REVIEW PAPER

Sensory-Friendly Emergency Department Visit for Patients with Autism Spectrum Disorder—A Scoping Review

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Abstract

Our goal was to develop non-pharmacologic strategies for addressing sensory challenges that patients with autism spectrum disorder (ASD) face in emergency departments (EDs). Search of five databases for articles written in English and published since 1980 returned 816 citations, of which 28 papers were selected for review. All studies were published in the last nine years, with 92.85% ($n = 26$) conducted in North America. We developed 26 consolidated strategies, encompassing five major domains, including guiding principles, care processes, people (behavior of staff members), objects, and places (facility design). Sensory-friendly care in ED requires an integrative approach and its success depends on guiding principles that tie various aspects of care and distinguishes ASD care from non-ASD care.

The reported prevalence of autism spectrum disorder (ASD) has been rising in the last two decades in the USA, with approximately 10% increase since 2014 and 175% increase since 2000 (Stichter et al., 2021). Meanwhile, the demand for emergency and urgent care is also increasing annually in the USA (Coster et al., 2017; Hooker et al., 2019), potentially leading to crowding, longer wait times, and ultimately poor patient outcomes (Morley et al., 2018). In their capacity as a safety net resource for many health care problems, emergency departments (EDs) are playing a critical role in the evaluation and management of individuals with ASD (American College of Emergency Physician, 2019). Individuals with ASD are considerably more likely to present to ED than those without ASD (Liu et al., 2017; Lytle et al., 2018), with some age groups having as much as four times the number of ED visits (Liu et al., 2017, 2019). Yet, the ED is characterized by a chaotic environment, unfamiliar people, rapid and multiple relocations to different areas within the department, and a lack of control over noise, light, odor, and temperature. Unpredictability and overstimulation, coupled with verbal and non-verbal communication deficits, can make ED visits especially an overwhelming experience for individuals on the autism spectrum (Iannuzzi et al., 2015).

To reduce stimuli of individuals with ASD, many ED guidelines and recommendations direct staff to adjust the environment in accordance with the sensory need of these patients (Giarelli et al., 2014; Nicholas, et al., 2016a, 2016b; Samet & Luterman, 2019; Venkat et al., 2016; Zanotti, 2018); however, the rapid pace of EDs, the urgency of care, and the acuity of events make the task of assessing and optimizing environmental stimuli challenging for ED staff (Wood et al., 2019). Sensory overstimulation in ED can lead to physical and psychological distress that may trigger agitation and aggression (Giarelli et al., 2014; Samet & Luterman, 2019), possibly resulting in the use of pharmacological treatments with serious adverse effects (National Clinical Guideline Centre—Acute and Chronic Conditions., 2010).

The goal of this review was to synthesize existing evidence regarding sensory challenges that patients with ASD face in EDs and to develop a knowledge base of non-pharmacological strategies for addressing these challenges. We addressed the following two specific questions in this review:

– What are the sources of sensory overstimulation in ED that affect the experience of individuals on the autism spectrum?
– What non-pharmacologic strategies can be used in EDs for addressing sensory sensitivities of individuals on the autism spectrum and facilitate their visits?

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Methods

Rather than addressing a specific research question and assessing the quality of past publications, the goal of this review was to synthesize and describe in more detail findings of previous studies to ED staff members who might otherwise lack time or resources to undertake such work themselves. As a result, we followed a scoping review methodology described by Arksey and O'Malley (2005) and used the Preferred Reporting Items for Systematic Reviews and Meta-analyses Protocols checklist (Moher et al., 2009). Our team included an emergency physician (AUTHOR 4), a nursing faculty member (AUTHOR 3), an environmental design researcher (AUTHOR 1), and a nursing doctoral student (AUTHOR 2), all with prior experience in performing scoping reviews and conducting qualitative data analysis. The team went through an iterative process to define, discuss, and finalize the search and review strategy.

Search Strategy and Database Selection

We searched PubMed, CINAHL, Web of Science, PsycINFO, and Engineering Research Database in August 2020. Also, nine key journal sites were searched to ensure potential articles were not missed during database and reference list searches. We drafted search terms using keywords and terms from manuscripts known to be relevant to the review and included terms describing the condition, setting, and sources of sensory stimulation. The following terms were used in all searches, although the syntax of the search was adapted per database requirements as necessary: ("autism spectrum disorder" OR ASD OR autistic OR autism) AND ("emergency care" OR "emergency department" OR "Emergency room" OR "emergency ward" OR "emergency unit") AND (sensory OR light OR noise OR acoustic OR temperature OR humidity OR "air quality" OR odor OR aroma OR furniture OR "finishing materials" OR comfort OR layout OR privacy OR clutter OR order OR crowd OR texture OR color/colour OR music OR artwork OR nature OR "physical environment" OR indoor OR architecture).

Eligibility Criteria

We included peer-reviewed journal articles, doctoral dissertations, and master's theses written in English since 1980. Both US and non-US studies were eligible. No age, sex, socio-economic, health, or gender limitations were placed on study participants. Case reports and clinical guidelines were included as long as they were peer reviewed. However, commentaries, editorials, conference papers, abstracts with no full texts, and review articles were excluded. We excluded reviews to avoid repeated inclusions of evidence from articles covered in such reviews as we examined those articles separately. However, we hand searched the reference list of relevant literature reviews to ensure completeness in article retrieval. Other studies that did not evaluate sensory challenges or focused on clinical outcomes (e.g., time slip phenomenon) were excluded.

Screening Process

The screening process was completed using Rayyan, a dedicated web-based application for systematic reviews (Ouzzani et al., 2016). Inclusion and exclusion criteria were discussed by the team to ensure their clarity. Two reviewers (AUTHOR 1, AUTHOR 2) independently screened the titles and abstracts and determined if studies met the inclusion criteria. When the two reviewers disagreed on the eligibility of a manuscript, a third reviewer (AUTHOR 3) broke the tie. The team discussed the ultimate decision of the first step and achieved consensus. Next, two reviewers (AUTHOR 1, AUTHOR 2) independently reviewed full texts to determine studies to include. No disagreement occurred in this step.

After determining the final list of papers, the following data were extracted from included studies: year of publication, brief summary of the manuscript, location of study, targeted population, and study methods.

Analysis Approach

To decode and synthesize the information provided in each article, we followed the method of qualitative inquiry (Lincoln & Guba, 2006) in two steps. In step 1, we pursued a structured approach to extract relevant data within each article that described either sensory issues or remediation strategies associated with each of the five senses (i.e., for a total of 10 pre-defined domains). In step 1, we used Dedoose, a dedicated web-based application for managing, analyzing, and presenting qualitative and mixed-methods research data (*Dedoose, Version 8.3.45, Web Application for Managing, Analyzing, and Presenting Qualitative and Mixed Method Research Data*, 2021). At the end of step 1, all data with each corresponding domain were exported into a spreadsheet.

In step 2, through an iterative process, data element identified in the first step was assigned to one or more secondary domains indicating the source of each sensory issue (e.g., noise from staff members versus noise from medical devices) or the source that derives each remediation strategy (e.g., access to sensory toys during wait time or expediting the care process to reduce with time). Step 2 was semi-structured in that while the goal was to identify sources of factor associated with challenges and remediation strategies, the topic domains were not predetermined, rather they

emerged through an iterative process by examining patterns in the data (i.e., evaluating for similarities and dissimilarities among concepts within and across each data element).

The overall coding strategy was discussed and approved by the entire team before implementation and was executed by one member of the team (AUTHOR 1). At the end of each step, the entire team reviewed and discussed the domains and associated data. Once consensus was achieved, two outputs were generated: (1) sensory issues that an individual with ASD may experience in ED along with a list of consolidated strategies to address them, and (2) the level of association between step 1 domains (sensory issues or remediation strategies) and step 2 domains (sources).

Results

Literature Search and Selection

We screened 816 titles and abstracts after excluding duplicates, excluding 94.36% ($n = 770$) records. The excluded studies focused on clinical and pharmacological management of ASD patients in ED, in which the retrospective analysis of insurance claims or medical records was the predominant data source. Title/abstract review of 10 dissertations was retrieved using the ProQuest database, and none were deemed relevant. Of the remaining 46 articles, review of full texts resulted in excluding 39.13% ($n = 18$) records. The 28 articles that were selected for inclusion represented 3.14% of the original 816 records. Figure 1 shows the flow diagram of the literature search and study selection.

Characteristics of the Included Studies

Table 1 shows the targeted population (children, adolescents, or adults), the methodology, location, and a brief description of each study.

In terms of publication year, while our inclusion criteria covered studies published since 1980, the earliest publication year for articles included in our review was 2012, with 71.4% ($n = 20$) of them published within 5 years of when we conducted our database search. As for the location, 92.85% ($n = 26$) of studies were conducted in North America. Only 21.43% ($n = 6$) studies did discuss the adult ASD population, while children and adolescent groups were the focus of 92.85% ($n = 26$) of studies. Regarding research methodology, more than half of studies, 53.57% ($n = 15$), offered clinical or practice guide from the perspective of the authors (multidisciplinary team of ED care providers). One of such studies was written by a physician who has also been diagnosed with

Fig. 1 PRISMA diagram summarizing the literature search and study selection process
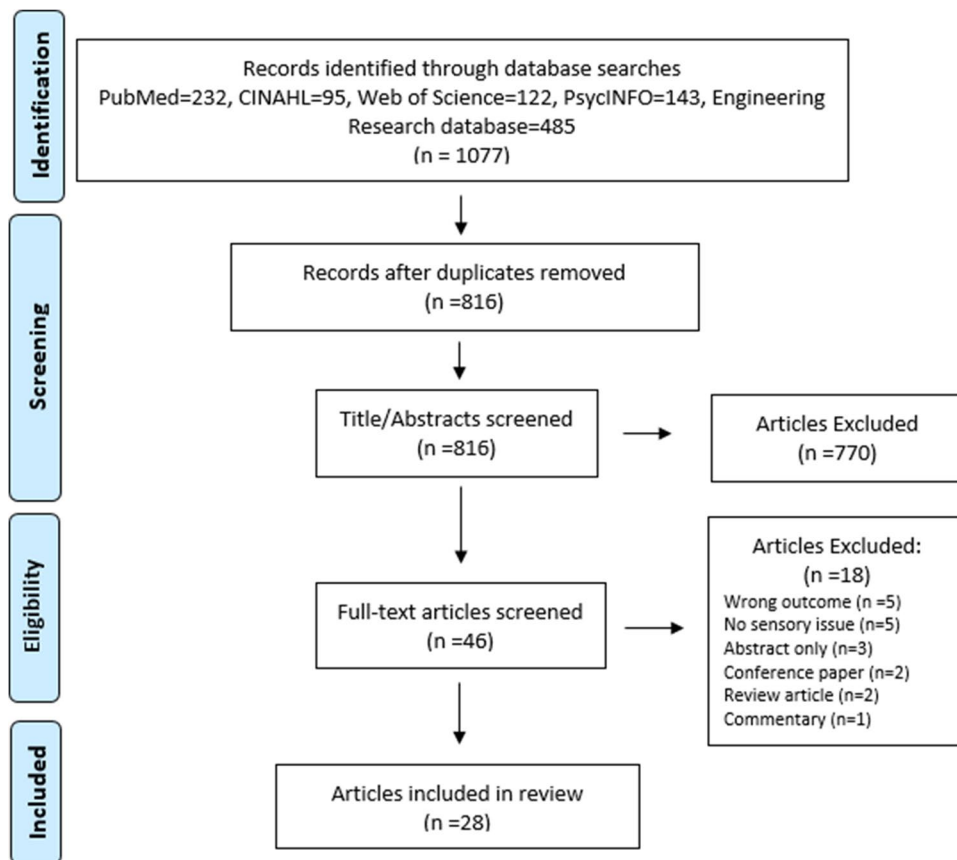
Table 1 Summary of the characteristics of the 28 studies included in the review

Study	Description	Population	Methods (sample size)	Place of study
Al Sharif and Ratnapalan, (2016)	This paper describes a patient with autism spectrum disorder (ASD) who had some challenging behavior in the emergency department (ED) when he presented with anaphylaxis and discusses management strategies that would help in caring for children with autism spectrum disorders	Adolescent	Case report (n = 1)	Toronto, Canada*
Autism Services, Education, Research, and Training Collaborative (2013)	This document describes the training module discussed in McGonigle, Migyanka, et al. (2014), McGonigle, Venkat, et al. (2014))	Children and adolescents	Clinical Guide (practice guidance)	Pittsburgh, PA
Chun et al. (2015)	This article focuses on the epidemiology, evaluation, and management of the two most common pediatric mental health emergencies, suicidal and homicidal/aggressive patients, as well as the equally challenging population of children with autism or other developmental disabilities	Children and adolescents	Clinical report (practice guidance)	Providence, RI*
Chun et al. (2016)	This article discusses the common clinical issues that may be encountered in caring for children and adolescents presenting to the ED or primary care setting with a mental health condition or emergency	Children and adolescents	Clinical report (practice guidance)	Irving, Texas*
Giarelli et al. (2014)	The goal of this study is to systematically record visual and auditory stimuli in an ED and identify patterns or thresholds of stimulation that kindle behavioral responses	Children	ED facility case study (n = 1)	A large US metropolitan hospital on the East Coast
Gray and Roback (2020)	This article presents the ED course of three children with ASD to illustrate challenges the faced, emphasize successful strategies, and highlight opportunities for improvement	Children	Case reports (n = 3)	Cincinnati, OH
Gupta et al. (2019)	The goal of this study is to identify pediatric patients with sensory sensitivities during a hospital visit and to implement a clinical pathway that can meet their sensory needs	Children and adolescents	Survey of patients (n = 2580)	Birmingham, AL
Harwell and Bradley (2019)	This article discusses strategies for providing autism-friendly care to children in the ED or any medical setting. The paper discusses inclusion of staff education, modifications to the environment, and individualizing care plans, to make a visit to the ED a more positive experience for children with ASD	Children	Clinical report (practice guidance)	Orlando, FL

Table 1 (continued)

Study	Description	Population	Methods (sample size)	Place of study
Hazen and Prager (2017)	This article discusses the growing number of pediatric patients presenting to EDs nationwide for acute psychiatric issues and decreased availability of the number of inpatient psychiatric beds	Children and adolescents	Clinical report (practice guidance)	Boston, MA
Kirsch et al. (2018)	The purpose of this study was to identify factors that predict parent satisfaction of their child with ASD's visit to a hospital ED or urgent care center	Children and adolescents	Survey of parents ($n = 378$)	Lake Success, NY
Lunsky et al. (2018)	The purpose of this paper is to provide a descriptive summary of the ED experiences of adolescents and adults with ASD, from the perspective of their families	Adolescents and adults	Survey of parents ($n = 46$)	Toronto, Canada
MacKenzie et al. (2013)	This paper discusses effective communication strategies with parents, care-takers, and outpatient providers and insights into likely etiologies of agitation as well as effective management strategies	Children and adolescents	Clinical guide (practice guidance)	Chicago, IL
McGonigle, Migyanka, et al. (2014), McGonigle, Venkat, et al. (2014))	This article presents a framework for improving the crisis evaluation of the tip-of-the-iceberg presenting behaviors of individuals with ASD and provides a suggested least-restrictive treatment model for adapting the ED environment to improve the care of these patients	Children and adolescents	Clinical guide (practice guidance)	Pittsburgh, PA
McGonigle, Migyanka, et al. (2014), McGonigle, Venkat, et al. (2014))	This paper describes the development of educational materials on ASD and the results of training of emergency medical services and ED personnel	Children and adults	Survey of emergency medical services personnel and emergency nurses ($n = 110$)	Pittsburgh, PA
Nicholas and et al., (2016a, 2016b)	This article discusses communication, sensory, and behavioral challenges in ED and uses the perspective of parents and their children with ASD	Children and adolescents	Interviews with parents of children with ASD ($n = 31$) and children with ASD ($n = 4$)	Toronto, Canada
Nicholas and et al., (2016a, 2016b)	The objective of this paper is to identify stakeholder perspectives in determining clinical priorities and recommendations to guide ED service delivery for children with ASD	Children	Focus groups with parents of children with ASD ($n = 16$), ED clinicians ($n = 37$), and ED administrators ($n = 7$)	Toronto, Canada

Table 1 (continued)

Study	Description	Population	Methods (sample size)	Place of study
Nicholas et al. (2020)	In this article, patient and family-centered care in the context of ASD is discussed. The aims are to examine how elements of patient and family-centered care are experienced and applied relative to ED care for children with ASD	Children and adolescents	Interviews with parents of children with ASD ($n=31$) and ED service providers ($n=22$)	Toronto, Canada*
Normandin et al. (2018)	This article discusses known risks of sedation for children and strategies nurses should consider including opening a discussion with the caregivers to learn if non-pharmacologic strategies might be useful to achieve positive results without sedation	Children and adolescents	Clinical guide (practice guidance)	Boston, MA*
Pon et al. (2015)	This article discusses risk stratification and interventions necessary when dealing with children and adolescents presenting with suicidal ideation and violent behavior. In addition, it provides a discussion of unique approaches to patients with ASD and ADHD	Children and adolescents	Clinical guide (practice guidance)	Phoenix, AZ*
Preissmann (2017)	The purpose of this paper is to represent a significant concern in almost every health-care setting, including specialized doctors and psychotherapists, outpatient medical care, access to preventive treatments (e.g., information on health and hygiene, vaccinations and early diagnostic screenings) and treatments in hospitals for emergency medical care	Children and adults	Clinical guide (practice guidance)	Heppenheim, Germany
Reese and Deutsch (2020)	In this report, case presentation of a youth with ASD who sought acute acute sexual assault care, but whose care was compromised because of multiple systems failures, including gaps in communication regarding her unique needs, and inconsistent knowledge among multidisciplinary team members regarding necessary adaptations in the implementation of trauma-informed care for youth with ASD	Adolescent	Case report ($n=1$)	Wilmington, DE*

Table 1 (continued)

Study	Description	Population	Methods (sample size)	Place of study
Richards (2017)	This article promotes a multi-strategy approach to making reasonable adjustments to help meet the needs of children with autism spectrum condition and provide them with a positive hospital experience	Children	Clinical guide (practice guidance)	London, UK*
Tint et al. (2019)	This study aimed to describe patterns of ED use and police interactions, as well as satisfaction with emergency services of 40 adults with ASD without intellectual disability over 12–18 months	Adults	Survey of adults with ASD ($n=40$)	Toronto, Canada
Venkat et al. (2012)	This study discusses clinical and epidemiological aspects of the five diagnoses that comprise ASD. Pharmacological and alternative therapies commonly utilized in the ASD patient population and the recognized adverse effects that may cause acute presentation	Children and adults	Clinical guide (practice guidance)	Pittsburgh, PA*
Venkat et al. (2016)	This study discusses an instrument to allow individuals with ASD, their families, and/or their caregivers to prepare ED staff for the care needs of this patient population ahead of acute presentation	Children and adults	Clinical guide (practice guidance)	Pittsburgh, PA*
Wood et al. (2019)	This article describes the nurse-initiated practice improvement process and the journey to create an evidence-based sensory-friendly pediatric ED. A model is presented so that other facilities can embark on their own initiative, and case studies are used to evaluate project outcomes	Children	Clinical guide (practice guidance)	Leesburg, VA*
Zanotti (2018)	This article presents multiple techniques to help ED personnel and healthcare professionals in outpatient settings deal with some of the unique challenges associated with caring for patients with ASD	Children	Clinical guide (practice guidance)	Ridgewood, NJ*
Zwaigenbaum et al. (2016)	This study aimed to characterize the perspectives of health professionals who care for children with ASD in the ED and to determine what strategies could optimize care	Children and adolescents	Interviews with physicians ($n=10$) and nurses ($n=12$)	Toronto, Canada

*The place where study was conducted was not mentioned in the article. The institution of the corresponding author is used as the place of the study

autism (Preissmann, 2017). Moreover, 32.14% ($n=9$) studies used data from interviews, surveys, or focus groups with a combination of parents ($n=6$), ED staff members ($n=4$), or adults with ASD ($n=1$). Six case reports were also presented and discussed in three papers. Overall, qualitative analysis was the predominant methodology and was used in 92.85% ($n=26$) of studies. A quantitative analysis was performed in 21.43% ($n=6$) studies, of which five studies used survey responses and one study conducted an objective measurement of environmental stimuli.

Sensory Challenges and Strategies to Address Them

Table 2 shows sensory challenges associated with hearing, sight, touch, taste, and smell; along with a consolidated list of non-pharmacological strategies to address these challenges.

Issues related to touch ($n=8$) and hearing ($n=7$) were mentioned in the greatest number of studies. On the other hand, strategies to overcome sight ($n=23$) and hearing ($n=22$) sensitivities were discussed in the greatest number of studies. The number of studies that discussed taste and smell issues ($n=4$) or remediation strategies for them ($n=5$) was the lowest.

Factors Associated with Sensory Challenges and Remediation Strategies

Through an iterative process, the following five distinct, but interconnected, domains emerged:

I. Processes: steps involved in delivery of care, including policies related to wait time, and the pace of care, and patient relocation during the encounter.
II. People: behaviors and practices of ED staff members in their interactions with patients, including verbal and non-verbal communications.
III. Objects: medical and non-medical equipment, devices, and tools used by staff members in the process of delivering care to patients. For remediation strategies, this domain was further broken down to two sub-domains, including how objects can be employed for patient orientation or in distraction and coping techniques.
IV. Places: characteristics of the physical environment in ED as determined by how the facility is designed and operated. For remediation strategies, this domain was further broken down to two sub-domains, including having a dedicated space throughout the ED for ASD patients, as well as the overall design feature, furniture, and amenities.
V. Principles: In addition to aforementioned four domains that covered factors (resources) associated with each quote, we identified a fifth domain that covered the philosophy that guides the entire aspects of caring for an ED patient with ASD.

For both sensory challenges and remediation strategies, Fig. 2 shows the interconnection among the five senses and the aforementioned source domains, excluding "Principles." The thicker the connecting lines, the stronger the level of association. For example, when it comes to sensory challenges (left panel), the highest interconnections exist between behavior of caregivers and care processes on one hand and objects on the other hand. As for remediation strategies (right panel), the top three highest interconnections exist between sight stimulation using objects for orientation and distraction, and also between touch stimulation using objects in distraction techniques.

Discussion

ASD diagnosis, etiology, and epidemiology is an evolving field of medicine The majority of ED ASD studies still focus on clinical and pharmacological management of patients. Developing non-pharmacological strategies for creating a sensory-friendly ED experience is a novel topic that started emerging in scholarly sources less than a decade ago. We identified that most studies of sensory issues for individuals with ASD receiving care in an ED focus on touch and hearing overstimulation, although other senses (i.e., visual, smell, and taste) were recognized as sources of overstimulation as well. Overstimulation stems from a combination of factors associated with the care process (e.g., slow care that increases patient exposure to stimuli or moving the patient from one room to another), behavior of staff members (e.g., approaching the patient in a fast fashion, abruptly, or in a loud voice or having multiple people talk with the patient), and the presence or use of objects in ED (e.g., touching the patient with cold objects or loud noises from devices and equipment).

With regards to remediation strategies, we found a variety of approaches that for the most part targeted sight, hearing, and touch senses. Similar to sensory challenges, remediation strategies entailed engaging a combination of factor associated with care process (e.g., reduced wait time), staff members (e.g., reducing the number of providers interacting with the patient), and objects (e.g., visual-aid tools for orientation or sensory toys for distraction). In the end, we were able to put together a list of 26 ED-specific, non-pharmacologic strategies for addressing sensory sensitivities of ASD patients. A brief discussion these strategies in the context of key factors associated with strategies is provided next.
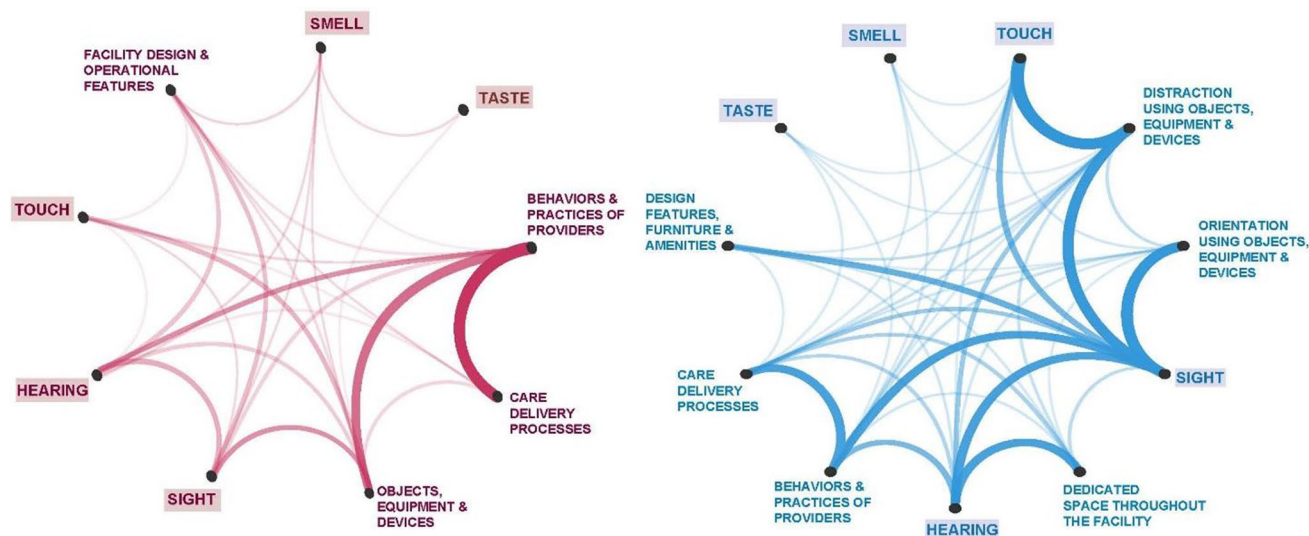
Table 2 Sensory challenges and strategies to address them

	Challenges faced by patients	Mitigation strategies
Hearing	Waiting rooms and treatment areas can be noisy places. Common sources of noise are (1) other patients and visitors: loud conversations, movement by people (footsteps), coughing and sneezing; (2) providers and staff members: talking abruptly and loudly with the patients, excessive talking, more than one person talking with the patient; (3) objects: loud television, moving carts, noise from equipment and machines, alarms, speakers, phones, keyboards, mouse clicking, jangling keys, hum from fluorescent lighting (Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2015; Giarelli et al., 2014; Harwell & Bradley, 2019; Nicholas, et al., 2016a, 2016b; Normandin et al., 2018; Zwaigenbaum et al., 2016) Raised voices reflecting urgency may increase the anxiety of patient and decreases the ability to process information. Patients with ASD may escalate when voices are raised or agitated (Autism Services, Education, Research, and Training Collaborative, 2013)	a. Establish a "one voice" policy by keeping the number of staff treating the patient to a minimum. Talk in a quiet, calm, friendly, and soothing voice. Avoid fast and abrupt speech. Keep directions simple, one step at a time. Use "yes" and "no" questions. In a situation where there are multiple providers, have one person take the lead in the communication with the patient at any one time (Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2015; Gupta et al., 2019; Harwell & Bradley, 2019; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Normandin et al., 2018; Pon et al., 2015; Richards, 2017; Venkat et al., 2016; Wood et al., 2019) b. Consider a separate waiting room in a quiet area that isolates the patient from the crowd. Offer private treatment rooms where you can close the door and curtains. If a quiet waiting room is not available, have the patient enter the treatment room as quickly as possible (Chun et al., 2015; Gupta et al., 2019; Harwell & Bradley, 2019; Hazen & Prager, 2017; Kirsch et al., 2018; Lunsky et al., 2018; MacKenzie et al., 2013; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Nicholas, et al., 2016a, 2016b; Preissmann, 2017; Richards, 2017; Tint et al., 2019; Venkat et al., 2016; Wood et al., 2019; Zwaigenbaum et al., 2016) c. Use noise-cancelling headphones or a white noise machine. Offer distraction devices, such as music devices with soft music, videos, or cause-and-effect toys that make sounds (Gerson et al., 2018; Gray & Roback, 2020; Gupta et al., 2019; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Venkat et al., 2012, 2016; Wood et al., 2019; Zwaigenbaum et al., 2016) d. Auditory stimuli (e.g., certain words or phrases or ringing a bell) can be used as a method for signaling transitions or starting a new activity (Chun et al., 2015) e. Shut off devices and equipment that are not in use, activate the silent or vibration mode (McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Zanotti, 2018)
Sight	Visual defensiveness is common among patients with ASD, which may manifest as dislike of sharp ashes of light, dislike of darkness and bright lights, covering or closing eyes at bright lights, looking down most of the time, and focusing on tiny pieces of dust or particles. Within-room and between-room differences in light level, as well as changes in environmental patterns may trigger behavioral responses (Giarelli et al., 2014; Nicholas, et al., 2016a, 2016b) Patients may be irritated when they cannot see where they are going and are looking at a white lights flicking by (Giarelli et al., 2014; Nicholas, et al., 2016a, 2016b) Disorder and clutter from objects, equipment, staff members, and other visitors will be a problem for patients with ASD. The greatest clutter often exists in the small space of the treatment rooms (Giarelli et al., 2014) Clutter from objects can be categorized in three groups: (1) large objects, such as window frames, wall signs, chairs, tables, backpacks, light fixtures, computer stands, wall clocks, fire extinguisher, wheelchairs, cabinets, curtains, monitors, waste baskets, wires, and file cabinets; (2) small objects, such as handbags, cups, glasses, magazines, and devices (e.g., thermometers, pens, charts, tape, and gloves); (3) transient items such as carts, laundry bins, wheelchairs and gurneys, and transient colors of clothing and other objects (Autism Services, Education, Research, and Training Collaborative, 2013; Giarelli et al., 2014; Zwaigenbaum et al., 2016) Individuals with autism are strongly attracted to water and shining objects. They may grab, touch, or place in mouth equipment and other dangerous objects. The clutter of equipment may entice the person to grab or touch them and could present a safety hazard. Markers and erasers for whiteboards could become projectiles for an agitated child. Some patients may become distracted and upset when some light switches are on and some were off (Autism Services, Education, Research, and Training Collaborative, 2013; Wood et al., 2019) Quick or rapid movement toward the person with an ASD may cause the person to exhibit the fight or flight response (Autism Services, Education, Research, and Training Collaborative, 2013)	f. Limit the traffic in and out of the examination room. Keep the number of staff treating the patient to a minimum (see a). Avoid fast and abrupt speech and movements. Approach the patient slowly and calmly, including in body language and facial expression. Body language and non-verbal signs can help divert meltdowns, tantrums, and escalating behaviors related to frustration, lack of control/self-determination, and sensory overload (Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2015; Gupta et al., 2019; Harwell & Bradley, 2019; Kirsch et al., 2018; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Normandin et al., 2018; Pon et al., 2015; Reese & Deutsch, 2020; Richards, 2017; Venkat et al., 2012, 2016; Wood et al., 2019; Zanotti, 2018) g. Offer a separate waiting and treatment rooms clear of wires, unnecessary objects, and equipment, where light can be dimmed or the room is lit with a single lamp (see b). Avoid rooms with bright or florescent lighting. Cover light switches (Chun et al., 2015, 2016; Gupta et al., 2019; Kirsch et al., 2018; MacKenzie et al., 2013; Nicholas et al., 2020; Normandin et al., 2018; Reese & Deutsch, 2020; Richards, 2017; Venkat et al., 2012; Wood et al., 2019; Zanotti, 2018; Zwaigenbaum et al., 2016) h. As much as it is possible, do tests and procedures all in one location to reduce the need to move the patient and give patient time to acclimated to their surroundings (Gray & Roback, 2020; Harwell & Bradley, 2019; Kirsch et al., 2018; Nicholas, et al., 2016a, 2016b; Wood et al., 2019) i. Use clear signage to help patients feel more comfortable and facilitate orientation to time and place. Place a "STOP" sign on the door to remind patients who are accustomed to visual cues to stay in the room (Nicholas, et al., 2016a, 2016b; Nicholas, et al., 2016a, 2016b; Wood et al., 2019) j. For children, provide an aesthetic environment that is child-centered, such as child- and youth-oriented activities, desired characters painted on the walls, and calming fish tank in the waiting room (Nicholas et Al., 2020, 2016a, 2016b; Venkat et al., 2016) k. Use visual cues in communication with the patient. Examples includes social stories, visual road map, visual calendar with timetable of the hospital visit, picture cards sequenced to show important events, role play, and demonstration of procedures on a caregiver or stuffed animals. Allow patient to see and touch the equipment and materials that will be used for splinting or bandaging before using them (Al Sharif & Ratnapalan, 2016; Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2016; Gray & Roback, 2020; Gupta et al., 2019; Harwell & Bradley, 2019; Lunsky et al., 2018; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Normandin et al., 2018; Pon et al., 2015; Venkat et al., 2012; Wood et al., 2019; Zanotti, 2018) l. Employ visual schedules to help children organize themselves, understand what will happen next, highlight or introduce activities that are unfamiliar to them, and create smoother transitions. Pictures can be used to communicate procedures (e.g., a stethoscope on chest), symptoms (e.g., sore throat, belly pain), location (e.g., exam room, X-ray, waiting room), personnel (e.g., physician, nurse, technician), and pain intensity level (Al Sharif & Ratnapalan, 2016; Chun et al., 2016; Zanotti, 2018) m. Visual stimuli (e.g., pointing to a picture, turning on a light, showing the patient a certain object) can be used as a method for signaling transitions or starting a new activity (Chun et al., 2015) n. Cover bandages with a non-threatening sticker or image to prevent the person from removing the bandage (Autism Services, Education, Research, and Training Collaborative, 2013; Venkat et al., 2012) o. Offer electronic tablet with cartoons and games for distraction while waiting or during procedures. Use sensory items such as stickers, cards, books, videos, and toys that make sounds or light up (Autism Services, Education, Research, and Training Collaborative, 2013; Gray & Roback, 2020; Normandin et al., 2018; Richards, 2017; Wood et al., 2019)

Table 2 (continued)

	Challenges faced by patients	Mitigation strategies
Touch	Tactile defensiveness is common among patients with ASD, which may manifest as the avoidance of being touched, as the person may already be in discomfort from wearing certain clothes or feeling the presence of tags (Giarelli et al., 2014) The source of tactile over-stimulation in the emergency department can be from people (providers touching and examining the patient) or objects (equipment of different temperatures, hard surfaces, splint or plaster cast, wound dressings, shots, or topical ointments, adhesive tape, creams, and patches). Wearing multiple armbands tends to be anxiety provoking (MacKenzie et al., 2013; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Nicholas, et al., 2016a, 2016b; Nicholas, et al., 2016a, 2016b; Venkat et al., 2016; Wood et al., 2019) One person may find mechanical restraint soothing and containing, whereas another person may experience the wrong kind of touch, even if it is gentle to an outsider, as very threatening and become extremely agitated (Lunsky et al., 2018) Although application of ice is normally a part of extremity injury treatment protocol in most EDs, for this patient group the application of ice may cause more distress (Wood et al., 2019)	p. Individuals with ASD have variable responses to touch, with some finding it soothing and others becoming distressed by touch. Some find deep pressure (the feeling of weight on their bodies) relaxing, but others respond to light touch. For deep pressure, a weighted blanket, a radiology leaded vest, or a "bean-bag" chair can serve to provide the sensation of a heavy touch. Those who prefer the sensation of a light touch may respond to gentle massage (manual or mechanical devices) or stroking the skin with a soft object (e.g., a cotton ball, gauze pad, soft blanket, cast underpadding) (Chun et al., 2015, 2016; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Normandin et al., 2018; Wood et al., 2019) q. For patients who are not sensitive to soft touch, touching the patient with a soft object can be used as a method for signaling transitions or starting a new activity (Chun et al., 2015) r. Occupy patient's hands or body with fidget toys as a distraction strategy. Occupational therapy devices (e.g., grip strengthening and manual dexterity devices, devices to improve balance) also may serve this function. Squeeze balls, pinwheels, sensory balls, sensory brushes, beaded necklaces, liquid motion relation toys, tactile squishy shapes, chewy tubes, chewelry (chewable jewelry), vibrating snakes can aid with relaxation. Loosely wound roll of gauze or cast underpadding can be a substitute for a squeeze toy (Chun et al., 2016; Harwell & Bradley, 2019; Nicholas, et al., 2016a, 2016b; Normandin et al., 2018; Wood et al., 2019; Zanotti, 2018) s. If physical restraint is required, wrapping the patient tightly in a blanket is preferable to arm and leg restraints. Blankets have a softer texture and may provide both temperature and tactile stimuli that are pleasing in this patient group (Autism Services, Education, Research, and Training Collaborative, 2013) t. Allow the person to control the level of the touch. Let the patient see and touch all materials prior to using them. Warm the equipment and use less abrasive materials. For example, use a soft collar or parallel towel rolls versus a hard collar for cervical immobilization (Autism Services, Education, Research, and Training Collaborative, 2013; Harwell & Bradley, 2019; Zanotti, 2018) u. Prepare the patient in advance for the need to touch, hold, or restrain. Approach slowly and demonstrate what you are going to do to help the patient understand and have a sense of control. Announce beforehand if you are going to touch the patient during the examination and do not palpate (e.g., the abdomen) suddenly without any warning (Autism Services, Education, Research, and Training Collaborative, 2013; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Preissmann, 2017; Venkat et al., 2012) v. Alternative seating options can help calm the patient. Examples include mat, ball, stretcher mattress on floor, rocking chair, or nylon folding sports stadium seat (Chun et al., 2016; Wood et al., 2019) w. If possible, combine armbands that have to be worn by the patient. For example, the allergy band can be secured to the identification band so it appears that only one band is worn (Wood et al., 2019)
Taste and smell	A person with an ASD may find the taste or smell of medications offensive (Autism Services, Education, Research, and Training Collaborative, 2013) Waiting rooms can be cramped and poorly ventilated, resulting in unpleasant smells (perfume, body odor, etc.). The presence of disinfectants and other sanitizing agents is unpleasant, and in combination with excessive light and noise can be frightening (Hazen & Prager, 2017; Preissmann, 2017; Wood et al., 2019)	x. Flavored lip balm and scratch-and-sniff stickers and markers can help in distracting the patient and should be considered as a coping mechanism during the visit (McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Wood et al., 2019) y. Consult with pharmacist regarding sensory sensitivities such as difficulty with texture or taste (Normandin et al., 2018) z. Consider medication taste in prescribing pharmacological therapy. Using the pediatric suspension of the medication may be helpful (Autism Services, Education, Research, and Training Collaborative, 2013; Venkat et al., 2016)

Fig. 2 The interconnection of source domains with domains representing sensory challenges (left) and with domains representing remediation strategies (right). The thicker the connecting lines, the stronger the level of association. Labels for the five senses are shaded to help in locating them on the diagram. We have used a more descriptive set of labels to help with interpretability

Care Philosophy and Guiding Principles

Each patient on the autism spectrum has unique sensory needs and preferences, requiring and individualized approach by ED staff members. The best source of information for understanding these needs and preferences are patients themselves and their caregivers (Wood et al., 2019). Unless the patient requires immediate intervention, staff members should discuss sensitivities and preferences of the patients with the patients or their family members (Autism Services, Education, Research, and Training Collaborative, 2013; Gray & Roback, 2020; Nicholas, et al., 2016a, 2016b; Venkat et al., 2012). Examples include means of restraint least disruptive to the patient, how the patient exhibits pain, the most effective orientation and coping strategies, the best ways to approach and touch the patient, and words, textures, flavors, and smells that should be avoided (Autism Services, Education, Research, and Training Collaborative, 2013; Harwell & Bradley, 2019; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Nicholas, et al., 2016a, 2016b; Normandin et al., 2018; Richards, 2017; Venkat et al., 2012; Wood et al., 2019). To the extent that it is safe for both patients and providers, input from patients and their caregivers should be used in planning and delivering treatments. Patient sensitivities and preferences should also be documented in the medical records to be used in future encounters (Nicholas, et al., 2016a, 2016b; Richards, 2017; Wood et al., 2019).

Care Delivery Processes

To reduce overstimulation, wait-time for ASD patients should be minimized (Al Sharif & Ratnapalan, 2016; Gray & Roback, 2020; Harwell & Bradley, 2019; Hazen & Prager, 2017; Kirsch et al., 2018; Lunsky et al., 2018; MacKenzie et al., 2013; Nicholas, et al., 2016a, 2016b; Nicholas, et al., 2016a, 2016b; Preissmann, 2017; Richards, 2017; Wood et al., 2019; Zanotti, 2018; Zwaigenbaum et al., 2016). Besides, EDs should consider one-place and one-voice policies for their ASD patients. One-place policy refers to performing tests and procedures in a quiet and clutter-free room, where sensory stimuli can be monitored and controlled, to minimize the need for moving the patient (Gray & Roback, 2020; Harwell & Bradley, 2019; Kirsch et al., 2018; Nicholas, et al., 2016a, 2016b; Wood et al., 2019). One-voice policy refers to keeping the number of staff members interacting with the patient to a minimum and having one person leading the communication, if possible, with assistance from the caregiver or a family member (Gupta et al., 2019; Harwell & Bradley, 2019; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Richards, 2017; Venkat et al., 2016; Wood et al., 2019; Zanotti, 2018). If the treatment is expected to take long or minimizing the number of providers is not practical, small breaks should be considered, at least in the event that the patient has escalated, to allow the person time to calm (Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2015, 2016; Preissmann, 2017; Zanotti, 2018).

Care Providers' Behaviors (People)

How ED staff members interact and communicate with an ASD patient plays an important role in the patient's sensory stimulation. All aspects of communication, including verbal (e.g., pace of talking, voice volume and tone, simplicity of words) and non-verbal (e.g., body language, facial expression, number of providers interacting with the patient, pace of movements), should be adapted to the need and preferences of the patient (Autism Services, Education, Research, and Training Collaborative, 2013; Chun et al., 2015; Gray & Roback, 2020; Harwell & Bradley, 2019; Kirsch et al., 2018; Nicholas, et al., 2016a, 2016b; Normandin et al., 2018; Pon et al., 2015). Providers should also prepare the patient by showing and letting the patient touch the equipment and materials before using them (Autism Services, Education, Research, and Training Collaborative, 2013; Harwell & Bradley, 2019; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Venkat et al., 2012; Zanotti, 2018). Procedures should be demonstrated on a caregiver or stuffed animals (Autism Services, Education, Research, and Training Collaborative, 2013; Venkat et al., 2012; Zanotti, 2018). Coupled with audio-visual communication aids (depending on patient preferences), this will help the patient have a sense of control and predictability that is crucial for them (Giarelli et al., 2014; Richards, 2017).

Objects, Equipment, and Devices

Tendency of individuals with ASD to seek sensory input should be employed in strategies for directing and orienting the patient (see strategies d, k, l, m, and q in Table 2) or in distraction and coping techniques (see strategies c, o, r, and x in Appendix 2). EDs should consider creating special kits that include social stories, visuals calendars, and sensory-regulation items to be used during the visit (Al Sharif & Ratnapalan, 2016; Gray & Roback, 2020; Lunsky et al., 2018; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Normandin et al., 2018; Richards, 2017; Wood et al., 2019; Zanotti, 2018). A pamphlet listing what is in the kit should be available with images so that patients can point to images and indicate which item they want (Wood et al., 2019).

Facility Design and Operation Features (Places)

No matter how well-trained staff members are in interacting with a patient with ASD, protecting the patient from excessive light, noise, odor, clutter, and crowdedness is most effectively achieved by physical separation. EDs should have ASD patients wait and be treated in separated rooms where environmental stimuli can be monitored and adjusted (e.g., by dimming lights, enhancing ventilation, playing soft music) in accordance with the patient's needs and preferences (Chun et al., 2015, 2016; Gupta et al., 2019; Harwell & Bradley, 2019; Hazen & Prager, 2017; Kirsch et al., 2018; Lunsky et al., 2018; MacKenzie et al., 2013; McGonigle, Migyanka, et al., 2014; McGonigle, Venkat, et al., 2014; Nicholas et al., 2020, 2016a, 2016b; Normandin et al., 2018; Preissmann, 2017; Reese & Deutsch, 2020; Richards, 2017; Tint et al., 2019; Venkat et al., 2012, 2016; Wood et al., 2019; Zanotti, 2018; Zwaigenbaum et al., 2016). To reduce clutter in treatment rooms, wires, cables, equipment, and devices should be stored and secured in cabinets or closets, preferably behind the patient (Wood et al., 2019). To help with patient communication, ED rooms should offer accommodations (e.g., chairs) for caregivers and family members (Nicholas et al., 2020). In addition, spaces used by patients with ASD should offer alternative seating options such as mat, ball, stretcher mattress on floor, rocking chair, or nylon folding sports stadium seat as using them can help calm the patient (Chun et al., 2016; Wood et al., 2019). Accommodating these items along with the successful implementation of most coping and distraction techniques may require additional space, either inside or adjacent to patient rooms. For example, a separate area should exist with alternative seating options for ASD patients to eat snacks, play with their favorite sensory toys, or walk and move around (Chun et al., 2015; Harwell & Bradley, 2019; Nicholas et al., 2020, 2016a, 2016b). Using communal playrooms in ED may be unsafe as they are normally full of sharp objects, potential projectiles, and dangling cords that are not safe for patients with ASD (Hazen & Prager, 2017).

Interconnection of Source Domains with Remediation Strategies and Sensory Issues

While we presented our strategies under five different domains, as Fig. 2 (right panel) shows, there are inherent interconnections among them that should be considered. For example, while the care process should be expedited to reduce the length of stay in ED's chaotic environment, effective communications with the ASD patient requires staff members to slow down and give the patient time to adjust and prepare for treatments. Accordingly, there is a strong association between care process and behavior of providers in Fig. 2 (right panel). In addition, control of hearing and sight stimulations can often be achieved simultaneously, for example by placing the patient in a quiet and clutter-free room with dimmable lights. As a result, a strong association also exists between hearing and sight senses. We considered dimmable lights as a design feature, resulting in another strong association between sight and design features in Fig. 2 (right panel). Several other strong connections in Fig. 2 exist between the sense domains and source domains. For example, the majority of distraction and coping strategies we

found in literature suggests letting the patient to touch and play with sensory toys of various colors or with blinking lights that offer both sight and touch sensations. As a result, both touch and sight senses have strong connections with objects as a source of distraction. Similarly, the majority of orientation techniques rely on using signs and images, leading to a strong connection between sight and objects as a source in orientation strategies.

Finally, for sensory challenges, a similar interconnection exists among the five senses and the source domains. The strength of the connecting lines in Fig. 2 (left panel) suggests that the most prominent source of sight and touch sensitivities are objects, equipment, and devices that often create a visual clutter and also come in contact with the patient (e.g., wristbands, bandages, gowns, stethoscope, pulse oximeter, thermometer, supplemental oxygen devices). For hearing sensitivities, the most common source was often mentioned to be fast, excessive, and loud speaking by staff members. A relatively high level of association between sight and hearing sensitivities can be observed in Fig. 2 (left panel), as often it is the same source (e.g., medical equipment or crowded waiting rooms) that results in both clutter and excessive noise. Within source domain, Fig. 2 (left panel) shows a high level of association between three domains of care process, behavior of providers, and objects, as the urgency of care in ED often requires having multiple staff members interact with the patient in a short period of time, during which a large number of equipment and devices are used.

Limitations and Future Studies

The first important limitation in the studies that we reviewed is the shortage of evidence on the adult population with ASD. As a result, some of the distraction and orientation strategies we found (e.g., cartoon or movie characters painted on the wall, offering sensory toys, or having a small trampoline in the waiting area) might not be as effective for adult ASD patients. Strategies targeting adults with ASD should be further evaluated in future studies as this group use ED considerably higher than children with ASD (Iannuzzi et al., 2015). The second limitation of our review is that only 2 out of the 28 studies that met out inclusion criteria were undertaken outside of North America. While the sensory sensitivities that we identified and non-pharmacological strategies we have listed in Table 2 might not be affected by cultural and geographical variations, this might limit the worldwide generalizability of our findings. Finally, the effectiveness of strategies that we identified in literature has not been fully established. Future studies should employ experimental or quasi-experimental methodologies to examine and document how adopting these strategies affect patient experience and care safety and quality outcomes compared with a comparison group.

Example of outcomes that can be studied include the frequency of agitation and delirium; the frequency of chemical, mechanical, and physical restraint use; the number of administrations and dosage of medications for managing sleep, pain, agitation, and delirium; length of stay; and overall satisfaction of patients and their family members. In addition, when it comes to ED staff members, it should be examined how supporting them in managing a vulnerable patient group with complex and multifaceted needs may lower burnout and improve job satisfaction. More importantly, the financial implication of implementation sensory-friendly care should be evaluated. While implementing strategies that we identified would require such additional resources as staff training, equipment, and physical space, it is highly plausible that additional costs are offset by reducing resource utilization (e.g., mediations, procedures, and length of stay), lowering staff burnout, and increasing revenue by welcoming patients who need sensory-friendly services.

Conclusion

Studying non-pharmacologic strategies for addressing sensory sensitivities of ED ASD patients is a novel topic. To our knowledge, this review is the first attempt at synthesizing and describing these early findings. Despite the novelty of the topic, we are able to develop a list of 26 consolidated strategies for creating a sensory-friendly experience for ED ASD patients. Our qualitative analysis of the language used for describing these strategies in the original studies revealed five major domains, including guiding principles of ED ASD care, care processes, people (behavior of staff members), objects, and places (facility design). The main take away of our review is that addressing sensory challenges that a patient with ASD faces in ED requires an integrative approach that incorporates all aspects of care, encompassing processes, people, objects, and places. More importantly, beyond having a body of remediation strategies targeting sensitives associated with the five senses, the success of sensory-friendly care depends on having guiding principles that tie various aspects of care and distinguishes ASD care from non-ASD care.

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