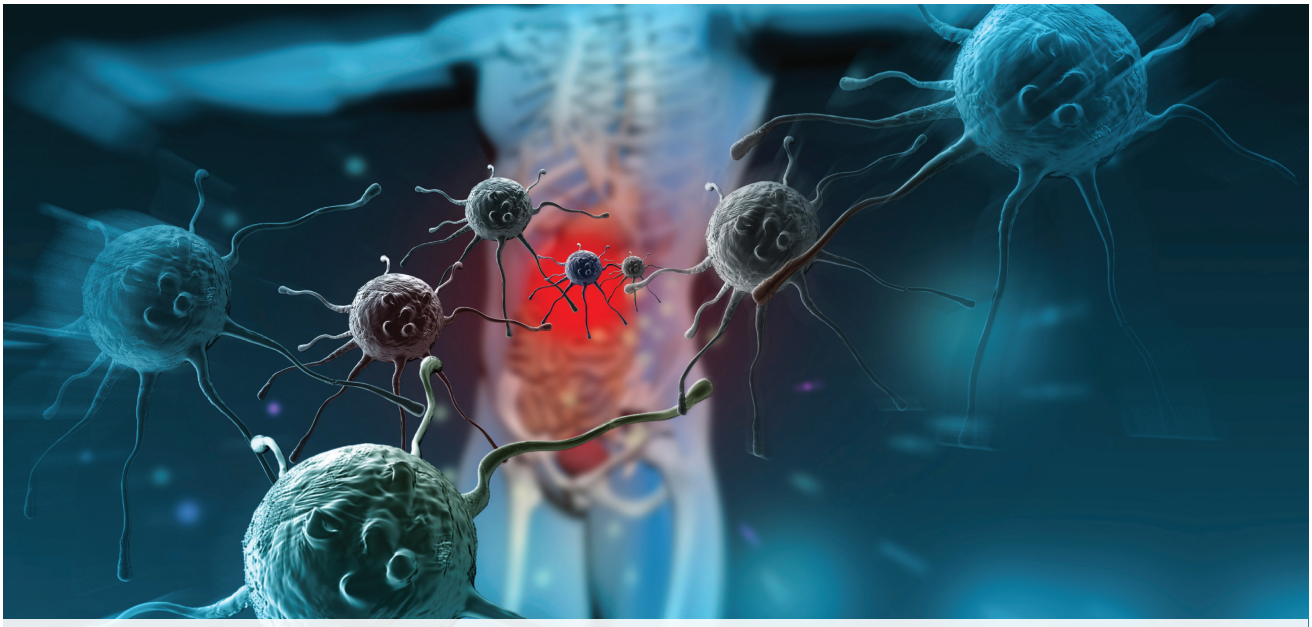

Anaphylaxis vs. Acute Infusion Reaction:

Differentiating Between These Adverse Events and Assessing Risk in the Home Care Setting

By Collin Chan, PharmD, Nancy Kramer, RN, BSN, CRNI® Melissa Leone, RN, BSN, Barbara McElroy, MSN, CRNI®, OCN, Wanda Rogers, RPh, MS, Marc Stranz, PharmD, and Connie Sullivan, RPh

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EDUCATIONAL LEARNING OBJECTIVES

1. Describe how adaptive immunity differs from the innate immune response.
2. List three factors that can be used to differentiate between an acute infusion reaction and anaphylaxis.
3. Identify the common intravenous therapy types administered in the home with the highest risk of acute infusion reaction and/or anaphylaxis.

AUTHOR BIO

Collin Chan, PharmD, is a Pharmacy Resident at Coram CVS/specialty infusion services in New Berlin, Wisconsin. Originally from California, he completed his undergraduate education at University of California, Davis and his pharmacy education at Loma Linda University School of Pharmacy. He has been intrigued about the home infusion sector since his first year of pharmacy school, and he is thrilled at the opportunity of working in the field. Chan is currently participating in a research project that will evaluate the effect text messaging has on a home infusion pharmacy's lead time, with a goal of optimizing branch efficiency and patient communication.

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Melissa Leone, RN, BSN, is the Manager of Nursing Operations for Coram CVS/specialty infusion services. She has been working in the home infusion industry for more than 25 years and has provided extensive education on access device-related topics at local and national conferences. Leone has been actively involved in the corporate product evaluation and selection process, as well as the development of staff and patient education resources for vascular access care and maintenance. She is the former Chair of NHIA's Education Committee and chaired the Clinical Track of the Education Committee this year. She has spoken at NHIA on the topics of patient and referral source satisfaction, disease management programs, the handling of hazardous pharmaceuticals and nurse zoning. She has also spoken nationally at the Infusion Nurses Society (INS) meeting on the subjects of patient satisfaction and catheter outcomes in home infusion, the latter of which was also the topic of an article in the *Journal of Infusion Nursing*. Most recently, Leone co-authored a research award-winning poster at ASPEN and co-authored an article in INFUSION magazine, both focusing on catheter-related bloodstream infections.

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Wanda Rogers, RPh, MS, is the National Director of Pharmacy at Coram CVS/specialty infusion services. She has extensive experience in retail, hospital IV room compounding, and clinical pharmacy and has been in the home infusion industry for more than 35 years. Rogers focuses on safe practices in the home infusion environment, and has recently become more involved in clean room construction as well as cleaning and aseptic monitoring. She is a member of the NHIA Standards Committee, the Joint Commission Medication Compounding Technical Advisory Panel, and is the Regional Past President of the Virginia Society of Hospital Pharmacists. Rogers earned her bachelor's in Pharmacy at West Virginia University and her master's at the University of Rhode Island.

Marc Stranz, PharmD, is *Vice President of Compliance for Elwyn Pharmacy Group*. He has worked for more than 30 years in sterile pharmacy compounding and was an early leader in the home infusion industry. He has held branch, regional, and corporate positions with several national providers, including Senior Vice President for Clinical and Strategic Operations at Coram and Vice President of Clinical Operations and Regulatory Affairs at BioScrip. He was also Corporate Director of Infusion Services for Omnicare and Chief Clinical Officer for BioScrip Specialty Services. A recognized business leader and subject matter expert, his work is part of the core practice standards of the industry established by professional organizations and standards bodies as well as the body of policy and procedure used by home infusion organizations. Stranz pioneered safe and efficient provision of advanced infusion therapies in home infusion and has sustained involvement in cutting-edge therapies. His expertise includes clinical and operational services, regulatory compliance, accreditation, sterile compounding, and design/build of cleanrooms and infusion facilities. He served on the USP Expert Panel for Sterile Compounding, the Board of Pharmaceutical Specialties Practice Analysis Taskforce in Sterile Compounding, and the *Institute of Environmental Sciences and Technology (IEST) Working Group for Controlled Environments per USP Chapter 797*. He obtained his bachelor's and doctor of Pharmacy degrees from Virginia Commonwealth University.

Connie Sullivan, RPh, is the Senior Director of Education and Data for NHIA, and the Vice President of Research for the National Home Infusion Foundation (NHIF). She earned her Bachelor of Science in Pharmacy with Honors from The Ohio State University in 1994, and has more than 18 years of infusion pharmacy practice experience, most recently serving as the Director of Infusion for Heartland I.V. Care, a division of HCR ManorCare based in Toledo, Ohio. In 2009, Sullivan was the Principle Investigator in the DAP-4Home Study, a prospective, randomized Phase IV clinical trial comparing clinical and economic outcomes in patients receiving Daptomycin and Vancomycin in the home setting. She has served as an advisor for the Community Health Accreditation Program (CHAP), helping to develop pharmacy and infusion

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AUTHOR DISCLOSURE STATEMENT

The authors declare no conflicts of interest or financial interest in any product or service mentioned in this program, including grants, employment, gifts, stock holdings, and honoraria.

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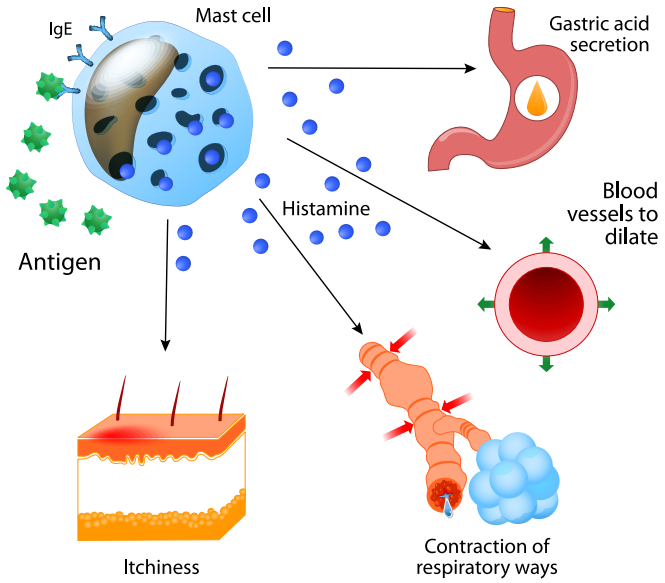
Home infusion has demonstrated safety, efficacy, cost savings, and positive outcomes for patients with a myriad of diagnoses and therapies over the past 30+ years. Hospital-acquired infections are reduced, compliance with treatment plans improves, and patients report better quality of life.[1]

The home setting does present challenges for clinicians however, when it comes to managing adverse infusion events. Hypersensitive reactions can occur with any drug administration; symptoms range from a facial flushing or a mild rash to the rare, but immediate, life-threatening, anaphylaxis.[2] Understanding hypersensitive responses, patient risk factors, and drugs that provoke a reaction, is essential for the home infusion provider to develop the patient treatment plan and achieve positive outcomes of the infusion therapy.

The Immune Response

The human immune system is designed to protect against foreign substances through innate and adaptive responses. Although categorized as separate systems, innate and adaptive immunity comingle and function interdependently.[3]



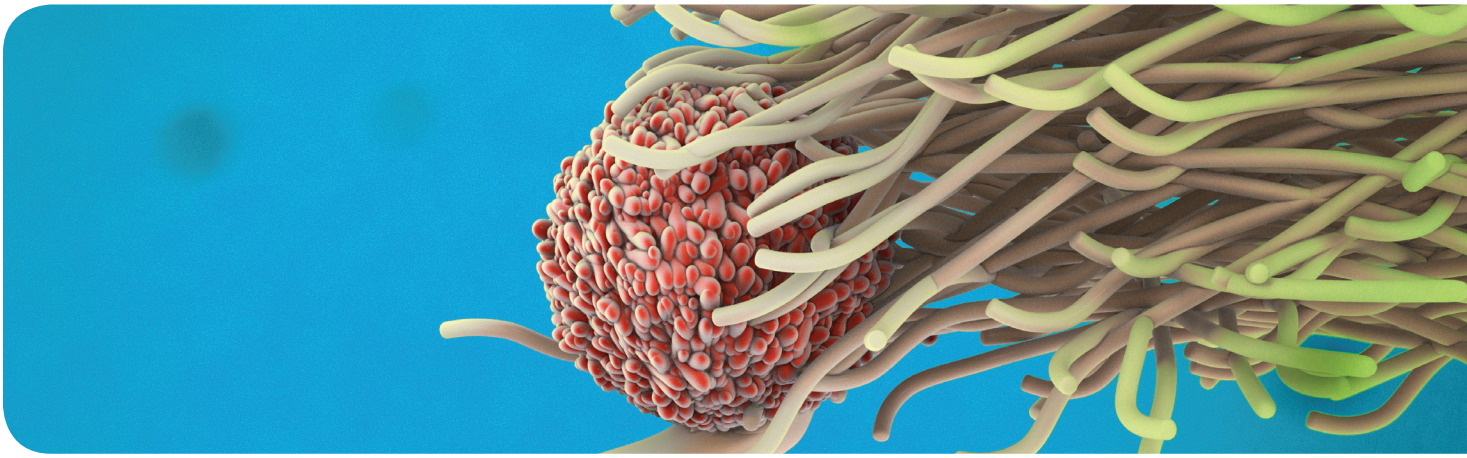
Role of Histamine in Ig E-Mediated Response

Innate immunity is a rapid, non-specific response when the body identifies a pathogen or foreign invader. Prior exposure isn't necessary and no protection against re-exposure is developed. Innate immunity attempts to neutralize pathogens through the enlistment of phagocytes, dendritic cells and natural killer (NK) cells. These innate cellular infiltration processes result in protective inflammation, recruitment of lymphocytes, and initiation of the adaptive immune response.[3,4]

Adaptive immunity is an acquired response that relies on recall from a prior exposure to a specific antigen. This memory activates a response directed by either humoral or cell-mediated lymphocytes. Each B lymphocyte (humoral) responds to extracellular agents with the production of a unique antibody that recognizes and binds with a specific antigen, targeting it for destruction. By maintaining mature forms of B (plasma) cells in the bone marrow, protection is provided against future exposures.[4,5] Intracellular invaders are impervious to antibodies and rely on T lymphocytes (cell-mediated) to release cytokines that activate leukocytes such as interleukins, tumor necrosis factor, and interferons.[6] These cytokines mediate inflammatory responses that may produce fever, chills, headache, nausea, and hypotension.[4] While B lymphocytes are responsible for the production of antibodies, T cells are critical to regulating adaptive responses.[7] When medications stimulate an immune response, these protective processes result in an allergic reaction.

Type 1 hypersensitivity is an allergic response that occurs after re-exposure to an agent in which antigen-specific antibodies were previously produced. During the initial exposure, or sensitization phase, patients remain asymptomatic, but antibodies, typically IgE, are produced that attach to mast cells and basophils. With subsequent exposure, the antigen binds with antibodies causing basophils and mast cells to release histamine, prostaglandins and leukotrienes.[8] Rash, itching, facial edema, bronchospasm and, hypotension may develop or escalate quickly to life-threatening airway obstruction or vascular collapse.[9,10] Although there are five different antibodies involved in the immune response, IgE is the one most often associated with allergic response.[4]

Non-IgE-mediated reactions, also known as anaphylactoid reactions, present with similar manifestations. However, as no antibodies are produced, these reactions aren't dependent on a prior exposure to elicit a hypersensitive response.[8] In anaphy-



lactoid reactions, the drug (i.e. Vancomycin), rather than IgE antibodies, causes the release of mediators from basophils and mast cells.[11] Histamine acts on H1 and H2 receptors causing constriction of smooth muscles in all body systems. The airway is compromised; vascular tone is decreased, hypotension and compensatory tachycardia develop; capillary extravasation leads to edema and exacerbation of cardiovascular effects; and GI muscles contract causing abdominal pain and loose stools. Urticaria and rash may develop as histamine is released in the skin. Prostaglandins and leukotrienes further bronchoconstriction and effects may continue for several hours.[10]

Cytokine release syndrome is a specific non-IgE-mediated reaction most commonly associated with infusions of monoclonal antibodies. Cytokines are proteins with key responsibilities in the immune response including mediating inflammation, inhibiting or promoting cell growth, and activating other immune effectors such as lymphocytes. Examples include interleukin (IL), interferons (IFNs), and tumor necrosis factor (TNF). Chemokines are specialized cytokines that bind to targeted cells to attract other immune effectors to destroy the cell. With cell destruction, cytokines are released and patients experience similar symptoms to anaphylaxis including fever, chills, nausea, rash and hypotension. Unlike anaphylaxis, cytokine release reactions are usually most pronounced with the first infusion when the greatest targeted cell kill occurs.[12]

Acute Infusion Reaction vs. Anaphylaxis

Differentiating between acute infusion reactions (AIRs) and anaphylaxis is challenging. In addition to factors such as patient history, known risk factors, and specific drug, timing is everything—the quicker the onset of symptoms, the more serious the reaction (see Exhibit 1 for common symptoms). Anaphylaxis should be suspected with subsequent dos-

Exhibit 1
Signs and Symptoms of Hypersensitivity Reactions

Anatomical System	Clinical Manifestation
Cardiovascular	Chest pain, palpitations, hypotension, hypertension, tachycardia, bradycardia, arrhythmia, edema, ischemia or infarction, cardiac arrest
Central Nervous System	Headache (throbbing in nature), dizziness, confusion, loss of consciousness
Dermatologic	Rash, pruritis, urticaria, flushing, local or diffuse erythema, conjunctival erythema and tearing, angioedema
Endocrine	Rigors, diaphoresis, fever, generalized feeling of warmth
Gastrointestinal	Nausea, vomiting, metallic taste, diarrhea, abdominal cramping and bloating
Genitourinary	Incontinence, uterine cramping or pelvic pain, renal impairment
Musculoskeletal	Arthralgias, myalgias, fatigue, tumor pain, hypotonia
Psychiatric	Anxiety, sense of impending doom
Respiratory	Cough, dyspnea, nasal congestion, rhinitis, sneezing, hoarseness, tachypnea, wheezing, chest tightness, hypoxemia, bronchospasm, reduced pulmonary expiratory flow, oropharyngeal or laryngeal edema, stridor, pulmonary infiltrates, cyanosis, acute respiratory distress syndrome

Source: Vogel W. Infusion Reactions: Diagnosis, Assessment, and Management. Clinical Journal of Oncology. April 2010.14(2):E10-E21.

Exhibit 2
Grading Hypersensitive Reactions

	Grade of Severity				
	1	2	3	4	5
	Mild	Moderate	Severe	Life-threatening	Death
Reaction	Transient rash or flushing Temp <100.4 F°	Rash, flushing, urticaria, dyspnea Fever ≥100.4 F°	Prolonged reaction that does not respond to treatment or reoccurs after initial treatment Symptoms include bronchospasm, hypotension and angioedema	Anaphylaxis	
Intervention	Continue infusion and monitor patient	Therapy interruption, symptomatic treatment (i.e antihistamines, NSAIDS) Resume therapy when resolved	Therapy discontinued and hospitalization required	Life-threatening—pressor or ventilatory support necessary	

Sources: Carney P and Ollom C. Infusion reactions triggered by monoclonal antibodies treating solid tumors. *Journal of Infusion Nursing.* 2008;31(2):74-83 and Vogel W. Infusion reactions: Diagnosis, assessment and management. *Clinical Journal of Oncology Nursing.* 2010;14(2):E10-E21.

es when symptoms are immediate and include respiratory distress and hypotension. Non-allergic reactions are usually less immediate and may not develop for 30 minutes to several hours. These non-IgE-mediated reactions can occur with first dosing. Some medications, such as monoclonal antibodies, can provoke either response, so the timing of the onset is the best indicator of the type of reaction.[4]

Regardless of the etiology, the response to any hypersensitive reaction is the same. With non-IgE-mediated responses, symptoms often improve or resolve with interruption of therapy and administration of antihistamines. The most common grading system for hypersensitive reactions utilizes the National Cancer Institute's (NCI) Common Terminology Criteria for Adverse Events (CTCAE). Exhibit 2 is adapted from these recommendations.[13]

Hypersensitive reactions can occur with any drug therapy, in any administration setting. Knowledge of risk factors, drug properties, and the significance of the timing, enables early recognition and rapid response to prevent life-threatening progression.[14] Clinician proficiency and appropriate patient education are essential in fostering the mission of home infusion, to provide the best patient outcomes in the best possible setting.

Risk Factors for Developing Anaphylaxis

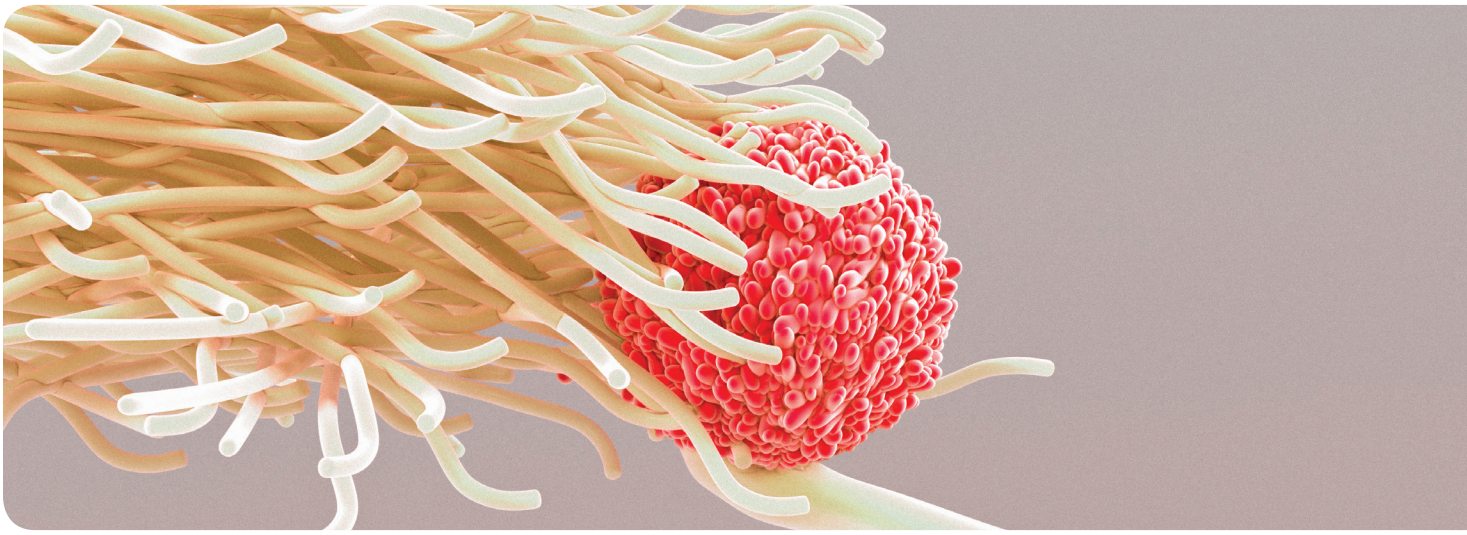
Immune responses to therapeutic medications can pose significant problems when providing patient care. Immunologically based adverse events from the administration of medications can lead to unwanted hospitalizations and even death. Providers must be cautious whenever providing any medication, but more caution is warranted when certain factors come into play.

The risk of immunogenicity, or the drug's ability to induce an immune response, rests upon three factors, which must be considered whenever a provider is evaluating for the safe administration of medications:

- Treatment factors
- Product-specific factors
- Patient-specific factors

Treatment Factors

Route of Administration. The route of administration plays a role in the risk assessment for a medication. Specifically, certain administration methods pose a higher risk for developing an immune response, with that risk escalating in the following order: inhalation > subcutaneous > intraperitoneal > intramuscular > intravenous.[15-18] The immunogenicity can be explained by the availability of immune cells at the site of administration. For example, the close proximity and sheer number of antigen-presenting cells (APCs), such as Langerhans cells, at the site of administration during a subcutaneous injection allows for a greater number of opportunities for the drug to interact with the immune system.[19,20] The greater the interaction with the immune system, the greater the risk for developing an immune response.



Dose. Higher doses of a given medication can lead to more drug exposure throughout the body, including the immune system. As a result, the immune system is provided with more interactions with the medication, leading to a greater risk for developing an immune response.[21,22] Use higher doses with caution in patients who are naïve to the medication.[23]

Dosing Frequency. The frequency of dosing a given medication can affect its immunogenicity as well. Patients receiving medication on an intermittent or as needed basis, or after a long period of being drug-free are at a greater risk of developing an immune response than if the medication was provided on an ongoing basis.[16,18] The mechanism behind this attribute can be credited to tolerance. Tolerance of the immune system toward foreign proteins can be maintained as long as a given protein remains accessible to the immune system. When the antigen presenting cells are overwhelmed with excess antigen (in this case, the prescribed therapy), lymphocytes bind to free antigen which prevents them from getting the second signals they need to become activated. This condition is known as high zone tolerance. It is overcome as the excess antigen is removed by phagocytes and serum proteases. Eventually, the antigen concentration is reduced to a stimulatory level.[20,24,25]

Duration of Therapy. Immunogenicity is a dynamic process, and antibodies can develop even after the provision of a first dose of a drug. In general, patients receiving treatment for a longer period of time are at an increased risk of developing an immune response than those taking the same medication for a shorter duration. Those taking only a single dose of the medication will have the least risk of developing anaphylaxis (unless they had a prior exposure at some previous point in time). The longer the period of drug exposure to the body, the longer the immune system has to generate an immune response to the medication.[16-18,26-28]

Product-Specific Factors

Presence of Non-Human Sequences. The general purpose of the immune system is to protect the body from foreign proteins and organisms. The immune system will attack anything deemed foreign, so as to prevent further bodily harm. As a result, the incidence and magnitude of the immune system's response to the administration of a medication is influenced by a balance of "foreignness" of the medication.[29] The more non-human the structure or source of the medication, the greater the immune response. For example, in the case of monoclonal antibodies, products originated from mice (e.g., chimeric) will exhibit more non-human entities than a humanized or fully human monoclonal antibody, and will subsequently have an increased risk for developing a hypersensitivity reaction.[30,31]

Chemical Structure. The immunogenicity of a given molecule can be inherent to the actual chemical structure. Epitopes, which are areas of the molecule that can be recognized by the immune system, can be based upon the primary, secondary, tertiary, or quaternary protein structure of a given medication. Epitopes recognized by T-cells are generally short primary peptide stretches. B-cell epitopes can be made up of either primary, secondary, tertiary, or quaternary structures of amino acids. During product design, much consideration goes into limiting the amounts of epitopes available to the immune system so as to limit the frequency of hypersensitivity reactions in patients.[18]

Molecular Weights. In general, larger molecules will have a greater variety of protein sequences and conformations. As a result, when the immune system comes

into contact with these large molecules, there are typically more opportunities for the immune system to locate epitopes. Therefore, the larger the molecule is, the greater the likelihood that an immune response can be generated. Medications with molecular weights greater than 10,000 Daltons can usually generate an immune response, such as monoclonal antibodies with a molecular weight of about 150,000 Daltons. Smaller peptides in the 5,000 – 10,000 Dalton range may generate fairly weak immune responses. Medications with a molecular weight of 1,000 – 5,000 Daltons are generally unpredictable in relation to immunogenicity. Finally, drugs with a molecular weight less than 1,000 are typically immunogenic only if bound to other carrier proteins.[26,32]

Haptens. A hapten is a small compound (less than 1,000 Daltons) that cannot initiate an immune response by itself unless it is conjugated with a larger protein carrier. These haptens are too small to elicit an immune response and must covalently bind and modify macromolecules to become immunogenic. This drug-protein complex will be recognized as foreign and processed by APCs, ultimately resulting in an immune response.[33]

Examples of this include the penicillins and sulfonamides, which are generally far too small to elicit an immune response by themselves. The B-lactam ring of the penicillins can spontaneously open under certain physiological conditions and react as a hapten directly without needing to be metabolized. The most common penicillin-derived hapten is the penicilloyl moiety, which can form protein carrier-complexes, such as the peniciloyl-polysine complex that is recognized as foreign by the immune system.[34] Sulfonamides can act as a prohapten, which are molecules that cannot directly haptenate a protein but must metabolize into a metabolite to bind to a protein.[35] Sulfonamides, for example, can be oxidized to the N^4-sulfonamidoyl hapten, which can subsequently bind to a protein carrier and generate an immune response. The sulfonamide reaction generally occurs only in sulfonamide antibiotics, as the non-antibiotic sulfonamides lack the N^1 heterocyclic ring and the N^4 amino nitrogen, which are required when binding to the carrier protein.[36]

Aggregates. Upon physical degradation of a drug, aggregation can occur, which is a process by which two or more molecules can bind to each other to form a higher order oligomeric structure. The conformational destabilization that brings the partial to complete unfolding of molecules can lead to covalent and non-covalent interactions. Various stress factors related to storage and handling have been reported that can cause physical degradation and therefore drug aggregation. Elevated temperatures, which can occur during storage or shipping, can cause proteins to denature. Frozen medications that are thawed during transport or from errors in storage can cause aggregation through a number of factors. Among others, these factors can include cryoconcentration (proteins and excipients form a concentration gradient near the freeze front), adsorption to the container surface, and a change in pH (non-uniform crystallization of the buffer). Mechanical stress, including agitation, shaking, stirring, and filling, can subject compounds to destabilization as well.[37]

The destabilization and resulting aggregation of proteins can lead to the formation of larger molecules, the presentation of repetitive epitopes, and the creation of new epitopes, ultimately leading to a greater risk of developing an immune response. As mentioned earlier, larger molecules generally have an intrinsic risk for developing a hypersensitivity reaction. In relation to the presentation of epitopes, whereas a single molecule will only have a given number of antigenic areas, that number will multiply when aggregation occurs and epitopes are repeated. The repeated presentation of epitopes can lead to multivalent cross-linking of B-cell receptors and lead to B-cell activation, independent of T-cells. Aggregation can also create new grooves and binding sites that can be presented to the immune system, thereby allowing for more opportunities for the immune system to generate a response.[38]

Patient-Specific Factors

Prior History of Allergic Reactions. For individuals with a prior history of anaphylaxis to a medication, there may be circulating antibodies within the body that can generate a subsequent hypersensitivity reaction upon re-exposure. For those individuals who have indeed had an anaphylactic reaction, alternative medications must be used to protect patients from experiencing a serious adverse event.[18,32]

Gender. The gender of an individual may account for some of the risk of developing immunogenicity. Studies have shown that females are at a slightly greater risk of developing an immune response than males.[24,26,39] However, the role of gender may not be as essential in generating an immune response as the other factors.[27]

Health of the Immune System. An immune response can only be generated in a functioning immune system. Individuals with a weakened or immature immune system will subsequently be at a lower risk for developing an immune response. Patients at the ends of the age-spectrum possess weaker immune systems. The immaturity of the immune system can account for this observation in infants.[40,41] And for the elderly, as with the function of other bodily systems, the immune system gradually los-

es responsiveness.[26,40-42] In these two age groups, a lower risk of developing an immune response is observed. A greater risk of immunogenicity is also seen in patients who are immune-compromised; whether due to a certain disease state or from intake of immunosuppressive medications.[32] In general, an immune system is required to develop any type of immune response. Therefore, those with a deficient immune system, for whatever reason, will be at a lower risk for developing anaphylaxis.

Genetic Makeup. All individuals have a unique set of genes that will encode various proteins in the body. One specific set of proteins that can vary among individuals is the Human Leukocyte Antigen (HLA). These molecules not only help the immune system to differentiate which cells are self and non-self, but they also help to display antigenic peptides to Antigen Presenting Cells (APCs).

As part of the immune response, a drug is taken up by an APC and processed into smaller peptides. Some of these peptides will bind to the HLA molecule inside the APC. While bound to the peptide, the HLA will subsequently travel to the surface of the APC and present this antigen to the body's immune system. The likelihood of an immune response to that peptide depends on the stability of the binding between the HLA and the peptide. How stable the interaction between a given amino acid sequence and the HLA depends on the genetic makeup of the HLA alleles, and this can vary greatly between individuals. Some HLA alleles are associated with a greater risk of developing an immunologic response, such as the DRB1*0701 allele. The variation between HLA alleles in individuals and their role in the binding of antigenic molecules is the primary mechanism by which a person's genetics contribute to the development of a hypersensitivity reaction.[45]

Lack of Endogenous Proteins. As mentioned above, the immune system will generate an immune response toward compounds that are deemed foreign to the body. This may pose a problem in individuals who are lacking in whole or in part necessary factors or enzymes. In these individuals, replacement therapy may be labeled as foreign to the immune system because there is either very little or no such endogenous protein circulating throughout the body. As a result, patients who have a deleterious mutation or are genetically null may be at a higher risk of developing an anaphylaxis reaction to the administration of therapeutically necessary medications.[16,18,23,46,47]

Incidence in the Home Setting

The incidence of acute infusion reactions in the home care setting is an area that warrants further investigation. Few studies have been conducted on anaphylaxis in this site of care, and conclusions have been limited to small populations.[48] Inconsistencies in grading reactions, underreporting, miscoding, and a lack of a national reporting system contribute to the challenges facing researchers.[4,49] The recently adopted International Classification of Diseases, 10th edition (ICD-10) introduced a drug-related anaphylaxis code which should enhance researchers' ability to capture the data and facilitate appropriate responses.[49] In spite of the dearth of literature, researchers report an increased incidence of anaphylaxis in the U.S., with medications identified as the primary cause.[50] It has been estimated that anaphylaxis related to all causes can be attributed to approximately 1,500 fatalities per year.[49]

While it was not specific to site of care, a 2007 review of literature found that hypersensitivity reactions are rare, with an incidence of less than 5%, provided patients receive proper premedication, close monitoring, and prompt intervention when symptoms occur.[51] In one of the few studies tracking home infusion reactions, 770 patients received 1,000 courses of 25 different IV antibiotic therapies in the home. The patients experienced 28 allergic reactions with a mean of 19.6 days to allergic reaction, none of which were anaphylactic or life-threatening.[52]

Any drug has the potential to elicit a hypersensitive response and the exponential growth in the development of new drugs, particularly biological therapies, that elicit hypersensitive reactions exacerbates the risk of life-threatening occurrences.[53] Parenteral drugs are more likely to evoke a response than oral formulations, as the risk increases with the invasiveness of the administration route.[49]Antibiotics are one of the most common causes of acute reactions, particularly the classes of beta lactam and quinolones.[54] Vancomycin, well known for causing infusion rate-related anaphylactoid (non IgE-mediated) reactions, has recently been implicated in an IgE-mediated event following intraperitoneal administration.[55] Monoclonal antibodies, immunoglobulin, and opiates have also been associated with acute infusion reaction.[49] Pre-treatment with antihistamines and/or corticosteroids can lower risk in patients or therapies that have a predisposition for inciting a reaction.[56]

Some experts argue for the routine dispensing of medications to manage a potential anaphylactic reaction for all home infusion therapies, while others dispute this intervention as possibly creating more problems than it resolves. Researchers have found that patients with high risk for anaphylaxis who have been prescribed an epinephrine autoinjector, often did not have the medication with them, or may fail to administer in a timely way. Bonds, et al, found that only 16% of patients studied were able to perform all five steps required to use the epinephrine autoinjector properly, with more than half of the remaining 84% missing three or more steps in the use-sequence.[57] In addition to injuries from accidental injection into the hand or fingers, patients may also experience anxiety, palpitation, myocardial infarction (MI), or death if the drug is administered intravenously rather than via the intramuscular route. Additionally, routine dispensing

of epinephrine may not be the best utilization of health care dollars.[52] Certainly dispensing of epinephrine is appropriate with identified at-risk patient population and medications.

An anaphylactic response is frightening, particularly in the home setting, where availability of resources is limited. However, even with the increasing incidence of minor hypersensitivity events, the risk of death from anaphylaxis is extremely low.[48] Thorough patient screening and education; knowledge of risk factors and drug properties; and appropriate monitoring and interventions, remain the most effective strategies in combating serious infusion reactions and reducing the risk of life-threatening consequences.[48,52]

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