

INNOVATION REPORT

A Novel Web-Based and Mobile Application to Measure Real-Time Moral Distress: An Initial Pilot and Feasibility Study

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Problem Definition: Moral distress (MoD) is a vital clinical indicator linked to clinician burnout and provider concerns about declining patient care quality. Yet it is not routinely assessed. Earlier, real-time recognition may better target interventions aimed at alleviating MoD and thereby increase provider well-being and improve patient care quality.

Initial Approach and Testing: Combining two validated MoD instruments (the Moral Distress Thermometer [MDT] and the Measure of Moral Distress for Healthcare Professionals [MMD-HP]), the authors developed a novel mobile and Web-based application environment to measure and report levels MoD and their associated causes. This app was tested for basic feasibility and acceptability in two groups: graduate nursing students and practicing critical care nurses.

Results: The MDT app appears feasible and acceptable for future use. All participants ($n = 34$) indicated the MDT app was satisfying to use, and 91.2% ($n = 31$) indicated the app was “very appropriate” for measuring MoD. In addition, 84.2% ($n = 16$) of practicing nurses indicated the app fit either “somewhat well” (47.4%, $n = 9$) or “very well” (36.8%, $n = 7$) into their typical workday, and 68.4% ($n = 13$) said they were either “extremely likely” or “somewhat likely” to use the app daily in clinical practice.

Key Insights and Next Steps: Education about moral distress and its associated causes proved important to the MDT app’s success. It is ready for future validity and reliability testing, as well as examining usability beyond nursing, longitudinal data monitoring, and possible leveraging to pre- and postintervention evaluation studies.

Moral distress (MoD) occurs when a health care provider recognizes a professional obligation (for example, to minimize unnecessary suffering) or an ethical action (for example, respecting patient wishes) but is constrained from meeting or taking it because of some external force.¹ Although first reported in critical care nurses,² MoD has been documented among other health care providers, including social workers, pharmacists, and occupational therapists.^{3–5} It has also been reported by health care leaders, including nurse managers, mid-level managers, and senior executives.^{6,7} MoD can signal the presence of obstacles, which can prevent delivery of safe, high-quality care^{8,9} and leave providers feeling powerless to bring about change.¹⁰ High levels of MoD, particularly when repeated over time, have been shown to be an independent predictor of burnout¹¹ and are significantly correlated with intent to leave.¹² Recognizing MoD early and providing a known MoD intervention (of which several have been described, with varying levels of success¹³) may contribute to improved patient care quality and health care professional

well-being. Indeed, a delay in addressing MoD can lead to a crescendo effect¹⁴ where moral residue¹⁵ or unhealthy work environments diminish or inhibit high-quality, safe patient care. Currently, no single instrument has been adopted by health care researchers, professionals, or organizations to monitor MoD in real time. The purpose of this innovation report is to describe the development and feasibility testing of a mobile application (and its companion website) to capture real-time MoD scores in an effort to increase MoD awareness and reporting, as well as shrink the time between reporting and MoD intervention.

Although no standard conceptual framework underlying the multifactorial nature of MoD exists, several have been proposed.^{14,16–18} Generally, sources of MoD occur at three main tiers: (1) the patient/family level (for example, because of perceived inappropriate treatment at end of life or disclosure/nondisclosure of patient information^{17,19}), (2) the unit level (for example, through intra- or inter-team conflict²⁰), and (3) the organizational level (for example, high patient-to-staff ratios or poor ethical climate^{17,21}). MoD levels tend to be highest among critical care providers, particularly nurses.²² Symptoms of MoD can include feelings of anger, frustration, sadness, and powerlessness.¹⁰ Out-

side of emotional responses, behaviors (including opting for fewer patient care working hours or a reluctance to go to work) can occur.¹⁰ These feelings and behaviors can be seen as self-protective, but they are also emblematic of an unhealthy work environment.^{23,24} This can put patient lives at risk,²⁵ so acknowledging rising MoD levels is essential. Sustained MoD can further lead to job dissatisfaction and compassion fatigue,²⁶ with burnout symptoms and higher levels of intent to leave.^{11,12}

Measuring MoD has undergone several iterations.^{17,27–29} The Measure of Moral Distress for Healthcare Professionals (MMD-HP) is perhaps the gold standard of instruments, with good reliability ($\alpha = 0.93$).¹⁷ Yet, it is intended to measure MoD over the past 6 to 12 months, with respondents rating both frequency and level of distress for each of its 27 items.¹⁷ As a counterpoint, the Moral Distress Thermometer (MDT) offers a 0-to-10-point MoD scale that can be operated quickly and in real time.²⁹ It has shown promising convergent and concurrent validity to another validated MoD measure, the Moral Distress Scale-Revised (MDS-R),²⁸ and has been well utilized in MoD intervention studies.^{30–32} It does not, however, create as strong a link to potential MoD causes. A follow-up study by Wocial et al.³³ provided additional options for providers to select causes behind their given MDT rating, but these causes did not undergo the more rigorous testing and evaluation done with MMD-HP.¹⁷ Therefore, combining the MMD-HP's causes and the MDT's simple, real-time interface could provide actionable data to unit leaders, ethics consultants, and health care professionals so they can begin to address MoD faster and in a more targeted way than using either the MMD-HP or MDT alone.

Using a mobile and/or Web-based application to measure real-time MoD holds promise, particularly given mobile health applications' general acceptance by both patients and providers.³⁴ In patient populations, this technology is largely used for self-monitoring of various diagnoses (such as diabetes³⁵) and/or behavior change (such as weight management³⁶). Among health care providers, the technology has centered on resources to improve patient care, such as drug-dosage calculators³⁷ and end-of-life care guides,³⁸ and has even seen implementation focused on provider burnout.^{39,40} Of note, these burnout apps often focus chiefly on building individual resilience, which can limit their usefulness in addressing systems-based MoD causes. Further, data on general resiliency and stress management apps have not been promising, with only 2.1% (21 of 1,009 assessed apps) sourcing published, peer-reviewed evidence of feasibility and/or efficacy.⁴¹ Given this limitation, shifting the focus of a mobile app (and/or its associated website) from an intervention (for example, an app aimed to build resiliency) to measurement and notification to key stakeholders capable of assisting with an intervention may be the most successful and feasible next step.

METHODS

We developed a mobile and Web-based application environment, the MDT app, and then conducted feasibility testing in two populations: graduate nursing students and practicing critical care nurses.

Development of the MDT Application

The MDT app was developed collaboratively with nursing, computer science, and biomedical engineering teams, as well as the original developer of the MDT [L.D.W.] and the MMD-HP [B.E.]. The development process was iterative, with a strong focus on cyber security, including robust data and system management protocols and prevention of social engineering threats such as user exploitation.⁴² It is a cross-platform reporting tool, built using Flutter,⁴³ an open-source software development kit. The app environment is accessible on Android, iOS, and the Web, with a cloud-native infrastructure built on Amazon Web Services (AWS).⁴⁴ Data are sent immediately and stored securely using serverless AWS technologies that will automatically scale to handle the amount of traffic it receives.⁴⁴ The application environment also supports federated identity providers, which create, maintain, and manage identity information and provide principal authentication to other service providers.⁴⁵ What this can afford is seamless integration with the authentication systems already in place at hospitals and universities. The application underwent a data security review by the Institutional Review Board for Health Sciences Research at the participating facility.

Figure 1 provides an overview of the application interface. The overall design was informed by Google's Material Design language principles,⁴⁶ which cater to translational platforms and have a central focus on mobile experiences. The principles also encourage bold, intentional colors and placement of graphics in a three-dimensional space.⁴⁶ Some aspects of color psychology (where softer hues can suggest a more joyous or relaxed state⁴⁷) were also referenced during development.

Participants begin by downloading the application to their mobile device (or accessing the app environment via the Web) and navigate through four screens. They first select "What's your temperature?" which is the loading screen for the MDT app. A brief definition of MoD appears on the next screen, and a participant can scroll up or down on the provided thermometer to indicate their unique MoD score. Scrolling up or down changes the color and indicates a number and words to identify the user's level of MoD. This image is a near exact replica of the original MDT.²⁹ After submitting a score, all participants advance to a cause screen, where a participant can select the cause (or causes) behind their chosen score. The depicted causes reflect the items found in the MMD-HP,¹⁷ including an additional "other" option should a user not find the cause they feel best matches their MoD score. The "other" option does not in-

Application Interface Overview

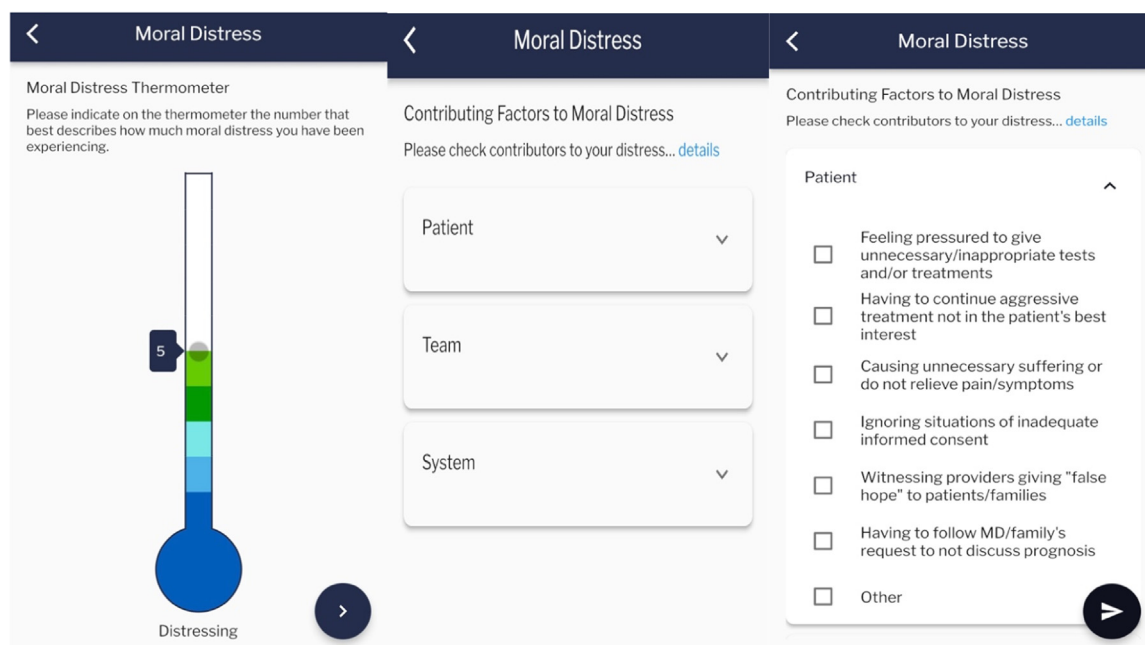


Figure 1: Shown here is the Moral Distress Thermometer (MDT) app interface. This figure demonstrates a sample user's navigation panels when accessing the application.

clude free-text space in an effort to prevent private health information from being included. Should a participant's score be > 3 , they are prompted to select a cause before advancing. This reflects an effort to help link higher scores with defined causes to better target an appropriate intervention. After advancing from the cause screen, a participant then views a Thank You screen, which contains information for contacting the targeted facility's MoD intervention service.

Feasibility and Acceptability Testing

The study was reviewed and approved by our Institutional Review Board (HSR210476).

Phase 1: Graduate Nursing Students. Graduate nursing students from a top-ranked public mid-Atlantic nursing school were invited to participate via e-mail, posted paper flyer, or in person by the primary author. This population was chosen as an initial testing bed because of their relative familiarity with current nursing practice and MoD, which is included in their curriculum. Nursing student participants were enrolled from March to May 2022 and included an approximate population of 120 students. Eligibility for this population included being actively enrolled in a nursing graduate program at the targeted mid-Atlantic nursing school. After providing consent, participants were provided with a brief education on MoD, including the definition of MoD and several examples of morally distressing situations.¹ Participants were then introduced to the MDT app and instructed to navigate through the app environment. They then completed an online, Qualtrics-based⁴⁸

survey to assess feasibility and acceptability (see Table 1). This survey, though rooted in concepts like those found in the system usability scale⁴⁹ and the usability metric for user experience,⁵⁰ was newly created to be readily relevant to the targeted users and the MDT app environment. Demographics were not recorded, as ascertaining feasibility and acceptability was the chief goal of this study. Data analysis included basic frequencies and review of data within the Qualtrics platform.

Phase 2: Practicing Critical Care Nurses. Following feedback from the first phase, minor adjustments to the MDT app were made, including adding an "other" option to the list of MoD causes and providing additional information on the relevancy of the MDT²⁹ and the MMD-HP¹⁷ to the MDT app environment. Practicing critical care nurses in one unit ($n = \sim 45$ nurses) in a large, rural mid-Atlantic academic health care system were then invited to enroll via e-mail. After two weeks and zero responses received, the primary author visited the targeted unit on five separate occasions during the day shift (0700–1930) and the night shift (1900–0730) for convenience sampling. Each shift included approximately seven nurses. Nurses were approached only if they were not actively providing patient care or performing other required nursing duties. Eligibility was confirmed by querying all potential participants if they had been licensed as a registered nurse for at least one year. Following confirmation, participants were introduced to the study, asked to provide consent, and, if consent was provided, given identical instructions found

Table 1. Participant Responses*

Survey question	Total	
	n	%
Is the Moral Distress (MoD) app appropriate for measuring MoD?		
Not appropriate	0	–
Not really appropriate	0	–
Neutral	0	–
Somewhat appropriate	3	8.8
Very appropriate	31	91.2
Is the MoD app satisfying to use?		
Yes	34	100
No	0	–
How likely would you use the MoD app daily in clinical practice?		
Very unlikely	2	5.9
Somewhat unlikely	1	2.9
Neutral	7	20.6
Somewhat likely	12	35.3
Extremely likely	12	35.3
Was the MoD app easy to login to?		
Yes	34	100
No	–	–
How easy was the MoD app to navigate?		
Very difficult	1	2.9
Somewhat difficult	1	2.9
Neither easy nor difficult	0	–
Somewhat easy	4	11.8
Very easy	28	82.4
Did any of these potential benefits occur? (Select all that apply)		
Felt my MoD score mattered	16	47.1
Felt my MoD score was being recorded	15	44.1
Felt I could more appropriately document my MoD	16	47.1
Felt leadership was more aware of MoD since piloting the app	9	26.5
Felt more MDCS consults occurred because of the app	2	5.9
I requested a MDCS consult	0	–
I discussed my MoD with a colleague	6	17.6
None of these	7	20.6
Other	5	14.7
Did any of these negative effects occur? (Select all that apply)		
I felt targeted by recording my MoD score	0	–
The app was too time-consuming	0	–
The app was hard to figure out	0	–
I worried my data would be leaked	1	2.9
I felt recording my score did not help me	1	2.9
It didn't matter if I recorded this or not	2	5.9
None of these	27	79.4
Other	3	8.8
How well do you feel the MoD app fit into your typical workday?		
Very poorly	0	–
Somewhat poorly	1	2.9
Neither well nor poorly	3	8.8
Somewhat well	15	44.1
Very well	15	44.1
Do you feel the MoD app fits into the organizational goals of this health system?		
Strongly disagree	0	–
Somewhat disagree	0	–
Somewhat agree	5	14.7
Strongly agree	26	76.5
I'm not sure	3	8.8
Do you feel the MoD app fits into the goals of your current role?		
Strongly disagree	0	–
Somewhat disagree	0	–
Somewhat agree	11	32.4
Strongly agree	22	64.7
I'm not sure	1	2.9

(continued on next page)

Table 1. (continued)

Survey question	Total	
	n	%
Do you feel the MoD app helped you better voice your concerns about MoD?		
Strongly disagree	0	–
Somewhat disagree	2	5.9
Somewhat agree	9	26.5
Strongly agree	20	58.8
I'm not sure	3	8.8

* N = 34 (n = 15 for graduate students; n = 19 for nurses; results were similar across both groups). All decimals were rounded to nearest 0.1.
MDCS, Moral Distress Consult Service.

in Phase 1 about MDT app navigation. Again, no demographic data were collected. Enrollment for nurse participants occurred from May to June 2022. Of note, the targeted health care system has an active MoD intervention in place,³¹ and although traveling nurses (n = 13) were present at the time of the intervention, most core staff were familiar with MoD and its implications. As in Phase 1, data were analyzed using basic frequencies and review of data within the Qualtrics platform. All enrollment, data collection, and data analysis were completed by the primary author.

RESULTS

Overall, results were similar between the two groups, with 15 graduate nursing students self-selecting to participate (12.5% response rate), and 19 of 22 critical care nurses participating (86.4% response rate; see Table 1). All participants (n = 34) indicated the MDT app was satisfying to use, and 91.2% (n = 31) indicated that it was “very appropriate” for measuring MoD. All participants (100%, n = 34) said the MDT app was easy to log in to, and 82.4% (n = 28) indicated the app was “very easy” to navigate. No participant said the app was “too time-consuming” or found it “hard to figure out.”

Among nurse participants, 84.2% (n = 16) indicated the app fit either “somewhat well” (47.4%, n = 9) or “very well” (36.8%, n = 7) into their typical workday, and 68.4% (n = 13) said they were either “extremely likely” or “somewhat likely” to use the app daily in clinical practice.

When selecting from a list of potential benefits, 47.1% (n = 16) of all participants checked “Felt my MoD score mattered,” and 47.1% (n = 16) indicated “Felt I could more appropriately document my MoD.” Nine participants (26.5%) selected “Felt leadership was more aware of MoD since piloting the app,” and 17.6% (n = 6) ticked “I discussed my MoD with a colleague.” Twenty-seven (79.4%) participants indicated no negative effects occurred because of their app use, and no participant indicated they felt targeted by recording their MoD score. One (2.9%) participant indicated worry their data would be leaked.

Across all participants, 26 (76.5%) strongly agreed the app aligned with the organizational goals of the health care system where the app was tested. When reflecting on whether the app aligned with their professional role (either as a student or as a nurse), 64.7% (n = 22) indicated “strongly agree.” Finally, 85.3% (n = 29) of total participants indicated either “strongly agree” or “somewhat agree” when asked if the app would help them to better voice their concerns about MoD.

Although all participants were provided the option to include free-text responses to their evaluation of the MDT application environment, none of the critical care nurses opted to do so. Seven (46.7%) graduate students provided qualitative feedback. This feedback, if relevant and able to be acted on, was incorporated into the MDT app and the study protocol prior to enrolling the nurses, as dictated in the Methods section above.

DISCUSSION

This pilot study represents a collaborative effort with actively working critical care nurses, nursing students, nursing researchers, computer science technologists, and biomedical engineers to employ local, research-based, and technological knowledge toward a specific, health-focused area: measuring MoD in health care professionals. This initial, limited analysis suggests that real-time assessment of MoD using the MDT app in the hospital setting is both feasible and acceptable. Because the MDT app’s confidentiality was trusted and participants believed it to be well-aligned with their organization’s goals and their own role as a nursing student or as an actively practicing nurse, this tool may be a useful “indicator light” to more accurately and regularly report MoD levels as they occur. Although the app is not intended to be used daily, this could lead to more timely and targeted MoD interventions and the potential alleviation of higher MoD scores. The MDT app’s reported ease of use speaks to a faster way for a user to bring forward concerns about morally distressing events. Of note, including education on MoD and its potential causes will be essential

to the MDT app's success, as the relative familiarity and knowledge about MoD was essential to correct application use.

Should the MDT app continue to perform well in future validation studies, it holds great potential for use as a measurement tool in research studies and quality initiatives for health care professionals. With regular, real-time MoD measurement, particularly at the time of morally distressing events, MoD awareness can increase and known interventions could be implemented sooner, be better targeted, and perhaps be more effective and/or lead to intervention improvements.

Potential Risks to Approach

In developing the MDT app environment, the study team recognized several potential risks, including those surrounding participant privacy, patient confidentiality, and organizational exposure. To address participant privacy, the MDT app was engineered to follow privacy best practices, which include encrypting data in transit, encrypting data at rest, and creating identity and access management (IAM) policies of least privilege.⁵¹ IAM policies restrict a user to specific data entry-points, rather than granting every user global access,⁵¹ which helps keep data secure. Further, a unique, anonymous identifier for each user is set to be automatically generated upon data entry. This identifier can be used in future studies to track a given user's experience over time, but it does not include any personally identifying information. Finally, the de-identified data from the MDT app (the MoD score, its selected causes, and minimal app utilization data, including date and time of use), are sent immediately and stored on a secure AWS cloud-based server. An AWS server, like any cloud-storage space, is not able to offer absolute protection but does offer higher levels of data security.⁵²

Risk to patient confidentiality was also evaluated. The MDT app does not include patient data collection or provide any free-text entry where patient data could be mistakenly entered. A slight risk does still exist, however, if, for example, a user was to select the MoD cause "having to continue aggressive treatment not in the patient's best interest," in a particular unit when there is only one patient who might meet that criterion. Completely removing this risk is impossible, given the high likelihood of identifying information a given user could experience during a specific morally distressing event.

Finally, the study team recognizes the potential for organizational exposure, particularly if system-level issues are frequently identified by the MDT app environment. However, root cause analyses are well-supported in health care systems and other high reliability organizations.^{53,54} Further, current MoD intervention studies suggest organizational support is crucial to the relative success of those interventions' ability to lower MoD scores.^{55,56} Perhaps, then, the benefits in engaging with this possible organizational ex-

posure outweighs the potential risks. The study team also acknowledges in-hospital reporting systems, which may be effective in some cases of improving patient care and safety, but can also be seen as punitive, particularly when reporting on system-level issues.^{57,58}

Next Steps

Future work includes larger-scale evaluations of this novel tool, including more rigorous reliability and validity testing, examining usability beyond nursing, longitudinal monitoring, and implementing the tool for pre- and postintervention for evaluative purposes. Further studies with larger sample sizes and greater attention to self-selection bias will also be necessary. Increasing MoD awareness is essential because without knowing MoD is occurring or understanding its contributing factors, any potential intervention cannot be properly focused or improved. The MDT app and its companion website have high potential to do this heightened awareness work, as well as serve as an indicator light for bedside staff, unit leaders, and higher-level management that MoD is on the rise. This can help ensure the highest quality of patient care, as well as trigger timely MoD interventions to staff in need. We look forward to how this tool can be used to help in MoD reporting.

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Conflicts of Interest. All authors report no conflicts of interest.

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REFERENCES

1. Jameton A. *Nursing Practice: The Ethical Issues*. Englewood Cliffs, NJ: Prentice-Hall, 1984.
2. Rodney P. Moral distress in critical care nursing. *Can Crit Care Nurs J*. 1988;5(2):9–11.
3. Sporrang SK, et al. We are white coats swirling round"—moral distress in Swedish pharmacies. *Pharm World Sci*. 2005;27:223–229.
4. Fantus S, et al. Exploring moral distress for hospital social workers. *Br J Soc Work*. 2017;47:2273–2290.

5. Penny NH, et al. An investigation of moral distress experienced by occupational therapists. *Occup Ther Health Care*. 2014;28:382–393.
6. Whitehead PB, et al. The nurse manager's experience of moral distress. *J Nurs Adm*. 2021 Jun 1;51:334–339.
7. Mitton C, et al. Moral distress among healthcare managers: conditions, consequences and potential responses. *Healthc Policy*. 2010;6:99–112.
8. Henrich NJ, et al. Consequences of moral distress in the intensive care unit: a qualitative study. *Am J Crit Care*. 2017;26:e48–e57.
9. Ludwick R, Silva MC. Errors, the nursing shortage and ethics: survey results. *Online J Issues Nurs*. 2003;8(3):9.
10. Wiegand DL, Funk M. Consequences of clinical situations that cause critical care nurses to experience moral distress. *Nurs Ethics*. 2012;19:479–487.
11. Fumis RRL, et al. Moral distress and its contribution to the development of burnout syndrome among critical care providers. *Ann Intensive Care*. 2017;7:71.
12. Austin CL, Saylor R, Finley PJ. Moral distress in physicians and nurses: impact on professional quality of life and turnover. *Psychol Trauma*. 2017;9:399–406.
13. Amos VK, Epstein E. Moral distress interventions: an integrative literature review. *Nurs Ethics*. 2022;29:582–607.
14. Epstein EG, Hamric AB. Moral distress, moral residue, and the crescendo effect. *J Clin Ethics*. 2009;20:330–342.
15. Webster GC, Bayliss FE. Moral residue. In: Rubin SB, Zoloth L, editors. *Margin of Error: The Ethics of Mistakes in the Practice of Medicine*. Hagerstown, MD: University Publishing Group. p. 217–230.
16. Corley MC, et al. Development and evaluation of a moral distress scale. *J Adv Nurs*. 2001;33:250–256.
17. Epstein EG, et al. Enhancing understanding of moral distress: the Measure of Moral Distress for Health Care Professionals. *AJOB Empir Bioeth*. 2019;10:113–124.
18. Morley G, Bradbury-Jones C, Ives J. The moral distress model: an empirically informed guide for moral distress interventions. *J Clin Nurs*. 2022;31:1309–1326.
19. Whitehead PB, et al. Moral distress among healthcare professionals: report of an institution-wide survey. *J Nurs Schol*. 2015;47:117–125.
20. McAndrew NS, Leske JS, Garcia A. Influence of moral distress on the professional practice environment during prognostic conflict in critical care. *J Trauma Nurs*. 2011;18:221–230.
21. Atabay G, Çangarli BG, Penbek Ş. Impact of ethical climate on moral distress revisited: multidimensional view. *Nurs Ethics*. 2015;22:103–116.
22. Corley MC. Moral distress of critical care nurses. *Am J Crit Care*. 1995;4:280–285.
23. Koskenvuo J, Numminen O, Suhonen R. Ethical climate in nursing environment: a scoping review. *Nurs Ethics*. 2019;26:327–345.
24. Lamiani G, Borghi L, Argentero P. When healthcare professionals cannot do the right thing: a systematic review of moral distress and its correlates. *J Health Psychol*. 2017;22:51–67.
25. Aiken LH, et al. Effects of hospital care environment on patient mortality and nurse outcomes. *J Nurs Adm*. 2008;38:223–229.
26. Yu H, Jiang A, Shen J. Prevalence and predictors of compassion fatigue, burnout and compassion satisfaction among oncology nurses: a cross-sectional survey. *Int J Nurs Stud*. 2016;57:28–38.
27. Corley MC. Nurse moral distress: a proposed theory and research agenda. *Nurs Ethics*. 2002;9:636–650.
28. Hamric AB, Borchers CT, Epstein EG. Development and testing of an instrument to measure moral distress in health-care professionals. *AJOB Prim Res*. 2012;3(2):1–9.
29. Wocial LD, Weaver MT. Development and psychometric testing of a new tool for detecting moral distress: the Moral Distress Thermometer. *J Adv Nurs*. 2013;69:167–174.
30. Chiafery MC, et al. Nursing ethics huddles to decrease moral distress among nurses in the intensive care unit. *J Clin Ethics*. 2018;29:217–226.
31. Epstein EG, Shah R, Marshall MF. Effect of a moral distress consultation service on moral distress, empowerment, and a healthy work environment. *HEC Forum*. 2023;35L21–35L35.
32. Wocial LD, et al. Factors associated with physician moral distress caring for hospitalized elderly patients needing a surrogate decision-maker: a prospective study. *J Gen Intern Med*. 2020;35:1405–1412.
33. Wocial L, et al. Pediatric Ethics and Communication Excellence (PEACE) Rounds: decreasing moral distress and patient length of stay in the PICU. *HEC Forum*. 2017;29:75–91.
34. Hitti E, et al. Mobile device use among emergency department healthcare professionals: prevalence, utilization and attitudes. *Sci Rep*. 2021 Jan 21;11:1917.
35. Adu MD, et al. Considerations for the development of mobile phone apps to support diabetes self-management: systematic review. *JMIR MHealth UHealth*. 2018 Jun 21;6:e10115.
36. Bardus M, et al. Mobile phone and Web 2.0 technologies for weight management: a systematic scoping review. *J Med Internet Res*. 2015 Nov 16;17:e259.
37. Koehler N, Vujovic O, McMenamin C. Healthcare professionals' use of mobile phones and the internet in clinical practice. *J Mob Technol Med*. 2013;2(1):3–13.
38. Yang JH, Shin G. End-of-life care mobile app for intensive-care unit nurses: a quasi-experimental study. *Int J Environ Res Public Health*. 2021 Jan 30;18:1253.
39. Narváez S, et al. Human-centered design of an mHealth app for the prevention of burnout syndrome. *Stud Health Technol Inform*. 2016;228:215–219.
40. Wood AE, et al. Reduction of burnout in mental health care providers using the Provider Resilience mobile application. *Community Ment Health J*. 2017;53:452–459.
41. Lau N, et al. Android and iPhone mobile apps for psychosocial wellness and stress management: systematic search in app stores and literature review. *JMIR MHealth UHealth*. 2020 May 22;8:e17798.
42. Aldawood H, Skinner G, et al. Educating and raising awareness on cyber security social engineering: a literature review. In: Lee MJW, et al., editors. *Proceedings of 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*. New York: IEEE; 2018, 62–68.
43. Flutter. Home page. Accessed Jun 7, 2023. <https://flutter.dev/>.
44. Amazon. Real-Time Communication on AWS-AWS. AWS Whitepaper, 2023. Accessed Jun 7, 2023. <https://docs.aws.amazon.com/pdfs/whitepapers/latest/real-time-communication-on-aws/real-time-communication-on-aws.pdf>.
45. Oasis. Glossary for the OASIS Security Assertion Markup Language (SAML) V2.0. Hodges J, Philpott R, Maler E, editors, Mar 15, 2005. Accessed Jun 7, 2023.

- <https://docs.oasis-open.org/security/saml/v2.0/saml-glossary-2.0-os.pdf>.
46. Google. Material Design. <https://m3.material.io/>. Accessed Jun 7, 2023.
 47. Jonauskaitė D, et al. What color do you feel? Color choices are driven by mood. *Color Res Appl*. 2019;44:272–284.
 48. Qualtrics. Home page. Accessed Jun 7, 2023. <https://www.qualtrics.com>.
 49. Brooke J, et al. SUS: a 'quick and dirty' usability scale. In: Jordan PW, et al., editors. *Usability Evaluation in Industry*. Bristol, PA: Taylor & Francis. –174 p. 189.
 50. Finstad K. The usability metric for user experience. *Interact Comput*. 2010;22:323–327.
 51. Amazon. Security Best Practices in IAM. AWS Identity and Access Management User Guide. (Updated: Jul 14, 2022.) Accessed Jun 7, 2023. <https://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html#grant-least-privilege>.
 52. Galiveeti S, et al. Cybersecurity analysis: investigating the data integrity and privacy in AWS and Azure Cloud platforms. In: Maleh Y, et al., editors. *Artificial Intelligence and Blockchain for Future Cybersecurity Applications*. Cham, Switzerland: Springer International. p. 329–360.
 53. Percarpio KB, Watts BV, Weeks WB. The effectiveness of root cause analysis: what does the literature tell us? *Jt Comm J Qual Patient Saf*. 2008;34:391–398.
 54. Carroll JS, Rudolph JW. Design of high reliability organizations in health care. *Qual Saf Health Care*. 2006;15(Suppl 1):i4–i9.
 55. Reilly KM, Jurchak M. Developing professional practice and ethics engagement: a leadership model. *Nurs Adm Q*. 2017;41:376–383.
 56. Sporrang SK, et al. Developing ethical competence in health care organizations. *Nurs Ethics*. 2007;14:825–837.
 57. Schectman JM, Plews-Ogan ML. Physician perception of hospital safety and barriers to incident reporting. *Jt Comm J Qual Patient Saf*. 2006;32:337–343.
 58. Wolf ZR, Hughes RG. Error reporting and disclosure. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Hughes RG, editor. editor, Rockville, MD: Agency for Healthcare Research and Quality, 2008. Accessed Jun 7, 2023 <http://www.ncbi.nlm.nih.gov/books/NBK2652/>.