Review Paper ■

A Systematic Review of the Literature on Multidisciplinary Rounds to Design Information Technology

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A b s t r a c t   Multidisciplinary rounds (MDR) have become important mechanisms for communication and coordination of care. To guide design of tools supporting MDR, we reviewed the literature published from 1990 to 2005 about MDR on information tools used, information needs, impact of information tools, and evaluation measures. Fifty-one papers met inclusion criteria and were included. In addition to patient-centric information tools (e.g., medical chart) and decision-support tools (e.g., clinical pathway), process-oriented tools (e.g., rounding list) were reported to help with information organization and communication. Information tools were shown to improve situation awareness of multidisciplinary care providers, efficiency of MDR, and length of stay. Communication through MDR may be improved by process-oriented information tools that help information organization, communication, and work management, which could be achieved through automatic extraction from clinical information systems, displays and printouts in condensed forms, at-a-glance representations of the care unit, and storing work-process information temporarily.

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Communication among care providers is a major part of information flow in health care, and effectiveness of communication is the cornerstone of patient safety. Consensus on the critical role of communication in patient safety is evidenced by the fact that one of the 2006 national patient safety goals of the Joint Commission on Accreditation of Healthcare Organizations is "to improve the effectiveness of communication among care providers." Communication failure among health care providers is one of the most frequently cited causes of preventable harm to patients.[1–5] For example, a retrospective review of 16,000 in-hospital deaths found that communication errors contributed to adverse outcomes almost twice as frequently as inadequate clinical skill.[2] Communication failure was reported as one of the major causes of adverse patient outcomes.[6] Ineffective communication was also found to negatively affect care provider satisfaction[7–9] and efficiency in care delivery.[10,11]

Communication among care providers occurs in various forms, including multidisciplinary rounds (MDR). Multidisciplinary rounds are mechanisms through which care providers from different specialties meet to communicate, coordinate patient care, make joint decisions, and manage responsibilities. Multidisciplinary rounds are given different names based on their purpose (e.g., discharge rounds,[12,13] daily rounds[12,14–17]), the clinical unit in which they take place (e.g., medical rounds,[18–20] surgical rounds[7]), location (sit-down[21] versus bedside rounds[15,19,22]), and their time frame (e.g., morning rounds,[23,24] postadmission rounds[25,26]). The complexity of patient care[27] has made MDR ever more critical to the safety[15,21,28,29] and efficiency of care.[12,30] For example, the increased frequency of MDR was shown to reduce mortality rates.[21,29]

Information technology is used ever more extensively in health care to reduce failures in information exchange and communication.[31,32] Although some have cautioned about the negative consequences of information technology,[33] well-designed information technology may improve communication and coordination in general and through MDR, which may lead to improved outcomes.

We reviewed the literature to provide guidance for designing and evaluating the impact of information tools that support information exchange and communication through MDR. The review was designed to (1) describe the information tools used by care providers in MDR and assess the evidence regarding the impact of information tools on the communication processes of MDR and outcomes, (2) identify the information needs of care providers in MDR, and (3) identify measures that can be used for evaluating the communication processes and outcomes of MDR. Problems with information exchange and communication in MDR are issues in various care settings and medical specialties. Therefore, the review was conducted without focusing on a specific care setting or specialty.

Methods

The published literature from 1990 to June 2005 was searched. For MEDLINE, we used the text words of ward

round$, multidisciplinary round$, medical round$, work round$, and clinical round$. For the Cumulative Index to Nursing and Allied Health Literature (CINAHL), we used the CINAHL subject heading of ''patient rounds,'' with all subheadings included. For Current Contents and Science Citation Index, we used the text words of ward round$, multidisciplinary round$, medical round$, work round$, clinical round$, and patient round$. We searched the American Medical Informatics Association symposium proceedings using the MeSH subject heading of ''patient care team.'' Only English and full-length papers were included in the review. The bibliographies of the papers identified through our search strategy were further searched for additional relevant literature.

Scope of Review

For this review, MDR were defined as regularly scheduled meetings (often daily) of health care providers from different disciplines who are involved in the care of the same patients or management of the same unit. Empirical studies, implementation notes, and position papers were included. For empirical studies, all papers relevant to this literature review were retrieved regardless of their study design. Editorials and letters were excluded. Abstracts of all papers identified were read and assessed by both authors independently. If there was any disagreement between the authors regarding the inclusion of a paper based on abstract, the full text of the paper was reviewed by both authors. In the absence of an abstract, the full text was retrieved and reviewed. Papers were included regardless of the type of rounds studied (e.g., sit-down rounds, bedside rounds, discharge rounds) as long as they were multidisciplinary. Papers related only to the teaching aspect of MDR were excluded from this review. Papers on sign-out rounds of residents and shift change rounds of nurses were not included since these types of rounds typically are not multidisciplinary, involving only physicians or only nurses.

The full text of included papers was reviewed by the first author for (1) information tools referred to, evaluated, developed, or suggested; (2) the information needs identified and summarized in the process of MDR; and (3) process and outcome measures used to assess MDR.

Four hundred three papers were identified using our search strategy, 44 of which met the inclusion criteria. A review of the bibliographies of these 44 papers yielded seven additional papers (for a total of 51), which were included in the review (Table NNN, available as a JAMIA online data supplement at www.jamia.org).

Analysis Framework

We analyzed the literature based on Donabedian's[34,35] structure-process-outcome model. Structure includes the information tools that care providers use in MDR. Information tools for rounds include patient medical records, notes, nursing flow sheets, and to-do lists. An information tool may or may not be computerized. Process occurs in three phases: pre-rounds, during rounds, and post-rounds. Pre-rounds activities include gathering and assembling information to prepare for rounds. During rounds, activities include communicating and exchanging information, building shared situation awareness about patients and the state of the unit, and making decisions collaboratively. Post-rounds activities

include coordinating and executing care plans based on the decisions made during rounds. Outcomes of MDR include clinical outcomes, efficiency, and satisfaction of care providers, patient and families. Under this framework, information tools may affect the processes of MDR (e.g., content of communication, situation awareness, barriers to communication), which in turn may affect outcomes (i.e., clinical outcomes, efficiency, and satisfaction of care providers, patient and families).

We categorized the reported information tools into patient-centric, process-oriented, and decision-support tools. Patient-centric information tools provide information regarding the clinical condition of individual patients. Process-oriented information tools are designed to help care providers organize information pre-rounds and manage communication and care processes in a unit. Decision-support tools provide references to diagnosis and treatment and are used as a guide by care providers in their decisions. Information needs in MDR were categorized into clinical information, reference information (regarding diagnoses and treatments), and information related to organizational and social issues.

We categorized the reported measures to evaluate the processes of MDR as those used to characterize communication processes, to assess communication, and to evaluate the effect on care processes. The outcome measures of MDR were categorized into four: clinical outcomes, efficiency, care provider satisfaction, and patient and family satisfaction.

Information Tools and Their Use

Sixteen articles reported use of information tools in MDR (Table 1). They represent a wide range of computerized and manual tools to support information, communication, and decision needs pre-, during, and post-rounds.

Patient-centric Information Tools

The review reiterated the importance of accessing up to date patient information, including patient medical records,[7,16,23,36–39] nursing flow sheets,[40] medications lists,[16] progress notes,[40] variance tracking forms,[39] and bedside patient monitoring devices.[23] Although the list of reported tools is not surprising, the usage patterns during MDR demonstrated unique requirements. One observational study of 14 physicians from three departments (internal medicine, surgery, and geriatrics) of a mid-sized hospital showed that although physicians used entire patient medical records during rounds, approximately 50% of all patient medical record accesses concerned information about medications, vital signs, and laboratory test results.[16] There were temporal connections among accesses to different parts of the medical records, as shown by the transition probabilities of accessing vital signs after medication information (0.143) and accessing laboratory results after medication information (0.076). Reported use of information tools during MDR also revealed the preference of entering information immediately into the patient medical records and processing all requests during rounds.[16,38] One report described the use of a video projector to display computerized patient medical records on a wall during sit-down rounds for all to see the relevant patient information.[38] Decisions made during rounds were entered directly into the patient medical records, eliminating double input of information afterward.[38]

Table 1 ■ Reported Information Tools in Multidisciplinary Rounds (MDR)

Patient-centric Information Tools	
Patient medical record[7,16,23,36–39]	Most frequently used. Medications lists, vital signs, and laboratory results are the most frequently accessed items during rounds.
Variance tracking form[39]	Designed to record patient variances from their respective clinical pathways. Used for identifying variances in patient outcomes and for discussing action plans.
Progress notes[40]	Used to record rounds discussions about patients' progress and plan of care.
Nursing flow sheet[40]	Used to document discussions related to discharge planning.
Bedside monitoring devices[23]	Accessed during MDR in a surgical intensive care unit to obtain vital signs on physiological monitors, respiratory status on ventilators (inspired oxygen saturation, ventilation mode, inspiration–expiration ratio, inspiration pressure) and fluid infusion dosages (catecholamine, lidocaine, potassium, and nitroprusside).
Process-oriented Tools	
Rounding list[25,41]	Used for summary view of up-to-date lists of patients and their active diagnoses, test results, and care plans; also used for note taking.
Rounding and sign-out Tool[42,43]	Used to automatically extract summary information from clinical information systems for rounding and sign out. Accessible through Web and able to print in a condensed format for quick reference and note taking. Summary information including patient demographics, vital signs, medication list, and plan for the patient. Shown to have halved the number of patients not discussed, halved prerounding time, shortened round durations.
Daily goals form[44,45]	Used to remind care providers to define patient goals explicitly. Including to-do list for discharge, safety risks, ventilator management, scheduled laboratory tests, removal of catheters, and family issues.
Needs assessment tool for discharge[13]	Used to record systematically patient needs discussed during discharge rounds. Including 12 categories of patient needs such as housing, finances, nursing care, and health education.
Decision-support Tools	
Evidence cart[46]	Easy to access trolley with compact disks of MEDLINE, Best Evidence, Radiological Anatomy, Scientific American Medicine, the Cochrane Library, and *JAMA* Rational Clinical Examination Series. Shown to increase the number of times care providers searched for clinical evidence and incorporated their findings into patient care decisions.
Online evidence-based medicine resources[37]	Used in a pediatric intensive care unit. Included online versions of the *American Academy of Pediatrics Red Book* and *picuBOOK* (both reference books).
Clinical pathway[40]	Used as reference to assess and discuss significant deviations from the clinical pathway and to aid care planning.
Graphic display of laboratory results and functional tests[47]	Used to visualize laboratory findings and functional test results on a tablet PC to allow quick access.

Process-oriented Tools

Interestingly, a majority of the reported process-oriented tools were created by care providers to support their own daily activities.[25,42–44] For example, UWCores, a centralized, Web-based computerized rounding and sign-out tool, was developed by a team of two physicians, two informatics researchers, and a computer systems developer in a large university medical center. The tool helped care providers organize information pre-rounds by automatically importing key patient data from clinical information systems and printing them out in a condensed format. Some of the reported process-oriented information tools were used to capture information that may be viewed as informal or temporary, not appropriate for inclusion as part of official patient medical records (e.g., to-do lists, informal notes).[13,42–44] For example, UWCores stored information that was not copied to clinical information systems. Other process-oriented information tools (the daily goals form, check-off list, and the needs assessment tool for discharge rounds) were developed to ensure consistent communication and information sharing by providing a summary list of patient needs and by explicitly requiring care providers to identify goals for each patient.[13,44]

Decision-support Tools

Decision making is a frequently occurring activity during MDR. Not surprisingly, the review identified a number of tools developed to support decision making during MDR.[36,37,40,46] One tool, an "evidence cart," containing compact disks of MEDLINE, Best Evidence, reprints of the *JAMA* Rational Clinical Examination series, a physical examination textbook, and other resources, improved access to information used in patient care decisions.[46] Clinical pathways were another type of decision support tool used to detect and assess patient progress in relation to set expectations during MDR.[40] Visualization of discrete data points was an interesting tool to provide quick access to and overview of laboratory findings and functional test results.[47]

Computing Platforms for Information Tools

Mobile platforms, such as personal digital assistants (PDAs),[48] wireless tablet PCs,[47,49] and wireless mobile computer carts seemed to be the preferred choice during MDR.[37] One PDA-based tool included an up-to-date patient list and active diagnoses, with annotation function, and was well received.[41] Residents thought that the tool aided communication between attending and resident physicians. An Ohio hospital system reported the use of wireless tablet PCs to allow quick and easy access to clinical information during rounds.[49] Anecdotal reports suggested that this mobile information tool allowed users to spend more time with patients instead of tracking down and printing information.

Impact of Information Tool Use on Communication Processes of Multidisciplinary Rounds and Outcomes

Studies support the use of information tools in MDR to improve communication processes and outcomes (Table 2). Process-oriented information tools were shown to improve communication processes of MDR such as pre-rounding time,[43] rounding time,[41,43] situation awareness,[44,45] and documentation of patient needs and decisions.[25] The use of a specific process-oriented information tool, a daily goals list, was associated with shortened length of stay.[44] Using a decision-support tool during MDR increased the inclusion of current evidence into patient care decisions.[46]

Information Needs

Twelve articles reported information needs during MDR.

Clinical Information Needs

Laboratory Results

Although frequently needed and critical to decision making,[23] laboratory results were often missing or not up to date during rounds; this absence affected decision making.[16,23,24,37] In a surgical intensive care unit (SICU) study, microbiology findings were the most frequently missing item (during 10% of bedside discussions).[23] In a survey study, 73% of care providers believed that the lack of test results often delayed clinical decision making during rounds.[14] One quality improvement project demonstrated that aligning the availability of morning laboratory results with the times of rounds resulted in 85% of test results being available for rounds, up from a baseline of 50%.[24]

Medications Used

Almost 30% of accesses to medical records during rounds were for information about medications, as reported in an observational study referred to earlier.[16]

Radiology Results

Radiology results (e.g., radiographs) were routinely needed information during rounds to make diagnostic decisions and monitor patients' progress.[7,37,50]

Information from Bedside Devices

Trends were requested during 12% of the bedside discussions in one SICU study.[23] Respiratory data and dysrhythmia patterns were the most frequently requested information.[23]

Table 2 ■ Evidence of the Impact of Information Tools in Multidisciplinary Rounds

References	Purpose	Platforms	Design	Measures and Main Results
Van Eaton et al.[43]	Rounding and sign-out tool	Computerized, Web-based, and printouts	161 surgical oncology, internal medicine, general surgery, trauma residents; randomized, cross-over design over 103 days	Number of patients not discussed due to time pressure or not notified overnight admissions (reduced from 5 to 2.5 patients/team/month, p = 0.0001), pre-rounding time with patients (increased 40%, not significant), prerounding copying time (50% reduction), rounds time per patient (1.5-minute reduction, p < 0.0001), and survey (82% of the residents reported finishing their work sooner).
Pronovost et al.[44]	Daily goals list	Paper forms	Surgical oncology ICU; prospective, cohort study	Length of stay (reduced from 2.2 to 1.1 days), percentage of residents and nurses who understood the daily goals for each patient (increased from 10% to 95%).
Hospital case management[45]	Daily goals list	Paper forms	Surgical ICU; case report	Percentage of nurses who knew the goals planned (increased from 50% to 98%).
Thompson et al.[25]	Post-admission rounds	One page paper form	Historical control, 2 month study	Percentage of completed documentation for needed deep vein thrombosis prophylaxis (increased by 19%) and for resuscitation status (increased by 32%).
Sackett and Straus[46]	Evidence cart	Computerized, CD ROMs	General medicine, 1 month on and 1 month off	Observed usage patterns, (98 times; 37 confirmed current or tentative diagnostic or treatment plans, 18 led to a new diagnostic skill, an additional test, or a new management decision, and 16 corrected a previous clinical skill, diagnostic test, or treatment). After removing the evidence cart, searches for evidence were carried out only 12% of the time.
Young et al.[41]	Patient list with note-taking	Handheld PC	Medical wards, questionnaire at end of rotation by 45 junior staff	Opinions of the ability to monitor patients (57% said easier), impact on discharge process (54% said easier), and time saving (24% said saved time, 38% said wasted time).

Decision Information Needs

The success of an easy-to-access decision-support tool ("evidence cart") demonstrated the value of having up-to-date references for diagnostic and treatment purposes during MDR.[46] The tool was used 98 times over a one-month period during rounds in a general medicine inpatient service: 37 of the uses related to confirming current or tentative diagnostic or treatment plans; 18 to learning new diagnostic skills, additional tests, or new management options; and 16 to correcting decisions. After removing the tool, there was a sharp rise in information requests for references (41 times in one month). However, searches for references were carried out only 12% of the time.[46] Another study examined 547 questions received by librarians from care providers during rounds in seven types of units (cardiac, hematology, medical, pediatric, neonatal, surgical, and trauma) in a university hospital over a 2.5-year period.[51] Questions were related mostly to treatment and disease description (36% and 31%, respectively). The medical ICU had more questions about disease description (42 questions) than treatment (27 questions) ($p < 0.01$), while the SICU and the trauma service had more questions about treatment (13 questions for SICU, 26 for trauma) than disease description (two for SICU, 13 for trauma; both $p < 0.05$).

Social and Organizational Information Needs

A large portion (17%) of the questions raised during MDR in a SICU study related to organizational issues, such as existence of a brain death protocol, identification of the primary nurse for a patient, bed management issues, admission and discharge policies, interdepartmental information, and identification of the note taker during rounds.[52] Two other studies reported that patient socioeconomic status, housing, social services, and family-related matters were needed during rounds.[13,15]

Processes of Multidisciplinary Rounds

Communication (Table 3)

To study the content of discharge rounds, an observation instrument that provided a summary list of patient needs (e.g., housing, finances, psychosocial, rehabilitation) discussed during rounds was developed and validated.[13] The instrument can be used to measure the effectiveness of discharge rounds in terms of the number of discharge needs (needs that must be met before the patient can be discharged) probed, identified, planned for, and carried out in the rounds process. Repetition of content during rounds was identified as a factor influencing care provider satisfaction in a survey.[22]

Situation Awareness (Table 3)

Information tools in a checklist format were shown to improve the ability of multidisciplinary care providers to share same understanding of goals, problems, and tasks.[44,45] Completing a daily goals form during rounds increased the percentage of residents and nurses who understood the goals of care for the day from 10% to 95%. The situation awareness of care providers at the end of the MDR was measured by their overall understanding of patient care in a controlled trial on an inpatient medicine service of an acute care hospital.[30] Understanding the goals for each patient and the roles of other care providers were used to assess the situation awareness of care providers as a result of MDR in a stroke rehabilitation unit.[57] Understanding the patient's hospitalization, the special needs of

Table 3 ■ Reported Measures Useful for Evaluation of Information Tools on Multidisciplinary Rounds

Communication Processes
  Content, frequency
    Percentage of each care provider's contribution to discussion[52,53]
    Types of information needed[7,13,15,16,23,24,36,37,46,51,52]
    Percentage of a specific type of information requested[7,16,23,37,52]
    Percentage of a specific type of information missing[14,16,23,24,37]
    Amount of repetition[22]
    Content coding of discharge planning rounds (housing, finances, community nursing, health education, psychosocial, nutritional, personal care, care of environment, equipment and supplies, rehabilitation, transportation and medical care)[13]
  Time
    Time spent on data gathering efforts (e.g., talking with the patient, physical examination, examining the patient record), teaching and leading activities (e.g., organizing team members' duties, teaching about a case), and other activities[54]
    Time spent on pre-rounding activities,[43] duration of rounds per patient[43]
    Total duration of rounds[53]
    Time needed to search for information during rounds[46]
  Noise and interruptions
    Problems with hearing discussions during rounds[7,14]
    Number of interruptions[23]
    Number and urgency of pages received during rounds[55]
Assessment of Communication
  Situation awareness
    Being familiar with all patients at the end of rounds[14,56]
    Understanding the goals for each patient[14,37,44,57]
    Understanding objectives for patient care[14,44,57]
    Understanding the roles of other multidisciplinary care providers[56,57]
    Perceived quality of communication[58]
  Decisions, goals, needs
    Patient needs identified[57]
    Goals set for each patient[57,58]
    Patient needs and decisions documented[25]
    Patient discharge needs probed, identified, planned for and followed through[13]
    Identification of unmet needs of patients[14,40]
    Number of patients not discussed during rounds[43]
Impact on Care Processes
  Frequency of medication errors[20,28,54,59,60]
  Duration of time that a medication error continues after it occurs[39]
  Number of urgent calls by nurses about a patient's condition[54]
  Variation from clinical pathway[39]
  New ideas developed for improving patient care[14,40]
  Discharge needs followed through[13]
  Goals met for stroke patient rehabilitation[58]
  Patient confidentiality[7,14,61]

geriatric patients, and the roles of other care providers were used in a survey study of an acute care unit's MDR.[56] In another survey study, familiarity with all patients at the end of rounds was used to assess daily otolaryngology rounds.[14]

Impact on Care Processes (Table 3)

The impact of communication during MDR has been measured in part by its effect on health care processes. The number of unmet patient needs identified and fresh ideas generated for improving patient care during rounds are examples of such measures.[14,40] Other reported measures of health care processes used to assess MDR include frequency

Table 4 ■ Reported Outcome Measures for Evaluation of the Impact of Multidisciplinary Rounds (MDR)

Clinical outcomes
　Mortality rate[15,21,54]
　Length of stay[12]
　Ventilator days[66]
　Incidence of nosocomial infections[58]
　Resuscitation status[25]
　Procedure complications[54]
　Readmissions[14,40,54]
　Prevention of deep vein thrombosis[39]
　Decubiti ulcers[21]
　Achievement of clinical performance targets of albumin,
　　hemoglobin, calcium-phosphate product, dose, and vascular
　　access type (fistula)[64,67,68]
　Primary and secondary fistulae patency[69]
　Duration of fistula patency following an operation[69]
　Status of patient education before discharge[46]
　Timing of discharge[21]
Patient and family satisfaction
　Patients' perceptions of medical care received (e.g., having
　　adequate explanation of problems, tests, and drugs, physician-
　　patient relations)[70]
　Overall patient satisfaction with MDR[71] (e.g., patients' feelings
　　during and after MDR, suggestions to improve MDR)
　Experiences of families regarding attending MDR[72]
　Maintenance of patient confidentiality[7,14]
　Relationship between the policy of parents leaving the unit
　　during rounds and breaches in patient confidentiality[61]
Efficiency measures
　Patient volume[45]
　Discharge rates[58]
　Hospitalization rates[15,17,30,62]
　Cost savings[26]
　Change in prescribing costs[14]
Care provider satisfaction
　Satisfaction with rounds[22]
　Rounds being constructive use of time for care providers[7,14,56]

of medication errors,[20,28,54,59,60] duration of time that a medication error continues after it occurs,[39] variation from clinical pathway,[39] and number of urgent calls by nurses about a patient's condition.[54]

Maintaining patient confidentiality and compliance with Health Insurance Portability and Accountability Act regulations during MDR were frequently reported issues in the literature.[7,14,61] Perceptions of care providers and families regarding patient confidentiality issues have been measured by questionnaire surveys[7,14] and unstructured interviews.[61] In a questionnaire survey conducted among nurses and physicians in an otolaryngology unit, 69% of the respondents expressed concerns over maintenance of patient confidentiality during MDR.[14] In a qualitative study, 75% of the neonatal ICU nurses interviewed believed that parents should leave the unit during MDR to protect patient confidentiality.[61]

Barriers to Communication in Multidisciplinary Rounds

Two barriers were identified: noise and interruptions. Most (87%) of the surgical rounds participants in a large pediatric hospital said that it was difficult to hear discussions during rounds.[7] Similarly, 73% of daily otolaryngology rounds participants reported that they had trouble hearing discussions during rounds.[14] Leading causes of interruptions during

rounds were nonrelated requests for nonurgent therapy and diagnostic decisions, requests for urgent therapy and diagnostic decisions, questions and comments from consultants, phone calls, and issues related to unit management.[23] Twenty-four percent of pages received by pediatric residents in a university-affiliated teaching hospital occurred during rounds or teaching conferences.[55] In a medical-surgical ICU, paging interruptions were reduced by designating a consulting resident every day responsible for handling all telephone calls and consultations that arose during rounds.[22]

Outcomes of Multidisciplinary Rounds

Clinical Outcomes (Table 4)
Mortality rate[15,21,29] has been used as a measure for evaluating the impact of implementing MDR. Two studies found that implementing MDR was associated with reduced mortality,[21,29] but another study found no significant effect of rounds on mortality.[15] Length of stay is another measure used to study the impact of MDR on clinical outcomes.[12,15,30,58,62,63] For example, in a randomized, controlled trial conducted in a large, acute care tertiary hospital, researchers found that replacing traditional once-a-week rounds with daily MDR reduced length of stay.[30] Other clinical measures reported for evaluating MDR include weaning, total ventilation time, prevention of complications (stress ulcers, deep vein thrombosis, falls, skin breakdown, infection), and readmissions.[40] The clinical measures for studying the impact of MDR may depend on the type of clinical specialty.[21,57,64,65] For example, in a cohort of 644 adult hemodialysis patients from 75 outpatient dialysis clinics, albumin and hemoglobin levels (well-accepted clinical performance measures for hemodialysis patients) were used to study the effect of the frequency of sit-down rounds.[21] Patients treated in clinics with monthly or more frequent rounds had a significantly greater likelihood of achieving albumin target levels.

Efficiency (Table 4)
A number of efficiency of care measures (discharge rates,[66] patient volume,[12,66] and costs per patient[15,30,62]) were used to evaluate the impact of implementing MDR. For example, conducting daily multidisciplinary discharge rounds increased patient volume by 36% in a major trauma center.[12]

Patient and Family Satisfaction (Table 4)
Questionnaire surveys[70] and semi-structured interviews[71] were used to study the impact of MDR on patient satisfaction. To investigate the impact of bedside versus sit-down rounds on patients, one study measured patient satisfaction by a questionnaire survey that included items related to having adequate explanation of problems, tests, drugs, and physician-patient relations.[70] In another study, an interview guide was developed to study patients' experiences of MDR in an acute psychiatric setting.[71] The guide included questions on patients' overall experiences regarding MDR, their experiences regarding the decision-making process during MDR, their feelings during and after the MDR, and their suggestions for improving MDR. One study reported the use of a nine-item questionnaire to measure the MDR-related experiences of families of patients with dementia.[72]

Care Provider Satisfaction (Table 4)
Satisfaction with MDR[22,58] and usefulness of MDR as perceived by care providers[7,14,56] have been assessed by surveys.

In an SICU of a large urban children's hospital, MDR were not viewed as a constructive use of nurses' time.[7] In an otolaryngology unit, however, 90% of the nursing and medical staff reported that MDR were a constructive use of nurses' time.[14] Implementing an explicit approach to communication during rounds and pre-rounds preparation increased the percentage of ICU staff who were satisfied with the process and outcomes of MDR (95% after versus 86% before), as evaluated by survey methods.[22]

Discussion

Communication is a key to patient safety,[73] but is challenged in a number of ways, such as frequent interruptions[74] and the increasingly fragmented nature of health care processes.[75,76] If designed well, information tools can be an important means to achieve reliable, consistent, efficient communication and to support collaborative work in health care settings. Years of research and development have resulted in increasing adoption of patient centric and decision support tools such as electronic health records and order entry systems.[77,78] There is great potential for future computerized information tools to support communication and collaboration among multidisciplinary care providers.[31,32,79]

MDR are important mechanisms for communication and coordination of care across various specialties, especially in intensive care settings. We believe that well-designed, process-oriented information tools for MDR will reduce gaps of communication, increase communication efficiency, support collaborative work, and ultimately enhance patient safety. What should these tools look like? What research is needed to improve multidisciplinary communication and care coordination, especially through the use of information tools? We discuss the findings of this review to address these two questions.

Features of Information Tools Supporting Multidisciplinary Rounds

Compared with paper-based tools, computer-based information tools may provide several features that can support the process of MDR. Computer-based information tools can extract relevant information from the existing clinical information systems automatically; thereby eliminating the need for care providers to manually copy information before rounds. Information is more likely to be automatically updated. Furthermore, computer-based tools can make up-to-date information accessible remotely, supporting the mobility of care providers before, during, and after MDR. Computer-based tools can provide at-a-glance overview and visualization of information during MDR, which makes it easier and faster for care providers to grasp a large amount of information. Finally, quick access to extensive medical knowledge in the process of MDR is possible only via computer-based tools. This review suggests five groups of features useful in computerized information tools that support MDR.

Automatic Summary of Up-to-Date Information on Patients and Unit Work Status

Locating relevant information rapidly during MDR and processing a large amount of information could be challenging and time-consuming.[36] Information tools can be designed to extract frequently accessed information (e.g., medications, vital signs) before and during rounds automatically from clinical information systems. Automatic extraction of information may shorten the time spent before and during MDR and direct care providers' attention to more productive information exchange, as opposed to rote recital of the latest patient laboratory test results. Information tools can be designed to facilitate information processing by integrated, at-a-glance view presentations of highly relevant information using visualization techniques.

Supporting Multiple Users

By and large, current clinical information systems are designed for single users. A consistent finding of the current review is the importance of active participation by nonphysicians (e.g., nurses,[18,80] pharmacists,[20,26,81] clinical librarians[82,83]). Nurses frequently view their roles in MDR as reactive, participating in discussions only when a question is posed to them.[38] The timing of what nurses say was found to be critical to their involvement within the discussion.[14,22] Multi-user information tools may facilitate the more active participation of multidisciplinary care providers in MDR by supporting information access by multiple providers simultaneously, providing a means for "posting" questions or suggestions, and providing awareness information about the progress of MDR (e.g., which patient will be discussed next). Multi-user information tools may also offer features such as indication of the need to communicate with other members or highlighting aspects of the patient conditions to facilitate the participation of multidisciplinary care providers. Furthermore, information tools may give an opportunity to multidisciplinary care providers to learn about the detailed agenda ahead of time and to prepare, for example, by listing issues to discuss with other care providers. These features may result in full participation and complete communication from all, especially nurses who often feel that they are ignored or passed over.[7,14,16] Using computerized information tools during MDR places additional requirements on usability, as interactions with computers will be time pressed by the group process of MDR.

Supporting MDR in a Mobile, Noisy, and Interruption-prone Work Environment

MDR are frequently conducted under mobile conditions, such as at bedsides.[15,19,22] Information tools should support the mobility of MDR by providing access to information at the mobile locations. Information tools may improve communication by making MDR less vulnerable to these challenges. For example, a tracking function can make it easier for care providers to determine where the discussion left off after an interruption during MDR.

Using Checklists Extensively

Although mundane and used widely, checklists as information tools can be useful to structure communication pre-rounds (by acting as an agenda for discussion), to trigger consistent and complete information exchange and communication during rounds, and to clarify goals, and to follow-up post-rounds.[13,40,44] Supporting the use of checklists in MDR will likely decrease the chance of things left uncommunicated or undone. The computerized information tools should support the extensive use of checklists, both online and through a printout.

Supporting Informal Communication Space

During MDR, care providers may discuss tentative or sensitive matters that are not appropriate for inclusion as part of official patient medical records, but that are important for patient care.[42] Information tools should provide an informal communication space for care providers to convey informal notes without worrying about permanently recording them in medical records.

Future Research

Health care is increasingly a collaborative process. MDR are a response to the need to ensure coordination and communication. Within the context of the widespread use of information and communication technology (ICT), this review identified a number of gaps that can be the focus of future research:

How Can Information and Communication Technology Be Used to Support Multidisciplinary Rounds and Communication?

Computer-supported cooperative work (CSCW) has been a paradigm for building tools that meet the demands of collaborative work.[84–86] By studying MDR using the CSCW paradigm, advances can be made in designing new information tools to support communication and coordination of care. The CSCW paradigm asserts the need to study the nature and characteristics of collaborative work in detail when developing any tools to be used in a collaborative work setting. In contrast, computerized information technology may have made it difficult for care providers to convey informal notes and observations. Few studies were reported on how clinicians adapt to the use of ICT for MDR. Few empirical data were reported on key features of electronic health records in terms of supporting the need for communication and collaborative work.

What Are Key Barriers to and Facilitators for Multidisciplinary Rounds?

Ethnographic studies such as the one by Manias and Street[38] should be conducted to identify barriers and facilitators for MDR. Information tools for MDR should be designed to eliminate or reduce the effects of barriers and increase the effects of facilitators.

How Can the Efficiency of Multidisciplinary Rounds Be Improved?

One concern for MDR is the time taken away from patient care activities. In general, MDR were viewed as crucial for the coordination of care and teamwork[14,57,87] and an efficient use of time,[21] but in some studies, they were found to be neither efficient nor constructive.[88] Information tools may make the information transfer and communication during MDR more efficient. By providing up-to-date and essential information at a glance, information tools may help care providers in gaining situation awareness rapidly, hence increasing the efficiency of MDR.

What Are the Potential Negative Effects of Information Tools on the Quality and Safety of Care?

Literature provides conflicting support for the impact of automatic extraction of information, as opposed to the manual copying of information pre-rounds from various information systems. In one study, automatic extraction of data reduced pre-rounding time significantly and improved resident satisfaction.[43] Another study, however, found that spending more time to collect data manually was associated with better clinical outcomes.[54] Future research should assess the impact of automatic extraction of information on clinical outcomes before designing information tools with this feature extensively.

What Evidence Supports the Use of Computerized Information Tools?

Only a limited number of studies have tested the impact of information tools on MDR. More intervention studies are needed to identify the design features of effective information tools and the impact of information tools on the processes of MDR and on outcomes.

Conclusion

Health care is collaborative; care providers communicate and collaborate to achieve shared goals through several mechanisms, one of which is MDR. Current information systems such as electronic health records and computerized provider order entry systems do not adequately support the collaboration needed among care providers in MDR. For improving communication and coordination of care, care providers need process-oriented information tools that extract information automatically from existing clinical information systems, present information in condensed forms, and store work-process information temporarily. Future research should focus on identifying the needs of care providers in conducting collaborative work, developing supporting information tools tailored for and integrated into existing collaborative work processes of care providers, and evaluating the impact of these tools on clinical and other types of outcomes.

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