Patient safety in dermatology: a ten-year update

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Abstract

Objective: We update and expand our 2010 article in this journal, *Patient safety in dermatology: A review of the literature* [4].

Methods: PubMed at the National Center for Biotechnology Information (NCBI), United States National Library of Medicine (NLM) was searched September 2019 for English language articles published between 2009 and 2019 concerning patient safety and medical error in dermatology. Potentially relevant articles and communications were critically evaluated by the authors with selected references from 2020 added to include specific topics: medication errors, diagnostic errors including telemedicine, office-based surgery, wrong-site procedures, infections including COVID-19, falls, laser safety, scope of practice, and electronic health records.

Summary: Hospitals and clinics are adopting the methods of high-reliability organizations to identify and change ineffective practice patterns. Although systems issues are emphasized in patient safety, people are critically important to effective teamwork and leadership. Advancements in procedural and cosmetic dermatology, organizational and clinical guidelines, and the revolution in information technology and electronic health records have introduced new sources of potential error.

Conclusion: Despite the growing number of dermatologic patient safety studies, our review supports a continuing need for further studies and reports to reduce the number of preventable errors and provide optimal care.

Keywords: Patient safety, quality, medical errors, near miss, medication errors, diagnostic errors, laboratory and pathology tracking, telemedicine, teledermatology, office-based surgery, cosmetic surgery, wrong-site surgery, infections, hand hygiene, corona virus disease 2019, COVID-19, universal pandemic precautions, medication vial infections, falls, laser safety, scope of practice, electronic health records

Introduction

Patient safety is the "prevention of harm to patients;" it is both a discipline and a responsibility with a major focus on identifying, reporting, analyzing, and preventing medical error, which does not always result in harm or injury. Medical errors that affect the patient are often called preventable adverse events, but it is just as critical to identify near misses or close calls that did not reach the patient, either by chance or by timely intervention [1]. In either instance, medical errors serve as an early warning system to prevent more serious future occurrences [2]. Basic tenets of medical error include: 1) to err is human; as humans, healthcare providers will commit errors, but failing to learn from them is inexcusable; 2) most errors are unintentional and unconscious; 3) many errors relate to health systems' organizational and structural issues rather than individual error; and 4) error prevention is based on a "team approach" as much as individual education and responsibility [1,3,4]. Our system of care delivery is built on a culture of safety involving health care professionals, organizations, and patients. Resulting harm to patients may occur when one or more of the many layers of safety protection fail (**Figure 1**).

Abbreviations:
Also see Table 2 for error prone abbreviations and Table 13 for abbreviations of organizations with patient safety online resources.

AAD	American Academy of Dermatology
ADC	Automatic Medication Dispensing Cabinet
ADE	Adverse Drug Event
AJCC	American Joint Committee on Cancer
ANSI	American National Standards Institute
APP	Advanced Practice Professional
ASDS	American Society for Dermatologic Surgery
ASLMS	American Society for Laser Medicine and Surgery
ATA	American Telemedicine Association
CDC	Centers for Disease Control and Prevention
CHIP	Childhood Health Insurance Program
CMS	Centers for Medicare and Medicaid Services
COVID-19	COronaVIrus Disease 19
ECRI	Emergency Care Research Institute originally; now ECRI, a nonprofit federally certified Patient Safety Organization
EHR	Electronic Health Record
EMR	Electronic Medical Record
EORTC	European Organization for Research and Treatment of Cancer
FDA	Food and Drug Administration
HIPAA	Health Insurance Portability and Accountability Act
HCP	Health Care Provider
HIV	Human Immunodeficiency Virus
HPV	Human Papillomavirus
MACRA	Medicare Access and CHIP Reauthorization Act of 2015
MeSH	Medical Subject Headings
MDV	Multi-dose vial
MIPS	Merit Based Incentive Payment System
MMS	Mohs Micrographic Surgery
MRSA	Methicillin-Resistant Staphylococcus aureus
NCBI	National Center for Biotechnology Information
NLM	National Library of Medicine
NPSG	National Patient Safety Goals of The Joint Commission (TJC)
NQF	National Quality Forum
OSHA	Occupational Safety and Health Administration of US Department of Labor
PASS	PULL, AIM, SQUEEZE, SWEEP for fire extinguisher use
PCP	Primary Care Physician
PDL	Pulsed dye laser
ppc	particles per cubic centimeter
PPE	Personal Protective Equipment
PSO	Patient Safety Organization
QPP	Quality Payment Program of CMS
RACE	RESCUE, ALARM, CONTAIN, EXTINGUISH when confronting a fire
SARS-CoV-2	Severe Acute Respiratory Syndrome coronavirus 2
SDV	Single Dose Vial
TDS	Teledermoscopy
TJC	The Joint Commission
TML	Tall Man Lettering
TNM	Tumor-Node-Metastasis
UP	Universal Protocol of The Joint Commission (TJC)
UPP	Universal Pandemic Precautions
USP	United States Pharmacopeia
VRE	Vancomycin -Resistant Enterococci
WHO	World Health Organization

Patient safety is a moral and ethical responsibility of all health care providers and is an evolving field with continual new challenges. The explosion in information technology is one source of potential error and it is important to remember "if you haven't thought of an error, it will eventually occur." Patient safety training and quality improvement projects are now a mandatory part of residency training in all specialties. The continuing emphasis on patient safety in health care occurs at multiple levels with sustainability, education, and preventive measures being key factors [1,3,5].

Figure 1. *Layers of protection designed to prevent patient harm.*

Adapted from, and with written permission of, Mike Murphy, Geisinger Health Systems Biomedical Communications, Danville, PA, August 11, 2020.

Patient safety is a subset of health care quality, which is defined as safe, effective, patient-centered (patient experience), timely (access to care), efficient, and equitable care [1]. Quality is measured by group or specialty-specific outcome or accountability measures, promulgated by regulators and professional organizations, and publicly reported for transparency. Health care organizations receive differential payments based on performance. In certain cases, there are no payments for egregious errors.

The National Quality Forum now designates "29 Serious Reportable Events" in 7 categories, which are defined as preventable, serious, and unambiguous adverse events (**Table 1**), [6]. With few exceptions, deaths related to medical error and systems factors are not associated with a specific International Classification of Disease code on death certificates, so there is no clear record of their magnitude. In 2016, an analysis by Makary and Daniel at Johns Hopkins suggested that medical error is the third leading cause of death in the United States compared to the list of most common causes of death published annually by the Centers for Disease Control and Prevention (CDC). The authors called for rapid and independent investigations to determine root causes of these deaths, standardized data collection, and standardized reporting [7].

We discuss two such high profile cases [8,9]. Maintaining and protecting patient safety occasionally has both professional and criminal implications, as exemplified in a recent highly publicized case involving misuse of an automatic medication dispensing cabinet (ADC), [8,9]. A nurse at Vanderbilt University Medical Center was arrested and criminally charged for the following failures. The nurse did not verify the specific medication with the physician, overrode the automatic dispensing cabinet (ADC) to obtain 10mg of vecuronium rather than 1mg Versed®, failed to check the medication name before administration, and did not stay with the patient after drug administration. Her criminal trial scheduled for July 13, 2020 was postponed along with a separate sanctions hearing before the Tennessee Board of Nursing [10]. Automatic medication dispensing cabinets allow healthcare providers (HCP) quick controlled access to medications and have overall increased medication safety. But overrides can lead to dangerous consequences including wrong-drug and wrong-dose as noted above. Overrides of ADCs is one of ECRI's [originally the Emergency Care Research Institute and now an independent, nonprofit federally certified Patient Safety Organization (PSO)] top-10 patient safety concerns for 2020. ECRI provides ADC override resources and mitigation strategies including 1) prospective and retrospective reviews by a pharmacy committee; 2) mandated medication order before removing any ADC medication, including overrides; and 3) implementation of technology-based safeguards [11].

Table 1. *Serious reportable events which apply to inpatient and outpatient (most cases) care.*

Category of serious reportable events	Examples of serious reportable events
Surgical or Invasive Procedural Events	Wrong-site, -person, or –procedure; retained foreign object; perioperative death of healthy patient (ASA class 1)
Product or Device Events	Patient death or serious injury from: 1) use of contaminated drugs, devices or biologics; 2) use or function of a device which is used or functions other than as intended; 3) intravascular air embolism
Patient Protection Events	Patient disappearance or suicide; discharge to unauthorized person
Care Management Events	Death or disability from medication and blood product administration errors; labor/delivery in low-risk pregnancy/neonate; falls; pressure ulcers; specimen loss; failure to notify of test results
Environmental Events	Death or disability from electric shock, burns, O_2 or gas administration errors or from physical restraints
Radiologic Events	Death or serious injury of a patient or staff associated with the introduction of a metallic object into the MRI area
Criminal Events	Sexual or physical assault or abuse; impersonation; abduction

Adapted from National Quality Forum 2011 [6].

In 2018, the medical records of an 81-year-old woman were misplaced resulting in egregious wrong-person, wrong-procedure brain surgery that led to her eventual death rather than her intended procedure for her dislocated jaw [9]. Her family asserted that the general standard of care had not been upheld and claimed "ordinary negligence," a legal claim with no cap on financial compensation; they were awarded $20 million. Later, the award was voided because the family had been barred from making claims of ordinary negligence. Had they claimed "medical malpractice" which caps awards, compensation may have been retained [9].

The practice of dermatology is not immune to medical errors. For instance, miscommunication with patients about methotrexate dosing has resulted in toxicity, sepsis, and death [12]. Self-reporting of medical errors in a non-punitive open environment is a basic tenet of patient safety. The high-profile incident of the Vanderbilt nurse and another case in the United Kingdom have fueled debate on the impact of criminalizing medical errors that result in patient harm [3,13]. At least two professional organizations have issued statements opposing criminalization, stating that it will inhibit the open and timely disclosure of key error-related information [14,15].

Methods

We update and expand our 2010 article in this journal, *Patient safety in dermatology: A review of the literature* [4], that examined articles from 1948 through 2009 concerning patient safety and medical error in dermatology [4]. For this updated review, PubMed at the National Center for Biotechnology Information (NCBI) at the United States National Library of Medicine (NLM) was searched September 2019 for English language articles published between 2009 and 2019. Each search used a combination of Medical Subject Headings (MeSH) and words in the title including the following: patient safety, computerized, EHR (Electronic Health Records), EMR (Electronic Medical Records), medical errors, medication errors, inappropriate prescribing, diagnostic errors, accidental falls, adverse effects, wrong-site surgery, cross infection, infection control, surgical wound infection, hand hygiene, pens, occupational exposure, dermatology, skin diseases, skin, cutaneous, dermatologic surgical procedures, lasers, laser therapy, biopsies, pathology, office-based/ambulatory surgery or procedures, non-physicians, and non-dermatologists. Additionally, relevant websites, books, and personal communications were scrutinized. Data were compiled from articles in this search that pertained to patient safety in dermatology and other outpatient settings. The references and the "other relevant articles" of the sources used in this review were searched. Potentially relevant articles and communications were critically evaluated by the authors, and selected references from 2020 were added. Despite the thoroughness of this search, there are sections on patient safety in dermatology that may have been overlooked.

Discussion

Medication errors

Medication error has been the most prevalent variable in patient safety studies for many reasons: medication use is extensive, prescriptions are carefully documented and easily accessed by computerized database systems, and fatalities related to these errors are recorded on the corresponding death certificate [4]. Medication errors are expensive, costing patients in one study an additional $4,700 on their hospital bills [16]. In a retrospective German error analysis, nonsurgical treatment errors were the most common type of error in dermatology. From 247 commissioned reports between 2004 and 2013, 48 were medication, 18 diagnostic, and 11 surgical treatment errors, respectively [17]. And in a United States survey study of 150 dermatologists, 36 of the 152 respondents reported that medication error was the most recent error in their practice [2].

Most current medication error reports are inpatient, which are more formally regulated, leading to greater monitoring and detection of adverse drug events (ADEs). This oversight includes medication error as a reportable quality and safety measure and the leading cause of error-related inpatient mortalities when resulting in patient harm [16]. One

study tracked solid organ transplant patients over the course of a year and identified 149 medication errors in 93 patients, with about a third leading to ADEs [18].

Outpatient care is also greatly impacted by medication errors with important implications for dermatology. A recent study of 3,850 outpatient prescriptions at a commercial pharmacy chain discovered 452 (11.7%) inaccurate prescriptions with 35% possibly leading to ADEs; omitted information (duration, dose, and frequency) was the leading cause of error [19]. A systems analysis of adverse drug events showed that although approximately 50% of prescription errors were identified before dispensing, only 2% of administration errors were detected and rectified [20].

There are several ways to think about medication errors systematically. One includes failure of adherence to the oft-cited five rights: right drug, -dose, -patient, -duration, and -route of administration. A relatively common example of a route-of-administration error is the injection of corticosteroids, meant to be intramuscular but incorrectly placed subcutaneously, leading to permanent lipoatrophy [17]. Medication errors are typically classified as prescribing, dispensing, and administration errors. Additional factors in medication errors include communication, product labeling, packaging, nomenclature, compounding, distribution, education, and monitoring issues. Each of these error-induced events may be related to professional practice, health care products, procedures, and systems [21].

Table 2 lists drug nomenclature-related error-prone abbreviations, dose expressions, symbols, drug abbreviations, and stems akin to all three phases of medication use [4]. Table 3 lists the top 100 most commonly prescribed dermatological medications with their sound- or look-alike counterparts, a review of which can help identify those requiring attention and safeguards to reduce the risk of errors [22,23]. Additional strategies promoted by the Institute for Safe Medicine Practices (ISMP) include: 1) using both brand and generic names on prescriptions and labels; 2) including the purpose of the medication on prescriptions; 3) configuring computer selection screens to prevent look-alike names from appearing consecutively, and 4) changing the appearance of look-alike product names to draw attention to their dissimilarities [22]. The Joint Commission (TJC), formerly the Joint Commission on Accreditation of Healthcare Organizations, recommends that each healthcare facility collaborate with their pharmacy consultant to: 1) identify its own list of sound- or look-alike medications; 2) create a standardized list of abbreviations, acronyms, symbols, and dose designations that could generate confusion and potential ADEs [16,24], and 3) safely manage and identify its unique high-alert and hazardous medications [24]. Drugs on the ISMP High-Alert Medications list have a heightened risk of causing significant patient harm when used in error. Those that may apply to dermatology practice include: EPINEPHrine, hypertonic saline solution, sedating agents, and oral (non-oncologic) methotrexate. Additional dermatology relevant "High-Alert Medications" for community and ambulatory settings include immunosuppressant agents (e.g., azaTHIOprine, cycloSPORINE, and tacrolimus) and pediatric liquid medications that require measurement (e.g., midazolam liquid for sedation).

Table 4. *Tall Man Lettering to help differentiate look-alike drug names for selected dermatologic drugs.*

Established name	Recommended name
Cyclosporine Cycloserine	cycloSPORINE cycloSERINE
Hydralazine Hydroxyzine	hydrALAZINE hydrOXYzine
Methylprednisolone Methyltestosterone	methylPREDNISolone methylTESTOSTERone
Prednisone Prednisolone	predniSONE prednisoLONE

Adapted from FDA Name Differentiation Project. The table above is current as of 4/28/2020 [25].

Certain medications in acute care settings require special safeguards to reduce the risk of errors and harm, such as routinely capitalizing parts of the drug names for look-alike drugs to be more visually explicit. 'Tall man lettering' or TML is encouraged by TJC, and **Table 4** illustrates examples of this technique [25]. The TML process highlights the differences between similar drug names by capitalizing dissimilar letters, starting on the left side

of the drug name. Also, TML can be used along with color or bolding to draw attention to the dissimilarities between look-alike drug names and alert healthcare providers that the drug name can be confused with another drug name. **Table 4** illustrates examples of the TML technique [25]. Finally, a list of selected dermatologic medications that should not be crushed because of their special pharmaceutical formulation or characteristics, such as oral dosage forms that are sustained release in nature, is contained in **Table 5**.

Standardizing all stages of handling these medications such as limiting access, using auxiliary labels and automated alerts, employing redundancies, and educating patients and caregivers is critical as the consequence of an error is clearly more devastating for patients [4].

Diagnostic error

Diagnostic error

Swerlick defines *diagnostic thinking* as a dynamic process in which a diagnosis may be a goal in itself for a simple diagnosis or the starting point for a set of complex symptoms. He further identifies the duality of diagnosis: taxonomy driven initially by billing and coding software plus our forecasting ability with diagnosis as a correct prediction. Both elements may require revision over time (Robert A Swerlick MD written communication 2015). *Diagnostic error* was defined in 2015 by the National Academy of Medicine as the failure to establish an accurate and timely explanation of the patient's health problem(s) or to communicate that explanation to the patient [26]. Every diagnosis is a potentially flawed process of balancing probability using heuristics and yielding an uncertain hypothesis that can be changed with additional data [27,28]. Diagnostic error is divided into three categories 1) no fault, such as from a masked or unusual presentation; 2) systemic flaws and poor technology; and 3) cognitive errors by physicians, which are estimated to be the largest source of error although they are difficult to define [27]. Attesting to the presence of cognitive errors, there is a 20% discrepancy between clinical and histological (gold standard) dermatologic diagnoses [29]. A survey of 150 dermatologists found that 85% reported that diagnostic errors happened once a year or less and that 86% of the errors did not cause patient harm [2]. Although these data generally suggest a lower rate of clinically significant diagnostic error, continued strides are needed toward improving diagnostic accuracy.

Diagnostic errors are the source of 30% of all malpractice claims [27]. They were the second most common cause of dermatology malpractice claims over a 24-year period, with improper performance of a procedure being first. The largest single recovery against a dermatologist was $10.5M for unrecognized metastatic basal cell carcinoma with severe morbidity [30]. Other misdiagnoses spurring legal action include failure to diagnose rare diseases like hepatoerythropoietic porphyria, that in childhood may appear to be skin damage from abuse [31]. Missing a skin cancer diagnosis by omitting an examination in areas such as the sole of the foot or behind the ears, is also considered misdiagnosis. Avoiding diagnostic error maintains the integrity of a physician's practice and avoids patient harm.

Diagnostic reasoning and failure

Diagnostic reasoning can be divided into intuitive and analytical types, both of which are sources of error. Intuitive reasoning is fast, relies on patterns and first impressions, has increased risk for error, and has decreased scientific merit when compared to analytical reasoning, which is slow and scientifically rigorous. The inexperienced rely on analytical reasoning, but too much deliberation can increase diagnostic uncertainty [27].

Types of failures of visual perception that contribute to diagnostic error include visual blindness or "tunnel vision," in which a subtle diagnosis is missed. "Inattentional blindness," or hiding in plain sight, occurs when a physician fails to recognize and prioritize key diagnostic findings. According to Lowenstein and Sidlow, commonly used visual diagnostic heuristics in dermatology practice include primary lesion, morphology, shape, location, distribution, pattern, color, feel, texture, and context, with primary lesion being the most reliable [27,32].

Table 6. *Common cognitive bias heuristics in dermatology.*

Heuristic:	Definition:
Anchoring heuristic	Premature closure to develop an appropriate differential diagnosis relying on first impression, even if new evidence discredits that diagnosis
Availability heuristic	Diagnosis based on information recall from past common cases most readily available in the physician's mind, without exploring less common diagnoses (i.e. rare diseases missed because not often seen or not known)
Base-rate neglect	Ignoring statistics that contribute to a correct diagnosis and incorrectly basing diagnosis on other information believed to be pertinent to diagnosis
Affect heuristic	Psychological factors in patient case skew physician's diagnostic process
Framing heuristic	Diagnosis affected by human tendency to view the patient in a particular context; and influenced by subtle wording of how the case is presented by others.

Adapted from Lowenstein & Sidlow [27].

The context of how a patient case is presented may introduce bias. Increased use of semantic qualifiers (e.g. dew-drop on a rose petal vesicle) to describe conditions can increase diagnostic accuracy, but their usefulness relies on their universality, specificity, and descriptiveness [28].

Cognitive diagnostic error can stem from lack of basic medical and scientific knowledge (e.g. incomplete knowledge of pathologic processes and clinical inexperience) and lack of patient information (e.g. patient history and examination inadequate to gather relevant information). In addition, poor comprehension of information includes the inability to use strength of evidence to weigh disease probability, cognitive bias, and misinterpretation of test results and visual diagnostic information from patient history and examination. Poor choice in diagnostic testing (e.g., inappropriate testing chosen to support or negate diagnosis) also leads to misdiagnosis [27]. Most cognitive errors stem from information processing [28]. Common cognitive biases in dermatology include anchoring, availability, base-rate neglect, affect, and framing heuristics (**Table 6**), [27]. To combat cognitive sources of diagnostic error, understanding metacognition, or the study of how humans think, is a potential tool. Methods to limit cognitive-based error include strengthening mental skills pertinent to dermatology, avoiding information overload, regularly requesting to be critiqued by professional peers, and practicing with humility (**Table 7**), [28].

Laboratory and tracking errors

Failure to accurately diagnose also occurs in laboratory and pathology testing and includes pre-analytical, analytical, and post-analytical errors (**Table 8**), [33–37]. In clinical laboratories, pre-

Table 7. *Techniques to increase diagnostic accuracy in dermatology.*

Recommendations	Action
Strengthen mental skills pertinent to dermatology	Increase ability to observe pertinent details Alternate related conditions, pathologies, treatments, etc. in the same study session to form a more complete differential diagnosis Increase ability to apply statistics in diagnosis
Avoid information overload	Too much information may overwhelm the diagnostic mind Use evidence-based guidelines, protocols, differentials and checklists to streamline the diagnostic process Avoid rushing into a diagnosis with "diagnostic momentum" and premature closure of the diagnosis; take extra time to consider differential diagnoses
Regular critiques from professional peers	Frequent feedback: 1) promotes humility 2) encourages active improvement Second opinions increase diagnostic accuracy

Adapted from Lowenstein, Sidlow & Ko [28].

Table 8. *Pre-analytical, analytical and post-analytical errors in laboratory/pathology testing.*

Error type	Specific error
Pre-analytical errors	1) Poor specimen sample: suboptimal biopsy/lesion site, clotted blood 2) Inadequate sample size/low volume 3) Misidentification of sample or patient: wrong patient, tissue laterality or anatomic location 4) Loss of orders from physician 5) Wrong container for specimen 6) Specimen improperly labeled 7) Improper specimen collection 8) Damage to specimen through improper storage, transportation, handling or accession 9) Improperly preparing the patient before specimen collection 10) Specimen; lost, inadequate size or volume, absent or discrepant measurements
Analytical errors	1) Test equipment not functioning correctly/poorly calibrated 2) Test not executed correctly (e.g. inadequate cuts and operator rushing) 3) Results not calculated correctly 4) Turn-around time is inadequate 5) Additional or repeat testing not available 6) Report defects: missing, erroneous, or nondiagnostic information (e.g., practitioner, procedure, date and code(s))
Post-analytical errors	1) Slow generation/transmission of test results to physician 2) Improper generation/transmission of test results to physician 3) Slow interpretation/transmission of results to patient 4) Improper interpretation/transmission of results to patient 3) Non-standardized units in results 4) Incorrect results not corrected 5) Failure to communicate lab errors to physician 6) Failure of proper data entry 7) Poorly functioning computer system

Adapted from Hollensead et al., Stahl et al., Plebani, Guar et al., Abdollahi et al., and Meier et al. [33,34,36–38,128].

analytical errors are the more common of the three [36,37]. In one study, the most frequently reported recent errors came from elements of the biopsy pathway. More specifically, 18% (N=27) of respondents reported pre-analytical errors related to incorrect information on the sample bottle or request form and 6% of respondents reported post-analytical errors from either a delayed or absent response to test results [2]. Increased use of information technology, standardization of processes, and increased education and communication are needed to decrease these categories of error (**Table 9**). Additionally, the success or failure of interventions to improve pathological specimen processing may be evaluated by an audit of amended pathology reports including minor modifications or major changes in any portion of the report. Such findings would identify misidentification and misinterpretation of results [38]. Historically, physicians have struggled in tracking, receiving, and acting on laboratory specimen test results. The entire process includes delivering abnormal test results to the patient and documenting, notifying, and tracking patients who require follow up [39,40]. Continuous quality improvement and monitoring is needed to explore the effects of electronic health records on these tracking and notification processes.

Error in diagnosing melanoma

Two factors which influence the accuracy of diagnosis in dermatology practice are skin color and the consistent use of evidence-based guidelines. In a survey of general practitioners in England, two pictures of melanoma from Black patients were misdiagnosed significantly more than two pictures of melanoma from Caucasian patients (62% and 31% misdiagnosis versus 13% and 7% misdiagnosis, respectively). Disparities in patient care arising from this failure must be addressed in further study and physician training [41]. Additionally, in a study from Romania, a country without national guidelines,

Table 9. *Best practices for tracking and notifying laboratory/pathology test results.*

Recommendations	Action
Specify data to be labeled and tracked during specimen processing and delivery, and result review and notification.	1) Physician name 2) Patient name 3) Patient identifier 4) Name of ordered test 5) Date test is scheduled AND date test performed 6) Facility at which test is performed 7) Date test is interpreted 8) Name of the interpreter 9) Date ordering physician notified 10) Date patient notified
Establish protocol for tracking test results	When and how test results will be: 1) logged 2) filed 3) reviewed by physician 4) communicated to patient
Document and review each step of laboratory /pathology specimen tracking regularly	Document: 1) paper log book 2) filing systems for patient charts and lab/path orders 3) computer systems and electronic health records Review: 1) Separate documentation for patient chart and organization's systems; keep available to check for discrepancies and errors 2) Automated reminders for testing/biopsies that require follow-up in writing and/or in electronic health records
Ensure patient understanding of when they will receive test results	1) Communicate orally and with written/visual material 2) Make sure patient understands: When results will be available How the patient will receive the results (i.e., phone call, follow-up visit, etc.) Welcome patient to call if they have not received results by specified date
Ensure HIPPA form is signed by patients and preferred contacts are specified	Result notification to patients 1) Communicate both positive and negative results 2) Communicate urgent/complicated results immediately (i.e., phone call)
Ensure test results are given to patients and signed by the physician before being filed	If results are positive, track patient until appropriate treatment or treatment refusal occurs Track: 1) follow-up appointment adherence 2) delivery of results 3) treatment of positive findings

Adapted from Table 6 in Cao LY, Taylor JS, & Vidimos A [4]; Abdolliah, Saffar & Saffar [37]; and Meier et al. [38].

dermatologists who did not consistently use American Joint Committee on Cancer (AJCC), tumor-node-metastasis (TNM), or European Organization for Research and Treatment of Cancer (EORTC) guidelines made more errors in diagnosis and treatment of melanoma. There were 166 errors in initial diagnosis and treatment among 33 patients with melanoma who came for a second opinion of their diagnosis and treatment. In addition to adhering to international guidelines the authors suggested these practices to avoid diagnostic error in cases of melanoma: 1) a multidisciplinary approach among the care team; 2) dermoscopy to help establish melanoma diagnosis; 3) appropriate

exision and re-excision with correct technique and based on Breslow tumor thickness; and 4) a complete pathology report for each excised lesion to help in staging and management [42].

Errors in the diagnosis and treatment of melanoma can be found at multiple levels including: clinical and histopathological diagnosis, surgical treatment, sentinel lymph node biopsy, staging, and management [42]. In a study of 588 cases of cutaneous melanoma and melanoma in situ diagnosed by physicians outside of Emory University, 114 (19%) were re-staged according to AJCC guidelines by Emory's physicians, resulting in a different treatment plan in 18% of cases [43]. Anonymous consultants were found to more likely misdiagnose dermatopathological specimens owing to a lack of integration of clinical information into the histological pattern [44]. A recent study in the United Kingdom found that pathological review of primary cutaneous melanoma by multidisciplinary teams of skin care specialists improved patient care. Inaccurate melanoma staging, based on the eighth AJCC's staging system, was detected in 6.7% of reviewed cases resulting in significant changes in clinical management for 2.9% of the cases [45].

One author of this article (EM) co-authored the proposal of the "CARE" acronym of "communication," "assess biases," "reconsider differential diagnoses," and "enact a plan" as a method to reduce diagnostic errors in dermatology (**Table 10**), [46]. Suggestions to increase diagnostic accuracy in dermatology (**Table 7**) and reduce diagnostic error through proper dermatologic biopsy technique have also been made (**Table 11**), [47].

Dermatological conditions in primary care

A study of physicians associated with Vancouver Coastal Health found that dermatologists were more diagnostically accurate (24.75% accuracy) than both general practitioners (3.52% accuracy) and family physicians (12.75% accuracy) in the recognition of melanoma [48]. Lower diagnostic accuracy seen in primary care physicians (PCPs) can also result in unnecessary antibiotic prescription. In a study of patients diagnosed with cellulitis by their PCPs, dermatologists agreed in only 10% of those patients [49]. Both studies suggest better training in dermatological diagnosis for primary care physicians.

Telemedicine in dermatology

The higher rates of diagnostic error among PCPs suggest that telemedicine consultations with dermatologists may help improve diagnostic accuracy [50-53]. Teledermatology is care transferring medical information including clinical images virtually from a patient through a website or app with the goal of receiving evaluation from a remote dermatologist. When dermoscopic images are included the visit is referred to as teledermoscopy (TDS). A 2017 Swedish study evaluated TDS initiated by primary care physicians who sent patient histories and images to dermatologists for triage of benign and malignant skin lesions [51]. In a comparison of TDS referrals with images versus traditional paper referrals without images, TDS resulted in significantly greater diagnostic agreement among practitioners. Teledermoscopy also resulted in more accurate diagnosis of melanoma so that patients could undergo surgical treatment on their first office visit. Also, benign lesions more often were referred correctly to primary care physicians, freeing up appointments for more urgent cases. However, interobserver agreement was less with melanoma in situ [51]. At the University of Missouri teledermatology video conferencing including "telementoring" has been used in outreach programs such as ECHO (Extension for Community Healthcare Outcomes) to improve diagnosis and management by PCPs who care for patients in rural areas which lack easy access to dermatologists [52]. Some patients prefer in-office visits and certain conditions mandate or are more amenable to them. A 2017 systematic review found that in-person visits generally result in more accurate diagnoses than telemedicine and teledermoscopy [53]. Teledermatology (as telemedicine) is typically practiced by either live interactive videoconferencing or asynchronous store and forward technologies, or a hybrid. A 2016 study of direct-to-consumer telemedicine websites and apps catering to California residents raised quality and patient safety concerns. Twenty-six percent of

Table 10. *"CARE" Approach: recommendations to decrease diagnostic error.*

Recommendations	Action
"Communication"	1) Increased use of open-ended questions 2) Decrease yes/no questions because they inhibit effective data gathering
"Assess for Biases"	Self-assessment for biases: 1) "Anchoring bias": latching onto the initial impression of a case rather than appropriately developing and considering a differential 2) "Attribution bias": attributing a condition to a specific part of a patient's history rather than considering all differential diagnoses (i.e., attributing rash to nickel allergy from patient's bracelet when the patient was actually exposed to poison ivy) 3) "Availability bias": settling on the most common diagnosis too quickly without considering more rare diagnoses 4) "Visceral bias": allowing an emotional response to the patient affect patient care
"Reconsider Initial Diagnosis"	Review the patient's history, physical exam and lab results while considering alternative diagnoses
"Enact a Plan"	Create treatment plan and communicate plan to patient and/or caregivers in understandable language

Adapted from Rush, Helms and Mostow [46].

"physicians" were not transparent about their licensure; others were found to be nurse practitioners (4/57 encounters), physician assistants (3/57 encounters), and international physicians from India and Sweden. In addition, 90% of the clinicians did not offer to send visit records to the patients' primary care physicians. Yet, 77% of encounters resulted in a diagnosis with 65% of those encounters receiving prescriptions. Significant diagnoses like polycystic ovarian syndrome and secondary syphilis were not detected [50]. Further research on provider regulations and standardization as well as consumer education is warrented to improve quality, safety, and efficacy of direct-to-consumer telemedicine. Teledermatology usage has increased significantly with the 2020 Covid-19 pandemic and both the American Academy of Dermatology (AAD), (aad.org) and the American Telemedicine Association (ATA), (americantelemed.org) have up-to-date policy statements, tutorials, and regulatory policy updates on their web sites.

Office-based surgery

Over the previous two decades, there has been an increasing shift of dermatological surgeries from the ambulatory surgical center to the office [4,54,55]. Approximately 80% of procedures are performed in an outpatient setting with 15% to 20% being office-based surgeries [54]. Office surgery offers many advantages: personalized and continuous care, cost-effectiveness, increased patient satisfaction, and decreased risk of infection [4]. Nonetheless, errors in dermatologic and cosmetic procedures are often under review because of their defined processes, readily measured outcomes, and visible nature.

Cosmetic procedures

Reports of patient deaths during liposuction in the 1990s highlighted the safety implications of ambulatory surgery and led several states to pass regulatory measures. Analysis of several large-scale studies using mandatory reporting databases for office procedures in Florida and Alabama were consistent between the states and revealed the bulk of complications and deaths were from cosmetic procedures performed under general anesthesia, mostly by plastic surgeons [4,54,56]. Over a span of seven years in Florida, 22.6% of surgical deaths and 13.6% of hospital transfers were related to liposuction performed under general anesthesia, with no reports of liposuction-related morbidity or mortality when local (tumescent) anesthesia was used [4,54]. Kreicher and Bordeaux reported that Mohs Micrographic Surgery (MMS) resections as

Table 11. *Avoiding diagnostic error by preventing biopsy mistakes.*

Recommendations	Action
Select correct biopsy for condition	Shave: single, elevated lesions Punch: inflammatory lesions Excisional: larger lesions (i.e., melanoma) Curettage: rarely appropriate for diagnostic biopsies
Avoid superficial shave biopsies	Superficial shave specimens may not be histologically adequate for diagnosis; obtain enough tissue in shave biopsy while avoiding cosmetic damage
Punch biopsies must be used for rashes	Punch biopsies reveal both deep and superficial pathology in inflammatory conditions; sutured punch biopsy cosmetically advantageous over shave biopsy
Excise melanomas	Complete removal of melanoma is more likely in excision than with shave or punch specimens
Use curettage sparingly	Tissue structure damaged during biopsy; can lead to diagnostic errors
Fix tissue appropriately	10:1 formalin volume to tissue volume; prompt fixation and gentle handling of the specimen are necessary for accurate diagnosis
Record biopsy	Photograph lesion relative to anatomical landmarks; take measurements from 2 or 3 specific anatomical landmarks to map lesion
Ensure pathologist has access to patient's history	Appearance, distribution, duration of lesion as well as topical products, oral medications, environmental exposures can narrow differential diagnosis
Refer ambiguous cases	Risky or non-responsive conditions may need second opinions to avoid diagnostic error

Adapted from Miedema, Zedek, Rayala, and Bain [47].

large as 20cm with subsequent reconstruction can be conducted both safely and effectively using tumescent local anesthesia, adding to the patient's comfort [55].

Minimally invasive cosmetic procedures

The National Ambulatory Medical Care Survey revealed that the number of cosmetic procedures quadrupled between 1995 and 2010 with plastic surgeons (36.1%) and dermatologists (33.7%) performing the majority. The American Society for Dermatologic Surgery (ASDS) conducted annual surveys between 2001 and 2007, which showed botulinum toxin injections, soft tissue augmentation, and laser therapy to be the procedures with the greatest rise in volume [57], an analysis confirmed in an American Society for Aesthetic Plastic Surgery 2013 survey [58]. More recent ASDS data shows continuing increases in minimally- and non-invasive cosmetic procedures with the numbers of injectable neuromodulator and soft-tissue filler procedures increasing by 42% and 78%, respectively since 2012. Additionally, laser, light, and energy-based treatments have increased by 74%, with seasonal variability noted in one practice for some procedures [59].

A selected list of current devices and procedures include: 1) injectables: neurotoxins, fillers (hyaluronic acid, poly-L-lactic acid, calcium hydroxyapatite), deoxycholic acid (Kybella®); 2) lasers: vascular, pigment, nonablative/ablative resurfacing; 3) microneedling; 4) radiofrequency microneedling; 5) platelet rich plasma; 6) body contouring: cryolipolysis; 7) skin tightening: microfocused ultrasound, subdermal radiofrequency; 8) thread lifts; 9) sclerotherapy; and 10) chemical peels.

Although botulinum toxin was originally used to treat spasticity and muscle pain, its role has expanded to include facial remodeling and symmetry restoration [56]. It is generally safe to use with little risk of serious complications. However, local diffusion into nearby muscle tissue can occur from improper injection technique with variables relating to concentration gradient and injection volume [58]. Since 2000, the use of hyaluronic acid, calcium hydroxyapatite, and poly-L-lactic acid fillers has been increasing because of the demand for

noninvasive cosmetic procedures with low risk for significant adverse events compared to previous silicone and bovine collagen fillers. The most common side effects of the newer fillers include injection-site reactions: erythema, swelling, pain, and bruising [56,58]. The reality is that aesthetic medicine is changing at a rapid pace with new devices and injectables coming to the market and providers of various backgrounds are performing them. State regulations vary, but a growing number of non-core, non-physician providers are offering these services to the public. Additional patient safety concerns are counterfeit products and devices which are neither tested nor verified with quality controls. In a recent survey of ASDS and American Society of Laser Medicine and Surgery (ASLMS) members, 765 responded that for medical devices and injectables, 37.4% and 41.1%, respectively, encountered counterfeits and 20.1% and 39.7%, respectively, experienced patients with adverse reactions from them [60]. Complications that we are aware of, aside from expected side effects, include: 1) a counterfeit product injected in the wrong depth and location at a home injection party by a non-physician; 2) hyaluronic acid filler injections performed outside the United States with delayed granulomas and infections; 3) non-core MD physician performing subdermal radiofrequency with a resulting patient full-thickness burn on the central neck, and 4) patient suffering fat atrophy and ulceration after injection of deoxycholic acid instead of neurotoxin to the glabellar complex; the patient had multiple procedures and the neurotoxin and deoxycholic acid are both clear, colorless liquids.

Wrong-site procedures

The Joint Commission has classified wrong-site surgery as one of the most common medical errors (13.1%) experienced in all of healthcare and one which may lead to major patient harm [61]. In a survey of 150 United States dermatologists wrong-site surgery ranked first (19%) as the "most serious" and 9th (3%) as the "most recent" self-reported practice error [2]. Dermatologists recognize Mohs micrographic surgery, an outpatient procedure with tissue conservation and immediate reconstruction has a high cure rate and an excellent safety profile [56]. However, owing to its high frequency, wrong-site surgery was a leading cause of medical malpractice lawsuits involving 14.3% of fellowship-trained Mohs micrographic surgeons in one study [62]. Many aspects of medical and dermatological care contribute to wrong-site procedures including environmental, provider, system, and patient issues (**Table 12**). The presence of wound healing around the biopsy site, other nearby biopsy sites, background sun-damaged skin, and an abundance of other benign, precancerous, and cancerous lesions in the immediate field may hide scars and lead to incorrect lesion identification [63–65]. Furthermore, the delay between the initial biopsy and planned procedure, often several days-to-weeks, can result in healed skin, contributing to the lack of a visible site [4,63,65]. Biopsy identification tips include: 1) avoid cryo- or topical therapy of actinic keratoses in areas of suspected skin cancer biopsy sites; 2) standardize anatomic nomenclature; e.g. thumb rather than first digit; 3) create different scars, e.g. circular, triangular, etc., for easier identification, if performing more than one biopsy in a skin area and 4) treat underlying inflammatory skin disease (Tri Nguyen MD, AAD presentation, 2011).

Although these scenarios are inevitable conditions of care, both physicians and patients play important roles in the number of wrong-site surgeries as delineated in **Table 12**. Neither should rely entirely on the sole assertion of the other as to the correct site, but should utilize objective documentation, especially photographs, measurements from landmarks, and active patient involvement with the use of a mirror. The absence of accurate photographs has been a major factor in wrong-site MMS [61]. Accurate biopsy site documentation and identification with the goal of eliminating any ambiguity includes: 1) using specific and consistent anatomic designations and identifiers, e.g. canthi, oral commissures; 2) using surrogate markers such as angiomas or nevi if landmarks are sparse; 3) listing a) *side* (laterality), b) *site* (anatomic), c) *size* (of lesion), and d) *sum* (triangulated measurements) on the specimen requisition in addition to usual demographics, date, time, proceduralist; and 4) taking more than one photograph, e.g. patient ID sticker, plus distant and close-up with ruler showing triangulated measurements [54,58,66].

Table 12. *Risk factors for wrong-site procedures.*

Source of risk	Risk factor
Environmental	High workload, fatigue, change of personnel Exclusion of surgical team members, patient and their family members in pre-operative assessment Incomplete or inaccurate communication among surgical team members, or between surgical team member and patient Pressure to reduce pre-operative preparation time Unusual time pressures or emergencies
System	Exclusion of surgical team members, patient and their family members in pre-operative assessment Incomplete or inaccurate communication among surgical team members, or between surgical team member and patient Involvement of more than one surgeon in procedure Pressure to reduce pre-operative preparation time Lack of institutional policies and controls Reliance solely on the surgeon to determine correct surgical site Similar procedures performed back-to-back in the same room Unusual operating room setup or equipment (e.g., change of patient's position during procedure, rotation of surgical table) Use of abbreviations related to surgical procedure, site, laterality
Provider	Illegible handwriting Inadequate medical record review Inadequate patient assessment Involvement of more than one surgeon in procedure Mislabeled or misinterpreted laterality markings on radiographs, computed tomogram and magnetic resonance images Performance of multiple procedures on multiple parts of a patient at one time Reliance solely on the surgeon to determine correct surgical site Wrong side draped or prepped
Patient	Extenuating patient characteristics (e.g., physical or mental incapacitations or disabilities, language barrier, morbid obesity) Presence of multiple prior treatment or biopsy sites Similar patient names

Modified and updated from Table 7 in Cao LY, Taylor JS, & Vidimos A [4].

In its 2020 ambulatory health care patient National Safety Goals, TJC again recommends utilizing the Universal Protocol (UP) for preventing wrong-site, -person, and -procedure errors. These three sentinel or "never" events are interrelated and in 2017 were the third most common adverse event reported to TJC [61]. The UP emphasizes teamwork and proper communication between all relevant caregivers to ensure optimal patient protection. The UP contains three necessary steps that must be completed prior to performing the procedure: 1) conducting a thorough pre-procedure verification process; 2) marking the procedure site in an unambiguous standardized fashion by the licensed independent practitioner performing the surgery or a postgraduate trainee who is under supervision of the licensed individual; 3) conducting a final time-out assessment to identify the correct patient, site, and procedure immediately before making the incision [66]. The active attention and involvement of the healthcare team is critical to maintain patient safety. **Box 1** lists the Cleveland Clinic Foundation's current Mohs UP which is adapted from TJC UP. The Joint Commission also mandates the use of at least two patient identifiers for every step in health care delivery to prevent patient misidentification (three identifiers for blood transfusions). These can include the individual's name, birthdate, standardized ID band markings, or other person-specific identifiers. Medical record systems that create the label from the procedure note can include these identifiers efficiently and reduce errors. Checking schedules in advance for same named patients and the ability of electronic health records (EHRs) to highlight or bold

similar patient names can help limit misidentification errors. We have also found that the use of the sign out from the UP is critical in preventing specimen labelling and processing errors. Critical factors are listed in **Box 2**.

Current literature offers several other practical suggestions for preventing wrong-site errors. One is the use of hand-held mirrors for reconfirmation of the biopsy site, but in our opinion it is only useful when supplemented by objective verification with accurate photographs [67]. These mirrors have also been proposed for use during and after the procedure to allow patients to appreciate the complexity of the surgery, reduce patient anxiety, and aid in post-operative wound care teaching [68]. A second is the use of the patient's own smartphone to document the biopsy site, given its popularity, high-quality camera, and innate ability to not violate the Health Insurance Portability and Accountability Act (HIPAA). Patients using the camera on their phone can serve as a universal electronic medical record (EMR) platform between dermatologists and patients. Highsmith et al. coined a three-step technique, BIOPSY 1-2-3, for smartphone use that can potentially reduce errors: have 'one' other person take the photograph to overcome the biopsy site selfie issues of inadequate distance and lower quality front facing camera; ensure 'two' anatomical landmarks are pictured; and acquire a minimum of 'three' pictures for each site [63]. We caution that smart phone selfie photographs may be mirror images which are usually but not always auto-flipped and that software is available to prevent auto-flipping. Thus laterality, especially in pre-operative selfies, must be interpreted with caution. Additionally, image flipping and manipulation is allowed in some EHR software programs and is another potential risk factor for wrong-site procedures [69].

Box 2. *Universal protocol sign-out check list for biopsy/ surgical specimen requisitions.*

The requisition includes:
Patient's first and last name
Patient's medical record number (MRN)
Date and time of collection
Initials of preparer
Ordering physician
Requested lab procedure
Valid diagnosis (ICD10) code for outpatient procedure
Also Include if applicable: Side, Site, Size and Sum (measurements)
Anatomical Site
Laterality (right or left Side)
Source of specimen
Clinical History
Date

Adapted from Cleveland Clinic procedure and MacFarlane D and Wysong A [129].

Infections

Hand hygiene and coronavirus disease 2019

Hospital-acquired infections are a major burden for both patients and healthcare systems. The CDC reported that nearly two million healthcare associated infections (HAI) occur across the United States every year with one in 31 hospital patients experiencing an HAI on any given day [70]. According to the CDC, TJC, and the World Health Organization (WHO), hand hygiene is the most important measure in preventing nosocomial infections in both the inpatient and outpatient setting [70,71]. The WHO has long promoted hand hygiene, which includes the 5 moments for hand hygiene: 1) before touching the patient; 2) before clean/aseptic procedures; 3) after bodily fluid exposure; 4) after touching a patient; and 5) after touching patient surroundings [72]. The WHO reported on many studies illustrating the success of hand cleansing on HAI rates and reduction of cross-contamination of resistant bacterial strains, particularly methicillin-resistant *Staphylococcus aureus* (MRSA), and even promoted "wash your hands day" on May 5, 2020. Global handwashing day occurs annually on October 15.

With coronavirus disease 2019 (COVID-19) hand hygiene products have received publicity because of shortages and adulteration. CDC recommends either alcohol-based hand rubs (ABHR), which in the concentrations of 60-95% alcohol have been shown to inactivate severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), or hand washing for at least 20 seconds, which mechanically removes pathogens, especially when hands are visibly soiled.

Compliance is better with ABHR [73]. CDC does not have a recommended alternative to hand rub products with greater than 60% ethanol or 70% isopropanol as active ingredients. In addition to both ethanol and isopropanol, the US Food and Drug Administration (FDA) approves the use of benzalkonium chloride in formulations of health care worker hand rubs, although it has less reliable activity against certain bacteria and viruses than either of the alcohols. Centers for Disease Control and Prevention also provides guidance and links to the FDA, the United States Pharmacopeia (USP), and WHO web sites for temporary and alternative hand sanitizers [73]. Since June 2020, the FDA has identified hand sanitizers containing toxic components such as methanol and 1-propanol. Currently, the list includes 160 products that may be labelled as containing methanol or products that have microbial contamination, subpotent percent of active ingredients, or association with a facility where other products have contained methanol or 1-propanol [74]. The AAD web site also has an extensive list of coronavirus resources for members and the public: e.g. dermatologic manifestations, treatment guidelines for patients on biologics, occupational best practices, personal protective equipment (PPE) use, office management during the COVID-19 pandemic, and multiple others. The American Academy of Dermatology also maintains and urges reporting of cases to a COVID-19 disease registry to help document and understand the dermatologic manifestations of the disease [75].

In the field of dermatology, touch is essential to care, making infection control particularly important. In a national survey of 474 dermatologists, only 53% (N=241) reported routinely washing their hands prior to examination, whereas most reported wearing gloves during examination as follows: always (21%, N=99), occasionally (76%, N=359), never (3%, N=13). This study also found that dermatologists who do not wear gloves tend to shake hands with their patients more, potentially leading to higher infection transmission rates [76]. This is particularly important in recent decades owing to the emergence and recognition of resistant bacteria, such as MRSA, vancomycin-resistant enterococci (VRE), and spore-forming bacteria (e.g., *Clostridium difficile, Bacillus anthracis*). Our previous review noted the importance of washing hands with soap and water when exposed to spore-forming bacteria for effective infection control. In most other cases, alcohol-based hand rub is preferred because of its convenience, fast-action, and potency against resistant bacteria, including MRSA and VRE [4].

Universal pandemic precautions

In a July 2020 published commentary, the Society for Health Care Epidemiology of America advocates the implementation of Universal Pandemic Precautions in the current environment to complement current universal precautions (now called standard precautions). Universal Pandemic Precautions are designed to protect health care providers, patients, and visitors from COVID-19 and consist of the *use of a mask and eye protection for all direct patient contacts or at a minimum, use of a mask and eye protection for direct patient contact when the patient is unable (e.g., children) or unwilling to wear a mask.* Universal Pandemic Precautions implementation should be conditional on local case numbers and transmission and this paradigm shift would offer protection against SARS and SARS-CoV-2 and help prevent transmission of other droplet-spread respiratory pathogens in the health care setting (e.g., influenza A and B, respiratory syncytial virus, seasonal coronaviruses). Universal Pandemic Precautions have been adopted in at least three academic medical centers in the U.S [77].

Gloves

Although dermatologic surgical procedures are typically reported as having infection rates between less than 1% and 3.5%, there has been debate on the cost-effectiveness of sterile versus nonsterile glove use. One retrospective analysis of postoperative infection data from 832 consecutive patients undergoing MMS reported an infection rate of 2.5% prior to and 0.9% after the sterility upgrade (P=0.04). This intervention included jewelry restrictions, sterile gloves and gowns for staff, sterile towels and dressings for patients, and alcohol hand rub before stages and reconstruction [78]. However, more recent literature that focuses on the independent

effect of glove sterility generally supports the use of nonsterile gloves as a safe alternative to sterile gloves because of similar infection rates and significant cost savings. The exception noted is for wound closure in larger and more extensive dermatological procedures. In a meta-analysis of 13 randomized controlled trials and observational studies which included 11,071 patients undergoing cutaneous or mucosal surgery, 1,360 patients were randomly assigned to treatment with nonsterile gloves versus 1,381 patients to treatment with sterile gloves; the remaining patients participated in observational trials. The results showed no difference in surgical site infection rates between the sterile versus nonsterile gloves in each subgroup analysis as well as in all the trials (2% versus 2.1%, respectively), [79]. Another prospective study of 60 randomized patients undergoing MMS at a single institution reinforced the claim as their results yielded two infections (6.6%) in the sterile group and one infection (3.3%) in the nonsterile glove group indicating nonsignificant differences (P=0.99), [80].

Medication vials

Relevant to dermatology is TJC's Sentinel Event Alert on the prevention of infection from misuse of medication vials. Thousands of patients have been adversely affected by the misuse of single-dose (SDV)/single use and multiple-dose vials (MDV). Hepatitis B and C and other bacterial infections were reported in 49 outbreaks with SDV and 19 with MDV. Causes of misuse include: 1) use of SDV on multiple patients; 2) use of the same syringe to re-enter MDV's multiple times for the same patient with reuse of that same MDV on multiple other patients; and 3) reusing a syringe to obtain additional dose(s) from an MDV and leaving it for use on another patient, risking back wash of any contaminating blood borne pathogens. **Box 3** lists suggested policies and procedures to prevent medication vial infections [81].

Box 3. *Strategies for the prevention of medication vial infections.*

Single dose vials (SDV), (no preservative):
One vial-one patient (CDC One and Only Campaign (ONE needle, ONE syringe, only ONE time
Discard vial after single use / never return to stock
If SDV must be entered multiple times for one patient-use a new needle / new syringe every time
Never combine content of multiple SDVs to obtain full dose
Do not store used single dose/single use (SD/SU) vials for later use, no matter what the size of the vial
Multiple dose vials (MDV) must be so labeled by the manufacturer
Limit the use to only one patient whenever possible to reduce the risk of contamination!
When used again: New needle – new syringe every time!
Do not leave needles in vial entry diaphragms between uses
Disinfect vial's rubber septum before puncturing by wiping with sterile 70% isopropyl alcohol, ethanol, iodophor or other approved antiseptic swab
Do not use beyond use dating: 28 days

Adapted from The Joint Commission (TJC) Patient Safety Alert #52 [81].

Falls

In 2015 TJC, citing six sources, reported that hundreds of thousands of patients fall each year in hospitals in the United States, with 30 to 50 percent resulting in injury. Falls with injury are a major patient safety problem and consistently rank in the Top 10 sentinel events *voluntarily* reported to TJC's Sentinel Event database. Between 2009-2015, there were 465 falls reported, most occurred in hospitals and death occurred in approximately 63%. The Joint Commission emphasizes that falls are vastly underreported and that no epidemiologic conclusions should be drawn from the data. Ambulatory settings are not immune to falls. "Any patient of any age or physical ability can be at risk for a fall due to physiological changes due to a medical condition, medications, surgery, procedures or diagnostic testing that can leave them weakened or confused" [82]. Risk factors for falls include age, orthostatic hypotension, multiple medication use (e.g., beta blockers, nitrates), autonomic symptoms, non-healing foot sores, self-reported depression, unclipped toenails, previous falls, dementia and impairments in cognition, vision, balance, gait, and strength [4]. A 2017 Cleveland Clinic Nursing Institute initiative proactively identified selected risk factors, screening questions and tools for prevention and management of falls in outpatient clinics (**Box 4**, **Figure 2**), [4,83].

Laser safety

The use of lasers in dermatology stems from their ability to target and destroy chromophores in tissues of interest. To generate the laser beam, light is shone through an optical cavity containing either a solid, liquid, or gas to determine the laser's wavelength.

Lasers are designed with wavelengths, energy densities, and pulse durations specific to the target chromophores, such as melanin. When a laser strikes a chromophore, its energy is converted into heat and sound waves which destroy the chromophore and the surrounding tissue, respectively [84].

Laser safety guidelines have been published by the AAD, ASDS, American National Standards Institute (ANSI), ASLMS, Laser Institute of America, Rockwell Laser Industries, FDA's Center for Devices and Radiological Health, Department of Labor's Occupational Safety and Health Administration (OSHA), and the Council of Radiation Control Program Directors [4,58]. Although compliance with these guidelines is voluntary, laser safety standards are legal requirements for practice, adopted in the US from the ANSI (ANSI; designation code Z136.6), [58].

We have updated the information on fire, plume and ocular hazards from dermatological lasers, the basics of which have not changed significantly in the past 10 years.

Potential fire hazards

Class IV lasers can cause both electrical fires and combustion fires. Electrical fires should be extinguished with halon extinguishers because they typically do not damage the laser; combustion fires in the surgical field should be extinguished with water. When they are not moistened, objects found in operating rooms, like dry towels and gauze sponges, can easily be ignited by lasers such as CO_2 and Nd:YAG lasers [85–87]. Oxygen and nitrous oxide increase the risk of fires [88]. Pulsed dye lasers (PDL) are believed to have a lower risk of causing cutaneous fires owing to low absorption by melanin and short pulses as compared to CO_2 lasers and Nd:YAG lasers [89]. However, fires caused by PDL have been reported on hairy skin surfaces in the presence of cannulae or facemasks with flowing oxygen [4,90]. **Box 5** presents updated safety recommendations for the prevention and handling

Box 4. *Falls: causes, screening, prevention and management in the ambulatory setting.*

Selected causes of ambulatory falls:
Standing or sitting on the side of an exam table or cart
Transferring from a chair/bed /wheelchair /stretcher
Ambulating from/to the restroom
Ambulating with/without an assistive device
Tripping/running
Fainting after a procedure /laboratory draws
Environment issues: slippery floors, mats

Selected screening questions:
Has patient had 2 falls in the past year or one with injury?
Is patient currently using an ambulatory assistive device (e.g. walker, cane, wheelchair, and crutches)?

Selected management and prevention actions (document in chart):
Place yellow Falling Person Sign (see Figure 2) on door of exam room if yes to screening questions 1 and 2 above
Patient should remain seated in a chair or wheelchair until the time of exam and should not be left alone on exam table
Leave the door to exam room open, if feasible
Escort patient: in/out of exam room, restroom, etc.
Assist with transfers, changing clothes
Verbally inform patient to remain where seated and call for help (or use call light if available) when needed
Ensure patient's belongings are within reach
Lock wheels on wheelchairs and exam tables- Wheel chairs can easily tip if patient reaches for items on floor
Supervise and assist all patients with impaired gait, vision or hearing
Apply non-skid socks
Document patient refusal of assistance

Adapted from Fall Prevention and Management, Nursing Institute, Cleveland Clinic Hospitals, April 2017 courtesy of Monica Weber, Director Professional Practice, Nursing Quality and Practice, August 18, 2020.

Figure 2. *Falling Person Sign to place on examination room door of patients at high risk of falling.*
From Fall Prevention and Management, Nursing Institute, Cleveland Clinic Hospitals, April 2017 with permission of Monica Weber, Director Professional Practice, Nursing Quality and Practice.

Box 5. *Fireproofing the laser operating room: Safety recommendations for preventing and handling laser-induced fires.*

Preventing laser-induced fires:

Class IV lasers may be associated with electrical and combustion fires

Halon fire extinguisher should be available for electrical fires (fluorohydrocarbon generally does not damage laser components unlike carbon dioxide extinguishers

Water should be available for combustion fires on the surgical field

All towels, gauze sponges, cottonoids, and clothing should be removed or continuously moistened throughout the procedure

Hair in or adjacent to laser fields should be shaved or continuously moistened with saline, or water- or water-soluble gel

Clear facemasks, nasal cannulae and other plastic airway devices should be used instead of colored devices

Patient's skin should *not* be cleaned with alcohol-based solutions; patient should not use hairspray or other alcohol-containing personal care products such as sunscreens and cosmetics before procedures

Surgical instruments with shiny reflective surfaces should be covered with wet sponges or ebonized to prevent reflection of the laser beam

Prevent flammable methane release (e.g., flatus) in the surgical field

Anesthesia:

Inspired gas mixture should contain minimal oxygen to maintain the patient's oxygen saturation, and gases (e.g., helium, nitrogen, compressed air) and inhaled anesthetics with less combustibility

Oxygen and other gases (e.g., nitrous oxide) should never be directed toward the laser field and ideally oxygen should be turned off for brief periods when lasering on the face

Laser procedures near the airway should ideally involve intravenous sedation and local nerve blocks; if general anesthesia with endotracheal intubation is absolutely required, endotracheal tube shafts should be made from a metal, laser-safe material or wrapped with aluminum or copper foil tape in a spiral manner, so that flexion of the tube does not expose bare areas to the laser; endotracheal cuffs should be filled with saline rather than air

Laryngeal mask airways with spontaneous respirations are preferred over face masks due to less oxygen leakage; if a face mask is used, an oxygen analyzer may be used to ensure minimal leakage

Fluorocarbon cryogens are non-flammable, although ethyl chloride has been reported to ignite after contact with laser pulses

Handling laser-induced fires:

A plan of action should be rehearsed by all operative personnel in case of a fire

A container of water or saline and a fire extinguisher should be available close to the operative field

Ventilation should be stopped and gases disconnected; endotracheal tube, mask, laryngeal mask airway, nasal cannula should be removed

Physicians should be aware that required protective eyewear makes it harder to see the onset of fire and smoke, and employ extra caution

Icepacks should be applied to patient skin after fire has been extinguished to minimize thermal injury

A flexible nasal pharyngoscope or bronchoscope can be used to survey the upper airway and laryngeal tissues for injury

Abundant water irrigation and povidone-iodine soap can be used to remove carbonized debris from burned areas

Bacitracin ointment should be applied to skin burns

Updated from Table 11 in Cao LY, Taylor JS & Vidimos A and current laser safety standards of practice at Cleveland Clinic [4], and elsewhere.

of laser-induced fires. Prior iterations of the annual updates of TJC National Patient Safety Goals (NPSG), (**Box 6**, for current 2021 Goals) presented broad strategies for preventing surgical fires in health care facilities. The previously listed NPSG # 11 advised educating all personnel in the operating room about controlling heat sources, fuel, and oxygen concentrations in the surgical field, in accordance with TJC Sentinel Event Alert 29 from 2003, "Preventing Surgical Fires" [4,91]. Multiple, recent surgical fire safety resources are available from TJC, the Council on Surgical and Perioperative Safety, and ECRI [92–94]. Two fire safety acronyms (mnemonics) and protocols have now been widely adopted by health care facilities as part of their Code Red policies to initiate a response to a fire: RACE (Rescue, Alarm, Contain and Extinguish) when first encountering a fire and PASS (Pull, Aim, Squeeze, and Sweep) when using a fire extinguisher [95].

Plume

Upon application of a laser, a plume of cell debris, steam, harmful hydrocarbons, such as polycyclic

Box 6. *The Joint Commission (TJC) 2021 Ambulatory Health Care National Patient Safety Goals (NPSG)*.*

The purpose of the National Patient Safety Goals is to improve patient safety. The goals focus on problems in health care safety and how to solve them.

Identify patients correctly

NPSG.01.01.01 Use at least two ways to identify patients. For example, use the patient's name and date of birth. This is done to make sure that each patient gets the correct medicine and treatment.

Use medicines safely

NPSG.03.04.01 Before a procedure, label medicines that are not labeled. For example, medicines in syringes, cups and basins. Do this in the area where medicines and supplies are set up.

NPSG.03.05.01 Take extra care with patients who take medicines to thin their blood.

NPSG.03.06.01 Record and pass along correct information about a patient's medicines. Find out what medicines the patient is taking. Compare those medicines to new medicines given to the patient. Give the patient written information about the medicines they need to take. Tell the patient it is important to bring their up-to-date list of medicines every time they visit a doctor.

Prevent infection

NPSG.07.01.01 Use the hand cleaning guidelines from the Centers for Disease Control and Prevention or the World Health Organization. Set goals for improving hand cleaning. Use the goals to improve hand cleaning.

Prevent mistakes in surgery#

UP.01.01.01 Make sure that the correct surgery is done on the correct patient and at the correct place on the patient's body.

UP.01.02.01 Mark the correct place on the patient's body where the surgery is to be done.

UP.01.03.01 Pause before surgery to make sure that a mistake is not being made.

*This easy-to-read document was created for the public by TJC. The exact language of the goals can be found at https://www.jointcommission.org/-/media/tjc/documents/standards/national-patient-safety-goals/2021/ahc_npsg_jan2021.pdf (accessed on March 11, 2021).

NPSG, National Patient Safety Goal.

#UP, Universal Protocol; the Sign Out is third stage of the Universal Protocol and is not listed with the 2021 Goals (See Box 1 for Sign Out details).

aromatic hydrocarbons, carbon monoxide, formaldehyde, ammonia, benzene, and toluene is released [86,96]. In animal studies, particles in the plume have been shown to cause bronchiolitis, emphysema, and congestive interstitial pneumonia by depositing in the lower respiratory tract [4]. Ablation of lesions containing microorganisms such as *Staphylococcus aureus*, human papillomavirus (HPV), and human immunodeficiency virus (HIV) has been hypothesized to put surgeons and staff at risk for infections related to inhaled, aerosolized microorganisms from the surgical plume. Two recent literature reviews detail the infectious composition of plumes from lasers and electrosurgical devices and highlight case reports of possible transmission of HPV by inhalation of laser-produced aerosols [97,98]. To minimize plume, it is important to use lasers with smoke evacuators that are within one centimeter of the laser treatment site to capture 99 percent of the plume [86]. Since Q-switched lasers may cause the ejection of skin fragments during use, masks and goggles are recommended [99]. A 2017 study found that cold sapphire skin cooling with gel decreased surgical plume in laser hair removal when compared to refrigerated air and cryogen spray. For instance, the cryogen spray was found to have a plume of 400,000 particles per cubic centimeter (ppc) whereas the cold sapphire skin cooling technique had a plume of about 35,000 ppc [100].

Eye safety

Lasers can damage the sclera, cornea, lens, choroid, and retina. The cornea and sclera are not as vulnerable as the retina, because the focusing power of the lens is not present. CO_2 lasers at 10,600nm damage the cornea and sclera, detectable by a burning sensation [4]. The retina is easily damaged by lasers in the 400nm to 1400nm range because the laser is focused by the cornea and the lens before reaching the pigment in the retina. Nd:YAG 1320nm lasers damage the cornea, lens, retina, and choroid [4]. Potassium titanyl phosphate and argon lasers can be focused by the lens onto the retina, causing retinal damage [85]. Q-switched Alexandrite and

Nd:YAG lasers are infrared lasers, making them the most likely to cause accidental damage to the retina [101]. Q-switched lasers cause thermal and photoacoustic damage to the eye. Long-pulsed Alexandrite lasers at 755nm damage the outer eye (causing cataracts, uveitis) even when the eyes are closed, and if the eyes are open, may burn holes in the macula resulting in macular scarring. Lasers in the visible light spectrum cause the aversion response (i.e., blinking or turning the head away from the stimulus) when directed at the eyes. The aversion response occurs in 0.25 seconds, but lasers with high power can damage the eye in less time [102].

Of further note, while performing surgery or utilizing lasers around the eyes, the oculocardiac reflex, otherwise known as the Aschner reflex, must be considered. Traction on the extraocular muscles, compression or manipulation of the eyeball, ocular trauma, or retrobulbar hematoma or block from anesthetics can induce up to 10% decrease in heart rate, especially in children and babies. Afferent stimulation of the ophthalmic branch of the trigeminal nerve results in efferent stimulation of the sinoatrial node by the vagus nerve, thus decreasing sinoatrial node firing and potentially causing bradycardia, atrioventricular block, and even asystole. While performing procedures, including laser surgeries, around the eyes, local peribulbar or retrobulbar anesthetics, IV atropine or glycopyrrolate, and oxygen/ventilation optimization must be utilized to avoid inducing the oculocardiac reflex in the patient [103–106].

While working with lasers, it is essential that the operator should never look directly at the laser output [58,98]. Also, it is imperative that lasers are not pointed at reflective surfaces which can scatter light, because reflective surfaces enhance the wavelength of lasers and cause eye damage [58,99]. Reflective surfaces, including mirrors, must be covered and even the surface of the laser equipment should be matte; windows should be covered as well [99]. Inadequate eyewear is found in 70% of all laser accidents, but proper use of protective eyewear prevents the power and density of lasers from causing eye damage [58]. Wrap-around goggles of the appropriate optical density for various wavelengths should be worn by anyone exposed to the laser and a warning sign should be placed on the outside of the door to warn of laser use. The surgeon should choose eyewear that is balanced between maximum optical density for protection of their own eyes, while also allowing clear visualization of the condition being treated [4]. Patients' eyes must be protected by instructing them to close their eyes and covering them with moist eye patches or stainless-steel goggles. Both the sclera and cornea must be protected with stainless-steel corneal eye shields when performing laser surgery near the eye, especially when treatment occurs within the orbital rim. Chlorhexidine must not be used as an antiseptic as it can cause corneal epithelial damage or opacification [4].

Skin safety

All laser exposure to the skin, both purposeful and accidental, can pose hazards such as redness, flaking, edema, and dryness at the treatment site [107]. Dermatologists using lasers should look for tissue reactions soon after laser application that show how much the tissue has been injured. These reactions are called clinical endpoints and are based on the location of laser application, temperature achieved during laser application, speed of heating, and pulse duration of the laser. Pulse duration should be less than or equal to the time for the chromophore of interest to cool, otherwise known as the thermal relaxation time. To evaluate clinical endpoints, the laser surgeon's goggles may be removed, but the laser should be on standby and not fired again until proper protective eyewear is back in place. The Nikolsky sign, an example of a clinical endpoint, is the sloughing of the epidermis with lateral shearing force pressure applied from the finger. Other endpoints include puckering, charring, metallic-gray blanching, second- and third-degree burns, stamping epidermal burns, crescent moon-shaped injuries, and darkening related to Q switched laser in patients with chrysiasis [108].

Patients with dark skin have historically had a higher risk of abnormal pigmentation and scarring after laser treatment for acne scars. Long wavelengths, long pulse duration, low fluences, pre-cooling,

cooling during the laser procedure, post-cooling, and treatment of a test spot before full treatment are all recommended to decrease the risk of complications in dark skin [58]. Non-ablative fractional lasers can be used on acne scars in Fitzpatrick skin types V to VI with skin bleaching before and after treatment as well as sun avoidance to decrease the risk of post-inflammatory hyperpigmentation [109]. In Fitzpatrick types IV to VI, the 1550 nm erbium-doped fractional laser has been shown to have decreased risk of post-inflammatory hyperpigmentation with pre- and post-laser treatment applications of hydroquinone 4% cream [110].

Package inserts for isotretinoin have recommended that the drug be discontinued for at least 6 months before laser treatments and other harsh procedures (e.g., waxing, dermabrasion) but a 2017 study found that there was insufficient evidence to delay laser treatments including vascular lasers, laser hair removal, and non-ablative fractional laser procedures [111].

Scope of practice expansion of non-dermatologist physicians and non-physician practitioners

With physician shortages and ever-increasing pressure for efficiency and cost-consciousness in healthcare, the number of advanced practice professionals (APPs), including physician assistants and nurse practitioners continues to grow, helping to reduce wait time and increase availability of dermatological care [4,112,113]. Coincident with this was a 52.3% increase in the number of dermatological procedures billed by APPs from 2.69 million (8.8% of 30.7 million) in 2012 to 4.54 million (13.4% of 33.9 million) in 2015 [111]. Also, an increasing number of non-dermatologist physicians and non-physician practitioners have been performing complex, once dermatologist-exclusive, procedures: destruction of malignant and premalignant lesions, tissue transfers, skin grafts, laser hair removal, skin peels, and skin biopsies [4,114].

Anderson et al. reported the accuracy for skin cancer diagnosis of physician assistants compared with dermatologists. In a study of 20,270 patients, the number of lesions biopsied to diagnose skin cancer (non-melanoma, invasive melanoma, or in-situ melanoma) was 3.9 for physician assistants and 3.3 for dermatologists ($P<0.001$). Overall dermatologists performed fewer skin biopsies per case of skin cancer and were more likely to diagnose melanoma in situ compared to their counterparts [113]. To diagnose one case of melanoma physician assistants needed to biopsy 39.4 and dermatologists 25.4 pigmented lesions, respectively. In short, the study findings have "important implications for the training, appropriate scope of practice, and supervision of PAs and other nonphysician practitioners in dermatology" [113]. The ASDS has opined that physician assistants and related medical staff should be licensed, regulated, and monitored by the state medical licensing board, which is currently the case in the majority of states. The American Society for Dermatologic Surgery also concurs with the AAD position that non-physician clinicians should only practice medicine under the direct, on-site supervision of a board-licensed dermatologist to ensure optimal patient care [115,116]. Advanced practice professionals are now key members of the dermatologic care community addressing patient needs, mostly in positive, collaborative relationships. However important ramifications for patient safety and quality care include the lack of formal training or certification programs in dermatology for APPs as well as for other non- dermatologic providers.

Electronic Health Records

Over the past decade, the adoption of EHRs has skyrocketed owing to their ability to benefit patients and healthcare services alike by providing quality healthcare and patient safety with communication advancements and error reduction. The promises, accomplishments, and pitfalls of EHRs are detailed by Wachter in two major books and are also intertwined with the explosion of information technology platforms [117,118]. According to the 2017 AAD member survey, EHRs have been adopted by more than 75% of dermatology practices, ranging from 97-98% in multispecialty and academic practices to 60% in solo practices, increasing to 87% with groups of 6 or more dermatologists. Electronic Health Record systems allow voluntary reporting of Quality

Payment Program (QPP) measures through the United States Centers for Medicare and Medicaid Services (CMS) value-based payment system provided in the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA). Quality Payment Program participation, typically the Merit Based Incentive Payment System (MIPS) may occur through DataDerm™, the AAD patient registry. A 2016 AAD EHR survey showed up to a 39% increase in hiring of administrative staff including scribes and medical assistants with clinical staffing staying level. Only 20% of those surveyed believed that EHR implementation increased efficiency, but the vast majority would not return to paper-based records [119]. However, paper records still abound including patient written notes, outside records, and laboratory results from different health systems. These records when scanned may be displayed in various places and highlight formatting issues with EHRs which include truncated reports, missing data, arrows confused with numbers, and key results buried (and missed) in the body of the report. Patients may be innumerate and prefer graphs when reviewing their own laboratory data. Health care providers are awash in data which often may reside outside their own systems. Patients may now come to their physician office appointments with test results ordered by others for additional review, interpretation, and integration such as toxicology, allergy, and genetic data (adapted and modified

Table 13. *Organizations with patient safety online resources.*

Organization	Website
Accreditation Association for Ambulatory Health Care (AAAHC)	https://www.aaahc.org/
Agency for Healthcare Research and Quality (AHRQ)	https://www.ahrq.gov/
Ambulatory Surgery Center Association (ASCA)	https://www.ascassociation.org/home
American Academy of Dermatology (AAD)	https://www.aad.org
American Association of Accreditation of Ambulatory Surgery Facilities (AAAASF)	https://www.aaaasf.org
American Medical Association (AMA) Patient Safety and Quality Tools	https://www.ama-assn.org/delivering-care/patient-support-advocacy/improving-patient-safety
American Osteopathic Association (AOA)	https://osteopathic.org/
American Society for Dermatologic Surgery (ASDS) Surgery (ASDS)	https://www.asds.net/
Anesthesia Patient Safety Foundation (APSF)	https://www.apsf.org/
Centers for Medicare and Medicaid Services (CMS)	https://www.cms.gov/
ECRI Institute	https://www.ecri.org/
Food and Drug Administration (FDA)	https://www.fda.gov/
The Joint Commission (TJC)	https://www.jointcommission.org/resources/patient-safety-topics/patient-safety/
Institute for Healthcare Improvement (IHI)	http://www.ihi.org/ihi
Institute for Safe Medication Practices (ISMP)	https://www.ismp.org/
Leapfrog Group	https://www.leapfroggroup.org/
Medical Group Management Association (MGMA)	https://www.mgma.com/
Medication Safety Officers Society (MSOS)	https://medsafetyofficer.org/
MedPAC	https://www.medpac.gov/
National Academy of Medicine	https://nam.edu/
National Center for Patient Safety (NCPS), Department of Veterans' Affairs	https://www.patientsafety.va.gov/
National Quality Forum (NQF)	https://www.qualityforum.org/Home.aspx
Pittsburgh Regional Health Initiative (PRHI)	https://www.prhi.org/
TMIT Global Research Test Bed	https://www.safetyleaders.org/
U.S. Pharmacopeia Healthcare Quality and Safety	https://www.usp.org/healthcare-quality-safety
World Alliance for Patient Safety, World Health Organization (WHO)	https://www.who.int/patientsafety/en/

Each site accessed on August 20, 2020.

from Michael L Astion MD PhD. Presentation, Society to Improve Diagnosis in Medicine, Sept 2013).

One retrospective study comparing handwritten versus electronic medical record data entry accuracy of dermatopathology requisitions supported the value of EHRs. Non-container labeling errors at a dermatopathology institute, including incomplete or illegible data was significantly reduced with the implementation of the EHR system [120]. The medical field's culture of limited time and emphasis on efficiency has facilitated a number of provider workarounds with EHRs. A 2012 survey-based study conducted at a national dermatology meeting reported that 82.8% of surveyed dermatology residents have at least once plagiarized by cutting, copying, and pasting a previous author's patient history into the respective EHR without confirming its validity. Patient safety and accuracy of health records can be put at risk for merely time-saving measures [121]. An Australian outpatient study on EHR productivity highlighted and confirmed what most EHR users can attest that significant is time required for sufficient training leading to initial reduced efficiency. Additional time is inevitable to troubleshoot and later update a new system [122].

Electronic drug alerts have had a significant impact on patient care, decreasing the number of hospitalizations and deaths related to a reduction in adverse drug reactions. Although many drug alerts have benefitted patients, they can pose a risk to patient safety when low-value or false-positive warnings present in abundance. The substantial number of medication alerts that are needed to prevent one adverse reaction and the irrelevant nature of some alerts can result in physician fatigue or decreased sensitivity to the signals. One experimental study modified their warning system and reported a decrease of 27.2% low-value alerts that may be contributing to alert fatigue and unintentional overriding of certain medication alerts by prescribing doctors [123]. Additionally, we have noticed that e-integration of outside electronic records into EHRs has resulted in reminders to reconcile long lists of outside medication records with current patient medication lists.

In 2015, TJC issued a Sentinel Event Alert detailing three cases of reported EHR harms: 1) picking the wrong route of drug administration from a drop-down menu (IM rather than IV); 2) placing a chest X-ray order on the wrong patient owing to clicking the wrong patient room number; and 3) placing an order for acetaminophen on the wrong patient when two records were open simultaneously and the pharmacist was interrupted [124]. Major factors in EHR errors include issues related to human-computer interface with data-related errors, workflow, IT communication and support, clinical content design, and decision support. The Joint Commission listed specific EHR process improvement checklists and other suggested solutions, which include a webinar and a link to Safer Guides for EHRs from the United States Office of the National Coordinator Website [124,125].

Conclusion

Over the past decade, patient safety has played an increasingly vital role in healthcare delivery. Hospitals and clinics have been urged to adopt the methods of high reliability organizations to identify and change ineffective practice patterns by: 1) recognizing that small things going wrong are early warning signs of trouble; 2) treating near misses and errors as information about the health of systems and learning from them; and 3) making "the right thing to do" the only option. While systems issues are emphasized in patient safety, people are critically important to effective teamwork and leadership. The AAD's patient safety initiative that began in August 2007 has sparked a culture which continually emphasizes quality and patient safety in all educational and committee activities. Additionally, the AAD Expert Resource group for Patient Safety Officers meets annually and is open to all AAD members from solo practice to large groups, who are encouraged to attend. With the advancements in procedural and cosmetic dermatology, organizational and clinical guidelines, and the revolution in information technology and EHRs, there are new sources of potential error. Despite the growing number of dermatologic patient safety studies, our review suggests the need for more reports to reduce the number of preventable errors, and to provide optimal care. **Table 13** contains an updated list of organizations with online resources

on patient safety. Finally, the commitment to patient safety and quality care in medicine depends on personal and professional responsibility.

Potential conflicts of interest

Dr. Taylor owns non-controlling common shares in AstraZeneca, Merck, Cigna, Johnson & Johnson, and Opko Health. He has consulted for Kao Brands and Monsanto (Bayer), is a member of the Cosmetic Ingredient Review Steering Committee and a non-dependent child is employed by Pfizer. Dr. Khetarpal is a speaker and trainer for Allergan and Galderma, and has consulted for and received research equipment from Eclipse Aesthetics.

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Table 2. *Selected error prone abbreviations, dose expressions, symbols, drug abbreviations and stems[#]*.

Do not use	Intended meaning	Misinterpretation or mistaken as	Correction
Error prone abbreviations			
µg	microgram	milligram, resulting in a 1,000-fold overdose	Use mcg or micrograms
AD, AS, AU	right ear, left ear, each ear	OD, OS, OU (right eye, left eye, each eye)	Use "right ear," "left ear," or "each ear"
BT	bedtime	b.i.d. (twice daily)	Use bedtime
cc	cubic centimeters	U or u (units)	Use mL or milliliters
D/C	discharge or discontinue	D/C followed by a list of medications could denote a list of medications patient should take upon discharge, or a list of medications patient should stop taking	Use "discharge" and "discontinue"
IJ	injection	IV (intravenous) or intrajugular	Use "injection"
IN	intranasal	"IM" or "IV"	Use "intranasal" or "NAS"
HS	half-strength	at bedtime	Use "half-strength" or "bedtime"
hs	at bedtime or hours of sleep	half-strength	Use "bedtime" or "half-strength"
IU*	International Unit	IV (intravenous) or the number 10 (ten)	Write "International Unit"
OD or o.d.	once daily	right eye (OD, *oculus dexter*), leading to oral liquid medications administered in the eye	Use "daily"
OJ	orange juice	OD or OS (right or left eye); drugs meant to be diluted in orange juice may be given in the eye	Use "orange juice"
Per os	orally, by mouth	left eye (OS, oculus sinister)	Use "PO", "orally" or "by mouth"
QD, Q.D., qd or q.d.*	every day	q.o.d (every other day); or q.i.d (four times daily), especially if period after the "q" or tail of the "q" is misread as an "i"	Use "daily"
qhs	nightly at bedtime	qhr (every hour)	Use "nightly"
qn	nightly or at bedtime	qh (every hour)	Use "nightly" or "at bedtime"
QOD, Q.O.D., qod or q.o.d.*	every other day	q.d. (daily); or q.i.d. (four times daily), especially if the period after the "q" or the "o" is poorly written	Use "every other day"
q1d	daily	q.i.d (four times daily)	Use "daily"
q6PM	every evening at 6 PM	every 6 hours	Use "6 PM daily" or "daily at 6 PM"
SC, SQ, sub q	subcutaneous	SC misinterpreted as SL (sublingual); SQ misinterpreted as "5 every;" the "q" in "sub q" misinterpreted as "every" (e.g. a heparin dose ordered	Use" subcut" or "subcutaneously"

		"sub q 2 hours before surgery" misunderstood as every 2 hours before surgery	
ss	sliding scale (insulin) or ½ (apothecary)	"55"	Spell out "sliding scale;" use "one-half"
SSRI	sliding scale regular insulin	selective-serotonin reuptake inhibitor	Spell out "sliding scale (insulin)"
SSI	sliding scale insulin	Strong solution of iodine (Lugol's)	Spell out "sliding scale (insulin)"
TIW, T.I.W., tiw or t.i.w.	three times a week	3 times daily or twice in a week	Use "3 times weekly"
U or u*	unit	Mistaken as the number 0 or 4 , resulting in a 10-fold or greater overdose (e.g. 4U seen as "40" or 4u seen as "44"); mistaken as "cc", so dose given in volume instead of units (e.g., 4u seen as 4cc)	Use "unit"
i/d	one daily	t.i.d. (three times daily)	Use "1 daily"
UD	as directed ("ut dictum")	Unit dose (e.g., diltiazem 125 mg IV infusion "UD" misinterpreted as meaning to give the entire infusion as a unit (bolus) dose)	Use "as directed"
Error prone dose expressions			
"Naked" decimal point (e.g., .3 mg)*	0.3 mg	Mistaken as 3 mg if decimal point is not seen	Use zero before a decimal point when the dose is less than a whole unit
Trailing zero after decimal point (e.g., 5.0 mg)*	5 mg	50 mg if decimal point is not seen	Do not use trailing zeros for whole number doses
Abbreviations such as mg. or mL. with a period following the abbreviation	mg or mL	The period is unnecessary and could be mistaken as the number 1 if written poorly	Use mg or mL without a terminal period
Drug name and dose written together without adequate space in between (especially problematic for drug names ending with letter 'l" e.g., benadryl50 mg)	Benadryl 50 mg	Mistaken as Benadryl 150 mg	Ensure adequate space between the drug name, dose, and unit of measure
Numerical dose and unit of measure written together without adequate space between (e.g., 10mg, 100mL)	10 mg 100 mL	"m" is sometimes misinterpreted as one or two zeros, causing a 10- to 100-fold overdose	Ensure adequate space between dose and unit of measure
Large doses without properly inserted commas (e.g., 100000 units, 1000000 units)	100,000 units 1,000,000 units	100000 has been misinterpreted as 10,000 or 1,000,000; 1000000 has been misinterpreted as 100,000	Use commas for dosing units at or above 1,000, or use words such as 1 "million" or 100 "thousand" to improve readability
Error prone symbols			
Apothecary units		Unfamiliar to many practitioners and may be confused with metric units	Use metric units
>, <	greater than, less than	Mistaken with each other or opposite of intended; >	Use "more than" or "less than"

		misinterpreted as 7 (seven); < misinterpreted as letter L; <10 misinterpreted as 40	
@	at	2 (two)	Use "at"
&	and	2 (two)	Use "and"
+	plus or and	4 (four)	Use "and"
°	hour	zero (e.g., q6° read as q 60)	Use "hr", "h" or "hour"
/ (slash mark)	Separates two doses or indicates "per"	1 (one) e.g., "25 units/10units" misread as "25 units and 110 units"	Use "per" rather than slash mark to separate doses
x2d	for two days or for two doses	each other	Use "for 2 days" or "for 2 doses"
Error Prone Drug Name Abbreviations and Drug Stems	**Intended name**	**Misinterpretation due to similar abbreviations or stems for multiple drugs**	**Use drug names in full**
APAP	acetaminophen	Not recognized as acetaminophen	Use complete drug name
DCN	doxycycline	Mistaken as Darvocet-N 100®	Use doxycycline
DPH	diphenhydramine	Mistaken as phenytoin, formerly called diphenylhydantoin	Use diphenhydramine
HCT	hydrocortisone	Mistaken as hydroCHLOROthiazide	Use hydrocortisone
HCTZ	hydroCHLOROthiazide	Mistaken as Hydrocortisone (seen as HCT 250 mg)	Use hydrochlorothiazide
MgSO4	magnesium sulfate	Mistaken as morphine sulfate	Use magnesium sulfate
MS, MSO4	morphine sulfate	Mistaken as magnesium sulfate	Use morphine sulfate
MTX	methotrexate	Mistaken as mitoxantrone, Mustargen®	Use methotrexate
TAC or tac	triamcinolone	Mistaken as tetracaine, adrenalin, cocaine or as Taxotere, Adriamycin and cyclophosphamide	Use triamcinolone
T3	Tylenol® with codeine no. 3	Mistaken as liothyronine which is sometimes referred to as T3	Use Tylenol with codeine no. 3
Norflox	stem for norfloxacin	Norflex®	Use complete drug name "norfloxacin"
IV Vanc	stem for intravenous vancomycin	Invanz®	Use complete drug name IV vancomycin

#Updated from Table 3 in Cao LY, Taylor JS, Vidimos A [4], See complete data from the Institute for Safe Medication Practices web site [126].

**These items are on the Joint Commission (TJC) official "Do Not Use" list Fact Sheet as of August 2020. https://www.jointcommission.org/-/media/tjc/documents/fact-sheets/do-not-use-list-8-3-20.pdf? Accessed on 11 March 2021.*

Table 3. *Top 100 most-commonly prescribed dermatological medications and their sound- or look-alike counterparts.*

Dermatological medications [23]*	Confused drug names with look-alike or sound-alike medication name pairs [22]**
Acitretin	n/i
Acyclovir	n/i
Adalimumab	n/i
Alclometasone dipropionate	n/i
Amcinonide	n/i
Ammonium lactate	n/i
Azelaic acid	n/i
Azithromycin	n/i
Betamethasone compounds:Betamethasone dipropionate; Betamethasone valerate; and Betamethasone /Propylene glycol	Beclomethasone, Dexamethasone
Bexarotene	n/i
C1 esterase inhibitor	n/i
Calcipotriene	n/i
Calcipotriene/Betamethasone	n/i
Calcitriol	n/i
Cephalexin	n/i
Ciclopirox	n/i
Ciclopirox olamine	n/i
Clindamycin phosphate/Benzoyl peroxide	Clarithromycin, Clinoril®, Gentamycin, Vancomycin
Clindamycin phosphate	Clarithromycin, Clinoril®, Gentamycin, Vancomycin
Clobetasol compounds: Clobetasol proprionate and Clobetasol propionate/emollient	Clotrimazole, Halobetasol
Clotrimazole	n/i
Clotrimazole/Betamethasone diproprionate	n/i
Cyclosporine, modified	Cyclosporine, Cycloserine, Cyclophosphamide
Dapsone	n/i
Desonide	Desitin®
Desoximetasone	n/i
Diclofenac sodium	n/i
Diflorasone diacetate	n/i
Doxepin hydrochloride	n/i
Doxycycline compounds: Doxycycline hyclate and Doxycycline monohydrate	Declomycin, Dicloxacillin, Dicyclomine, Doxazosin, Doxepin, Minocycline, Tetracycline
Econazole nitrate	n/i
Erythromycin base	n/i
Etanercept	n/i
Famciclovir	n/i
Fluconazole	Flucytosine, Fluorouracil, Fluoxetine, Furosemide, Itraconazole, Metronidazole, Phenytoin
Flurandrenolide	Flunisolide, Fluocinolone, Fluorouracil, Fluticasone
Fluticasone compounds: Fluticasone and Fluticasone propionate/salmeterol	Flunisolide, Fluocinolone, Fluorouracil
Gabapentin	Gemfibrozil
Gentamicin sulfate	Gentian violet
Halcinonide	n/i
Halobetasol propionate	Clobetasol
Hydrocodone/acetaminophen	Oxycodone
Hydrocortisone compounds: Hydrocortisone; Hydrocortisone butyrate; Hydrocortisone butyrate emollient; and Hydrocortisone valerate	Cortisone, Fludrocortisone, Hydralazine, Hydrocodone, Hydrochlorothiazide, Hydroxychloroquine, Prednisone
Hydroxychloroquine sulfate	Hydroxyurea

Hydroxyzine hydrochloride	Hydralazine
Imiquimod	n/i
Immune globulin,gamma caprylate(IGG)	n/i
Immune globulin, gamma(IGG)	n/i
Infliximab	Rituximab
Ingenol mebutate	n/i
Interferon alfa-2b,recombinate.	n/i
Interferon gamma-1B, recombinate	n/i
Isotretinoin	Tretinoin
Ketoconazole	Ketoprofen
Levocetirizine dihydrochloride	n/i
Lidocaine	n/i
Methotrexate sodium	Metrogel®, Metronidazole
Methoxsalen, rapid	Metrogel®, Metronidazole
Metronidazole	Fluconazole, Mebendazole, Meropenem, Metformin, Methocarbamol, Methotrexate, Methylprednisolone sodium succinate, Metoclopramide, Miconazole, Omeprazole, Potassium chloride
Minocycline hydrochloride	Doxycycline
Mometasone furoate	Fluticasone
Mupirocin and Mupirocin calcium	Bacitracin, Cortisporin, Miacalcin
Mycophenolate mofetil	n/i
Naftifine hydrochloride	n/i
Nystatin	HMG-CoA reductase inhibitors, "Statins"
Nystatin/triamcinolone	HMG-CoA reductase inhibitors, "Statins"
Oxiconazole nitrate	n/i
Permethrin	n/i
Pimecrolimus	n/i
Prednisone	Prednisolone
Selenium sulfide	n/i
Silver sulfadiazine	Sulfasalazine
Spironolactone	n/i
Sulfacetamide sodium	n/i
Sulfamethoxazole/Trimethoprim	n/i
Tacrolimus	n/i
Tazarotene	n/i
Terbinafine hydrochloride	Terbutaline, Tetracycline, Tolbutamine
Thalidomide	n/i
Tretinoin	Tenormin, Triamcinolone
Triamcinolone acetonide	Tretinoin, Tetracaine
Ustekinumab	n/i
Valacyclovir hydrochloride	Valganciclovir
Vismodegib	n/i
Vorinostat	n/i
Zoster vaccine live/preservative free	n/i

n/i: none identified.

**The list of the top 100 most commonly prescribed dermatological medications is defined in the American Academy of Dermatology's "The Burden of Skin Disease in the United States." and includes systemic and topical drugs and vaccines [23].*

***The list of confused drug names with look-alike or sound-alike medication name pairs is from Table 4 of Cao LY, Taylor JS and Vidimos A [4] and the Institute for Safe Medication Practices which is current as of 2/28/2019 [22].*

Table 5. *Selected dermatologic oral dosage forms that should not be crushed.*

Drug product	Active ingredient(s)	Dosage form(s)	Reasons/comments
Aspirin enteric-coated	(aspirin)	Caplet; Tablet	Slow-release; Enteric-coated
Azulfidine EN-Tabs®	(sulfaSALAzine)	Tablet	Slow-release
Bayer EC®, Bayer Regular	(aspirin)	Caplet	Enteric-coated
Biaxin-XL®	(clarithromycin)	Tablet	Slow-release
Ceftin®	(cefuroxime)	Tablet	Taste (Note: use suspension for children)
CellCept®	(mycophenolate)	Capsule; Tablet	Teratogenic potential
Cipro XR®	(ciprofloxacin)	Tablet	Slow-release
Claravis®	(ISOtretinoin)	Capsule	Mucous membrane irritant
Cytoxan	(cyclophosphamide)	Tablet	Note: drug may be crushed but company recommends using injection
Doryx®, Doryx MPC®	(doxycycline hyclate)	Tablet	Slow-release
Dulcolax®	(biscodyl)	Capsule; Tablet	Enteric-coated; Liquid-filled
Ecotrin® All Strengths	(aspirin)	Tablet	Enteric-coated
Erivedge®	(vismodegib)	Capsule	Note: package insert indicates potential teratogenic effects; material safety data sheet warns against skin contact; health care workers should take appropriate precautions
Eryc®	(erythromycin)	Capsule	Enteric-coated pellets
Erthryomycin Base	----------	Tablet	Enteric-coated
Erythromycin Stearate	----------	Tablet	Enteric-coated
Erythromycin Ethylsuccinate	----------	Tablet	Enteric-coated
Hydrea®	(hydroxyurea)	Capsule	Note: exposure to the powder may cause serious skin toxicities; health care workers should wear gloves to administer
Minocin®	(minocycline)	Capsule	Mucous membrane irritant
Motrin®	(ibuprofen)	Tablet	Taste
Myfortic®	(mycophenolic acid)	Tablet	Slow-release; Enteric-coated
Myorisan®	(ISOtretinoin)	Capsule	Mucous membrane irritant
Naprelan®	(naproxen)	Tablet	Slow-release
Neurontin®	(gabapentin)	Capsule; Tablet	(b,h)
Oravig®	(miconazole)	Tablet, buccal	Buccal form
Otezla®	(apremilast)	Tablet	Film-coated
OxyCONTIN®	(oxyCODONE)	Tablet	Slow-release; Note: crushing, chewing, or dissolving tablets can cause rapid release and absorption of a potentially fatal dose
Plaquenil	(hydroxychloroquine)	Tablet	Film-coated
PriLOSEC®	(omeprazole)	Capsule	Slow-release
Propecia®	(finasteride)	Tablet	Note: women who are, or may become, pregnant, should not handle crushed or broken tablets
Proscar®	(finasteride)	Tablet	Note: women who are, or may become, pregnant, should not handle crushed or broken tablets
Solodyn®	(minocycline)	Tablet	Slow-release
Voltaren XR®	(diclofenac)	Tablet	Slow-release
Xanax XR®	(alprazolam)	Tablet	Slow-release

Data from Institute for Safe Medication Practices on oral dosage forms that should not be crushed is current as of 2-21-2020 [127].

Box 1. *Mohs surgery safety checklist / Universal Protocol (Every Patient Every Time!).*

To be used for all MOHS procedures.
Date:_____ Mohs Physician:_____ Referring Physician:_____
Patient Label: verify patient name and date of birth
SIGN IN: and **Pre-Procedure Checklist Verification** / nurse initials filling out form_____
Blood pressure_____ Heart Rate_____:
Allergies: yes__ no__ list: _____
Anticoagulant: yes__ no__ list:_____
Antibiotic prophylaxis: yes__ no__ list:_____
Immunosuppressive medications: yes__ no__ list:_____
Implanted Devices: yes__ no__ list:_____
Special equipment / supplies required? yes__ no__ list:_____
Pertinent medical history: yes__ no__ list:_____
Medications: yes__ no__ list:_____
Available in Medical Record to assist with correct site for MOHS procedures: (check all that apply)
Pathology report: yes__ no__
Office note with clinical description: yes__ no__
3 point coordinate measurement: yes__ no__
__Check here if the 3 point coordinate is **NOT adequate** for site identification (verify with the physician)
__Check here if the diagram is **NOT adequate**
__Check here if MOHS procedure was canceled or delayed. Please explain in comments:_____
Surgical Site(s)

Location	Tumor type
1_____	1_____
2_____	2_____

Informed consent completed? yes__ no__
Site Marked? yes__ initial__

TIME OUT: (Checklist occurs in the procedure room with all team members present and involves interactive verbal communication)
__All team members STOP activity for TIME OUT
__Protective eyewear
__Correct patient,
__Correct procedure,
__Correct side
__Correct site,
__Correct position (if applicable)
__All issues discussed and resolved
MOHS layers; A B
SIGN OUT: Verbal confirmation prior to team leaving room.
__Name of procedure recorded?
__Specimen(s) placed into container, labelled prior to closing,
and sent correctly? yes n/a
__Counts completed and reconciled prior to the last stitch.
Equipment issues addressed? yes n/a
Review key concerns for recovery and management of the patient:
Keep post op dressing in place for____hours
Return for suture removal in _____days
NOTES: (measurements, types of closure, suture used etc.)
Comments:_____

Adapted from Cleveland Clinic procedure.