint. Those tasked with implementing innovations should align the goals of their division and the goals of the changes being made with the organization's overall mission. Every staff member in an organization will be more likely to subscribe to a new change if they know why it is done in light of their company's purpose. Simon Sinek (2009) captured this idea in one of the most famous TED Talks of all time when he established the mantra that “people don't buy what you do; people buy why you do it” (par. 5).

The responsibility of crafting and aligning a vision with organizational goals falls on hospital leaders, as “senior executives can help outline, create, and implement a vision for spreading the project throughout the organization” (Balas et al., 2019, p. 6). Any change to patient care ought to prioritize safety and outcomes. This has happened in the hospitals where ICU Liberation was implemented, eased the change for executives and caregivers alike.

Understanding the business case for change.

Better patient outcomes in any case are positively correlated with shorter hospital stays and fewer resources consumed for each patient (Rojas-Garcia et al., p. 53). Put simply, stronger outcomes equal lower costs. Granted, in the short term, major organizational changes such as ICU Liberation are costly due to the significant expenditure of labor and capital to implement it. However, long-term demand of hospitals and their ICUs will continue to increase, given the United States' prevalence of degenerative diseases and aging population—the number of Americans age 65 and over is projected to double by 2060 (Haseltine, par. 3). Revenue generated by this heightened demand and usage will likely lead to a positive return on the investment made in ICU Liberation. This is demonstrated retrospectively by the known harms delirium, and PADIS overall inflict on a patient. Koftis et al. (2020) explain: “Evidence indicates that delirium is not only a robust prognostic indicator of worse survival immediately, but also of the cost of care and quality of survival” (p. 5). A prospective study by Lord et al. (2013) further demonstrates that early ICU rehabilitation programs—that is, ICU programs that seek to restore patients' activity and mobility actively—are likely to generate net financial savings over time (p. 1).

ICU Liberation is known to improve patient outcomes and will very likely generate monetary savings. Barr (par. 22) indicated that at one of the nation's leading Veterans Affairs hospitals, the reduction in ICU and hospital length of stay generated six million dollars in annual savings. Executives and hospital leaders ought to understand the business case for this change just as much as the medical case. This understanding will ensure stronger support and much-needed engagement from healthcare leadership.

Observation 2: Recognition of the human aspect is powerful

The issue of organizational culture and buy-in among caregivers has been mentioned previously, and it remains the single most significant influence on the successful implementation of any advancement. The reason is simple: if a team does not want or appreciate the reasons for a change, no one will feel any urgency to implement it, even if it is good and necessary. Statistics and facts are important, but innovators must be careful not to lose themselves in the data and forget that human lives are at stake.

A notable trait found in hospitals that have implemented ICU Liberation is the use of “storytelling.” This is a strategy meant to generate support among caregivers based on the impact that the ABCDEF Bundle can have on patients and their families. As the name suggests, this approach is beneficial because stories are often more persuasive than facts and statistics. As explained by Balas et al. (2019):

Patients, ICU survivors, and their families should be encouraged to talk to ICU staff and health care executives about their Bundle-related ICU experiences, both negative (e.g., memories of significant

pain or delirium) and positive (e.g., the importance of having family members at the bedside; family members' ability to contribute to their loved one's care; the joy and hope family members experienced seeing their loved one awake, extubated, and walking again). Such stories can help to change hearts and minds much more effectively than Bundle statistics. Videotaped stories of ICU survivors and their families can be shared (with permission) to help educate staff and health care executives about the impact of the ABCDEF Bundle on patients, both during their hospitalization and after their discharge. (p. 56)

Certainly, no hospital can rely solely on testimonials and emotional appeals to make decisions. Nevertheless, it is vital to recognize patients for their humanity and appreciate the long-term impact of innovations in patient care. These firsthand accounts of patients' experiences can also help engage hospital leaders whose support is necessary to enact any major change. No line of work influences lives like healthcare, and any changes from the status quo must be made with caution. However, ICU Liberation sets a precedent that innovation is possible and should be pursued for the sake of patients' lives.

Observation 3: Flexibility in unforeseen circumstances is essential

It would be a mistake not to consider the events of the last eighteen months when discussing major changes in healthcare. To be sure, the SARS-CoV-2 (COVID-19) virus has affected nearly every aspect of life on Earth, but still none more so than healthcare. A global pandemic is arguably the most difficult time to attempt new approaches to patient care, yet a plague is ironically the season where creative thinking is most needed. COVID-19 has hospitalized millions around the world and placed overwhelming strain on caregivers, especially in intensive care. Recall that a major element of ICU Liberation—Element B— involves exercising the respiratory system through both SATs and SBTs. The virus attacks the respiratory system first and above all else. Furthermore, early research has suggested that some ninety percent of COVID-19 patients in the ICU require mechanical ventilation, nearly half of whom need endotracheal intubation—the most invasive method (Koftis et al., 2020, p. 2). Additionally, other virus-related protocols, including distancing, no-visitation policies, and caregivers dressed in full personal protective equipment, make full Bundle implementation extremely difficult yet increase the risk of PADIS exponentially. In other words, full implementation of ICU Liberation is more challenging now than ever before.

COVID-19's worsening of PADIS in the ICU also finds its roots in the physiology of the disease. The virus invades the central nervous system and, at its worst, destroys the respiratory tract (Koftis et al., 2020, p. 5). It is obvious why mechanical ventilation is often needed; still, the effects of deep sedation, long-term ventilation, and isolation create a “delirium factory” and follow patients home well after discharge, whether they were COVID-19 patients or not. Nonetheless, creative solutions may be sought to alleviate the degenerative effects of long-term hospitalization. For example, SATs and SBTs are not possible during paralysis in prone (positioned lying on their stomach) patients. A possible solution proposed by Koftis et al. (2020) is frequent monitoring and reduction of neuromuscular blocking drugs (NMBDs) whenever possible to reduce paralysis. SATs and SBTs may be resumed as much as possible (p. 6). Additionally, delirium screening using established protocols and adjustment of sedation based on ventilation needs may also be employed.

Scenarios like the current pandemic again prove the importance of seeking persistence over perfection. ICU Liberation is certainly not the only system or innovation that has been disrupted by the virus. Knowing this, it is not necessary to fully implement every step of a new protocol to consider it a success. It is believed that even partial application of the ABCDEF Bundle can reduce delirium in mechanically ventilated patients by up to fifty percent (Koftis et al., p. 5). Moreover, for every ten percent increase in ABCDEF compliance, patients enjoy a fifteen percent increase in both survival and days free from coma and delirium.

There will never be a perfect time to innovate in healthcare. Adhering to established practices is safe and familiar, but at what cost? In a season when demand for healthcare and ICU space is at an all-time high,

physicians and researchers would be remiss not to think outside of the box, to either expand on the ideas put forth through ICU Liberation, or to pursue other changes to improve patient care. Indeed, lives and livelihoods depend on it.

Lessons Learned

Innovations that show promise and have a positive impact on patient outcomes are worth research, consideration, and attempt. Many articles and books have been published about organizational innovation (Alharbi et al., p. 1197), each claiming to have the secret key to cultivating meaningful change in one's team. Rather than relying on speculative and abstract principles, it is prudent to look at what previous innovators have done—what has worked and what has not. In the case of ICU Liberation, several organizational and behavioral characteristics have been observed. Up to this point, though, most of these traits have been abstract. What do characteristics like organization and communication look like in the real world? In a study of the original ICU Liberation Collaborative, Barnes-Daly et al. (2018, p. 213) explore several tangible implementation strategies related to these categories. For example, to promote greater organization, hospitals utilized auditing and feedback mechanisms to monitor both process and clinical outcomes. As previously mentioned, communication efforts involved interprofessional teams, led by a champion from each discipline (physicians, nurses, respiratory therapists, et cetera) to mentor others involved in implementation efforts. Frequent coaching calls and meetings were also utilized to ensure consistency and understanding for everyone involved.

These actions need not be unique to the ABCDEF Bundle. Part of the resistance to changing the status quo is based on the difficulty of uniting healthcare teams around that change. As physicians and hospital leaders evaluate possible changes to intensive care, emergency room protocols, rounding procedures, or any other area, they must ensure their teams are engaged and coordinated. Humanization of care, such as through sharing patient and family stories attesting to the benefit of the proposed change, is a highly effective method for motivating teams (BarnesDaly et al., 2018, p. 213). Chains of command are also useful when various departments collaborate, with a champion from each unit who serves as both a leader and a liaison.

The successful implementation of ICU Liberation demonstrates the importance of fundamentals like consistency, communication, and neatness, which are essential characteristics that ought to be displayed by HCOs around the clock. Innovation requires special attention to the medical impacts that changes have on a patient. From a logistical standpoint, though, the hospitals that engage their entire staff from the top down, consistently communicate and hold each other accountable for their success are far more likely to enjoy the greatest benefit of ICU Liberation or any other change they wish to adopt.

Significance and Contribution of this Thesis to Future Innovation

Strain continues to increase in the American healthcare system, with patient demand increasing faster than the number of caregivers available to meet the need. Even without the COVID-19 pandemic, unhealthy lifestyles are prevalent among an aging population. The understaffing faced by many hospitals and ICUs increases the risk for medical errors, delayed treatment, and poor patient outcomes, which in turn drive up the cost of care. This combination of challenges means that innovation is more important in healthcare now than ever before. ICU Liberation is one proven example of a change that challenges the traditional school of thought related to intensive care and does so in a way that reduces the degenerative effects of mainstream ICU treatments.

Innovations and other changes to the status quo often occur slowly, and in many cases, this is good and even important. Premature application of changes to patient care, especially in the areas of drug therapy and other clinical treatments, can either fail to work as intended or even inflict adverse effects on patients (Bates, Sheikh, & Asch, 2017, p. 400). In some cases, however, change is much more difficult to implement than it should be. Physicians, nurses, and healthcare administrators across America can attest to this reality. Bates, Sheikh, and Asch (2017) observe:

In most industries, competition from start-ups can move complacent firms toward innovation. In health care, it is far harder for start-ups to supplant successful firms because of health care's enormous capital and regulatory requirements. Because of these barriers to entry, change usually has to come from within. (p. 401)

Nothing in this paper is meant to suggest that every hospital should independently search for their own unique answers to healthcare's complex problems. Such an approach would be expensive and time-consuming and would result in different standards of care at each hospital. Rather, hospitals ought to leverage all their resources, including research and discoveries made by fellow healthcare institutions, as well as the intelligence of their immediate team. This approach is precisely how ICU Liberation began: recall that the ICU Liberation Collaborative pioneered the ABCDEF Bundle with more than seventy hospitals around the United States.

Two main takeaways may be drawn from this paper, one general and one specific. As previously mentioned, little if any research has been dedicated to the actual process of implementing ICU Liberation. Almost all study of the Bundle has been dedicated to the clinical process of it and how it has benefited patient care. It should be remembered that to benefit patient care, ICU Liberation first had to be enacted effectively, so it is worth the time to determine what caregivers did to ensure the smoothest implementation possible. The processes each hospital followed should serve as a measuring rod for other hospitals and areas of medicine, wondering how best to enact changes and innovations.

More specifically, for any hospital that has not yet evaluated implementing the ABCDEF Bundle for its ICU, it would be wise to consider it. Prior to their study, Pun et al. (2019) recognized that "clinical reproducibility in medical research is often poor" (p. 9), and for hospitals to have confidence in ICU Liberation, there would need to be clear evidence of its direct impact on patient care (in essence, a dose-response relationship). Their study of more than 15,000 adults across sixty-eight ICUs demonstrated an obvious impact on patient outcomes. "Patients who received more of the ABCDEF Bundle elements each day had a large and significantly improved likelihood of surviving; having less coma, delirium, and physical restraint; being liberated from ventilation; avoiding ICU readmission; and being discharged home" (Pun et al., 2019, p. 8). This proved to be true even if a given ICU only implemented a portion of the Bundle—full compliance with all elements A-F is unnecessary to benefit patient care.

Another study of over 6,000 patients (Barnes-Daly, Phillips, & Ely, 2017, p. 1) further proved the benefit of even partial Bundle compliance: for every ten percent increase in total compliance, patient outcomes improved by seven percent. Further, outcomes improved by fifteen percent for every ten percent increase in partial compliance. Hospitals seeking to think outside the box ought to start with ICU Liberation: it is not an easy innovation, but it has a proven record of success that allows newly innovating hospitals to follow in the footsteps of those that have already implemented the Bundle.

Conclusion

In the healthcare system, innovation should not occur in a vacuum. It is said that hindsight is 20/20, and hospitals should learn from the progress made nationwide. The ICU Liberation Collaborative and the subsequent wave of participating institutions set a strong example of the essential actions and traits a hospital must possess to enact changes to patient care. A unique attribute of this paper is that it did not deeply explore the specific medicine behind innovation in patient care. For the purposes of the paper, the author assumes that any alterations a hospital may be considering are already proven to benefit the quality of care and patient outcomes. Rather, this paper targeted the administrative and logistical behaviors necessary to execute change while maintaining a team's morale.

The intensive care unit is dynamic and highly reliant on established protocols. This aspect of the ICU is one reason why, to this day, a relatively small number of hospitals adhere to the ABCDEF Bundle. In a 2017 global survey of 1,521 critical care physicians, just over half reported implementing any portion of the Bundle (Morandi et al., p. 6), and compliance was very loosely defined in this study. Still, patients of those hospitals following the Bundle or any element of it enjoy higher survival rates, reduced incidence of PADIS, and reduced readmission rates. If a ward as volatile as the ICU can successfully roll out a change beneficial to patients, other units and hospitals should draw inspiration. ICU Liberation demonstrates that implementation is arguably even more important than the policy itself. Further, it shows the necessity of persistence, organization, communication, and culture in the pursuit of change.

All caregivers should constantly ask themselves, “How can we keep improving the way we treat our patients?” One strong answer is to start in the ICU, where change is most difficult but where patients deserve the most focused attention on their well-being. From there, healthcare teams may turn their attention to the needs of patients throughout the hospital. Innovation is possible and necessary; when intentionally pursued, lives will be saved, and patients’ futures will be brighter.

References

- “About ICU Liberation.” (n.d.). Retrieved from <https://www.sccm.org/ClinicalResources/ICULiberation-Home/About>
- Alharbi, I.B.A., Jamil, R., Mahmood, N.H.N., & Shaharoun, A.W. (2019). Organizational innovation: A review paper. *Open Journal of Business and Management*, 7(3): 1196- 1206. <https://doi.org/10.4236/ojbm.2019.73084>
- Balas, M.C., Pun, B.T., Pasero, C., Engel, H.J., Perme, C., Esbrook, C.L., ... Stollings, J.L. (2019, February 15). Common challenges to effective ABCDEF Bundle implementation: The ICU Liberation campaign experience. *Critical Care Nurse*, 39(1): 46-61. <https://doi.org/10.4037/ccn2019927>
- Barnes-Daly, M.A., Phillips, G., & Ely, E.W. (2017). Improving hospital survival and reducing brain dysfunction at seven California community hospitals: Implementing PAD guidelines via the ABCDEF Bundle in 6,064 patients. *Crit Care Med*, 45(2): 171-178. <https://doi.org/10.1097/CCM.0000000000002149>
- Barnes-Daly, M.A., Pun, B.T., Harmon, L.A., Byrum, D.G., Kumar, V.K., Devlin, J.W., ... Balas, M.C. (2018). Improving health care for critically ill patients using an evidencebased collaborative approach to ABCDEF Bundle dissemination and implementation. *Worldviews Evid Based Nurs.*, 15(3): 206-216. <https://doi.org/10.1111/wvn.12290>
- Barr, J. (2019, November 25). How ICU Liberation brought value to our patients, team members, and administrators. Retrieved from <https://www.sccm.org/Blog/November-2019/HowICU-Liberation-Brought-Value-to-Our-Patients>
- Barr, J., Ghaferi, A.A., Costa, D.K., Hedlin, H.K., Ding, V.Y., Ross, C., ... Asch, S.M. (2020). Organizational characteristics associated with ICU Liberation (ABCDEF) Bundle implementation by adult ICUs in Michigan. *Crit Care Explor*, 2(8): 1-10. <https://doi.org/10.1097/CCE.0000000000000169>
- Bates, D.W., Sheikh, A., & Asch, D.A. (2017). Innovative environments in health care: Where and how new approaches to care are succeeding. *Health Affairs*, 36(3): 400-407. <https://doi.org/10.1377/hlthaff.2016.1311>

- Daniel, M. (2016, May 3). Study Suggests medical errors now third leading cause of death in the U.S. Retrieved from https://www.hopkinsmedicine.org/news/media/releases/study_suggests_medical_errors_now_third_leading_cause_of_death_in_the_us
- Elmore, R.F. (1980). Backward mapping: Implementation research and policy decisions. *Political Science Quarterly*, 94(4): 601-616. <https://doi.org/10.2307/2149628>
- Ely, E.W. (2017). The ABCDEF Bundle: Science and philosophy of how ICU Liberation serves patients and families. *Crit Care Med*, 45(2): 1-19. <https://doi.org/10.1097/CCM.0000000000002175>
- Fernandez-Gonzalo, S., Turon, M., De Haro, C., Lopez-Aguilar, J., Jodar, M., & Blanch L. (2017). Do sedation and analgesia contribute to long-term cognitive dysfunction in critical care survivors? *Medicina Intensiva*, 42(2): 114-128. <https://doi.org/10.1016/j.medine.2017.06.011>
- Gabbard, E. (2021, March 8). Achieving buy-in for the ICU Liberation campaign. Retrieved from <https://www.sccm.org/Blog/February-2021/ICU-Liberation-Administrators-andThird-Party-Pay>
- Gupta, D.M., Boland, R.J., & Aron, D.C. (2017). The physician's experience of changing clinical practice: A struggle to unlearn. *Implementation Science*, 12(28): 1-11. <https://doi.org/10.1186/s13012-017-0555-2>
- Haseltine, W. (2018, April 2). Aging populations will challenge healthcare systems all over the world. Retrieved from <https://www.forbes.com/sites/williamhaseltine/2018/04/02/agingpopulations-will-challenge-healthcare-systems-all-over-the-world/?sh=1ed8563a2cc3>
- "ICU Liberation Bundle A-F." (n.d.). Retrieved from <https://www.sccm.org/ClinicalResources/ICULiberation-Home/ABCDEF-Bundles>
- Koftis, K., Roberson, S.W., Wilson, J.E., Dabrowski, W., Pun, B.T., & Ely, E.W. (2020). COVID-19: ICU delirium management during SARS-CoV-2 pandemic. *Critical Care*, 24(176): 1-9. <https://doi.org/10.1186/s13054-020-02882-x>
- Lord, R.K., Mayhew, C.R., Korupolu, R., Manthey, E.C., Friedman, M.A., Palmer, J.B., & Needham, D.M. (2013). ICU early physical rehabilitation programs: financial modeling of cost savings. *Crit Care Med*, 41(3): 717-724. <https://doi.org/10.1097/CCM.0b013e3182711de2>
- Morandi, A., Piva, S., Ely, E.W., Myatra, S.N., Salluh, J.I.F., Amare, D., ... Latronico, N. (2017). Worldwide ABCDEF (Assessing pain, Both spontaneous awakening and breathing trials, Choice of drugs, Delirium monitoring/management, Early exercise/mobility, and Family empowerment) survey. *Critical Care Medicine*, 45(11): 1- 23. <https://doi.org/10.1097/CCM.0000000000002640>
- "Patient Safety." (13 September 2019). Retrieved from <https://www.who.int/news-room/factsheets/detail/patient-safety>
- Pun, B.T., Balas, M.C., Barnes-Daly, M.A., Thompson, J.L., Aldrich, J.M., Barr, J., ... Ely, E.W. (2019). Caring for critically ill patients with the ABCDEF Bundle: Results of the ICU Liberation Collaborative in over 15,000 adults. *Crit Care Med*, 47(1): 1-22. <https://doi.org/10.1097/CCM.0000000000003482>

- Rangachari, P. (2018, March 13). Innovation implementation in the context of hospital QI: Lessons learned and strategies for success. *Innov Entrep Health*, 5, 1-14.
<https://doi.org/10.2147/IEH.S151040>
- Rojas-Garcia, A., Turner, S., Pizzo, E., Hudson, E., Thomas, J., & Raine, R. (2017). Impact and experiences of delayed discharge: A mixed-studies systematic review. *Health Expectations*, 21(1): 41-56. <https://doi.org/10.1111/hex.12619>
- Sinek, S. (2009). How great leaders inspire action. Retrieved from
https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action?language=en
- Singer, P. (2019). Preserving the quality of life: Nutrition in the ICU. *Critical Care*, 23(139): 1- 5.
<https://doi.org/10.1186/s13054-019-2415-8>

State-Mandated Staffing Ratios in Nursing

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Introduction

In recent years, nurses have been placed under increasingly more stress due to several issues that are out of their control. One issue is being asked to take on an increased number of patients. One study found that each additional patient assigned to a nurse decreased the likelihood of patients receiving excellent quality care by 22%, and a 33% increased probability of a longer stay (Driscoll et al., 2018). Aiken et al., as early as 2002, reported from their study that “each patient added to nurses’ existing workloads was associated with a 7 percent increase in mortality following common surgeries, and there was also a significant increase in nurse burnout and job dissatisfaction, precursors of voluntary turnover, as nurses’ workloads increased.” Implementing state-mandated nurse staffing ratios has been proposed as a solution to additional patient workload assignments placed on nurses. While there is mounting evidence that increased patient workload impacts patient care negatively, only one state has implemented such a mandate. The purpose of this paper is to explore the literature on this topic and provide insight into the advantages, disadvantages, and barriers to implementation.

State Mandated Nurse Staffing Ratios

State mandates on nurse staffing ratios are laws/legislation that identify the maximum number of patients assigned to one nurse depending on the type of unit the nurse is assigned. The legislation to establish minimum staffing levels for licensed nurses was passed in 1999. However, the law did not go into effect until 2004 (Spetz, 2008). According to McHugh et al. (as cited in Han et al., 2021)

“California is the only state that has mandated minimum staffing ratios for licensed nurses [RNs plus licensed practical/vocational nurses (LPNs)] in all hospital units (e.g., critical care unit, general care unit, emergency department, transitional inpatient care unit), and the ratios are set specifically by type of patient care unit to reflect patient acuity. The law allows hospitals in areas with low RN staffing to hire LPNs who provide basic nursing care and work under the supervision of RNs; 50% of the nurses can be LPNs for compliance with the law” (p. S463).

Since implementing the mandate, California hospitals have seen a substantial increase in the number of registered nurses working in hospitals (Aiken et al, 2010). “A higher level of nursing staff indicates more nurses (or a higher proportion of nurses) for assigned patients. Lower nurse staffing is defined as fewer nurses (or lower proportion) for the number of assigned patients” (Driscoll, 2018, p. 7). Aiken and Sermeus argue that “hospitals with excellent work environments and nurse staffing had improved outcomes for patients and nurses alike” (2012, p.4). Because California is the only state that has passed legislation regarding staffing ratios, it is often used as a model to show the effectiveness of this type of legislation in determining if it would be beneficial if implemented in other states.

Alternatives to State-Mandated Nurse Staffing Ratios

While California is the only state to have implemented a mandatory nurse-to-patient ratio, other states have implemented alternative mechanisms/regulations. Oregon, Ohio, Washington, Texas, Connecticut, Nevada,

and Illinois have Staffing Committees, and Public Reporting is present in New Jersey, Rhode Island, Vermont, Illinois, and New York (Han et al., 2021). The staffing committee approach differs from the staffing mandate by requiring that direct patient care registered nurses create a staffing plan based on the skill mix associated with available nurses and patient needs. This approach considers that not all hospital settings are the same, unlike the staffing mandate approach, by examining skill mix and patient needs (Han et al., 2021). The public reporting approach to nurse staffing is described by Faber et al. (2009, as cited in Han et al. 2012). as providing “transparency to the public, which, in theory, allows consumers to choose higher staffed hospitals and puts market pressure on understaffed hospitals to improve their staffing ratios” (p. S465). In a study comparing the three types of staffing legislation, Han et al. did not find statistically significant evidence supporting staffing committees or public reporting compared to mandated ratios. The investigators recommended that further research be conducted on staffing alternatives. This study was limited due to inherent hospital differences (e.g., nurse involvement/power in decision-making). As of 2020, 14 states have introduced legislation regarding nurse staffing ratios (Han et al., 2021).

Advantages of State-Mandated Nurse Staffing Ratios

There are several advantages to implementing state-mandated nurse staffing ratios, including increased patient safety and increased nurse and patient satisfaction. When nurses are assigned too many patients, it places patients at higher risk for preventable medical errors, avoidable complications falls and injuries, pressure sores, increased length of stay, and readmissions (National Nurses United, n.d.). Kane et al. reported in 2007 that higher patient workloads had an independent and direct effect on quality of care, contributing to reduced patient safety, medical errors, patient falls, and unfinished nursing tasks. Research from the last few decades has overwhelmingly shown that safe staffing levels and ratios help improve patient outcomes associated with mortality, adverse events, complications, failure to rescue, failure to thrive, quality of care, costs, and length of stay (National Nurses United). For example, Shekelle, in a systematic review, states, “lower rates of hospital-acquired pneumonia, pulmonary failure, unplanned extubation, failure to rescue, and nosocomial bloodstream infections were related to higher RN staffing in pooled analyses of several studies” (2013, Benefits section, para 2). Throughout the literature reviewed, several studies showed a correlation between higher staffing levels of registered nurses and decreased hospital-related mortality. According to Driscoll et al. (2018), increased nurse staffing reduced in-hospital mortality by 14%. The staffing ratios affect patients and nurses not only from a medical perspective but also from a holistic standpoint. Aiken and Sermeus describe that “improved work environments and reduced ratios of patients to nurses were associated with increased care quality and patient satisfaction” (2012, Abstract Results section). It therefore seems reasonable to surmise that investing in more nurse staffing will lead to better and safer patient care, as well as a more positive work environment for nurses.

California: Before and After the State Mandate

Since the California legislature passed the nurse staffing mandate, there have been many positive outcomes, such as increased staffing, nurse job satisfaction, and patient satisfaction. When compared to the baseline staffing, hospitals that had low staffing prior to the state mandate showed an increase in RN and LPN staffing after the mandate (Han et al., 2020). Aiken et al. report, “most California nurses, bedside nurses as well as managers, believe the ratio legislation achieved its goals of reducing nurse workloads, improving recruitment and retention of nurses, and having a favorable impact on quality of care” (2010, p. 917). They also report that after the mandate was enacted there was a concurrent increase in nurse job satisfaction between 2004 and 2006. The conclusion reached by the researchers, from the comparison before and after the state mandate, is that the higher the rate of compliance with benchmark ratios, the lower the rate of burnout, job dissatisfaction, reporting a fair or poor work environment, not noticing changes in patient conditions, and rate of intentions to leave their jobs. Likewise, the more compliant a facility is with nurse-

to-patient ratios, the lower the rate of patient complaints, verbal abuse, and inadequate quality of care (Aiken et al.).

Disadvantages of Staffing Ratios

Much data has been collected since the time of the implementation of California's nurse staffing mandate. These data have been used to promote the implementation of a staffing mandate in other states. Many studies have used data from other states that do not have any staffing mandates to compare to California hospitals to determine if the state staffing mandate has been effective in promoting patient safety and decreasing nurse burnout. This leads researchers to question the research data. This has also produced hesitancy associated with implementing mandated staffing in other states. Causal inferences are called into question when it is possible that other factors could have influenced the data.

Although there is a significant amount of evidence suggesting an increase in the number of RNs is beneficial to patient safety, there is not a "one-size-fits-all" number on the ratio of patients to one nurse. Shekelle describes "lack of a published evaluation of an intentional change in RN staffing from some initial value (for example, 6 patients to 1 RN on general medical wards) to some lower patient–RN staffing value (such as 5:1 or 4:1) limits conclusions on increasing nurse staffing ratios as a patient safety strategy" (2013, Discussion section, para. 1). Another article mentions that "due to the heterogeneity between studies, particularly in nurse-to-patient ratios, no recommendation can be made regarding the optimal ratio required to improve patient outcomes" (Driscoll et al., 2018).

The California staffing mandate identifies RNs and LPNs and the staff that must meet the mandatory ratios, which may decrease the need for other assistive personnel. Shekelle (2013), reported in the systematic review that "some California nurses perceived that they had less support from the use of licensed vocational nurses, unlicensed personnel, and non-nursing support services (such as housekeeping and unit clerks) after implementation of the mandate" (Harms section, para. 1).

Many nurses understand the immense importance of other personnel, such as LPNs and nursing assistants, when faced with caring for a group of patients, which leads to the following question: What is the right mix of personnel for patient care staffing?

Feasibility/Barriers of Implementation

One of the most prominent arguments against state-mandated nurse staffing ratios is cost. Hospital administrators are concerned that employing more registered nurses will not be cost-effective. One article, titled *Patient Outcomes After the Introduction of Statewide Intensive Care Unit Nurse Staffing Regulations*, reported that "given the excess costs of enacting and enforcing state-wide legislation to implement acuity-guided ICU nurse staffing, future efforts to regulate patient-to-nurse ratios should carefully first consider the extent of the effects of the mandate on nurse staffing levels" (Law et al. 2018, Conclusion section). The research from this article was conducted in an ICU and found that for their particular care setting, "state-wide legislation to mandate nurse staffing strategies may not effectively improve patient outcomes" (Law et al, 2018, Conclusion section). This could be due to the already low ratio of patients per nurse in the intensive care unit setting because of the critical acuity of these patients. Employing more RNs to satisfy a mandate may also be cost-prohibitive for rural hospitals, and those with less funding when recruiting nurses and meeting salary requirements are problematic.

According to PricewaterhouseCoopers in the 2007 report, *What Works: Healing the Healthcare Staffing Shortage*, it costs between \$40,000–\$85,000 to replace a single nurse and adding 133,000 RNs to the U.S. hospital workforce—the number of RNs needed to increase nursing staff to the 75th percentile— would

produce medical savings of \$6.1 billion (about \$19 per person in the US). Therefore, adding more nurses to help promote adequate staffing can help save money. Along with these statistics, van den Heede et al. (as cited in Shekelle, 2013), reported that assuming an increased number of nurses will decrease the number of deaths by 5 per 1,000 elective hospitalizations, which translates into cost savings of \$35,000 per avoided death and \$3,500 per year of life gained. Rosenberg (2011) also stated that the possibility of improvements to patient care would outweigh the costs. The dilemma of increased cost associated with employing more nurses is best described by Buerhaus (as cited in Han et al., 2021), “the argument against staffing mandates centered on whether the benefits, in terms of quality outcomes, outweigh the costs of complying with the standards” (para. 5).

Conclusion

Numerous articles support the claim that improving nurse staffing allows for more desirable patient and nurse outcomes. Throughout this project, we were only able to find one article, *Patient Outcomes After the Introduction of Statewide Intensive Care Unit Nurse Staffing Regulations*, that differed from the majority and stated that decreased nurse-to-patient ratios do not significantly impact patient outcomes. Despite this one conflicting article, our search found several key pieces of data supporting the importance of mandating a safe nurse-to-patient ratio in acute care hospitals. We hope that this project report has been educational and informative regarding this very important topic. We hope that one day more states will follow California’s example to enact a mandated minimum nurse-to-patient staffing ratio.

References

- Aiken, L.H., Clarke, S. P., Sloan, D. M., Sochalski, J., & Silber, J. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association*, 288(16), 1987-1993.
- Aiken, L. H., & Sermeus, W. (2012). Patient safety, satisfaction, and quality of hospital care: Cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. *BMJ: British Medical Journal*, 344(7851), 20. doi:<https://doi.org/10.1136/bmj.e1717>
- Aiken, L. H., Sloane, D. M., Cimiotti, J. P., Clarke, S. P., Flynn, L., Seago, J. A., Spetz, J., & Smith, H. L. (2010). Implications of the California nurse staffing mandate for other states. *Health Services Research*, 45(4), 904–921. <https://doi.org/10.1111/j.1475-6773.2010.01114.x>
- Driscoll, A., Grant, M. J., Carroll, D., Dalton, S., Deaton, C., Jones, I., Lehwaldt, D., McKee, G., Munyombwe, T., & Astin, F. (2018). The effect of nurse-to-patient ratios on nurse-sensitive patient outcomes in acute specialist units: *A systematic review and meta-analysis. European journal of cardiovascular nursing: journal of the Working Group on Cardiovascular Nursing of the European Society of Cardiology*, 17(1), 6–22. <https://doi.org/10.1177/1474515117721561>
- Han, X., Pittman, P., & Barnow, B. (2021). Alternative approaches to ensuring adequate nurse staffing: The effect of state legislation on hospital nurse staffing. *Medical Care*, 59(Suppl. 5), S463–S470. <https://doi.org/10.1097/MLR.0000000000001614>

- Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical Care*, 45(12), 1195–1204. <https://doi.org/10.1097/MLR.0b013e3181468ca3>
- Law, A. C., Stevens, J. P., Hohmann, S., & Walkey, A. J. (2018). Patient outcomes after the introduction of statewide ICU nurse staffing regulations. *Critical Care Medicine*, 46(10), 1563–1569. <https://doi.org/10.1097/CCM.0000000000003286>
- PricewaterhouseCoopers' Health Research Institute. (2007). What works: Healing the healthcare staffing shortage. Retrieved from council.brandeis.edu/pdfs/2007/PwC%20Shortage%20Report.pdf
- National Nurses United. (n.d.). RN staffing ratios: A necessary solution to the patient safety crisis in U.S. hospitals. Retrieved from <https://www.nationalnursesunited.org/sites/default/files/nnu/graphics/documents/Ratios-A-Necessary-Solution-to-the-Patient-Safety-Crisis-in-US-Hospitals.pdf>
- Rosenberg K. (2011). California mandated nurse-patient ratios deemed successful. *The American Journal of Nursing*, 111(10), 17. <https://doi.org/10.1097/01.NAJ.0000406407.18944.94>
- Spetz, J. (2008). Nurse satisfaction and the implementation of minimum nurse staffing regulations. *Policy, Politics & Nursing Practice*, 9(1), 15-21. doi:10.1177/1527154408316950
- Shekelle, P. G. (2013). Nurse-patient ratios as a patient safety strategy: A systematic review. *Annals of Internal Medicine*, 158(5 Pt 2), 404-409. <https://doi.org/10.7326/0003-4819-158-5-201303051-00007>

Diabetic Management in the Hispanic Community

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Introduction

Type II Diabetes is one of the leading preventable diseases in the United States. As stated by the Centers for Disease Control and Prevention (CDC, 2021) “more than 37 million Americans have diabetes and approximately 90-95 % of them have type 2 diabetes” (Type 2 Diabetes, para. 1). Type II Diabetes can present in any individual and self-management of diabetes can be difficult and vary among any ethnicity. The CDC (2022) states that “people of certain racial and ethnic groups are more likely to develop prediabetes and type 2 diabetes, including African American, Hispanic or Latino, and Asian American people” (Hispanic or Latino People and Type 2 Diabetes, para.1). Hispanics have more than a 50% chance of developing Type II diabetes and are more likely to develop it at a young age (CDC, 2022, para. 3). The focus of this project is to understand what factors impact with adequate management of diabetes within the Hispanic community.

Clinical Problem

According to Hernandez et al. (2018), the “prevalence rate for developing Type II diabetes in Hispanics is twice that of their non-Hispanic counterparts” (p.783). Hispanics face many barriers that can interfere with their ability to receive adequate education or adequate care regarding their Type II diabetes. Thomas et al. (2017) state that understanding these barriers is “necessary for nurses and other health care professionals to develop and implement the type ii diabetes care mechanisms or interventions that are sustainable, cost-effective, and culturally sensitive” (p.3). Understanding barriers such as medication adherence, low socioeconomic status, language differences, and social support can help increase adherence to diabetic management plans.

Barriers to Diabetic Management

One barrier that is commonly addressed in the literature is medication adherence. Medication adherence is defined as “whether a patient takes their medication as prescribed (e.g. twice daily) as well as whether they continue to take a prescribed medication” (Michael Ho et al., 2009, Medication Adherence, para. 1). Many factors play a role in medication adherence, for instance, cost, health literacy, and education. Mota et al. (2019) state that “patients who struggled to keep track of their medications, those uncertain about what their medications are for, and those who believe they take too many medications were substantially more likely to have out-of-control diabetes” (p. 604). According to Polonsky et al. (as cited in Mota et al.), treatment complexity and convenience were also key factors in decreased medication adherence (p. 604). During a conversation with an acquaintance who has had type II diabetes for about 10 years, the following was made comment: “Most of the time, I don’t understand what I am taking, I just take the medication since the doctor told me” (J. Vergara, personal communication, May 1, 2022). Being able to have open communication between the healthcare provider and the patient is important in order to help promote medication adherence.

Fernandez et al. (2017) investigated the language barrier that exists between patients and healthcare providers. These investigators found that limited English-speaking Latino patients showed more medication

adherence than English-speaking Latinos, followed by white patients, irrespective of patient-physician language concordance. Therefore, lack of medication adherence is just one of the many barriers that can decrease the likelihood of compliance to a diabetic management care plan.

Another barrier that is prevalent in the literature is socioeconomic status. Thomas et al. (2017) determined that income was the “major constraint to buying medications, groceries, and supplies for managing diabetes” (p.5). Lack of insurance coverage or healthcare access is another factor considered a disadvantage to managing diabetes. Marquez et al. (2019) stated that “health insurance status, a proxy for health care services, is a substantial predictor of poor glycemic control in US Latino Populations” (pp.413-414). Although the Affordable Care Act was enacted, “10 million Hispanic adults between the ages of 18-64 remain uninsured” (Marquez et al, 2019, p. 414). The healthcare team that is providing care to the individual with Type II diabetes can also influence their compliance. Being able to have a provider who is willing to provide culturally specific care and support the client is important to diabetic management.

Another barrier to diabetes management is social support and attitudes towards diabetes. As defined by Rotberg et al. (2016) social support is “the perception that assistance is available for an individual person, plays a significant role in the health of Latinos who are navigating an unfamiliar health care system while facing the challenges of acculturation and social development” (p. 279). Social support is a huge player when it comes to the management of diabetes. Hispanics who do not adhere to lifestyle changes or follow regimens that help control their diabetes are likely to have diabetic complications such as neuropathy, nephropathy, retinopathy, and macrovascular complications. Diabetes is “one of the leading causes of death in Hispanic communities behind cancer, heart disease, injuries, and stroke” as stated by Ngyuen et al. (2017, p. 2). If we are able to increase social support, this will positively impact management in Hispanics with type II diabetes.

Social support revolves around family, friends, physicians, and others playing a role in their care. Being able to include family in the management plan can increase the likelihood of better clinical outcomes. For example, including the spouse in dietary education can help increase compliance with dietary changes needed to help better control glucose levels. Oftentimes, diabetes in an individual can increase stress, which leads to negative attitudes toward diabetes. During the conversation with the acquaintance who has type II diabetes, she commented that once she was diagnosed with Type II diabetes, she felt that it was a “death sentence,” and it became difficult to care for herself and her family (J. Vergara, personal communication, May 1, 2022). Increasing the patient's and families' knowledge of diabetes has been shown to increase adherence as well as create a support mechanism for the client to rely on. As a healthcare provider, it is important to be aware of cultural traditions but there is no possible way to know them all. There has been an increase in culture sensitive programs for the Hispanic community that have helped to improve management.

Methods to Improve Management

Self-management is an important component in autonomous care and it is notable that this comes with many barriers. Brown et al. (2021) state that “Hispanic/Latino patients are less likely to attend educational courses compared with non-Hispanic Whites due to the lack of cultural representation in the curriculum” (p.3-4). It is important to provide culturally specific patient-centered care in order to increase attendance and adherence to teachings. Nguyen et al. (2017) reported that diabetes self-management education (DSME) resulted in increased diabetic self-management knowledge and retention. These programs are not only culturally relevant but promote social support because they include other Hispanic individuals who have type II diabetes. Being able to participate in a group setting increases participation and allows participants to discuss how they are managing their diabetes as well as the barriers they face.

These types of programs have been shown to improve the patient's attitude toward taking control of their diabetes as well as improving their ability to cope with the disease. It is important to keep in mind the lack of income and insurance when it comes to promoting programs that are hospital-based. Guccirdi et al. (as cited in Nguyen et al., 2017) found that "hospital-based DSME programs were more effective than community-based programs in achieving positive outcomes such as blood glucose control, physical activity, and diet changes" (p.3). There are also community-based programs that are available for individuals who have little to no income. Morales et al. (2020) state that public health programs that utilize community health workers are also highly effective. Community health workers are effective in providing education on nutrition and physical activity. One program that is recognized by the American Diabetes Association is "Project Dulce". This program builds "on cultural strengths, resources to motivate health behavior change, incorporates culturally relevant food and activity recommendations and addresses the socio-cultural context" of the Hispanic Community (Fortmann et al., 2019, p. 296). Culture-specific programs ensure that education is tailored to the Hispanic community. For example, a translator is present, and all information that is given is translated and tailored to the literacy level of the patients. This program not only meets face-to-face but also has a digital program called "Dulce Digital". As telehealth rises, there have been more applications being produced to help clients manage their diabetes.

Resources for Diabetes Management

There are various resources, for children or adults, that can be found in Memphis and the state of Tennessee that can help an individual with type II diabetes. There has been a rise in child obesity, diagnosis of prediabetes, and diagnoses with Type II diabetes in children. LeBonheur Children's Hospital has a diabetes self-management education (DSME) program specifically for children. On the LeBonheur Children's Hospital website, it states that DSME classes are held in "the Le Bonheur Outpatient Center Diabetes/Endocrine Clinic, the FedEx Family House, and the Children's Foundation Research Center." LeBonheur has other programs like school care plans (i.e., diabetic medical management plan), community support, and how to handle diabetes in school (i.e., accommodations, psycho-social support).

The Shelby County Health Department has a program called the "National Diabetes Prevention Program" that has an online test for individuals to take that allows them to see if they are at risk for developing type II diabetes. They offer a program called the "National Diabetes Prevention Program Lifestyle Change Program" led by trained lifestyle coaches, with a CDC-approved and evidenced-based curriculum that helps individuals find support and help take control of their health (Shelby County Health Department, National Diabetes Prevention Program, para. 3). This program offers "a full year of support with weekly sessions for up to 6 months, then monthly sessions for the rest of the year" (Shelby County Health Department, National Diabetes Prevention Program, para. 4).

Methodist LeBonheur Hospital has joined forces with the Shelby County Health Department and has offered group meetings for diabetes prevention. Methodist LeBonheur Hospital has various contact information on who to reach to join the program. As of right now, they are looking for participants in a "virtual diabetes prevention program called Sugar Rite". This program is a "12 month weight loss program based on the CDC National Diabetes Prevention Program" (Methodist LeBonheur Healthcare, National Diabetes Prevention Program, para. 4).

For an individual who does not want to go to a hospital-based educational program, there are various community-based programs. For example, the Young Men's Christian Association, or YMCA, offers a diabetes prevention program that follows the same CDC-approved curriculum. This program is offered in both English and Spanish, and teaches "strategies for eating healthier, increasing physical activity, and

making other changes that will improve overall health and well-being” (YMCA, Diabetes Prevention Program, para. 4).

Another community resource is “The Church Health Center,” which offers a diabetes, self-management class. Their program is a “four-part series that teaches the basics of diabetes, its role in the body, diabetes medication, and chronic disease management, as well as nutrition courses (Church Health, para.1). This program is offered in-person as well as online. The modules and educational materials are provided and are offered both in English and Spanish. Overall, there are various hospital-based and community-based programs that can be found within the city of Memphis and the state of Tennessee.

Conclusion

Overall, diabetic management in the Hispanic community currently faces many barriers. With information from the literature, it is apparent that socioeconomic status, medication adherence, language differences, and social support play major roles in managing diabetes. Providing culturally specific, up-to-date education on diabetes management has been shown to increase the likelihood of a patient increasing their ability to self-manage their diabetes.

References

- Brown, F., Thrall, C., Postma, J., & Uriri-Glover, J. (2021). A culturally tailored diabetes education program in an underserved community clinic. *The Journal for Nurse Practitioners*. <https://doi-org.bchs.idm.oclc.org/10.1016/j.nurpra.2021.02.022>
- Center for Disease Control and Prevention. (2021). Types 2 Diabetes. *Diabetes*. <https://www.cdc.gov/diabetes/basics/type2.html>
- Centers for Disease Control and Prevention. (2022). Diabetes. *Hispanic or Latino People and Type 2 Diabetes*. <https://www.cdc.gov/diabetes/library/features/hispanic-diabetes.html>
- Church Health. (n.d.). *Diabetes Self-Management*. <https://churchhealth.org/diabetesclass/>
- Fernandez, A., Quan, J., Moffet, H., Parker, M.M, Schillinger, D., & Karter, A.J. (2017). Adherence to newly prescribed diabetes medications among insured Latino and White patients with diabetes. *JAMA Internal Medicine*, 177(3). Doi:10.1001/jamainternmed.2016.8653
- Fortmann, A.L., Savin, K.L., Clark, T.L., Philis-Tsimikas, A., & Gallo, L.C. (2019). Innovative diabetes interventions in the U.S. Hispanic Population. *From Research to Practice*, 32(4). <https://doi.org/10.2337/ds19-0006>
- Hernandez, R., Carnethon, M., Giachello, A. L., Penedo, F. J., Wu, D., Birnbaum-Weitzman, O., Giacinto, R. E., Gallo, L. C., Isasi, C. R., Schneiderman, N., Teng, Y., Zeng, D., & Daviglius, M. L. (2018). Structural social support and cardiovascular disease risk factors in Hispanic/Latino adults with diabetes: Results from the Hispanic community health study/study of latinos (HCHS/SOL). *Ethnicity & Health*, 23(7), 737–751. <https://doi.org/10.1080/13557858.2017.1294660>
- LeBonheur Children’s Hospital. (n.d.). Diabetes Self-Management Education. *LeBonheur Children’s Hospital*. <https://www.lebonheur.org/our-services/endocrinology/diabetes-self-management-education-program/>

- Marquez, I., Calman, N., & Crump, C. (2019). A framework for addressing diabetes-related disparities in the US Latino populations. *Journal of Community Health*, (2019)44, 412-422. <https://doi.org/10.007/s10900-018-0574-1>
- Methodist LeBonheur Healthcare. (n.d.) *National Diabetes Prevention Program*. <https://www.methodisthealth.org/healthcare-services/diabetes-endocrinology/national-diabetes-prevention-program/>
- Michael Ho, P., Bryson, C.L., & Rumsfeld, J.S. (2009). Medication Adherence. *American Heart Association Life-Long Learning*. <https://doi.org/10.1161/CIRCULATIONAHA.108.768986>
- Morales, J., Glantz, N., Larez, A., Bevier, W., Conneely, M., Fan, L., Reed, B., Alatorre, C., Paczkowski, R., Ahmed, T., Mackenzie, A., Duncan, I., & Kerr, D. (2020). Understanding the impact of five major determinants of health (genetics, biology, behavior, psychology, society/environment) on type 2 diabetes in U.S. Hispanic/Latino families: Mil familias - a cohort study. *BMC Endocrine Disorders*, 20(4). <https://doi-org.b/10.1186/s12902-019-0483-z>
- Mota, A.B., Sala, E.E.F, Perdomo, J.M., Solis, J.A., Soloranzo, W.M., Hochman, M., & Reilly, J.M. (2019). Assessing barriers to medication adherence among Latinos with diabetes: A cross-sectional study. *Society of General Internal Medicine*, 35(2), 603-605. DOI: 10.1007/s11606-019-05041-3
- Nguyen, A. L., Sepulveda, E., & Angulo, M. (2017). “It feels good to know that someone cares”: Hispanic adults’ motivations for attending diabetes education classes. *Hisp Health Care Int.*, 15(2), 52-57. DOI: 10.1177/1540415317698701
- Rotberg, B., Junqueira, Y., Gosdin, L., Mejia, R., & Umpierrez, G. E. (2016). The importance of social support on glycemic control in low-income Latinos with type 2 diabetes. *American Journal of Health Education*, 47(5), 279–286. <https://doi.org/10.1080/19325037.2016.1203838>
- Shelby County Health Department. (n.d.). *National Diabetes Prevention Programs*. <https://www.shelbytnhealth.com/484/National-Diabetes-Prevention-Program>
- Thomas, A., Ashcraft, A. S., Owen, D. C., & Conway-Phillips, R. (2017). Making it all work: Qualitative descriptions of Hispanic adults managing type 2 diabetes with limited resources. *Global Qualitative Nursing Research*, 4(1-13) <https://doi.org/10.1177/2333393617691860>
- YMCA Memphis. (n.d.). *Diabetes Prevention Program*. <https://www.ymcamemphis.org/main/diabetes-prevention-program/>

Improving the Role of the Nurse in Caring for Children with Exposure to Adversity

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Introduction

This paper aims to identify and improve the role of the pediatric nurse in caring for children with exposure to childhood trauma. Included in this paper is (a) an explanation of adverse childhood experiences and the effects they have on early brain development, (b) eye-opening statistics about the effects of childhood trauma on health in adulthood, (c) recognizing the signs of a child with exposure to adversity, (d) universal screening tools and how the pediatric nurse can appropriately intervene, and finally, (e) a proposal for a new framework for pediatric healthcare. While the findings of the literature reviewed are alarming, it merely scratches the surface of the profound effects of childhood adversity. The goal of this analysis is to enlighten people, specifically pediatric nurses, on this profound topic and inspire others to help move toward a better healthcare system for our children and upcoming generations.

Adverse Childhood Experiences and Their Impact on the Developing Brain

Adverse Childhood Experiences (ACEs) are characterized by exposure to toxic stress in the first 18 years of life. ACEs were discovered and termed by Dr. Felitti and Dr. Anda through their research to determine how childhood adversity impacts overall health outcomes in adulthood (1998). Felitti and Anda created the ACEs questionnaire (Appendix A) by establishing 10 categories of adversity in the household to measure their findings. Answering ‘yes’ to a question is equivalent to 1 point, allowing for a maximum of 10 points (1998). The categories include the following:

1. Emotional abuse,
2. Physical abuse,
3. Sexual abuse,
4. Physical neglect,
5. Emotional neglect,
6. Substance abuse in the household,
7. Mental illness in the household,
8. Mother treated violently,
9. Divorce or parental separation, and
10. Criminal behavior in the household.

There are three types of stress an individual may be exposed to: positive, tolerable, and toxic. Positive stress refers to events that create a short-lived stress response and are beneficial to the child’s development, such as meeting new people, getting immunizations, or attending a new child-care facility (National Scientific Council on the Developing Child [NSCDC], 2014). Tolerable stress refers to events or stressors that have the potential to become positive or toxic depending on the caregiver’s degree of support for the child (Shonkoff et al., 2012). Grieving the death of a loved one, facing discrimination, or dealing with a parental divorce are examples of tolerable stress because the negative outcomes can be prevented (Shonkoff et al.; NSCDC). With the help of an attentive, dependable caregiver, the child is better equipped to navigate the

feelings and emotions that result from these events. Toxic stress, however, results from “strong, frequent, or prolonged activation of the body’s stress response systems in the absence of the buffering protection of a supportive, adult relationship” (Shonkoff et al., p. 236). It is important to stress the gravity of a healthy, buffering relationship with an adult because it can genuinely make all the difference in a child’s response to adversity (Burke Harris, 2019). When the child lacks a reliable caregiver, these challenging events create toxic stress responses in the developing brain, which ultimately lead to physiologic changes and damaging life-long effects (NSCDC, 2014). Much like the rest of the body, the brain of an infant, a child, and an adolescent are still in the developing stages, which leaves the child highly susceptible to hormonal and neuronal changes (Shonkoff et al., 2012).

A few of the most important brain structures that contribute to the stress response include the following: (a) the amygdala, responsible for the fight-or-flight response; (b) the prefrontal cortex, responsible for regulating reason, judgment, mood, and emotions; (c) the hippocampus, responsible for creating and maintaining memory; (d) the hypothalamic-pituitary-adrenal (HPA) axis, responsible for initiating production of cortisol; and (e) the sympatho-adrenomedullary (SAM) axis, responsible for initiating the production of adrenaline and noradrenaline (Burke Harris, 2019; Shonkoff et al., 2012). When the brain recognizes a threat, the amygdala instantly sounds an alarm throughout the brain, kickstarting the stress response. The adrenal glands begin releasing adrenaline and cortisol, or stress hormones, that result in the heightening of senses and the suppression of certain brain functions to optimize chances of survival. Adrenaline, the short-acting stress hormone, increases heart rate and blood pressure to send blood to the parts of the body that need it most and opens the airway to maximize oxygen consumption. It enhances the prefrontal cortex’s ability to reason and make decisions quickly. Cortisol, however, is a long-acting stress hormone that helps the individual adapt to long-term stressors. It disrupts sleep, stimulates the accumulation of fat, and destabilizes mood (Burke Harris).

In a child or adolescent with a healthy, intact stress response, this process ends when the stressor has subsided. The stress response turns off, and the high levels of adrenaline and cortisol feed into the brain, allowing the brain to return to normal function (Burke Harris, 2019). However, those exposed to toxic stress, or ACEs, without the presence of a buffering caregiver have difficulty returning to baseline despite the stressor no longer being active. Unfortunately, repeated exposure to adversity and trauma can lead to allostatic overload, or a “physiologic response to stress accumulation,” which can ultimately result in lasting effects on both mental and physical health (Zarnello, 2018, p. 53). Chronic stress not only affects the patient’s overall health, but according to Burke Harris and the National Scientific Council on the Developing Child (2014), it literally restructures the brain in the following ways:

- Amygdala – becomes enlarged, hindering its ability to decipher whether a situation is truly dangerous or not,
- Prefrontal cortex – decreases in function due to inhibition by the amygdala, resulting in difficulty concentrating and poor judgment,
- Hippocampus – begins to shrink, making the creation of short-term and long-term memories less attainable, and
- Cortisol – prolonged release results in suppression of immune function, leading to increased inflammation and an altered ability to fight infection.

These are only a few examples of the ways in which chronic or toxic stress impacts the development of the brain and body systems. Dr. Victor Carrion led research that studied patients between the ages of 10 and 16 who had exposure to trauma and symptoms of post-traumatic stress disorder (as cited in Burke Harris, 2019). Magnetic resonance imaging discovered that “the more symptoms a kid had, the higher his cortisol levels were and the smaller the volume of his hippocampus” (p. 58). Ultimately, it is vital to understand

that the plasticity of the brain during early childhood years makes the brain highly susceptible to changes (NSCDC, 2014), so when the brain is in a constant state of ‘fight-or-flight,’ the brain adapts to the child’s environment, increasing the likelihood for negative outcomes in the future.

The Effects of ACEs on Long-Term Health

The original ACEs study by Felitti and Anda (1998) found a significant dose-response relationship between childhood adversity and negative health outcomes, meaning the more ACEs an individual reported, the more likely that individual is to develop poor health. Of the 17,421 patients who participated in Felitti and Anda’s research, over 60% of them had experienced at least one ACE and 12.5% had experienced four or more ACEs (as cited in Burke Harris, 2019; Esden, 2018). Several studies have been conducted since then that have provided similar statistics. Two surveys in 2010, one including 26,000 individuals (Centers for Disease Control and Prevention) and the other including 54,000 (Gilbert et al.) both found that 59.4% of the population was exposed to at least one ACE and roughly 15% had been exposed to four or more ACEs (as cited in Esden, 2018). Research shows that, compared to individuals with an ACE score of 0, patients with an ACE score of 4 or higher are 7 times more likely to develop an alcohol use disorder and 12 times more likely to attempt suicide, and patients with an ACE score of 6 or more are at risk of a shorter life expectancy by 20 years compared to those with no exposure to childhood adversity (Esden, 2018). Similarly, those with an ACE score of 2 or more are twice as likely to be hospitalized for an autoimmune disorder (Burke Harris, 2019). According to Esden (2018), these studies have also determined an undeniable dose-response relationship between exposure to ACEs and the development of “ischemic heart disease, chronic obstructive pulmonary disease, cancer, skeletal fractures, and liver disease” (p. 13) in adulthood. High ACE scores have also been linked to an increase in risk-taking behaviors, which place individuals “at higher risk of school failure, gang membership, unemployment, poverty, homelessness, violent crime, incarceration, and becoming single parents” (Shonkoff et al., 2012, p. 237). It is necessary to note that adults involved in these categories are less likely to have stable and reliable relationships with their children, leaving the children with a lack of adequate protection against the lifelong effects of childhood trauma (Shonkoff et al., 2012).

In 2014, the Adverse Childhood Experiences Task Force of Shelby County collaborated with Baptist Memorial Hospital for Women and Knowledge Quest and Porter-Leath to determine the prevalence of ACEs in Shelby County, Tennessee (The Research and Evaluation Group at Public Health Management Corporation [REGPHMC], 2014). This study was conducted using several methods, in which participants were surveyed and interviewed on their ACE exposure, current health status, level of education, and household. When determining odds on risk-taking behaviors, it was found that, compared to adults in Shelby County with no ACEs, those with four or more had “3.7 times greater odds of being a current smoker, 3.1 times greater odds of being categorized as a problem drinker, 4.4 times greater odds of having had 30 or more sexual partners, ... 4.5 times greater odds of having had used illicit drugs at least once,” and 20.7 times greater odds of reporting a suicide attempt, despite controlling for gender, age, race, and educational status (REGPHMC, 2014, p. 12). When investigating current health conditions, they discovered that individuals in Shelby County with four or more ACEs were “3.9 times as likely to have chronic bronchitis or emphysema, 2.4 times as likely to have had hepatitis or jaundice, 2.2 times as likely to have had ischemic heart disease, 1.9 times as likely to have had cancer, ... 2.2 times as likely to have fair or poor self-rated health” (p. 2), and 5.6 times as likely to be diagnosed with depression. During data collection, researchers also surveyed participants on community adversities since dangerous communities can also contribute heavily to toxic stress. The community ACEs identified in this study included witnessing someone beaten, stabbed, or shot; experiencing discrimination, being bullied, and being in an unsafe neighborhood. Sixty percent of participants reported witnessing someone be beaten, 37% reported

witnessing someone be shot or stabbed, 41% reported being bullied during childhood, 21% reported not feeling safe in their neighborhood, and 13% reported having felt some degree of discrimination growing up (REGPHMC, 2014). Individuals who are exposed to any form of adversity, in or out of the home, are at risk for developing toxic stress which has been “shown to cause physiologic disruptions that persist into adulthood and lead to frank disease, even in the absence of later health-threatening behaviors” (Shonkoff et al., 2012, p. 238). In other words, even if exposure to childhood adversity is one’s *only* risk factor, they are still very much at risk for asthma, cardiovascular disease, chronic obstructive pulmonary disease, autoimmune diseases, any form of cancer, stroke, and many other disorders that contribute to the leading causes of death in America (Burke Harris, 2019; Shonkoff et al., 2012). While all of these statistics are alarming, it seems as though Shelby County, along with many cities in America, lacks the necessary education and resources to prevent these numbers from increasing.

Recognizing the Signs of Exposure to Adversity

Before discussing *how* the nurse should intervene, we must first understand *when* the nurse should intervene which requires recognizing when a child exhibits signs of exposure to adversity. Unfortunately, it is far too common for children with ACEs to be misdiagnosed with attention deficit hyperactivity disorder (ADHD) because the symptoms are extremely similar (Burke Harris, 2019). Some of the most prevalent symptoms in children with ACEs are difficulty concentrating, decline in academic performance, and behavioral misconduct, which are primarily due to the hypervigilant state that these patients experience from their stress response’s failure to completely shut down (Burke Harris, 2019; Goddard et al., 2022). In fact, a child with an ACE score of 4 or more is “thirty-two times as likely to have learning or behavior problems” (Burke Harris, 2019, p. 61). Though these are the most common, toxic stress can manifest in any number of ways, including difficulty sleeping, irritability, excessive worrying, outbursts of anger, and inconsolability (Goddard et al., 2022, Table 2, p. 4). In Dr. Burke Harris’s book, *The Deepest Well: Healing the Long-Term Effects of Childhood Adversity* (2019), she discusses many of the individual patients she has encountered who were found to have been exposed to adversity, such as a 10-year-old with severe asthma that flared up when her father would punch a hole in the wall (p. 6), a 5-month-old with failure to thrive, or failing to gain weight and meet milestones, and an ACE score of 2 (p. 77-79), a 9-month-old with an ACE score of 5 who had already dealt with three ear infections and two cases of pneumonia (p. 140-141), and a 7-year-old with high adversity exposure who developed asthma, eczema, behavioral problems, and extensive growth failure (p. 1-7). Pediatric nurses assess and care for kids at every developmental stage, and it is vastly important to understand that each patient may respond differently to toxic stress depending on where they are developmentally. Burke Harris’s (2019) team read thousands of research articles and collected data. Their findings included the following:

“In babies, exposure to ACEs is associated with growth delay, cognitive delay, and sleep disruption. School-age children show higher rates of asthma and poorer response to asthma rescue medication (such as albuterol), greater rates of infection (such as viral infections, ear infections, and pneumonia), and more learning difficulties and behavioral problems, and adolescents exhibit higher rates of obesity, bullying, violence, smoking, teen pregnancy, teen paternity, and other risky behaviors such as early sexual activity.” (p. 143)

Simply being aware of how adversity exposure may present in different age groups allows pediatric nurses to better understand how to approach the patient and caregivers and prevent possible re-traumatization (Goddard et al., 2022). Also, knowing the long-term effects that childhood adversity and toxic stress have on the developing brain allows pediatric nurses the opportunity to advocate for patients and educate parents on the importance of a nurturing relationship to buffer the child’s response to adversity.

Universal Screening and Trauma-Informed Care for Nurses

Nurses have a special role to play in addressing the harmful effects of childhood adversity because they are known for their compassion and the genuine care they provide for their patients. Pediatric nurses see their patients and families one-on-one and have more opportunities to establish trust and begin the challenging conversations that come with addressing ACEs. Regardless of the area of practice, whether a pediatric clinic, a pediatric emergency department, or a pediatric hospital unit, each patient should be screened for adverse childhood experiences. While there are many screening tools available, Dr. Burke Harris (2019) and her team have created a ‘de-identified’ screening tool that allows parents to relay a child’s ACE score without revealing the specific ACEs (Appendix B). This screening tool includes both the original ACE study questions and those regarding community adversities. Not only does this save time, but they also found that parents were able to answer more truthfully because they did not feel they *had* to discuss the details of the adversities. Knowing a child’s ACE score before ever placing a stethoscope on them lets the nurses know when they should listen extra carefully or ask extra questions. In turn, this makes nurses better health professionals, as Dr. Burke Harris (2019) would say, because, from the beginning of the visit, nurses would know what the patient is at risk for developing in the future. A few of the most important roles of the nurse include assessing, educating, and advocating for the patient, which are all vital in the ACE screening process. In all hospital and primary care settings, there should be immediate follow-up by a nurse after an ACE screening to establish rapport, educate the patient and family, and determine if the child’s score requires further intervention, referrals such as child-parent psychotherapy, or resources within the community to encourage resilience for the patient (Burke Harris, 2019). According to Esden (2018), physicians reported that the “lack of time to counsel patients after a disclosure of childhood trauma” and the lack of formal training on how to do so were found to be major barriers to screening for childhood adversity (p.16). However, with the proper training, nurses can bridge that gap by being a listener and advocate for the patients.

One thing that nurses should practice universally is trauma-informed care. Part of this includes using universal trauma precautions; much like how all blood is treated as though it could be contaminated, all patients should be treated as though they have a history of trauma or ACEs (Goddard et al., 2022). According to Goddard et al. (2022), the most efficient way to enforce trauma-informed care is with the “4 Rs:” realizing the overall impact of childhood adversity, recognizing signs of trauma exposure in patients, responding to the signs with proper screening tools, and resisting re-traumatization. Pediatric nurses are in an ideal position to implement these recommendations because it is the responsibility of the nurse to educate themselves and patients’ families, make appropriate referrals for patient care, and provide optimal resources to families who need them (Zarnello, 2018). Preventing re-traumatization is likely the area of practice that may be overlooked the most, but it “can be as simple as allowing the client to choose whether they want to sit, stand, or lie down during an examination as it gives them a sense of control over an aspect of their care” (Berryman, 2022, p. 6). Nurses should also fully explain procedures to patients before starting them in order to prevent re-traumatization, specifically with procedures such as pelvic or rectal exams (Esden, 2018). It also requires nurses to evaluate their own behaviors toward patients, such as eye contact, body language, and listening attentively to patients and their families. Patient guardians are generally not offended “when asked about childhood trauma, as long as they do not receive a negative response to the disclosure,” therefore it is the nurse’s responsibility to ensure that neither the patient nor parents feel shamed when discussing ACEs (Esden, 2018, p.17).

It is also important to note that implementing trauma-informed care will look different in varying clinical settings. For example, the pediatric nurse in a primary care office will likely have more time to speak in detail with parents about their child’s needs than the pediatric nurse in an emergency department. Therefore,

when putting universal ACE screening into practice, the vastly different atmospheres of the clinical setting in which they will be implemented must be considered. In pediatric emergency departments, specifically, the screening tool for ACEs may need to be revised, as it could interfere with the triage process, ultimately increase wait times, and possibly result in false answers due to a lack of rapport with the nurse. It is also likely that many nurses may skip over the questions when the waiting room is especially full, leaving the opportunity for children who truly need help to be treated for their symptoms instead of the underlying causes.

A New Framework for Pediatric Health Care

Many of the findings discussed above can be minimized or prevented with the management of stress hormone regulation during early childhood and adolescent years. Healthcare providers in clinics and hospitals tend to treat a client's symptoms, rather than determining the underlying cause and resolving it. However, it is taught in nursing school, and likely in medical school as well, to always search for and treat the root of the problem; otherwise, the symptoms will continue to surface, and the problem will inevitably become larger. Kerker et al. (as cited in Esden, 2018) surveyed almost 600 pediatricians and found that only 4% reported routinely screening for ACEs in their practice, and a staggering 76% of these physicians were unfamiliar with the original ACE study altogether. Therefore, the first priority in reshaping our healthcare system is bringing awareness to just how heavily one's health can be affected by the experiences they have as a child.

In order to address the problem at hand, healthcare providers must understand why it is a problem in the first place. This can be done by hosting seminars and providing in-service training in the pediatric hospital that requires staff attendance to educate all healthcare providers, specifically pediatric nurses. Esden (2018) cites a study conducted by Choi and Seng that reported "statistically significant improvements in knowledge, skills, and attitudes" after only one hour of trauma-informed care education (p. 17). Once nurses are educated, they can then administer routine ACE screenings, educate parents and families on how their children may be affected by adversity, and teach them what can be done to mitigate the effects.

Along with universal and routine ACE screenings, there must also be routine treatments in place to ensure all children and youth receive the care they need. According to Bucci et al. (2015), it is recommended that a patient with an ACE score of 0-3 and no symptoms of toxic stress should receive anticipatory guidance, while patients with an ACE score of 4 or more or a score of 1-3 with symptoms should be referred for treatment. The first line of treatment, which was found to be extremely beneficial in mitigating the effects of trauma according to Burke Harris (2019), is child-parent psychotherapy, in which the child and parent attend therapy together. In addition to child-parent psychotherapy, the child and parent may also benefit from individual therapy. Supportive and involved parents or caregivers who work through their own adversities are better equipped to be present for their children when faced with childhood adversity (Burke Harris, 2019). As discussed by Dr. Burke Harris (2019) and by Bucci et al. (2015), pairing therapy with (a) exercise, (b) proper nutrition, (c) sleep, (d) mental health, (e) mindfulness, and (f) supportive relationships can be vital to improving stress response dysregulation.

Outside of simply treating the child for ACEs, it is crucial to take action in the areas where improvement may be needed. Some suggestions from the NSCDC (2014) include aiding parents who struggle to adjust to the challenges of raising children, creating accessible, high-quality early education programs for children who are at higher risk of experiencing toxic stress, and having affordable assistance available to those who lack sufficient knowledge to care for children who have signs of toxic stress. The Centers for Disease Control and Prevention recommend initiating "home visiting to pregnant women and families with newborns, ... [implementing] parenting training programs, ... intimate partner violence prevention,

preschool enrichment, social support for parents, and sufficient income support for lower income families” (REGPHMC, 2014, p. 18). Lastly, Bucci et al. (2015) and Burke Harris (2019) suggest a multi-disciplinary approach to address all aspects of the problem, including home visits to accommodate families with a lack of access to transportation and adequate child-care, wellness nursing to provide consults to attain and maintain optimal health, psychiatry to determine the need for medications, and biofeedback services to regain control over the body’s response to a dysregulated stress response system.

If the alarming statistics and long-term effects of adverse childhood experiences are not enough to encourage new ways of approaching healthcare, it should also be noted that treating children with ACE exposure will decrease the number of adults fighting chronic diseases in the future, and therefore generate significant decreases in the costs of treating these health problems. Zarnello (2018) states “treating [chronic diseases] accounts for 86% of healthcare costs in the United States” (p. 52), and the National Center for Chronic Disease Prevention and Health Promotion (2023) reports that “90% of the nation’s \$4.1 trillion in annual health care expenditures are for people with chronic and mental health conditions” (para. 1), both of which can be notably reduced with early detection and treatment of ACEs. The long-term effects and costs of childhood trauma exposure are undeniable, but with early detection and intervention, healthcare providers, especially nurses, are in the ideal position to begin the process of reducing these factors little by little.

Conclusion

Recent research on childhood adversity indicates that our current healthcare system is not sufficient. In order to combat the permanent changes to developing brains and the climbing statistics of chronic disease in America, a transformation must be made. Shonkoff et al. (2012) state it perfectly by saying, “the time has come to expand the public’s understanding of brain development and shine a bright light on its relation to the early childhood roots of adult disease” (p. 237). Healthcare professionals are in an ideal position to implement revolutionary care involving early detection of ACEs, early intervention, and potential prevention of long-term health complications caused by ACEs. It is our obligation to provide the best possible care to patients and their families to optimize health outcomes, and the first step involves educating ourselves so we can educate our patients. We should also become familiar with and advocate for improved community resources to give our patients the best chances at better futures.

References

- Berryman, B. (2022). Implementing trauma-informed care for pediatric clients with adverse childhood experiences. [Unpublished paper]. Nursing Division, Baptist Health Sciences University.
- Bucci, M., Gutiérrez Wang, L., Koita, K., Purewal, S., Silvério Marques, S., Burke Harris, N. (2015). Center for youth wellness ACE-questionnaire user guide. *Center for Youth Wellness*.
- Burke Harris, N.. (2019). *The deepest well: Healing the Long-term Effects of Childhood Adversity*. Mariner Books.
- Esden, J. L. (2018). Adverse childhood experiences and implementing trauma-informed primary care. *The Nurse Practitioner*, 43(12).

- Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., Koss, M. P., & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The adverse childhood experiences (ACE) study. *American Journal of Preventive Medicine*, 14(4), 245-258.
- Goddard, A., Janicek, E., & Etcher, L. (2022). Trauma-informed care for the pediatric nurse. *Journal of Pediatric Nursing*, 62. <https://doi.org/10.1016/j.pedn.2021.11.003>
- National Center for Chronic Disease Prevention and Health Promotion (2023). Health and economic costs of chronic diseases. *Centers for Disease Control and Prevention*.
<https://www.cdc.gov/chronicdisease/about/costs/index.htm>
- National Scientific Council on the Developing Child. (2014). Excessive stress disrupts the architecture of the developing brain: Working paper 3. *Updated edition*.
<http://www.developingchild.harvard.edu>.
- Shonkoff, J. P., Garner, A. S., Siegel, B. S., Dobbins, M. I., Earls, M. F., Garner, A. S., McGuinn, L., Pascoe, J. M., & Wood, D. L. (2012). The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*, 129(1), e232–e246. <https://doi.org/10.1542/peds.2011-2663>
- The Research and Evaluation Group at Public Health Management Corporation. (2014). Adverse childhood experiences in Shelby County, Tennessee.
- Zarnello, L. (2018). The ACE effect. *Nursing*, 48(4), 50–54.
<https://doi.org/10.1097/01.nurse.0000530408.46074.64>

Rural and Urban Access to Nutritious Foods: Program Implementation in Hospitals

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Faculty Reviewer(s): Dr. Christina Davis

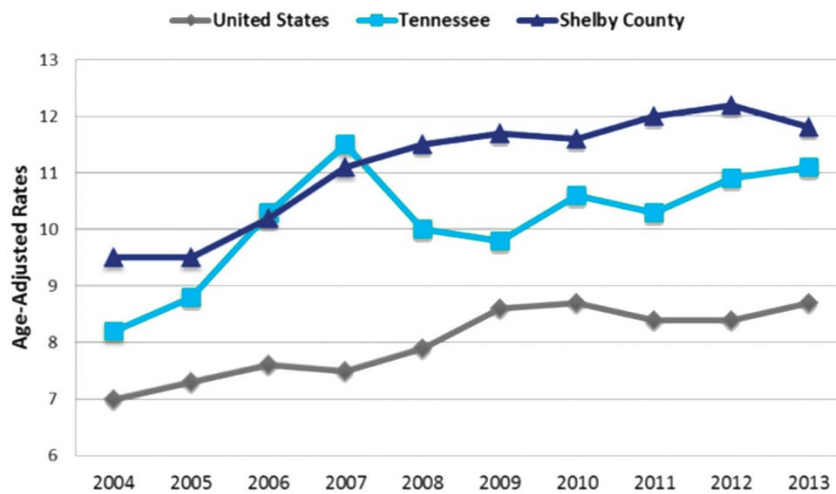
Introduction

According to the International Journal of Environmental Research and Public Health, within the U.S, “more than two-thirds of all deaths are caused by one or more of these five chronic diseases: heart disease, cancer, stroke, chronic obstructive pulmonary disease, and diabetes” (Raghupathi, 2018). This is a tragic truth about the health of our nation, and should strike the healthcare system as a lot of these diseases are preventable through proper lifestyle and diet management. Furthermore, the Milken Institute estimates that “modest reductions in unhealthy behaviors could prevent or delay 40 million cases of chronic illness per year” (Raghupathi, 2018). Why is it that these issues have not been addressed more aggressively? Why don’t people make those modest reductions in their unhealthy behaviors to improve their health outcomes? One of the biggest issues, I would hypothesize, is a lack of education and accessibility to nutritious foods within rural and urban settings, which I seek to research in this paper. By specifically targeting those at risk- those in an urban or rural setting and those living at or below the poverty level- the hospital system could fight and win the battle over chronic disease in a much more efficient way. My goal is to research programs that already have this purpose in mind, draw from their success and failures, and design the basis of a program that can be implemented into, or affiliated with, the Baptist Hospital system to improve the health outcomes of those fighting chronic illness, and reduce their prevalence within the hospital to lighten the burden of healthcare workers. However, while diet and lifestyle play a significant role in the poor health of our community, I am also aware that cultural and social factors also play a role in this as well. For the purposes of this paper, I will only be discussing factors pertaining to diet and lifestyle choices as more research has yet to be conducted on other factors.

Statistics

People living in these conditions are often simply unaware of what it means to eat healthy and are unable to access nutritious foods even if they did. At the same time, the healthcare system is flooded with patients and healthcare workers are left overwhelmed like they have never been before. Payments associated with chronic illness also take up a significant amount of healthcare costs. According to the American Action Forum, 84% of healthcare costs are associated with chronic illness, with the rates of chronic illness in the South being significantly higher than in the rest of the United States. (Hayes and Gillian, 2020). The prevalence of chronic illness in children is at an all-time high as well, with 27 percent of children in the United States suffering from a chronic condition and roughly six percent of children having more than one chronic condition (Hayes and Gillian, 2020).

Figure 1: Rates of Chronic Illness

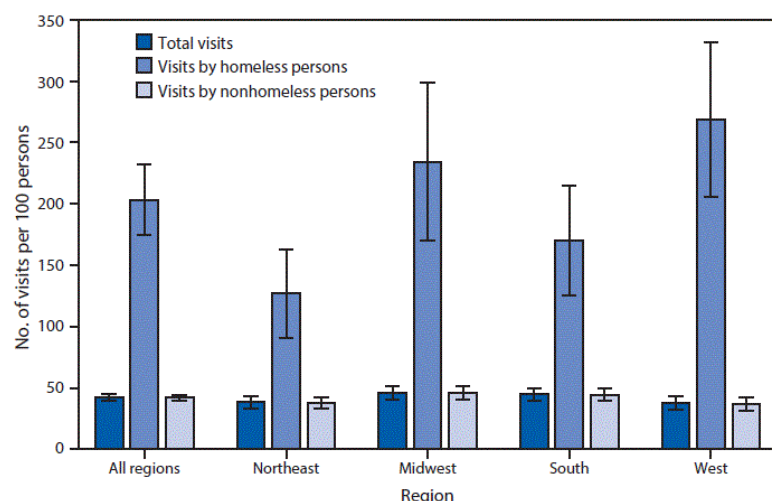


Specifically in Memphis, the rates and prevalence of chronic illness are staggering. According to Better Tennessee, an organization run by Blue Cross Blue Shield, 70% of residents in Shelby County are overweight and about a third of its residents are obese (Better Tennessee, 2018). Additionally, one in every three adults in Shelby County has diabetes. As a result, heart disease is the county’s leading cause of death followed by cancer and injury. However, proper nutrition and exercise have been known, in some cases, to reverse the effects of chronic illness. According to an article published in the American Journal of Lifestyle Medicine, “Research indicates that 80% of chronic diseases are preventable with simple lifestyle changes, such as tobacco cessation, improved diet, moderate exercise, and maintenance of a healthy weight...The whole-foods, plant-based (WFPB) dietary pattern has been shown to prevent and reverse multiple chronic medical conditions” (National Library of Medicine, 2022). Because most people with these chronic illnesses spend significantly more time in a hospital setting, and because of Baptist’s location in the Mid-South, I believe that the Baptist Hospital system can have a significant impact in this area of people’s health, as well as reduce its own burden of patients with chronic illness, by partnering with resources surrounding it or by directing its influence and resources towards an actionable nutrition education and supplementation program.

Key Elements of an Effective Model

According to an empirical study of chronic disease in the U.S housed in the National Library of Medicine, “the success of population health and chronic disease management efforts hinges on a few key elements: identifying those at risk, having access to the right data about this population, creating actionable insights about patients, and coaching them toward healthier choices” (Raghupathi, 2018). I think these are key factors in determining what can be done, specifically in Memphis, to fight the epidemic of chronic illness. With regard to those at risk, according to an article in the Journal of the American Medical Informatics Association, in Memphis, “statistical results confirmed that neighborhoods with higher rates of crime, poverty, and unemployment were associated with an increased likelihood of having a higher affinity among major chronic conditions” (Shin et. al., 2019).

Figure 2: Rates of Hospitalization Among the Homeless



The areas of major need are those with increased crime, poverty, and unemployment rates- namely, inner city areas. Because people living in these areas do not have the means to access healthy foods, nor do they have proper nutritional education, they are unable to make an informed decision on their diet habits even if they wanted to. The hospital system, however, can be a huge outlet for change and prevention of diet and lifestyle factor induced co-morbidities. In the South, there are roughly 180 emergency room hospitalizations per 100 homeless persons (CDC, 2018). Those who are hospitalized usually operate around the “revolving door model”, coming in and out of the hospital simply utilizing it for shelter and temporary health fixes. If the hospital were to partner with associations with the same goal in mind, supplementation could be exchanged for referral. When presented with patients who fit the correct health and lifestyle criteria for nutrition supplementation, the hospital could refer these patients to either a self-made nutritional program or an affiliate in order to supply their needs. This raises awareness of these programs which may garner greater funding, and also helps supplement those in rural and urban settings.

Nutritional Education Programs Presently in Place

A few nutritional programs already implemented within the Memphis area include LeBonheur Children’s Hospital Nutritional Therapy program, St. Jude Children’s Research Hospital Medical Nutrition Therapy Program, WIC (Women, Infants, and Children), “Cook Well, Be Well by Church Health, and an Adolescent Bariatric Program within Baptist Hospital.

LeBonheur Children’s Hospital, a comprehensive and highly rated hospital specifically for pediatric patients located in downtown Memphis, has implemented a “Nutritional Therapy” program aimed at helping children develop healthy eating habits and accommodate their nutritional needs throughout their lifetime (LeBonheur Children’s Hospital, 2023). By targeting high-risk children, this program helps future generations have a solid foundation to become a healthier population than the previous. While their program is only limited to children with severe illness and is not designed simply for those in rural and urban settings, it still targets those who are at the highest risk and steers patients in the right direction at an important and foundational age.

St. Jude Children’s Research Hospital also has a Medical Nutrition Therapy program designed for families with children who have cancer (St. Jude Children’s Research Hospital, 2023). This program is cancer-specific in that nutritional recommendations made for these patients may differ from those of the general population. Similarly to the nutritional program at LeBonheur Children’s Hospital, this program is geared towards a high-risk population and can help to serve future generations, but it doesn’t aid the current population of adults in rural and urban settings who have a lack of nutritional education and access.

Another valuable program is WIC (Women, Infants, and Children)- a nationwide organization that supplies low-income women and children with nutritious foods up until the children are five years old (WIC Fact Sheet, 2). This well-implemented program has a lot of successes that a new program, even one targeting a different population, could draw from. This program is widely implemented in hospitals, making it accessible to those at high risk, and is also accessible through schools, making it beneficial for future generations as well. It is funded by the federal government and generous donations, making it low cost, and also provides services outside of lowering the cost of nutritious foods “including health screening, nutrition and breastfeeding counseling, immunization screening and referral, substance abuse referral, and more” (WIC Fact Sheet, 2). Because of their strategic approach within their target population, in a review of more than three dozen studies conducted from roughly 1980-2000, “WIC increased average birth weight, reduced the incidence of low birth weight, and improved several other key birth outcomes” (Carlson and Neuberger, 2021). WIC’s success, I believe, comes from identifying specific components within their target population leading to health disparities, and finding an effective way of management that is also easily accessible. By gearing these strengths toward our target population, those in rural and urban communities, I think a productive and effective program could be created within or adjacent to the Baptist Hospital system.

Church Health within Crosstown Concourse in Midtown Memphis has a cooking and nutrition class called “Cook Well, Be Well,” which teaches the uninsured and underserved population beneficial skills for healthy eating habits, budget-friendly recipes, and basic nutrition principles to carry throughout their lifetime (Church Health, 2023). It is housed under Church Health, a medical organization who’s “services include primary and specialty care, dentistry, eye care and counseling” for the underserved and uninsured (Church Health, 2023). Their website also has a wealth of information on local churches and food pantries that provide free meals at certain times of the week. While Church Health is already its own medical organization, I think partnership with them through referrals to their nutrition classes and, in return, their supplience of nutritious food within the hospital, would greatly benefit patients from both Baptist Hospital and from their medical system. I think it would also lend to a more holistic approach within the Baptist Hospital system when caring for patients.

Finally, I thought the Adolescent Bariatric Program within Baptist Hospital ought to be addressed though it does not directly address nutrition. The program provides bariatric surgery for adolescents whose BMI is over 40 or over 35 with complications such as Type 2 diabetes, high blood pressure, or sleep apnea (Baptist Weight Loss Center, 2023). It ought to be mentioned, however, since it does list several requirements to be eligible one of which is “a documented history of weight management and weight loss attempts with supervised diets and exercise programs” (Baptist Weight Loss Center, 2023). While the patient’s attempt at weight loss using nutrition is a positive requirement for this surgery and a step in the right direction, it still does not address the primary issue of lifelong healthy diet and lifestyle habits involving access to nutritious foods, and it also does not address preventative medicine. To my knowledge and research, this is the only program within Baptist Hospital that utilizes or mentions nutrition.

Though all of these programs are greatly effective for their target populations, it appears that all of these programs, with the exception of Nutrition at Church Health, are aimed at families rather than individuals suffering from chronic conditions. To my knowledge and research, there are very few programs implemented within hospitals in the Mid-South for the individually disadvantaged. This is not a weakness in the systems mentioned; however, for the purposes of this study, it is a disadvantage in building a program as there are not many already in place to draw specific strengths.

Foundational Elements of an Actionable Program

So, based on the wealth of information we have for our community regarding nutritional needs and access, what can be done? What kind of model would be realistic, actionable, and effective? A few foundational elements, I believe, could help tremendously. The first foundational component could be a partnership with the surrounding nutritional supplementation programs already in place such as WIC, Nutrition at Church Health, local churches, or even local farmers' markets. If the knowledge of physicians can be combined with the generosity of these organizations, I think Memphis would be one step closer to achieving a healthier community. While parameters are already in place for these organizations individually, for the sake of longevity and efficacy, the following requirements could be given to patients utilizing these services: at least one comorbidity, income at or below the poverty level, and/or living in a qualified rural area. Furthermore, through partnerships with local services, such as Nutrition at Church Health, Baptist would have a source of healthy foods for their patients that otherwise wouldn't be obtained. Another service that I think would be of benefit would be requiring physicians to engage in further nutritional education in order to better inform their patients of the benefits of engaging in a healthy diet. If a physician is caring for a patient with a preventable chronic illness, I think making the provision of brief nutritional and lifestyle education tailored to the patients' population as a requirement and priority would help enlighten patients about budget-friendly and available options there are to them to improve their diet and lifestyle. Lastly, if a program were to exist as a separate entity under Baptist Hospital itself, centralizing it in a rural location would help with accessibility amongst those living in those areas who need its services most.

Limitations

There are many limitations to a program such as this being implemented- this is only a starting point to the possibility of implementing an efficacious program centered around these principles into the hospital system. Some of the barriers to this type of program are a lack of patient compliance and willingness to participate, a lack of physician-patient trust, and a sense of competition between medical entities rather than a sense of partnership. A physician can only go so far as the patient is willing to participate. The efficacy of a treatment is largely based on the willingness of a patient to trust and utilize it, no matter how passionate or knowledgeable the physician may be. Furthermore, a social component of compliance is also to be considered in that patients will probably be likely to participate in unhealthy behaviors if their family or friends participate in them as well or if their upbringing involved such activities. Research to improve patient compliance would greatly improve the efficacy of this type of program. A lack of physician-patient trust would also be a large barrier for some of the same reasons stated above. If a patient is unwilling to trust their physicians' knowledge or trust them enough to be truthful about their habits and health, then the patient cannot come up with an effective and implementable plan of care. This lack of trust can be due to cultural differences or mistakes from prior physicians. Research in this area would greatly improve the accuracy of information on this program's target population in order to create achievable goals for its participants. Lastly, a sense of competition between two medical entities could create a barrier for this kind of program. Unfortunately, nutrition and healthy lifestyle habit advocacy are not as engrained into the hospital system due to the revenue it generates compared to treatment using pharmaceuticals and surgery. Furthermore, partnering with another corporation could lead to dishonesty or losses of one corporation to another, and can pose a threat more than a partnership between the two entities. Further research on all these barriers would help tremendously in narrowing the disparities of nutritional accessibility and education.

Conclusion

Effectively implementing a nutritional education and food supply program for those with low accessibility and education would greatly improve the health and wellness of this population and would greatly decrease the rates of hospitalization of those suffering from chronic illness. Based on my research, I believe a program built on partnership, accurate data about target populations, and a healthcare model making nutrition and lifestyle a priority would be key to making such a program successful and accessible. I think Memphis especially would benefit from a program such as this due to the high prevalence of chronic illness

compared to the rest of the nation. Through not only an implementable program but also through a holistic, patient-centered mindset, health disparities between the affluent and the poor, the rural and the suburban, can be made much smaller and lead to a healthy and happy population.

References

- Bansal et. al. "Impact of a Whole-Foods, Plant-Based Nutrition Intervention on Patients Living with Chronic Disease in an Underserved Community". *American Journal of Lifestyle Medicine*. Jun. 2021. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9189580/>
- Baptist Memorial Hospital. "Weight Loss and Bariatric Surgery". *Baptist Memorial Hospital*. 2023. <https://www.baptistonline.org/services/weight-loss/weight-loss-surgery>
- Better Tennessee. "Memphis and Shelby County Health Brief". *Better Tennessee*. 2018. <https://bettertennessee.com/memphis-shelby-county-health-brief/>
- Carlson, Steven. Neuberger, Zoe. (2021). *WIC Works: Addressing the Nutrition and Health Needs of Low-Income Families for More Than Four Decades*. Center on Budget and Policy Priorities. <https://www.cbpp.org/research/food-assistance/wic-works-addressing-the-nutrition-and-health-needs-of-low-income-families>
- Centers for Disease Control and Prevention (2018). *QuickStats: Rate of Emergency Department (ED) Visits, by Homeless Status and Geographic Region — National Hospital Ambulatory Medical Care Survey, United States, 2015–2018*. Centers For Disease Control and Prevention. MMWR Morb Mortal Wkly Rep 2020;69:1931. DOI: <http://dx.doi.org/10.15585/>
- Church Health. *Medical Clinic* (2023). Church Health. <https://churchhealth.org/clinical-services/medical/>
- Le Bonheur Children's Hospital (2023). Nutrition Therapy. LeBonheur Children's Hospital. <https://www.lebonheur.org/services/nutrition-therapy>
- O'Neill Hayes, Tara. Gillian, Serena. (2020). *Chronic Disease in the United States: A Worsening Health and Economic Crisis*. American Action Forum. <https://www.americanactionforum.org/research/chronic-disease-in-the-united-states-a-worsening-health-and-economic-crisis/>
- Raghupathi, W., & Raghupathi, V. (2018). An Empirical Study of Chronic Diseases in the United States: A Visual Analytics Approach. *International journal of environmental research and public health*, 15(3), 431. <https://doi.org/10.3390/ijerph15030431>.
- Shin, E. K., Kwon, Y., & Shaban-Nejad, A. (2019). Geo-clustered chronic affinity: pathways from socio-economic disadvantages to health disparities. *JAMIA open*, 2(3), 317–322. <https://doi.org/10.1093/jamiaopen/ooz029>
- St. Jude Children's Research Hospital. (2023). *Medical Nutrition Therapy (MNP)*. <https://www.stjude.org/treatment/services/clinics-and-services/clinical-nutrition/medical-nutrition-therapy-mnt.html>
- United States Department of Agriculture. *The Special Supplemental Nutrition Program for Women, Infants and Children (WIC Program)*. United States Department of Agriculture. <https://www.fns.usda.gov/wic/wic-fact-sheet>

Considering Hypertension as a Direct Link to Neuroinflammation and Subsequent Pathogenesis in Alzheimer's Disease: A Narrative Review

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Faculty Reviewer(s): Dr. Charity Brannen

Introduction

Alzheimer's disease (AD) is recognized as a chronic, neurodegenerative disease as a result of amyloid- β (Ab) accumulation and the formation of neurofibrillary tangles (NFTs) within the brain.¹ AD is the most common form of dementia, an umbrella term used to describe symptoms of cognitive decline expressed as forgetfulness, impaired problem-solving skills, confusion, and difficulty speaking among others.¹ In addition to physical deficits caused by AD, the emotional impact it poses on individuals can be quite upsetting. What's more, family and friends who are often caregivers must watch the slow, heartbreaking course of their loved one's decline. Aside from mere observation, psychiatric symptoms, or behavioral and psychological symptoms of dementia (BPSD) are expressed by signs of aggression, apathy, hallucinations, and irritability, making the caregiving role even more challenging.²

There is no one-size-fits-all diagnosis for AD as both the age in which symptoms appear and the rate of progression can vary. Specifically, early-onset AD (EOAD) and late-onset AD (LOAD) are used to characterize time of symptom onset. The former describes the presence of symptoms before the age of 65, whereas the latter represents symptoms beginning after the age of 65.³ AD can be further divided in accordance to its rate of progression. The frequent form, known as typical AD progresses over the course of 8-10 years, whereas rapidly progressive AD (rpAD) is much more expeditious with the survival age at onset being 2-3 years.⁴

Extensive research has been employed on AD pathology over the past century, leading to the development of two popular theories: the amyloid hypothesis pinpoints the accumulation of Ab within the brain as a causal factor for the downstream production of NFTs formed by the addition of phosphate groups to τ -proteins.⁵ Relatively speaking, the cholinergic hypothesis places emphasis on the neurotransmitter, acetylcholine, as being the culprit to neurodegeneration.⁵

Nonetheless, researchers are shifting their focus to other potential determinants such as immunological response pathways, chronic hypertension, and neuroinflammation. The purpose of this review is to investigate established literature and connect it to newer, promising propositions in hopes of providing scientists with effective therapeutic drug targets. In particular, this paper will help establish a foundational understanding regarding amyloidogenic pathways and determine whether chronic hypertension has the potential to be mechanistically linked to AD as a modifiable risk factor.

Established Research

AD Epidemiology

Dementia's ubiquitous nature is represented by the large number of individuals who currently suffer from AD and other neurodegenerative disorders. Epidemiological studies confirm that globally over 25 million individuals have dementia, with AD being the remarkable diagnosis. One US study investigated the prevalence of AD in a sample population consisting of individuals > 70 years of age, finding 9.7% of the individuals had AD.⁶ According to 2023 figures reported by the Alzheimer's Association, > 6 million Americans have been diagnosed with AD, with a projected increase in prevalence to 13 million by 2050. In

2021 alone, AD and other related dementias have created a financial burden of \$621B and are expected to reach \$1T over the next 25 years.⁷

AD Pathogenesis

Current understandings of pathophysiological mechanisms for AD focus on the degeneration of neurons in the brain and its underlying causes have been linked to the previously mentioned accumulation of A β plaques outside of cells and NFTs consisting of hyperphosphorylated τ -protein inside cells in areas of the brain associated with thinking and emotion. Ultimately, these neurotoxic growths hinder neuronal communication as they arrest intracellular trafficking and cell-to-cell communication.

APP processing

Imperative for neuronal repair and plasticity, amyloid precursor protein (APP) is predominantly found in the neural membrane with elevated concentrations near the synaptic cleft.⁹ Like many transmembrane proteins, APP's functionality declines over time. Sequential cleavage via secretase enzymes breaks down the protein by either an amyloidogenic or non-amyloidogenic pathway. Non-amyloidogenic processing of APP involves extracellular cleavage by α -secretase between the Lys16 and Lys17 residues with extracellular release of secreted APP (APPs α), an important regulator for normal synaptic signaling and plasticity, leaving a CTF83 fragment in the membrane.¹⁰ Sequential cleavage of the CTF83 fragment by γ -secretase leads to the generation of APP intracellular domain (AICD). AICD then enters the nucleus where it regulates transcription and neuroprotective pathways.^{10,11} Alternatively, in the amyloidogenic pathway, APP is first cleaved at a different location by β -secretase, releasing APPs β and leaving a CTF99 fragment in the plasma membrane. The CTF99 fragment is cleaved by γ -secretase and produces A β ₄₀₋₄₂ peptide in addition to AICD. A β ₄₀₋₄₂ is associated with negative downstream effects noted in AD by its interaction with Apolipoprotein E (APOE). Interaction between APOE and A β ₄₀₋₄₂ results in the aggregation of A β oligomers, leading to the formation of A β plaques and the generation of reactive oxygen species (ROS), ultimately resulting in oxidative damage.¹¹

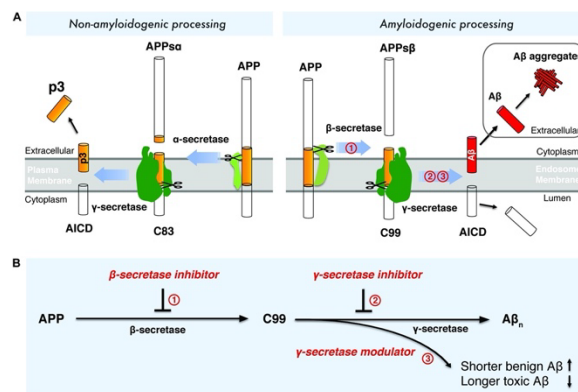


Fig. 1. Comparative illustration demonstrating the processing of APP in amyloidogenic and non-amyloidogenic pathways.¹¹

Neurofibrillary Tangles

Microtubules span the intracellular portion of neuron's axons to provide structural integrity and help facilitate intracellular transport. τ -proteins are embedded in the microtubules where their function is to assist in stabilization; however, in the presence of A β , τ -proteins become hyperphosphorylated, causing them to dissociate from microtubules and aggregate together.¹² This aggregation of hyperphosphorylated τ -proteins generates intracellular NFTs and destroys the microtubules, ultimately hindering neural communication, thus expediting the progression of AD.¹³

Dysfunction in Cholinergic Neurons

In physiological conditions, cholinergic neurons play an important role in the transmission of acetylcholine, which helps stimulate neurons and synchronize their action potentials. In contrast, cholinergic neurons in amyloidogenic conditions found in the cerebral cortex and hippocampus experience a decrease in choline acetyl transferase (ChAT), an enzyme responsible for catalyzing the production of acetylcholine. The concurrent disruption NFTs cause on microtubules along with the decrease in acetylcholine production results in a synergistic impairment on neuronal activity.¹⁴

Genetic Predispositions for AD

Variations in the APOE alleles have been targeted as primary genetic risk factors for AD. APOE proteins are made of 299 amino acids and facilitate lipid regulation for neuronal membrane repair and remodeling.¹⁵ APOE isoforms are a result of allele differences which lead to abnormal amino acid residues within the protein.¹⁶ APOE has 3 isoforms: E2, E3, and E4, and correspond with e2, e3, and e4 alleles, respectively. Each allele is responsible for encoding variations in amino acid residues 112 and 158 on APOE.¹⁷ The isoforms and their corresponding amino acid residues are as follows: ApoE2 (Cys112, Cys158); ApoE3 (Cys112, Arg158); ApoE4 (Arg112, Arg158).¹⁷ Although alterations are limited to two amino acids, these changes dictate the structure of the protein and thus determine its function. Studies have labelled the e4 allele as being the dominant genetic risk factor for AD due to its hindrance in the processing and removal of Ab.¹⁷

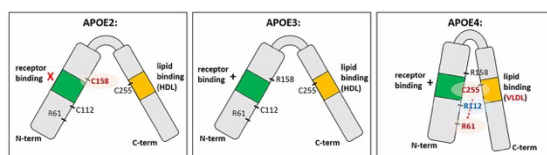


Fig. 2. APOE allele variation and their associated amino acid residues. e2 contains two cysteine residues at 112 and 158, e3 has cysteine and arginine residues at 112 and 158, respectively, and e4 has two arginine residues at 112 and 158.¹⁷

Diagnostics

Given the complex nature of AD and the similarities it shares with other forms of dementia, such as Lewy body dementia and vascular dementia, diagnosing individuals can be quite difficult. Initially, a review of the individual's medical history, followed by a physical examination is performed. Evaluating cognitive function can be accomplished by implementing a standardized test like the Mini-Mental State Examination (MMSE). The MMSE measures cognitive function on a 30-point scale, with 10 points dedicated to evaluating familiarization with time and place, while the other 20 points assess attention, comprehension, recollection, and language. Implications show that achieving a score of 23 or 24 can reliably distinguish between normal cognitive function and cognitive impairment.¹⁸

Functional brain imaging, such as positron emission tomography (PET) and single photon emission computed tomography (SPECT), are especially used as diagnostic tools for detecting alterations in brain activity by employing radioactive tracer molecules which provide visualization of Ab plaques within the brain. Additionally, magnetic resonance imaging (MRI) and computed tomography (CT) help physicians detect changes in brain size and differentiate between other causes of dementia such as subdural hematomas or intracranial tumors, respectively.¹⁸

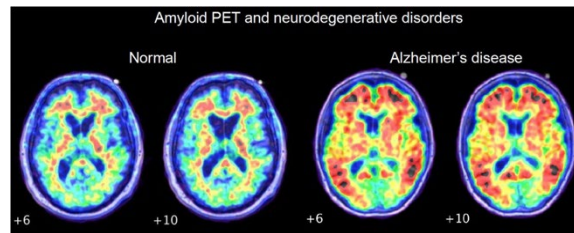


Fig. 3. On the left, PET scans of a normal brain display an absence of Ab plaque accumulation compared to the brain image on the right with AD. The increased concentration of red coloring is representative of Ab plaque accumulation.¹⁸

Conventional Treatment for AD

Presently, moderately effective drug treatment for AD includes both acetylcholinesterase inhibitors (AChEIs) and N-methyl-D-aspartate (NMDA) antagonists.¹⁹ Relevant to AChEIs, donepezil, galantamine, and rivastigmine demonstrate temporary, yet effective, intervention for AD by inhibiting acetylcholinesterase activity within neuronal synaptic clefts, ultimately reducing the breakdown of ACH in the brain.^{19,20} However, clinical studies show treatment with AChEIs only being beneficial when administration is started immediately, as patients who began treatment 6 months or later experienced minimal cognitive improvement.²⁰

Additionally, studies find the NMDA antagonist, memantine, to be notably effective when administered with galantamine or rivastigmine as it provides promising improvement in behavior and overall cognitive function.²¹ Additional analysis comparing memantine monotherapy versus combination therapy with galantamine and rivastigmine should be assessed to further determine its efficacy in treating AD.

Emerging Research

Cerebral Hypoxia and Neuroinflammation

Animal studies have been conducted to investigate the potential link between inflammation and hypertension in AD. The studies suggest that hypertension accelerates the onset of AD pathology and increases cerebral hypoxia and hypoperfusion, leading to a cycle of microglial activation, reactive oxygen species production, and blood-brain barrier (BBB) dysfunction. Further, results imply that hypertension induces cerebrovascular microgliosis, increased microvascular deposition of A β and hippocampal neurodegeneration, and microglial activation with IL-1 β upregulation.²² These results suggest that central nervous system (CNS) inflammation may be one of the possible mechanistic links between hypertension and AD.

Glial Cell Activation

Neuroinflammation is an innate physiological response that aids in the removal of toxic molecules as well as repairing the central nervous system (CNS) following injury.²³ In the amyloidogenic brains of individuals with AD, however, neuronal death as a result of Ab plaques and NFTs are responsible for acute inflammatory responses.²³ This is particularly due to the release of molecules by damaged neurons, triggering microglia to secrete cytokines and chemokines, signaling the downstream activation of astrocytes and ensuing neuroinflammation.²³

Indeed, evidence has proven the presence of inflammation within the brain in patients diagnosed with hypertension, as well as hypertensive animal models.²⁴ Additional findings in these models indicate pro-inflammatory responses within the brain in the form of activated microglia and astrocytes in concurrence with increased cytokine and ROS release.²⁴ Both astrocytes and microglia have two functional phenotypes. In hypertensive models, anti-inflammatory microglia (M1) undergo a change in phenotype by switching to their pro-inflammatory (M2) form.²⁴ Additionally, astrocytes can express either their neuroprotective (A2) or neuroinflammatory (A1) phenotypes; however, evaluations of astrocyte sensitivity to pro-inflammatory

mediators in hypertensive models have only been employed using glial fibrillary acidic protein (GFAP), which have been unremarkable for changes in phenotype.²⁴ Although it has been confirmed hypertension induces neuroinflammation in both human and animal models, further analysis should continue as the specific mechanisms responsible for this change remain unknown.

Production and secretion of APOE in the brain are facilitated by microglia and astrocytes, respectively. APOE serves as an immunological regulator in that it promotes glial cell anti and pro-inflammatory immune responses in an isoform-dependent manner. Recent studies have isolated microglia and astrocytes from C57BL/6J mice carrying e2, e3, and e4 alleles and compared their inflammatory responses to exogenous lipopolysaccharide (LPS) stimuli by measure of TNF α secretion.²⁵ Primary cell cultures of glial cells were obtained using cortices collected from human APOE targeted-replacement mice. Ice-cold Opti-MEM media was used to separate tissue followed by centrifugation. Resuspended microglia were subjected to a nutrient-specific growth medium. Specifically, 2% fetal bovine serum (FBS), 0.6% glucose, 1mM sodium pyruvate, and 3% fetal horse serum (FHS) were used. The solution was agitated by shaking at 37 °C overnight, followed by disruption of adhered cells with trypsin. To confirm glial cell purity, immunofluorescence for microglial marker Iba-1 was used, confirming nearly 95% purity. Both TNF α and APOE concentrations were measured using enzyme-linked immunosorbent assay (ELISA). Isoform-dependent response to pro-inflammatory molecules was examined. TNF α secretion in APOE4 microglia was significantly higher in comparison to APOE2 and APOE3²⁵, validating the propagation of APOE4-induced neuroinflammation.

Cerebral Pathology and Decreased CBF

Decrease in blood flow to the brain is recognized as an early sign of AD, with studies showing a link between reduced CBF in the posterior cingulate cortex and subsequent cognitive decline in individuals without cognitive impairment.²⁶ The reason for this reduction is still being studied, yet some suggest it may be due to a decrease in metabolic demand, while others believe it may be due to cerebrovascular dysfunction.²⁷ Evidence from studies on AD transgenic mouse models and asymptomatic mutation carriers with familial AD suggests cerebrovascular pathology may be a contributing factor to reduced blood flow in individuals with AD.²⁸

Additionally, cerebrovascular problems may be a potential explanation for why individuals with midlife hypertension are at a higher risk of developing sporadic, late-onset AD.²⁹ This idea is supported by both preclinical and clinical research.^{30,31} Treating cerebrovascular complications with antihypertensive medication could be a practical target for reducing the cognitive and functional decline associated with AD by restoring blood flow to the brain. Experiments conducted on AD mouse models showed that hypertension in middle-aged animals resulted in decreased cerebral blood flow (CBF).³² However, treating these animals with the angiotensin receptor blocker, eprosartan, increased blood flow in the hippocampus.³³

Linking Hypertension to AD

Recent studies explore the impact of inflammatory mechanisms on the onset of hypertension.³⁴ Thus, inflammation associated with these conditions may play a part in causing brain inflammation linked with AD and heightened susceptibility to developing the disease.³⁵

Inflammatory Mediators

Mechanisms responsible for differences between inflammatory and vascular responses during normal and hypertensive conditions remain unexplained. It is known that injury to the vasculature system increases adhesion molecule expression on endothelial cells, leading to the propagation of various pro-inflammatory mediators (TNF α , interferons, and IL-1,2, and 6) secreted by lymphocytes, monocytes, and macrophages.³⁶ Further exacerbation results from disruption of the BBB and leakage of glial activating plasma proteins such as fibrinogen, thrombin, and immunoglobulins.³⁷

Other mechanisms linking hypertension to AD presume decreases in nicotinamide adenine dinucleotide (NAD⁺) due to aging leads to accumulation of defective mitochondria.³⁸ Mitophagy is a physiological process utilized for the removal of mitochondria with help from NAD⁺ as a cofactor; thus, when levels are low, this process becomes disrupted.^{38,39} Abnormalities in the processing of defective mitochondria contribute to both neurological and cardiovascular diseases, where the latter influences atherosclerosis and hypertension. Hence, damaged endothelial cells in combination with oxidative stress lead to immunological responses responsible for the exacerbation of AD pathogenesis.⁴⁰

Further, chronic hypertension is known as a major risk factor for atherosclerosis, which has the potential to induce pro-inflammatory responses within the vasculature system.⁴¹ Notably, immunological responses relative to atherosclerosis are a consequence of increased vasculature permeability leading to the influx of T-cell and monocyte accumulation in blood vessels and secretion of additional pro-inflammatory molecules.⁴² It's postulated there is some correlation between atherosclerotic vessels and neuroinflammation. In an attempt to determine the relationship between the two, Denes et al. (2012) used mice that had been placed on a diet high in pro-atherosclerotic foods and then measured inflammatory responses by microglia.⁴² Activation of microglia in mice with atherosclerosis was significantly higher, providing an obvious association between the two.⁴²

Moreover, emphasis is placed on the accumulation of IL-1b along with increased oxidative stress in the brain as a result of salt-induced hypertension.^{42,43} Studies performed by Qi et al. (2016) noted a significant increase in inflammatory mediators within the hypothalamic paraventricular nucleus (PVN) of salt-sensitive rats when fed high-salt foods compared to rats with normal diets.⁴³ This evidence provides a promising correlation between hypertension and its influence on neuroinflammation, as increased levels of IL-1b are remarkable for pro-inflammatory responses.

Angiotensin II as a Blood Pressure Regulator

The renin-angiotensin system (RAS) plays a central role in blood pressure (BP) regulation by the binding of angiotensin II (Ang II), a peptide hormone, to associated receptors, causing an increase in BP.⁴⁴ Studies prove a decrease in the incidence of stroke and increased cognitive function upon RAS inhibition.⁴⁵ Thus, administration of Ang II in animal models as a mechanism for increasing BP provides researchers with a method for observing the impact hypertension induced by Ang II has on cognitive function. In both animal models and humans, Ang II type 1 receptors (AT₁R) are found in high concentrations within the brain. Categorically, AT₁R appears in microglia, astrocytes, and cerebrovascular endothelial cells (CECs).⁴⁵ Upon binding of Ang II to AT₁R, the pro-inflammatory signaling pathway is activated, causing the release of cytokines, ROS, and expression of cell adhesion molecules (CAM).⁴⁶ Further, the influx of inflammatory mediators disrupts the BBB and disturbs mechanisms for CBF maintenance.⁴⁶ It's important to note that in non-hypertensive models, Ang II fails to cross the BBB, yet in models remarkable for hypertension, Ang II gains access as a result of perforated capillaries in cerebroventricular organs (CVO).⁴⁷

Recently Approved and Potential Treatments for AD

Although existing therapeutics for AD provide, in some measure, improved cognitive function and decreased disease progression, absolute rehabilitation remains ambiguous. The classic approach for treating AD focuses primarily on slowing its progression in its later stages, yet, by the time symptoms appear, significant neurodegeneration has already occurred.⁴⁸ Novel AD therapeutics shift from reversing disease progression to treating the disease in its beginning stages.

Intervention with Monoclonal Antibodies

Briefly, antibodies (Ab) provide adaptive immunity within the body by facilitating the destruction and removal of pathogens. Monoclonal Abs (mAbs) are synthetic proteins that stimulate an immunological response by mimicking the body's endogenous Abs.⁴⁹

Promising drug treatment for AD has recently been revived by the Ab-directed mAb, Aducanumab.⁵⁰ Approved by the FDA in June 2021⁵⁰, aducanumab demonstrates being efficient in preventing Ab plaque formation and removing previously formed plaques. Results from 3 randomized control trials (RCTs) confirmed substantial dose and time-dependent decreases in Ab plaque generation⁵¹. Reported side effects include amyloid-related imaging abnormalities (ARIA), altered mental status, and mild encephalitis.⁵² Administration of aducanumab is recommended to be performed by intravenous infusion as this promotes perfusion through the BBB.⁵³

Nilvadipine as a CBF Mediator

As mentioned previously, diminished blood flow to the brain has been recognized as a hallmark sign of AD onset; therefore, a recent six-month randomized, double-blind, placebo-controlled study investigated specifically how reduced CBF contributes to the progression of AD. In particular, the study was aimed at determining how the calcium antagonist, nilvadipine, would affect CBF in people with mild-to-moderate AD. Researchers measured CBF in whole-brain gray matter and specific regions of interest, such as the hippocampus, using magnetic resonance arterial spin labeling.⁵⁴ A total of 58 patients were randomly assigned to the trial, with 29 in each group. Out of those, 22 participants in both groups had no magnetic resonance exclusion criteria and were medication-compliant during the entire six-month period. The average age was 72.8 ± 6.2 years.

The use of nilvadipine resulted in a decrease of systolic BP by 11.5 mmHg, while the CBF in whole-brain gray matter remained unchanged. However, the CBF in the hippocampus increased by 24.4 mmHg.⁵⁴ These results suggest that nilvadipine not only lowered BP but also increased CBF in the hippocampus, which indicates the positive effects of antihypertensive treatment on cerebrovascular health in individuals with AD. Furthermore, the findings suggest that cerebral autoregulation is preserved in AD.

Neuroinflammatory Antagonist

As described earlier, TNF α plays a key role in regulating inflammatory responses within the brain. Further, animal studies have connected an increase in ionized calcium-binding adapter molecule 1 (IBA1) production to be associated with neurodegeneration observed in AD.⁵⁵ Hydralazine, which is a medication that relaxes smooth muscles, has the dual benefit of reducing BP and inhibiting the production of TNF α in the hippocampus while also reducing the levels of IBA1 and GFAP in mice that were administered Ang-II as an inducer for hypertension.⁵⁵

Additionally, microglia in the brain express ACE, AT₁R, and AT₂R. Captopril, an ACE inhibitor drug used to treat hypertension, can reduce the secretion of nitric oxide and TNF in rat glial cells.⁵⁶ In a study on 5xFAD AD model mice, administering captopril through the nose for 3.5 weeks reduced cortical CD11b staining, which is a marker of activated microglia. After two months of treatment, both CD11b and Ab levels decreased in cortical regions.⁵⁶ The activation of microglial AT₁R under CNS inflammatory states switches them towards the pro-inflammatory and cytotoxic M1 phenotype, while activation of AT₂R shifts microglia towards the inflammation-resolving M2 phenotype. This knowledge has led to the utilization of both AT₁R antagonists and AT₂R agonists in reducing neuroinflammation in AD models.⁵⁷

Minocycline, an antibiotic, is a medication that has been used successfully to treat hypertension and neuroinflammation due to its anti-inflammatory and neuroprotective properties.⁵⁸ When minocycline is administered into the lateral ventricle of mice brains, it can prevent hypertension induced by Ang-II and decrease the levels of TNF α , IL-1 β , and IL-6 in the PVN as well as the number of activated microglia in this area.⁵⁹ As promising as these results are, combining different medications requires careful preclinical and clinical studies to evaluate their safety and effectiveness since previous studies have shown harmful interactions between some antihypertensive drugs and non-steroidal anti-inflammatory drugs.⁶⁰

DRUG	EFFECTS ON NEUROINFLAMMATION
MINOCYCLINE	Diminished PVN microglial activation and mRNAs for TNF, IL-1b and IL-6
HYDRALAZINE	Reduced hippocampal TNF and glial activation
CATOPRIL	Lowered nitric oxide and TNF
NILVADIPINE	Decreased systolic BP and increased CBF in the hippocampus

Fig. 4. Brief descriptions of how antihypertensives and the antibiotic minocycline mediate neuroinflammation.

Conclusion

Clearly, AD represents a significant challenge for many as it's the most relative form of dementia seen across the world. In this review discussions regarding the ways in which researchers are exploring other potential factors, such as chronic hypertension, immunological response pathways, and neuroinflammation, that could contribute to AD were discussed. Moreover, the relationship between inflammatory mechanisms and hypertension suggests the inflammation associated with hypertension may play a role in causing brain inflammation related to AD, potentially increasing the risk of developing the disease. Although current treatment options demonstrate mild improved cognitive function, curing the disease has yet to be achieved. Although animal biological machinery differs from humans', continuing to experiment with administration of antihypertensives such as calcium channel blockers, smooth muscle relaxants, and ACE inhibitors in animal models with AD, it's possible that absolute rehabilitation from this demoralizing disease could be accomplished in the near future.

List of Abbreviations

A1	=	Astroglia Phenotype 1
A2	=	Astroglia Phenotype 2
Ab	=	Antibody
Ab	=	Amyloid Beta
AChEI	=	Acetylcholinesterase Inhibitors
AD	=	Alzheimer's Disease
AICD	=	APP Intracellular Domain
Ang II	=	Angiotensin II Receptor
APOE	=	Apolipoprotein E
APP	=	Amyloid Precursor Protein
APPsa	=	Secreted APP Alpha
APPsb	=	Secreted APP Beta
Arg	=	Arginine
ARIA	=	Amyloid-Related Imaging Abnormalities
AT ₁ R	=	Angiotensin II Type 1 Receptor
BBB	=	Blood-Brain Barrier
BP	=	Blood Pressure
BPSD	=	Behavioral and Psychological Symptoms of Dementia
CAM	=	Cellular Adhesion Molecule
CBF	=	Cerebral Blood Flow
CD11b	=	Integrin Alpha M
CER	=	Cerebrovascular Endothelial Cells
ChAT	=	Choline Acetyl Transferase
CNS	=	Central Nervous System
CT	=	Computed Tomography

CTF83	=	Carboxyterminal Fragment 83
CTF99	=	Carboxyterminal Fragment 99
CVO	=	Cerebroventricular Organs
Cys	=	Cysteine
EOAD	=	Early-Onset Alzheimer's Disease
FBS	=	Fetal Bovine Serum
FHS	=	Fetal Horse Serum
GFAP	=	Glial Fibrillary Acidic Protein
IL	=	Interleukin
LOAD	=	Late-Onset Alzheimer's Disease
LPS	=	Lipopolysaccharide
M1	=	Microglia Phenotype 1
M2	=	Microglia Phenotype 2
mAb	=	Monoclonal Antibody
MRI	=	Magnetic Resonance Imaging
NAD	=	Nicotinamide Adenine Dinucleotide
NFTs	=	Neurofibrillary Tangles
NMDA	=	N-methyl-D-aspartate Antagonist
PET	=	Positron Emission Tomography
PVN	=	Paraventricular Nucleus
RCT	=	Randomized Control Trial
ROS	=	Reactive Oxygen Species
rpAD	=	Rapid Alzheimer's Disease
SPECT	=	Single Photon Emission Computed Tomography
TNF α	=	Tumor Necrosis Factor Alpha

References

1. Breijyeh Z, Karaman R. Comprehensive Review on Alzheimer's Disease: Causes and Treatment. *Molecules*. 2020;25(24):5789. doi:<https://doi.org/10.3390/molecules25245789>
2. Altomari N, Bruno F, Laganà V, et al. A Comparison of Behavioral and Psychological Symptoms of Dementia (BPSD) and BPSD Sub-Syndromes in Early-Onset and Late-Onset Alzheimer's Disease. *Journal of Alzheimer's Disease*. Published online November 27, 2021:1-9. doi:<https://doi.org/10.3233/jad-215061>
3. Leszek J, Mikhaylenko EV, Belousov DM, et al. The Links between Cardiovascular Diseases and Alzheimer's Disease. *Current Neuropharmacology*. 2020;19(2):152-169.doi:<https://doi.org/10.2174/1570159x18666200729093724>
4. Schmidt C. Rapidly Progressive Alzheimer Disease. *Archives of Neurology*. 2011;68(9):1124. doi:<https://doi.org/10.1001/archneurol.2011.189>
5. Armstrong RA. What causes alzheimer's disease? *Folia Neuropathol*. 2013;51(3):169-88. doi: 10.5114/fn.2013.37702. PMID: 24114635.
6. Qiu C, Kivipelto M, von Strauss E. Epidemiology of Alzheimer's disease: occurrence, determinants, and strategies toward intervention. *Dialogues Clin Neurosci*. 2009;11(2):111-28. doi: 10.31887/DCNS.2009.11.2/cqiu. PMID: 19585947; PMCID: PMC3181909.
7. 2021 Alzheimer's disease facts and figures. *Alzheimers Dement*. 2021 Mar;17(3):327-406. doi: 10.1002/alz.12328. Epub 2021 Mar 23. PMID: 33756057.
8. Gouras GK, Olsson TT, Hansson O. β -Amyloid peptides and amyloid plaques in Alzheimer's disease. *Neurotherapeutics*. 2015 Jan;12(1):3-11. doi: 10.1007/s13311-014-0313-y. PMID: 25371168; PMCID: PMC4322079.

9. O'Brien RJ, Wong PC. Amyloid precursor protein processing and Alzheimer's disease. *Annu Rev Neurosci.* 2011;34:185-204. doi: 10.1146/annurev-neuro-061010-113613. PMID: 21456963; PMCID: PMC3174086.
10. Livingstone RW, Elder MK, Barrett MC, Westlake CM, Peppercorn K, Tate WP, Abraham WC, Williams JM. Secreted Amyloid Precursor Protein-Alpha Promotes Arc Protein Synthesis in Hippocampal Neurons. *Front Mol Neurosci.* 2019 Aug 14;12:198. doi: 10.3389/fnmol.2019.00198. PMID: 31474829; PMCID: PMC6702288.
11. Zhao J, Liu X, Xia W, Zhang Y, Wang C. Targeting Amyloidogenic Processing of APP in Alzheimer's Disease. *Front Mol Neurosci.* 2020 Aug 4;13:137. doi: 10.3389/fnmol.2020.00137. PMID: 32848600; PMCID: PMC7418514.
12. Gong CX, Iqbal K. Hyperphosphorylation of microtubule-associated protein tau: a promising therapeutic target for Alzheimer disease. *Curr Med Chem.* 2008;15(23):2321-8. doi: 10.2174/092986708785909111. PMID: 18855662; PMCID: PMC2656563.
13. Schindowski K, Belarbi K, Buée L. Neurotrophic factors in Alzheimer's disease: role of axonal transport. *Genes Brain Behav.* 2008 Feb;7 Suppl 1(1):43-56. doi: 10.1111/j.1601-183X.2007.00378.x. PMID: 18184369; PMCID: PMC2228393.
14. Picciotto MR, Higley MJ, Mineur YS. Acetylcholine as a neuromodulator: cholinergic signaling shapes nervous system function and behavior. *Neuron.* 2012 Oct 4;76(1):116-29. doi: 10.1016/j.neuron.2012.08.036. PMID: 23040810; PMCID: PMC3466476.
15. Mahley RW. Apolipoprotein E: from cardiovascular disease to neurodegenerative disorders. *J Mol Med (Berl).* 2016 Jul;94(7):739-46. doi: 10.1007/s00109-016-1427-y. Epub 2016 Jun 9. PMID: 27277824; PMCID: PMC4921111.
16. Liu CC, Liu CC, Kanekiyo T, Xu H, Bu G. Apolipoprotein E and Alzheimer disease: risk, mechanisms and therapy. *Nat Rev Neurol.* 2013 Feb;9(2):106-18. doi: 10.1038/nrneurol.2012.263. Epub 2013 Jan 8. Erratum in: *Nat Rev Neurol.* 2013. doi: 10.1038/nrneurol.2013.32. Liu, Chia-Chan [corrected to Liu, Chia-Chen]. PMID: 23296339; PMCID: PMC3726719.
17. Fernandez CG, Hamby ME, McReynolds ML, Ray WJ. The Role of APOE4 in Disrupting the Homeostatic Functions of Astrocytes and Microglia in Aging and Alzheimer's Disease. *Front Aging Neurosci.* 2019 Feb 11;11:14. doi: 10.3389/fnagi.2019.00014. PMID: 30804776; PMCID: PMC6378415.
18. Chapleau M, Iaccarino L, Soleimani-Meigooni D, Rabinovici GD. The Role of Amyloid PET in Imaging Neurodegenerative Disorders: A Review. *J Nucl Med.* 2022 Jun;63(Suppl 1):13S-19S. doi: 10.2967/jnumed.121.263195. PMID: 35649652; PMCID: PMC9165727.
19. Vaz M, Silvestre S. Alzheimer's disease: Recent treatment strategies. *Eur J Pharmacol.* 2020 Nov 15;887:173554. doi: 10.1016/j.ejphar.2020.173554. Epub 2020 Sep 15. PMID: 32941929.
20. Yiannopoulou KG, Papageorgiou SG. Current and Future Treatments in Alzheimer Disease: An Update. *J Cent Nerv Syst Dis.* 2020 Feb 29;12:1179573520907397. doi: 10.1177/1179573520907397. PMID: 32165850; PMCID: PMC7050025.
21. Robinson DM, Keating GM. Memantine: a review of its use in Alzheimer's disease. *Drugs.* 2006;66(11):1515-34. doi: 10.2165/00003495-200666110-00015. PMID: 16906789.
22. Kruyer A, Soplop N, Strickland S, Norris EH. Chronic hypertension leads to neurodegeneration in the TgSwDI mouse model of Alzheimer's disease. *Hypertension.* 2015;66:175–182.
23. Bajwa E, Klegeris A. Neuroinflammation as a mechanism linking hypertension with the increased risk of Alzheimer's disease. *Neural Regen Res.* 2022 Nov;17(11):2342-2346. doi: 10.4103/1673-5374.336869. PMID: 35535868; PMCID: PMC9120695.
24. Youwakim J, Girouard H. Inflammation: A Mediator Between Hypertension and Neurodegenerative Diseases. *Am J Hypertens.* 2021 Oct 27;34(10):1014-1030. doi: 10.1093/ajh/hpab094. PMID: 34136907.

25. Lanfranco MF, Sepulveda J, Kopetsky G, Rebeck GW. Expression and secretion of apoE isoforms in astrocytes and microglia during inflammation. *Glia*. 2021 Jun;69(6):1478-1493. doi: 10.1002/glia.23974. Epub 2021 Feb 8. PMID: 33556209; PMCID: PMC8717762.
26. Benedictus MR, Leeuwis AE, Binnewijzend MA, Kuijter JP, Scheltens P, Barkhof F, van der Flier WM, Prins ND. Lower cerebral blood flow is associated with faster cognitive decline in Alzheimer's disease. *Eur Radiol*. 2017; 27:1169–1175. doi: 10.1007/s00330-016-4450-z
27. de la Torre J. The vascular hypothesis of Alzheimer's Disease: a key to preclinical prediction of dementia using neuroimaging. *J Alzheimers Dis*. 2018; 63:35–52.
28. Gama Sosa MA, Gasperi RD, Rocher AB, Wang AC, Janssen WG, Flores T, Perez GM, Schmeidler J, Dickstein DL, Hof PR, Elder GA. Age-related vascular pathology in transgenic mice expressing presenilin 1-associated familial Alzheimer's disease mutations. *Am J Pathol*. 2010; 176:353–368. doi: 10.2353/ajpath.2010.090482
29. Wiesmann M, Kiliaan AJ, Claassen JA. Vascular aspects of cognitive impairment and dementia. *J Cereb Blood Flow Metab*. 2013 Nov;33(11):1696-706. doi: 10.1038/jcbfm.2013.159. Epub 2013 Sep 11. PMID: 24022624; PMCID: PMC3824191.
30. Iadecola C. The neurovascular unit coming of age: a journey through neurovascular coupling in health and disease. *Neuron*. 2017; 96:17–42. doi: 10.1016/j.neuron.2017.07.030
31. Kisler K, Nelson AR, Montagne A, Zlokovic BV. Cerebral blood flow regulation and neurovascular dysfunction in Alzheimer disease. *Nat Rev Neurosci*. 2017; 18:419–434. doi: 10.1038/nrn.2017.48
32. Wiesmann M, Capone C, Zerbi V, Mellendijk L, Heerschap A, Claassen JA, Kiliaan AJ. Hypertension impairs cerebral blood flow in a mouse model for Alzheimer's Disease. *Curr Alzheimer Res*. 2015; 12:914–922.
33. Wiesmann M, Roelofs M, van der Lugt R, Heerschap A, Kiliaan AJ, Claassen JA. Angiotensin II, hypertension and angiotensin II receptor antagonism: roles in the behavioural and brain pathology of a mouse model of Alzheimer's disease. *J Cereb Blood Flow Metab*. 2017; 37:2396–2413. doi: 10.1177/0271678X16667364
34. McKenzie JA, Spielman LJ, Pointer CB, Lowry JR, Bajwa E, Lee CW, Klegeris A. Neuroinflammation as a common mechanism associated with the modifiable risk factors for Alzheimer's and Parkinson's diseases. *Curr Aging Sci*. 2017;10:158–176.
35. Newcombe EA, Camats-Perna J, Silva ML, Valmas N, Huat TJ, Medeiros R. Inflammation: the link between comorbidities, genetics, and Alzheimer's disease. *J Neuroinflammation*. 2018;15:276.
36. Winkowski PJ, Radkowski M, Wszedybyl-Winkowska M, Demkow U. Brain inflammation and hypertension: the chicken or the egg? *J Neuroinflammation*. 2015 May 3;12:85. doi: 10.1186/s12974-015-0306-8. PMID: 25935397; PMCID: PMC4432955.
37. Sprague AH, Khalil RA. Inflammatory cytokines in vascular dysfunction and vascular disease. *Biochem Pharmacol*. 2009 Sep 15;78(6):539-52. doi: 10.1016/j.bcp.2009.04.029. Epub 2009 May 4. PMID: 19413999; PMCID: PMC2730638.
38. Wang X, He HJ, Xiong X, Zhou S, Wang WW, Feng L, Han R, Xie CL. NAD⁺ in Alzheimer's Disease: Molecular Mechanisms and Systematic Therapeutic Evidence Obtained in vivo. *Front Cell Dev Biol*. 2021 Aug 3;9:668491. doi: 10.3389/fcell.2021.668491. PMID: 34414179; PMCID: PMC8369418.
39. Pires M, Rego AC. Apoe4 and Alzheimer's Disease Pathogenesis-Mitochondrial Deregulation and Targeted Therapeutic Strategies. *Int J Mol Sci*. 2023 Jan 1;24(1):778. doi: 10.3390/ijms24010778. PMID: 36614219; PMCID: PMC9821307.
40. Chakravorty A, Jetto CT, Manjithaya R. Dysfunctional Mitochondria and Mitophagy as Drivers of Alzheimer's Disease Pathogenesis. *Front Aging Neurosci*. 2019 Nov 20;11:311. doi: 10.3389/fnagi.2019.00311. PMID: 31824296; PMCID: PMC6880761.

41. Li JJ, Chen JL. Inflammation may be a bridge connecting hypertension and atherosclerosis. *Med Hypotheses*. 2005;64(5):925-9. doi: 10.1016/j.mehy.2004.10.016. PMID: 15780486.
42. Denes A, Drake C, Stordy J, Chamberlain J, McColl BW, Gram H, Crossman D, Francis S, Allan SM, Rothwell NJ. Interleukin-1 mediates neuroinflammatory changes associated with diet-induced atherosclerosis. *J Am Heart Assoc*. 2012 Jun;1(3):e002006. doi: 10.1161/JAHA.112.002006. Epub 2012 Jun 22. PMID: 23130147; PMCID: PMC3487321.
43. Qi J, Yu XJ, Shi XL, Gao HL, Yi QY, Tan H, Fan XY, Zhang Y, Song XA, Cui W, Liu JJ, Kang YM. NF- κ B Blockade in Hypothalamic Paraventricular Nucleus Inhibits High-Salt-Induced Hypertension Through NLRP3 and Caspase-1. *Cardiovasc Toxicol*. 2016 Oct;16(4):345-54. doi: 10.1007/s12012-015-9344-9. PMID: 26438340.
44. Abiodun OA, Ola MS. Role of brain renin angiotensin system in neurodegeneration: An update. *Saudi J Biol Sci*. 2020 Mar;27(3):905-912. doi: 10.1016/j.sjbs.2020.01.026. Epub 2020 Jan 30. PMID: 32127770; PMCID: PMC7042626.
45. Yim HE, Yoo KH. Renin-Angiotensin system - considerations for hypertension and kidney. *Electrolyte Blood Press*. 2008 Jun;6(1):42-50. doi: 10.5049/EBP.2008.6.1.42. Epub 2008 Jun 30. PMID: 24459521; PMCID: PMC3894487.
46. Zhang M, Mao Y, Ramirez SH, Tuma RF, Chabrashvili T. Angiotensin II induced cerebral microvascular inflammation and increased blood-brain barrier permeability via oxidative stress. *Neuroscience*. 2010 Dec 15;171(3):852-8. doi: 10.1016/j.neuroscience.2010.09.029. Epub 2010 Sep 24. PMID: 20870012.
47. Biancardi VC, Stern JE. Compromised blood-brain barrier permeability: novel mechanism by which circulating angiotensin II signals to sympathoexcitatory centres during hypertension. *J Physiol*. 2016 Mar 15;594(6):1591-600. doi: 10.1113/JP271584. Epub 2015 Dec 21. PMID: 26580484; PMCID: PMC4799983.
48. Przybyłowska M, Dzierzbicka K, Kowalski S, Demkowicz S, Daśko M, Inkielewicz-Stepniak I. Design, synthesis and biological evaluation of novel *N*-phosphorylated and *O*-phosphorylated tacrine derivatives as potential drugs against Alzheimer's disease. *J Enzyme Inhib Med Chem*. 2022 Dec;37(1):1012-1022. doi: 10.1080/14756366.2022.2045591. PMID: 35361039; PMCID: PMC8979514.
49. Quinteros DA, Bermúdez JM, Ravetti S, Cid A, Allemandi DA, Palma SD. Therapeutic use of monoclonal antibodies: general aspects and challenges for drug delivery. *Nanostructures for Drug Delivery*. 2017:807–33. doi: 10.1016/B978-0-323-46143-6.00025-7. Epub 2017 Mar 31. PMCID: PMC7151974.
50. Padda IS, Parmar M. Aducanumab. 2022 Nov 30. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan–. PMID: 34424635.
51. Kverno K. New Treatment Aimed at Preventing Alzheimer's Dementia. *J Psychosoc Nurs Ment Health Serv*. 2022 May;60(5):11-14. doi: 10.3928/02793695-20220324-02. Epub 2022 May 1. PMID: 35510912.
52. Cummings J, Aisen P, Lemere C, Atri A, Sabbagh M, Salloway S. Aducanumab produced a clinically meaningful benefit in association with amyloid lowering. *Alzheimers Res Ther*. 2021 May 10;13(1):98. doi: 10.1186/s13195-021-00838-z. PMID: 33971962; PMCID: PMC8111757.
53. Tashima T. Delivery of Intravenously Administered Antibodies Targeting Alzheimer's Disease-Relevant Tau Species into the Brain Based on Receptor-Mediated Transcytosis. *Pharmaceutics*. 2022 Feb 14;14(2):411. doi: 10.3390/pharmaceutics14020411. PMID: 35214143; PMCID: PMC8876001.
54. de Jong DLK, de Heus RAA, Rijpmma A, et al. Effects of Nilvadipine on Cerebral Blood Flow in Patients With Alzheimer Disease. *Hypertension*. 2019;74(2):413-420. doi:https://doi.org/10.1161/hypertensionaha.119.12892
55. Qi J, Yu XJ, Shi XL, Gao HL, Yi QY, Tan H, Fan XY, Zhang Y, Song XA, Cui W, Liu JJ, Kang YM. NF-kappaB blockade in hypothalamic paraventricular nucleus inhibits high-salt-induced hypertension through NLRP3 and caspase-1. *Cardiovasc Toxicol*. 2016;16:345–354.

56. Asraf K, Torika N, Apte RN, Fleisher-Berkovich S. Microglial activation is modulated by captopril: in vitro and in vivo studies. *Front Cell Neurosci.* 2018;12:116.
57. Labandeira-Garcia JL, Rodríguez-Perez AI, Garrido-Gil P, Rodríguez-Pallares J, Lanciego JL, Guerra MJ. Brain renin-angiotensin system and microglial polarization: Implications for aging and neurodegeneration. *Front Aging Neurosci.* 2017;9:129.
58. Kielian T, Esen N, Liu S, Phulwani NK, Syed MM, Phillips N, Nishina K, Cheung AL, Schwartzman JD, Ruhe JJ. Minocycline modulates neuroinflammation independently of its antimicrobial activity in staphylococcus aureus-induced brain abscess. *Am J Pathol.* 2007 Oct;171(4):1199-214. doi: 10.2353/ajpath.2007.070231. Epub 2007 Aug 23. PMID: 17717149; PMCID: PMC1988870.
59. Shi P, Diez-Freire C, Jun JY, Qi Y, Katovich MJ, Li Q, Sriramula S, Francis J, Sumners C, Raizada MK. Brain microglial cytokines in neurogenic hypertension. *Hypertension.* 2010;56:297–303.
60. Fournier JP, Sommet A, Durrieu G, Poutrain JC, Lapeyre-Mestre M, Montastruc JL. Drug interactions between antihypertensive drugs and non-steroidal anti-inflammatory agents: a descriptive study using the French pharmacovigilance database. *Fundament Clin Pharmacol.* 2014;28:230–235.

Poor Quality Care Impact on the Healthcare System

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Introduction

As a member of the healthcare field before, during, and after the Coronavirus Disease 2019 (COVID-19) pandemic, I have seen the downfall and shortcomings the healthcare system has faced. The COVID-19 Pandemic left a gap in healthcare staffing (Martin, et al., 2023). Most healthcare staff either resign due to the mental and emotional impact of COVID-19 or from being physically burned out from the increased work demands. As a result of inadequate healthcare staffing, the healthcare system has suffered due to the increase in work demands, burned-out nurses, increased wait times, and client dissatisfaction.

Being a current healthcare worker, the most frequent and increasing healthcare concern that I have seen is the delivery of poor-quality care. Poor-quality care is one of the most prevalent healthcare concerns today (Yanful, et al., 2023). Quality healthcare is a service representing the seven-dimensional aspects of safety, effectiveness, client-centeredness, integration, equitability, efficacy, and timeliness (World Health Organization [WHO], 2020). Ensuring all seven-dimensional aspects of healthcare are implemented during indirect or direct client care is necessary to promote positive health outcomes and client experiences. High-quality care consists of medical care services that aim to promote and support positive health outcomes, instill client trust, and adapt to changes within the community (Yanful, et al., 2023). High-quality care and universal health coverage (UHC) for all clients are expected within the healthcare field, but unfortunately, that does not always happen. When high-quality care is lacking in the clinical setting, healthcare providers and clients' medical outcomes and clients' perception of the healthcare system are impacted (Yanful, et al., 2023). There are three key aspects to consider when aiming to promote quality improvement. These three key aspects include client care that is evidence-based, availability of needed resources to treat clients, and an adaptable healthcare system that can respond to the clients' individual needs. A literature search was conducted through PubMed, Medline, and the National Library of Medicine using the keywords and phrases quality care, poor-quality care, high-quality care, the impact of poor-quality care, quality care affected population, benefits of adequate staffing, nurse burnout, poor-quality care effect on mortality rates, COVID-19 effect on the healthcare system, factors contributing to poor quality care, primary health care effect on quality care, and UHC relationship to quality care.

A contemporary concern in healthcare is poor-quality care. According to Langlois et al., (2020), "strengthening primary healthcare has been shown to improve population health outcomes and reduce all-cause mortality and is a cost-effective strategy for achieving UHC" (p. 1). Research studies have linked quality care and UHC to worldwide issues that affect clients' health outcomes, healthcare costs, and clients' healthcare experiences (*Agency for Healthcare Research and Quality*, 2020; Langlois et al., 2020; Yanful et al., 2023). The goal of UHC is to ensure that each individual and all communities have direct access to medical care without causing financial burden, while also providing efficient quality care through promotive, curative, rehabilitative, and palliative medical services (WHO, 2020). Without UHC, clients may have limited or no access at all to healthcare services or clients may delay treatment due to the cost (WHO, 2023). As a result of not having access to healthcare services and delayed treatment, clients' health outcomes will significantly decline leading to increased hospital readmission rates and increased hospital and emergency room overflow.

Studies have shown that poor-quality care happens more in low and middle-income countries and leads to between five and a half to over eight million deaths annually per country (Langlois et al., 2020). However, high-income countries, such as the United States, can also be affected, specifically individuals of low-

income, immigrants, Indigenous populations, and maternal populations (Yanful, et al., 2023). Furthermore, poor-quality care has a detrimental effect on the healthcare system such as increased incidences of misdiagnoses and medication errors (*Agency for Healthcare Research and Quality*, 2020).

Contributing Factors to Poor Quality of Care

Researchers revealed that the occurrence of poor quality care is due to the healthcare system limited resources, lack of universal health coverage, poor communication between healthcare providers, inconsistency in standard guidelines, health inequalities, or the lack of training and professionalism amongst healthcare providers (*Agency for Healthcare Research and Quality*, 2020; Langlois et al., 2020; Yanful et al., 2023). Additionally, the Organization for Economic Co-Operation and Development (OECD) explains that not having access to primary healthcare can also contribute to the occurrence of poor-quality care because clients cannot obtain follow-up appointments or routine doctor visits. Clients' inaccessibility to appointments are mostly due to the lack of available appointments, high co-pay and deductibles, or the lack of insurance coverage (*Agency for Healthcare Research and Quality*, 2020; *Realizing the Potential of Primary Health Care*, 2020).

As members of the healthcare system, providers have a binding contract with society. This binding contract symbolizes the expectations that healthcare workers must uphold regardless of the clients' race, financial status, social status, or insurance status. Healthcare providers are expected to always provide high-quality care that is effective, equitable, efficient, timely, client-centered, integrated, and safe. As stated in *Realizing the Potential of Primary Health Care* (2020), "In addition, applying an "equity" approach ensures that quality care is available to all, and that the quality of care provided does not differ by race, ethnicity, or other personal characteristics unrelated to a patient's reason for seeking care" (p.90). Avoidance or not efficiently fulfilling the needs of the population because of health inequalities can lead to poor quality care, distrust and dissatisfaction from clients, and clients' reluctance to engage in their own healthcare decisions. Another contributing factor to poor quality of care is healthcare providers' lack of knowledge and medical training. Evidence states that:

One of the biggest impacts of a lack of training in healthcare is the patient's quality of care. It is not just that there are fewer trained people in the industry but also that healthcare workers' training is less relevant to what is happening in the field (Huc-Curae: Care Anywhere [AUCU], 2024, para. 2).

Nurses and healthcare providers tend to have a busy workload. With the increasing demand for healthcare providers, healthcare staff members often lack the time, resources, and interest to enhance their skills and knowledge and invest in training courses (Huc-Curae: Care Anywhere, 2024). As a healthcare worker, I have seen medication errors, poor bedside manners, misuse of medical equipment, poor infection control techniques, and misdiagnosis because of inadequate training and knowledge. These errors and poor quality of care often lead to client harm and dissatisfaction (*Agency for Healthcare Research and Quality*, 2020).

Improving Quality of Care

It is my belief that the identification of poor-quality care is significantly important to the healthcare system because it could help implement strategies to improve healthcare services worldwide. The use of metrics that can measure and track patient outcomes is vital when deciding what is working to improve quality care. According to the OECD, the utilization of client questionnaires such as patient-reported experience measures (PREMs) and patient-reported outcome measures (PROMs) could allow clients to share their individual experiences, and their perception of the quality care that was provided, and provide feedback that can be used to promote improved quality care within the healthcare system (*Realizing the Potential of Primary Health Care*, 2020). As a result, the potential improvement of quality care could lead to a better

high-quality system that will “prevent 2.5 million deaths from cardiovascular disease, 900,000 deaths from tuberculosis, 1 million newborn deaths and half of all maternal deaths each year” (WHO, 2020, para 6).

My experience in the healthcare field has led me to believe that promoting the effectiveness and importance of using primary healthcare for routine preventive screenings, sick visits, medication management, follow-up appointments for chronic diseases, and as a direct line of communication with healthcare providers may help with improving quality of care. In return, clients may establish care with a primary healthcare provider which can lead to a decrease in hospital traffic and improve the quality of care in the healthcare system by freeing up more hospital beds, reducing hospital readmissions, lessening emergency department wait times, making available more healthcare staff, and decreasing unnecessary treatments (*Realizing the Potential of Primary Health Care*, 2020). According to the OECD, about 12% of the United States population is treated in the emergency department for non-urgent problems.

Conclusion

Despite the promise of UHC, the persistent lack of investment in primary healthcare, resources, staffing, and continuation of education has led to systemic deficiencies, resulting in poor quality care that undermines health outcomes and worsens inequities within the healthcare system. I believe having access to primary healthcare is the key to improving worldwide quality of care because of the readily available resources to routinely treat chronic diseases and provide preventive care services and annual checkups in a timely manner. Poor quality care will continue to increase over time if the correct actions are not taken to fix the problem. As stated in the *National Healthcare Quality and Disparities Report* (2021), “improving care requires facility administrators and providers to work together to expand access, enhance quality, and reduce disparities. It also requires coordination between the healthcare sector and other sectors for social welfare, education, and economic development” (p.15). Evidence suggests that factors such as limited resources in the healthcare setting, inadequate staffing, lack of universal health coverage, poor communication between providers, inconsistency in standard guidelines, health inequalities, and healthcare provider's lack of training and professionalism can affect the quality of care provided to clients.

To ensure that all clients receive high-quality care, healthcare providers need better training and accessibility to training courses, standard guidelines should be consistently followed in every clinical setting, policies that diminish health inequities should be enforced, and patient-centered care and professionalism should be enhanced (*Agency for Healthcare Research and Quality*, 2020; Langlois et al., 2020; Yanful et al., 2023). As stated in *Realizing the Potential of Primary Health Care* (2020), “Person-centered care and successful communication help lead to increased individual and provider satisfaction, trust in the provider, and functional and psychological well-being. Effective communication also leads to improved outcomes” (p. 92). Implementing strategies to improve the quality of care for all clients requires commitment and communication from all members who are a part of the healthcare system, willingness to adapt to changes, and a focus on continuous improvement. Improving quality care also requires adequate staffing in the healthcare field. An increased number of healthcare staff members could reduce work demands, allow more time with clients, reduce the number of burned-out nurses, provide more organization, and promote better collaboration between healthcare providers (Eaton, 2023). Furthermore, utilizing PREMs and PROMs client questionnaires in healthcare settings could accommodate healthcare providers with a comprehensive understanding of clients’ healthcare experiences and health outcomes. Healthcare provider's ability to understand clients’ experiences and individual health outcomes will allow them to deliver better, high-quality care. Hopefully, because of these implementations, quality of care will improve, mortality and morbidity rates will decrease, trust within society will be rebuilt, and overall, we will see trending results of an improved healthcare system.

References

- Agency for Healthcare Quality and Disparities. (2020). *2019 National healthcare quality and disparities report*. AHRQ Publication. <https://www.ncbi.nlm.nih.gov/books/NBK578527/>
- Eaton, D. (2020, September 18). *The importance of safe patient staffing for nurses and the benefit for grads*. Wolters Kluwer. <https://www.wolterskluwer.com/en/expert-insights/importance-of-safe-patient-staffing-for-nurses-and-benefit-for-grads>
- Huc-Curae: Care Anywhere. (2024). *Lack of training in healthcare: impact, causes, and opportunities for change*. HUCU.AI. <https://www.hucu.ai/lack-of-training-in-healthcare-impact-causes-and-opportunities-for-change/>
- Langlois, E.V., McKenzie A., Schneider, H., & Mecaskey, J.W. (2020). Measures to strengthen primary health-care systems in low- and middle-income countries. *Bulletin of the World Health Organization*, 98(11), 781-791. <https://doi.org/10.2471/BLT.20.252742>
- Martin, B., Kaminski-Ozturk, N., O'Hara, C., & Smiley, R. (2023). Examining the impact of the COVID-19 pandemic on burnout and stress among U.S. nurses. *Journal of Nursing Regulation*, 14(1), 4–12. [https://doi.org/10.1016/S2155-8256\(23\)00063-7](https://doi.org/10.1016/S2155-8256(23)00063-7)
- Organization for Economic Co-Operation and Development (2020), *Realising the potential of primary health care*, OECD Publishing, Paris. <https://doi.org/10.1787/a92adee4-en>
- World Health Organization. (2020, July 20). Quality Health Services. <https://www.who.int/news-room/fact-sheets/detail/quality-health-services>
- World Health Organization. (2023, October 5). Universal health coverage (UHC). [https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-\(uhc\)](https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc))
- Yanful B; Kirubarajan, A., Bhatia, D., Mishra, S., Allin, S., & Di Ruggiero, E. (2023). Quality of care in the context of universal health coverage: A scoping review. *Health Research Policy and Systems*, 21(1). <https://doi.org/10.1186/s12961-022-00957-5>

The Impact of Inadequate Healthcare on the Homeless Population

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Introduction

Homelessness is an issue in the United States that is ever-growing and ever-changing (U.S. Department of Housing and Urban Development, 2022). In 2022, there were an estimated 582,462 people who were deemed homeless in America. Homelessness is described as an individual who lacks a stable and fixed income and a permanent nighttime address. About 40% of the estimated homeless population were in unsheltered areas such as the street or abandoned buildings; the other 60% were located in emergency shelters or housing programs. Furthermore, according to the Homeless World Cup (2022), the reported number of people experiencing homelessness was 150 million worldwide.

There are many health disparities among the homeless population. According to Tyminski and Gonzalez (2020), the life expectancy for homeless individuals in America is over twenty years lower than that of the average person. For people experiencing homelessness (PEH), the life expectancy is around 42-52 years, whereas the average U.S. life expectancy is around 78 years. Moreover, PEH have a three-to-six-fold higher likelihood of experiencing an acute illness in comparison to the general population, and roughly 70% of PEH are not health insured. This means that PEH need more access to health care, and they are unable to receive it. The problem is that when people who need health care access are unable to access it easily, they could possibly have physical or mental declines in their health.

The purpose of this paper is to perform a literature review on the current state of health care among PEH and the mental and physical impacts of health care on that population. The research question is as follows: Are homeless individuals at an increased risk for an overall decrease in mental well-being?

Needs and Disparities of the Homeless

The homeless population in the United States indicates that homelessness is not specific to one race or ethnicity (U.S. Department of Housing and Urban Development, 2022). Among the estimated 582,462 homeless people in America: 50% are White, 37.3% are Black, 6.1% are Multiracial, 3.4% are American Indian, 1.8% are Native Hawaiian or Pacific Islander, and 1.4% are Asian. By gender, 60.6% are male, 38.3% are female, 0.6% are transgender, 0.4% are non-binary, and 0.1% are questioning. In 2022, the Community Alliance for the Homeless in Tennessee counted 1,055 homeless people in the Memphis/Shelby County area. Of those individuals, 298 were women, 743 were men, 12 were non-binary, and 4 were transgender. When dividing those numbers into racial demographics, 786 were Black, 223 were White, 6 were Indigenous or Alaskan Native, and 36 were multiracial (Community Alliance for the Homeless, 2022).

The homeless population is also at risk for multiple comorbidities (Capriotti et al., 2022). Illnesses such as tuberculosis (TB), Human Immunodeficiency Virus (HIV), and Hepatitis C Virus (HCV) are just some of the issues experienced by PEH. The incidence rate of TB is ten times higher in PEH than the general population. This is due to the more crowded living conditions, substance use, the co-infection of HIV/AIDS, incarceration, inadequate healthcare access, poor adherence to the treatment, and the higher prevalence of TB drug resistance. For HIV, the use of shared needles and the act of transactional sexual intercourse or sexual assault are the main risk factors for contracting the virus. For HCV, the prevalence is 9.8%-52.5% among PEH. The risk factors are similar to those for HIV.

According to a survey inclusive of 966 homeless adults by Baggett et al. (2010), 73% of participants said that they had at least one unmet health need. Those needs include the following: 32% had the inability to get medical or surgical care; 36% had inadequate prescription medication access; 21% needed mental health care; 41% lacked coverage for eyeglass or vision care; and 41% had trouble getting dental care. The main factors contributing to those unmet needs were a lack of food, being displaced from the home as a minor, vision impairments, and a lack of health insurance.

Having to live on the streets and in homeless shelters can precipitate an array of health risks among PEH, including being exposed to communicable diseases, experiencing weather such as thunderstorms or destructive tornados, violence, the use of drugs, and malnutrition (Institute for Health Policy Leadership, 2021). The lack of access to care can cause adverse outcomes. PEH who lack insurance or transportation may resort to using emergency services more often due to the limited options for care. PEH are often discharged from health care facilities with unhelpful resources or are placed into settings not ideal for a proper recovery, and this leads to higher rates of being readmitted and having adverse health outcomes. According to Simon et al. (2022), PEH "...lack financial security, stable housing, and food access. Meals may not be available at convenient times and locations...they are often not in frequent contact with...support persons...they do not have the resources equated with the social determinants of health" (p. 235).

Different age groups have different healthcare needs, and that does not change when it comes to PEH (Van Dongen et al., 2019). This study assessed age-specific needs within the homeless population through a sample of 378 participants, divided into older (above age fifty) and younger (below age fifty) groups. The older adults reported more heart disease (23.7% to 10.3%), vision problems (26.8% to 14.6%), limited familial support (33% to 19.6%), and hospital care used in the last year (50.5% to 34.5%) compared to the younger adults, respectively. In contrast, the younger adults had higher reports of cannabis use (45.2% to 12.4%), excessive alcohol use (27% to 16.5%), dental care used in the last year (46.6% to 20.6%), and mental health care used in the last year (25.6% to 16.5%) compared to the older adults.

Access to Care

According to a 2019 study by Paudya et al., the outlook on health care to PEH is one of hopelessness. PEH's opinion of their health was that there was nothing they could do for their health, and that the barriers were too substantial to overcome. These barriers include being alienated, lacking social support, and thinking that they had done irreversible damage to their health.

Another study by Mc Conalogue et al. (2019) found that the most common mental health issues reported among PEH were depression, anxiety, personality disorders and post-traumatic stress disorder (PTSD). The use of substances among PEH was also prevalent, but is commonly reported to be used as a coping mechanism. The same study found that PEH understood that substance use could impact their mental illnesses but explained that the perception of substance use was mainly to suppress memories or flashbacks to painful moments. Having no home or stable income, living among and dealing with people who rob and steal from you, or having a mental illness or a mental or physical disability can cause the turn toward substances to forget about the hardships, even if only temporarily.

According to Becker and Foli (2021), the reasons that PEH do not seek out care are due to a

"...distrust in healthcare services, emerging from feelings of...stigma from providers; prioritizing physiological needs such as food, shelter, clothing, over the safety needs of health; delaying seeking care until physical symptoms are severe; and having decreased access to healthcare because of being uninsured or having no money, requiring transportation, experiencing long wait times for appointments, or lacking knowledge of available healthcare services" (p. 278).

These barriers can contribute to higher incidences of serious health issues. If PEH cannot receive care due to these barriers, their health may decline. Therefore, delaying care may cause the exacerbation of a problem that could have been detected or treated earlier.

In regard to homeless youth, there were 30,090 homeless youth documented in 2022 (U.S. Department of Housing and Urban Development, 2022). Ninety-one percent of those were between the ages of 18-24, and the other 9% were under 18. It has been found that homeless youth are more likely to have been bullied, physically or sexually abused, or had encounters with child protective services than their peers (Morisseau-Guillot et al., 2019). Homeless youth, when compared to housed youth, are at a six times higher risk of suffering from two or more mental illnesses. Homeless youth correspondingly have barriers to accessing care, such as distrusting authority figures, cost of care, and issues of their record remaining confidential if they are minors (Klein et al., 2000). In addition, if these youth are getting care in a hospital setting, they may be asked for an address, health insurance, and parental permission for any treatment if they are under eighteen.

Literacy and health literacy are other factors that contribute to the health care of PEH (Farrell et al., 2019). Literacy is the ability to read and write. Health literacy involves the understanding of health problems and being able to follow the treatments and make informed decisions about one's health. Among PEH, literacy levels are perceived as higher than they are in actuality. Out of 192 participants in the study by Farrell et al. (2019), 86 reported that they read "very well"; next, when assessed for health literacy, 76% had a level of high school equivalence. Overall, 145 were at a high school level; 25 were at a 7-8th grade level; 12 were at a 4-6th grade level; and 10 were at a 3rd grade level or below.

Issues in Emergency Departments

Emergency departments (ED) are commonly used among PEH, as this may be the only health care that a homeless person can access (Moss et al., 2023). According to the study by Moss et al. (2023), out of 3,271 participants, 18.4% left the ED before getting treatment, and 1.2% died in the ED. The reason for leaving before treatment may be that PEH are nervous, feeling judged or mistreated, or they simply do not want to wait long for care. The reason for the death rate may be due to the fact that many PEH wait to call emergency services until their condition is so severe that they cannot be saved. Those same factors and barriers to regular health care may be present here as well: cost, lack of insurance, lack of transportation, or fear of providers.

Another issue faced by the homeless regarding care in the hospital is related to discharge education (Jenkinson et al., 2020). Hospital discharge is intended to send patients back to an environment equipped for recovery, yet most PEH do not fit into this category. Discharge education also highlights the follow-up care that should be performed. When a PEH gets discharge education, they may not be able to make the follow-up appointments. Additionally, they may not have had a staff member sit with them and explain what is expected of them regarding care. Most emergency homeless shelters are not equipped to provide the care needed for PEH who have been released from the hospital (Jenkinson et al., 2020).

Interventions

Lamanna et al. (2017) outline interventions to promote the continuity of care in an attempt to resolve the issues surrounding PEH, including fear of providers, lack of insurance or transportation, and cost. The first intervention mentioned is providing proper access to services. Accompanying PEH to their appointments with new providers was proven effective in reducing the barriers to accessing services. Some PEH have mental illnesses or cognitive disabilities that can cause difficulty for them to remember their appointment date, time, and location. Others can simply be too nervous to go to a new provider and place that is unknown. Next, offering timely services is important. Appointments made in a timely manner with additional services were deemed necessary to address the needs of PEH. Providing care in a timely manner can show the PEH that receiving care is not always as stressful as they have had in the past and that not all health care will

take a long time. Then, supporting PEH's early and sustained engagement in care is needed. Attending to PEH's individual needs, maintaining frequent contact with PEH, and offering services that were knowledgeable were considered critical to supporting continuity of care. Lastly, coordinating multiple diverse services can "...facilitate access, reduce unnecessary duplication, and improve the effectiveness and efficiency of health and social services" (p. 60). These interventions can promote continuity of care and allow for PEH to receive continuous access to health care.

Another intervention involves health education (Jean, 2017). A method of primary prevention involves educating PEH on risk factors for prevalent illnesses to their community such as TB, HIV, or HCV. Education can help PEH understand the causes, risk factors, and treatments for these illnesses. If PEH already have health problems, proper education on the cause, treatment, and lifestyle choices is critical to ensure that the problem does not exacerbate. Another primary preventative method is vaccines, such as Hepatitis A and B, influenza, TDAP, Meningitis, and HPV. Vaccines can prevent PEH from contracting these illnesses and will build up their immunity to them.

Secondary prevention of health issues for PEH involves health screenings (Jean 2017). The article by Jean (2017) outlines several screenings, including ones for conditions common in PEH, mental and behavioral health, and safety and living conditions. Common screenings include HIV, HCV, TB, cancer, heart disease, tobacco use, TBI, diabetes, hypertension, low bone density, and oral and vision problems. Mental health screenings include substance use, alcohol use, depression, anxiety, suicide risk, and PTSD. Safety and living condition screenings include housing, intimate partner violence, human trafficking, nutrition and food security, and environmental illnesses. These screenings may detect the existence of a physical or mental illness and allow for treatment of these problems, which could lead to better health outcomes.

Other interventions include continuing the implementation of patient-centered care, improving the coordination between resources, developing structural aspects of services, and identifying the limitations of scope and capacity to make sure that the care being given is intensive (Bell et al., 2022). In addition, increasing the availability of therapeutic spaces, and implementing long-term plans that are supported by evaluation are important. The expected outcome of these interventions is that PEH will receive care that prioritizes their health, involves multiple healthcare disciplines, and has their long-term health status in mind.

With these interventions, PEH may have an easier process when accessing health care, be able to access care that detects illness or diseases before exacerbation, and possibly prevent the progression of disease (Bell et al., 2022). Another outcome is that PEH may use emergency services less because they should be getting the adequate care they need, and do not need to go to the ED as often when their health problems become severe.

Conclusion

The problem among the homeless population relating to health care includes a lack of access, which might lead to decreased physical and mental well-being. Factors that contribute to this access are cost, lack of insurance, lack of reliable transportation, mental illness, or a fear of providers or facilities. Interventions such as providing proper access to services, offering timely services, supporting early and sustained engagement in care, and coordinating multiple diverse services can help provide continuity of care and allow PEH to have access to care when they need it. Health education can help PEH understand their current illnesses, how to treat the illnesses, and how to make health-conscious decisions for themselves. Providing screenings and immunizations are methods of prevention that allow for the prevention or early detection of illness and, therefore, early treatment. If successful, the utilization of these interventions could allow for fewer ED visits, fewer incidences of severe or exacerbated illness, and a higher prevalence of early testing and immunizations.

Another service that could be implemented in a community to allow these interventions to work at their full potential is providing literacy classes to PEH. These classes may help people build the skills to enhance their reading and writing skills, and, therefore, increase the knowledge of understanding their health needs. Another idea includes implementing more resources that provide free healthcare such as checkups or follow-up care, and services that offer prescription medications at discounted rates with ways of helping PEH pick up their medication.

Overall, the issues of homelessness and the impact of healthcare access are numerous. With the use of the aforementioned interventions, PEH should be able to have better access to health care and, therefore, have an increased physical and mental well-being.

References

- Baggett, T. P., O'Connell, J. J., Singer, D. E., & Rigotti, N. A. (2010). The unmet health care needs of homeless adults: A national study. *American Journal of Public Health, 100*(7), 1326–1333. <https://doi.org/10.2105/AJPH.2009.180109>
- Becker, J. N., & Foli, K. J. (2021). Health-seeking behaviours in the homeless population: A concept analysis. *Health & Social Care in the Community, 30*(2). <https://doi.org/10.1111/hsc.13499>
- Bell, L., Whelan, M., Fernandez, E., & Lycett, D. (2022). Nurse-led mental and physical healthcare for the homeless community: A qualitative evaluation. *Health & social care in the Community, 30*(6), 2282–2291. <https://doi.org/10.1111/hsc.13778>
- Capriotti, T., Cull, C., & Cohn, A. (2023). Comorbid infections affecting persons experiencing homelessness, barriers to treatment, and nursing implications. *MEDSURG Nursing, 32*(3), 149–154.
- Community Alliance for the Homeless. (2022). *Point in time count*. CAFTH Memphis. <https://www.cafth.org/point-in-time-count/>
- Community Alliance for the Homeless. (2023). 2023 Memphis/Shelby County point-in-time summary - [cafth.org](https://www.cafth.org/wp-content/uploads/2023/08/2023-PIT-Summary-.pdf). <https://www.cafth.org/wp-content/uploads/2023/08/2023-PIT-Summary-.pdf>
- Farrell, S. J., Dunn, M., & Huff, J. (2019). Examining health literacy levels in homeless persons and vulnerably housed persons with mental health disorders. *Community Mental Health Journal, 56*(4), 645–651. <https://doi.org/10.1007/s10597-019-00525-2>
- Homeless World Cup. (2022). *Global Homelessness Statistics*. <https://www.homelessworldcup.org/homelessness-statistics>
- Institute for Health Policy Leadership. (2021, March 11). *Disparities in health care for the homeless*. <https://ihpl.llu.edu/blog/disparities-health-care-homeless>
- Jean, M. (2017). Preventive care for people experiencing homelessness part I of II in a series on preventive care. *National Health Care for the Homeless Council*. Retrieved from <https://nhchc.org/wp-content/uploads/2019/08/healing-hands-preventative-care-finalized.pdf>

- Jenkinson, J., Wheeler, A., Wong, C., & Pires, L. (2020). Hospital discharge planning for people experiencing homelessness leaving acute care: A neglected issue. *Healthcare policy | politiques de Santé*, 16(1), 14–21. <https://doi.org/10.12927/hcpol.2020.26294>
- Klein, J. D., Woods, A. H., Wilson, K. M., Prospero, M., Greene, J., & Ringwalt, C. (2000). Homeless and runaway youths' access to health care. *Journal of Adolescent Health*, 27(5), 331–339. [https://doi.org/10.1016/s1054-139x\(00\)00146-4](https://doi.org/10.1016/s1054-139x(00)00146-4)
- Lamanna, D., Stergiopoulos, V., Durbin, J., O'Campo, P., Poremski, D., & Tepper, J. (2017). Promoting continuity of care for homeless adults with unmet health needs: The role of brief interventions. *Health & social care in the community*, 26(1), 56–64. <https://doi.org/10.1111/hsc.12461>
- Mc Conalogue, D., Maunder, N., Areington, A., Martin, K., Clarke, V., & Scott, S. (2019). Homeless people and health: A qualitative enquiry into their practices and perceptions. *Journal of Public Health*, 43(2), 287–294. <https://doi.org/10.1093/pubmed/fdz104>
- Morisseau-Guillot, R., Aubin, D., Deschênes, J.-M., Gioia, M., Malla, A., Bauco, P., Dupont, M.-È., & Abdel-Baki, A. (2019). A promising route towards improvement of homeless young people's access to mental health services: The creation and evolution of an outreach service network in Montréal. *Community Mental Health Journal*, 56(2), 258–270. <https://doi.org/10.1007/s10597-019-00456-y>
- Moss, C., Anselmi, L., & Sutton, M. (2023). Emergency department outcomes for patients experiencing homelessness in England: Retrospective cross-sectional study. *European Journal of Public Health*, 33(2), 161–168. <https://doi.org/10.1093/eurpub/ckac191>
- Paudyal, V., MacLure, K., Forbes-McKay, K., McKenzie, M., MacLeod, J., Smith, A., & Stewart, D. (2019). 'If I die, I die, I don't care about my health': Perspectives on self-care of people experiencing homelessness. *Health & social care in the community*, 28(1), 160–172. <https://doi.org/10.1111/hsc.12850>
- Simon, A. B., & Wolf, Z. R. (2022). Mini-ethnography and case studies on homeless persons' primary care needs in an urban community. *International Journal for Human Caring*, 26(4), 215–237. <https://doi.org/10.20467/humancaring-d-21-00003>
- Tyminski, Q., & Gonzalez, A. (2020). The importance of health management and maintenance occupations while homeless: A case study. *Work*, 65(2), 297–301. <https://doi.org/10.3233/wor-203081>
- U.S. Department of Housing and Urban Development (2022). The 2022 Annual Homeless Assessment Report (AHAR) to Congress. <https://www.huduser.gov/portal/datasets/ahar/2022-ahar-part-1-pit-estimates-of-homelessness-in-the-us.html>.
- Van Dongen, S. I., van Straaten, B., Wolf, J. R., Onwuteaka-Philipsen, B. D., van der Heide, A., Rietjens, J. A., & van de Mheen, D. (2019). Self-reported health, healthcare service use and health-related needs: A comparison of older and younger homeless people. *Health & social care in the community*, 27(4). <https://doi.org/10.1111/hsc.12739>