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Interdisciplinary Handoffs between Obstetric Nursing and Neonatal Physician Teams: An Observational Study

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Interdisciplinary Handoffs between Obstetric Nursing and Neonatal Physician Teams: An Observational Study

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KEYWORDS: interprofessional handoffs, patient safety, neonatal handoffs, labor and delivery

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What is known about the subject?

- Neonatal handoffs are a unique example of inter-professional inter-service handoffs- between obstetric nurses and neonatal physicians for high-risk deliveries.
- These exchanges are often ad-hoc, lack structure, and are prone to errors.

What this study adds?

- This is the first study evaluating the communication content of neonatal handoffs in the delivery room.
- We identified missing core clinical elements, with each additional missed element increasing the potential for adverse events nearly two-fold.
- Opportunities for improving the neonatal handoff process includes standardizing the content and associated workflow process.

Abstract

Objective: We investigated the content and quality of communication of inter-service, inter-professional handoffs between obstetric nurses and neonatal physicians for high-risk deliveries.

Design: Observational study.

Setting: Labor and Delivery unit at a tertiary care hospital.

Method: We audio-recorded handoffs between obstetric and neonatal teams (*n*=50) and conducted clinician interviews (*n*=29). A handoff content framework was used to qualitatively code missing core and ancillary content, and their potential for adverse events.

Results: 52% of handoffs missed one or more clinical content elements; a third of the handoffs missed at least one core clinical content element. Increase in the number of missed clinical content elements increased the odds of potential adverse events by 2.39 (95%CI 1.18–5.37). Both residents and nurses perceived handoffs to be of low quality and inconsistent, and attributed it to the lack of a structured handoff process.

Conclusion: Streamlining handoff processes by instituting standardization approaches for both information organization and communication can improve the quality of neonatal handoffs.

Introduction

Handoffs serve as an interactive forum for the transfer of information, responsibility and authority between clinicians[1]. Handoffs occur at different points in the care delivery process: at routine shift changes and at non-routine service or location changes[2]. Although handoffs are instrumental for care continuity, evidence suggests that they are a source for medical errors[3].

Compared to shift-based handoffs, the challenges are exacerbated in inter-service inter-professional handoffs (e.g., emergency nurse and medicine resident) because of the differences in clinical expertise, professional backgrounds and varying roles[4-6]. One such commonly occurring handoff is between obstetric (OB) nurses and the neonatal physicians for high-risk deliveries. Nearly 10% of all deliveries in the US require an intervention from a neonatologist; 1% of newborns require extensive resuscitation support from a neonatal intensive care unit (NICU) team at delivery[7]. As such, these handoffs are complex and vulnerable to safety threats affecting care and management needs and demands of both the mother and the newborn [8-10].

We investigated the following research questions: (a) What is the nature of clinical content exchanged during OB nurse to NICU physician handoff communication? (b) What is the core clinical content that is discussed; what is missed? What is the potential for missed clinical content for causing adverse outcomes? (c) What are OB nurses' and NICU physicians' perceptions regarding the quality and effectiveness of handoff communication?

Method

Study Setting and Participants

This study was conducted in the Labor and Delivery (L&D) unit at the University of Illinois Hospital and Health Science Center (UI Health). The L&D unit performs approximately 2700

and cares for all pregnant patients in labor including prematurity or any complex maternal or fetal medical conditions as described in the American Academy of Pediatrics Manual[11].

Study participants included clinicians from the OB and neonatal teams. The OB team works in the L&D unit and comprises of 2 attending physicians, 4 OB residents, 2 family medicine residents, 1-2 midwives, and 8-10 OB nurses. The neonatal team consists of one NICU attending physician, one neonatology fellow, one pediatric-neonatal resident (post graduate year 2 or 3) and one pediatric intern. Four neonatology fellows, 25 pediatric residents, and four OB nurses participated in the study over a 6-month period. The Institutional Review Board approved this study and consents were obtained from all participants.

Patient Involvement

There was no direct patient involvement in this study.

Neonatal Handoffs

Neonatal handoffs involve the communication of patient-related information between the OB nursing team and the neonatal team. Neonatal handoff process is initiated when an OB nurse contacts the neonatology fellow for assistance in a high-risk delivery. The fellow coordinates with the pediatric-neonatal resident(s) and meets the OB team (OB nurse, OB resident(s), and OB attending) in the L&D room. An OB nurse then provides a verbal handoff to the pediatric-neonatal resident (i.e., neonatal handoff). This handoff includes clinical content related to maternal obstetric history (age, gestational age, lab results, imaging, and medications), medical history and pregnancy history (any intra-partum events, rupture of membrane, color of amniotic fluid, chorioamnionitis, fetal tachycardia or bradycardia). Handoffs follow a narrative format, with each OB nurse following their own conversational style and structure. For example, some

nurses used personalized hand-written handoff notes, whereas others used an antepartum assessment sheet as a guide for their handoff discussion.

After the handoff, the antepartum assessment sheet is provided to the neonatal team. The antepartum assessment sheet, generated from the electronic health record (EHR) and completed by the mother's admitting nurse, contains information related to maternal age, gestational age, labs and other relevant information.

Post-delivery, the neonatal team performs resuscitation and stabilization activities for the newborn, as necessary. Depending on the clinical status of the newborn, decisions regarding the transfer of the newborn to the NICU are also made. Pediatric residents with the neonatal team then create a "delivery note" in the newborn's chart with updated information regarding labs, resuscitation events, Apgar scores and the newborn's disposition. This delivery note includes maternal information obtained at the time of delivery handoff, information gathered after accessing mother's patient record, and resuscitation events performed in the delivery room.

Data Collection

Data collection methods included general observations, clinician shadowing, semi-structured interviews, and audio recording of neonatal handoff communication.

We conducted approximately 20 hours of observation taking detailed field notes to develop a general understanding of clinical workflow of the OB and neonatal teams. These sessions focused on observing the general coordination, decision making and communication processes, and tasks performed by both teams (conducted by the first author).

We shadowed the OB and neonatal teams during neonatal handoffs to obtain insights on how the OB nurse requested neonatal consulting service, artifacts used for neonatal handoffs (by the OB team), and other team interactions. We shadowed 50 neonatal handoffs which involved four

OB nurses and 29 neonatal team members (neonatal fellows (*n*=4) and pediatric residents (*n*=25)).

During these shadowing sessions, we audio-recorded fifty (*n*=50) neonatal handoffs between the OB and neonatal team. After each handoff, we also collected the associated, de-identified antepartum assessment sheets and the resident delivery notes (*n*=50).

Semi Structured Interviews

We conducted semi-structured interviews with pediatric residents (*n*=12) and OB nurses (*n*=3). Separate interview guides were used for residents and nurses (Appendix). Resident interviews focused on gathering perceptions regarding the neonatal handoff process, completeness and quality of maternal information provided by the OB team, and potential suggestions for improving the handoff process. Nurse interviews focused on the following: ease of data gathering for handoff, existing tools and sources, perceptions of an effective handoff, identified barriers, and suggestions to improve the neonatal handoff processes.

Data Coding and Analysis

Qualitative Coding

Observation and shadowing data were coded using an open coding approach[12] to identify OB and NICU team workflows. Examples of workflow processes included roles and responsibilities, handoff activities, decisions made during handoffs, workflow dependencies, artifacts used, communication challenges, and information presentation strategies.

All audio-recorded verbal handoffs were de-identified and transcribed verbatim for further analysis. Verbal communication for each handoff was segmented into functional units called utterances. Utterances are psychological analogs of a single unit of experience including statements, commands, and single words (e.g., “okay”) [5,13].

Our modified clinical content framework comprised of the following data elements: mother's antepartum history, intra-partum, and delivery course (Table 1). Informed by literature review[14,15] and discussions with OB and NICU care teams, a subset of these clinical content elements were categorized as core elements, and the rest as ancillary elements. The core elements constituted essential information required for safe resuscitation and disposition of the newborn[16].

[INSERT TABLE 1 HERE]

Recent research reports have suggested that missing information regarding one or more of the core content elements can potentially cause adverse outcomes for the newborn and/or the mother[17,18]. To identify missing elements, after all handoffs were coded using the clinical content framework, we evaluated each handoff for content *completeness* and content *relevance*. Content completeness for each handoff was evaluated based on the presence of core and ancillary elements. Content relevance was evaluated based on the appropriateness of specific ancillary content elements in a handoff. For this, we used the pediatric resident's delivery note as our "gold standard" for establishing the veracity of the verbal information.

The coding for the presence (or absence) and relevance (or irrelevance) of handoff content was conducted in the following manner: when a core clinical content element was discussed during the handoff, it was coded as being "present." For example, if a patient's HIV/Hepatitis B was negative and this information was communicated during handoff, it was coded as present. Similarly, when an ancillary content element was relevant to the patient, but was not discussed during the handoff, it was coded as "missing." For example, fetal heart rate/tracing was a relevant content element in cases where the fetus had bradycardia. In such a case, the fetal heart

rate/tracing content element was coded as missing, if it was not discussed. In cases where an ancillary content element was irrelevant (and was also not discussed), it was coded as "irrelevant." For example, maternal drug urine screen, if negative is not an essential core element and was not discussed during handoff. Hence, it was coded as irrelevant (Table 2).

[INSERT TABLE 2 HERE]

A subset of the handoffs was coded by a second physician (*n*=10) with 98% of agreement for content completeness and with 99% agreement for content relevance. Coding discrepancies were resolved through discussion.

Adverse Events

Using information from the resident delivery note and handoff communication, we investigated whether missing information could have caused potential adverse events. For this, the first author captured the following information from the resident delivery note: resuscitation events including type of resuscitation, Apgar scores, and disposition of the newborn. Next, we determined if one or more of the missing (both core and ancillary) elements during the handoff communication could have led to adverse outcomes, as represented by greater need for resuscitation, poor 5-minute Apgar scores, or unexpected disposition to the NICU for the newborn. For example, if antenatal acute hemorrhage was omitted from neonatal handoff and the newborn needed full resuscitation, the unavailability of such information could have caused potential delays and unnecessary interventions, leading to potential adverse outcomes.

This coding was performed by the first author and a pediatric fellow using a subset of 10 cases. There was 90% agreement on the cases, and differences were resolved through discussion.

Statistical Analysis

We computed descriptive statistics regarding the percentage of missing core and ancillary clinical content elements during handoff communication. Next, using logistic regression, we estimated the odds of potential adverse outcomes based on the number of missing clinical content elements per patient. All analyses were performed using R, and an alpha level of 0.05 was used.

Results

52% (*n*=26) of the neonatal handoffs had at least one missing clinical content element, with an average of 0.98 (S.D.=1.15) missing clinical content elements per handoff. 32% (*n*=16) of the handoffs had one or more missing core clinical content elements, with an average of 0.48 (S.D.=0.81) missing core clinical content elements per handoff.

[INSERT FIGURE 1 HERE]

The common core missing elements were color of fluid (16%, *n*=8), time of the rupture of membrane (14%, *n*=7), mother's blood type (10%, *n*=5) and HIV/Hepatitis B status (4%, *n*=2). Among the ancillary clinical content elements, the rupture membrane type was missing in 12% (*n*=6) of the neonatal handoffs (Figure 1; Appendix Table 1).

Based on the logistic regression, we found that with unit increase in the number of missing clinical content elements increased the odds of adverse events by 2.39 (95% CI 1.18, 5.37).

Interviews with the neonatal and OB teams highlighted the factors contributing to the high-degree of missing information shared and its potential effects. Residents were dissatisfied by the content presented during handoffs, describing it as of being "*poor quality*" as they were often "*one-liners*" with "*incomplete information*." They described their frustration with the

inaccuracies in the presented information. One resident remarked that "…..*a lot of the information is not clear. Sometimes the reason for NICU attendance is not clear and conflicting information provided by the baby nurse, mother's nurse and the OB residents.*" As a result, residents noted that they often do not fully rely on the presented information for their decision-making: "*I don't go off of it, because it's been wrong, so often.*"

Nurses attributed the poor quality of the handoff content to three factors: limited time available for preparation, fragmentation information that was difficult to assemble in an efficient and quick manner, and inconsistent use of information tools for aggregating or supporting handoffs (Table 3). These coupled with the lack of a structured process for handoffs, led to considerable subjectivity in the organization and varying presentation formats followed for handoffs.

[INSERT TABLE 3 HERE]

Nurses acknowledged that handoff processes were "*inconsistent,*" and highlighted that at times information was simply not available. One nurse remarked that "*patient information sheets [are] not available all the time,*"; other times there is not enough time to look up things and as a result "*some things could be missed*", and at other times the nurses rely on "*reading out the [information entered by the admitting nurse] on the antepartum assessment sheet, which is sometimes not updated."*

Discussion

Based on an exploratory study of inter-service, inter-professional handoffs between OB and NICU teams, we found that 52% of the handoffs missed one or more clinical content elements. In nearly a third of the handoffs, at least one core clinical content element was not discussed, increasing potential for adverse events for both the mother and the newborn. In addition, not

discussing clinical content elements during handoffs increased the potential for adverse events by over two-fold. The high percentage of handoffs where one or more core clinical elements was not discussed increases the potential for acute or long term complications and adverse outcomes[19]. Residents and nurses attributed these communication failures to the lack of a formalized mechanism or protocol for capturing or sharing the handoff content.

Perceptions of poor handoff quality is reflective of the lack of shared understanding between OB nurses and neonatal physicians—a critical function of effective handoff communication[2,20]. Our study findings highlight two fundamental issues that can impact the development of a shared understanding during neonatal handoffs. First, there was mismatch between the expectations of the physicians and nurses regarding the information communicated during handoffs. During handoffs, OB nurses focused on maternal peripartum events and laboratory tests; although such information was relevant and important for care activities, residents expected additional information related fetal imaging (including cardiac and ultrasound findings) and anomalies, which are key for determining the disposition of the newborn.

Second, there was considerable subjectivity in the manner in which nurses prepared and organized information for handoffs, owing to a variety of factors including lack of time, unavailability of information, differing expertise and experience of the nurses, differences in communication styles, and the differences in the tools used (e.g., antepartum sheet, maternal admission sheet, or personal notes).

Both these factors point to the need for creating a structure to organize the content and process of neonatal handoffs. Although patient safety organizations have standardization goals for handoffs, much of these efforts have been on shift-based handoffs [13,21]. Inter-service, inter-professional handoffs present a new and unique challenge for handoffs. Structured and

streamlined communication in time-pressured situations have been supported through the use of standardized approaches such as checklists in surgery, and air-traffic controller-pilot communication using standardized formats have been found to be remarkably successful [22]. Such a standardized strategy was repeatedly highlighted by all participants as a feasible and robust mechanism to reduce the inconsistencies in neonatal handoff content and process.

This study has several limitations. The study was conducted in a single academic hospital setting, and hence some of our findings may not be generalizable to other settings. We used a convenience sample of 50 neonatal handoffs. However, handoffs were analyzed at a granular level and were supplemented with interviews and observations. Although the potential for adverse outcome measure was independently coded and verified, it is a subjective measure.

Funding Statement

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Competing Interests Statement

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Contributor Statement

AA and JA conceived the study; AA collected the data. AA, TK and JA were involved in the coding, analysis and interpretation of the results. All authors were involved in the drafting of the manuscript, and approved the final version.

Data Sharing

This is a qualitative study and therefore the data generated is not suitable for sharing beyond that contained within the report. Further information can be obtained from the corresponding author.

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Table 1. Clinical content framework for Neonatal Handoffs (Core content elements are represented in bold)

Patient history	Handoff elements
Antepartum	Age, **gestational age**, gravida/para, multiple gestation, **blood type**, **rhogam status,** genetic studies, and sonographic findings.
Intrapartum	GBS, RPR, Rubella, **HIV/Hepatitis B**, chorioamnionitis, position of the baby, size of the baby, biophysical profile, maternal diabetes, maternal drug/urine toxicology, steroid status, maternal drug status, medications, and psychiatric history
Delivery	Type of delivery, induction, **reason for induction, reason for C-section, rupture of membrane time and type**, **color of amniotic fluid**, **reason for NICU attendance**, and fetal heart rate/tracing

Table 2. Content completeness and relevance framework that was used for coding.

Element type	Status during handoff discussion	Coding
Core Clinical Content Element	Discussed (e.g., HIV status)	*Present*
Core Clinical Content Element	Not discussed (e.g., HIV status not discussed)	*Missing*
Ancillary Clinical Content Element	Relevant to the patient case and discussed (e.g., fetal tracing discussed for a patient with fetal bradycardia)	*Present*
Ancillary Clinical Content Element	Relevant to the patient case and not discussed (e.g., fetal tracing discussed for a patient with fetal bradycardia)	*Missing*
Ancillary Clinical Content Element	Not relevant to the patient case and not discussed (e.g., drug urine screen for the mother is not relevant when there is no known history of abuse)	*Irrelevant*

Table 3. Examples from interviews regarding the challenges faced by residents and nurses during handoffs.

Barriers	Root Contributor(s) (with examples from the data)		s
Variability in handoff content	Limited time available for handoff preparation	*"Limited time especially in urgent or crash CS. Looking up stuff takes time"* (RN1*).*	
		"If mom just comes and delivers then there is no time to look up details in chart. I then read out the antepartum assessment sheet, which is sometimes not updated" (RN2).	
	Information is fragmented and distributed in different sources making access difficult	"*Pregnancy summary report. Review of results, power notes, antepartum assessment sheet. Information is at a lot of places*" (RN1)	
		"Tools helpful but they are scattered, most of the time. I have to look at multiple places" (RN2)	
		"*There are a lot of sources which I have to access to get information in the mother's chart*" (RN3)	
	Inconsistent use of tools for handoffs	*"Sometimes, they have their own list, some use antepartum assessment sheet*" (MD1)	
		"*Sometime there is no tool used*" (MD2);	
		"*I use antepartum sheet and add anything significant that happened*" (RN1).	
Variability in the handoff process	Inconsistencies in how handoff is conducted	"*Inconsistent, some people better at giving information*" (MD1);	
		"*It is not consistent, dependent on who is giving the handoff* (MD6)";	
		"*Not very consistent. I gown up, and sometimes sign-out is whispered*" (MD8);	

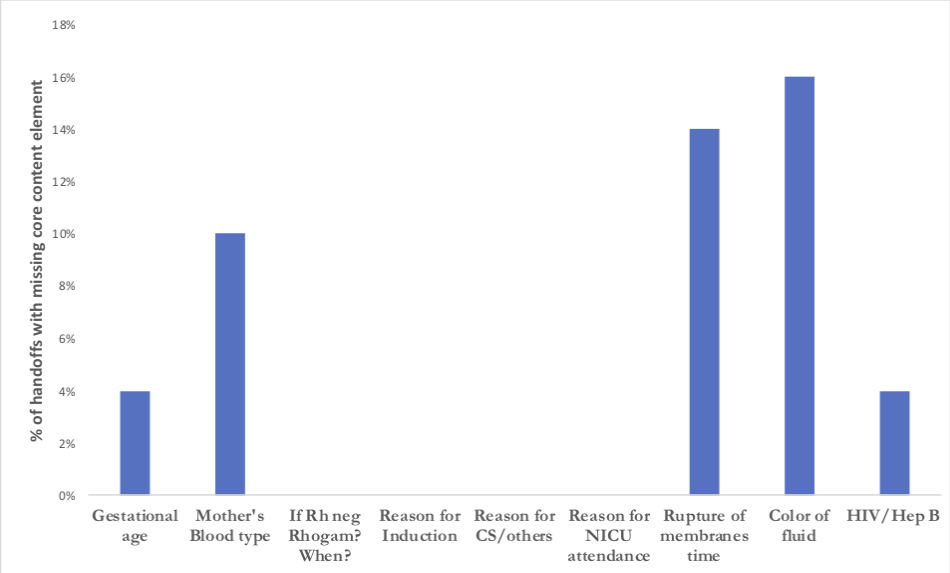

Figure 1. Percentage of handoffs with missing core clinical content elements

Appendix

Interview Questions (Nurse)

1. How many years of experience do you have working as a L&D nurse?
2. What content do you handoff to NICU residents?
3. Do you follow a format for the handoff process? – Is it structured or varying depending on the case?
4. Do you have necessary tools to give an effective handoff? – In EHR or paper?
5. Are the tools available in EHR helpful?
6. What do you think are the factors that make an effective handoff?
7. Do you think the patient information available to you before handoff to the NICU team is adequate?
8. What are some barriers to complete information flow? Any examples of cases that you encountered?
9. What changes can be made to improve the handoff process?

Interview Questions (Residents)

1. Could you comment on the consistency of the sign-out from L&D nurse?
2. Do you get complete patient information during delivery from the nurse?
3. How do you rate the quality of the Antenatal assessment note? – Why/why not?
4. Do you feel you have enough information at the delivery after handoff for management of the patient in the NICU?
5. What information is typically shared by the nurses?
6. Do nurses use a tool to support their verbal sign-out to you?
7. Is there any information you want to be a part of the handoff which is generally missed?
8. What changes can be made to improve the handoff process?

Appendix Table 1. Clinical content categories and number of missing elements in each.

Clinical Content Category	Count of Missing
Gestational age	2
Mother's Blood type	5
If Rh neg Rhogam? When	0
reason for Induction	0
Reason for CS/others	0
Reason for NICU attendance	0
Rupture of membranes time	7
Color of fluid	8
HIV/Hep B	2
Age	1
Gravida and Para	0
Multiple Gestation	0
Induction	0
Type of delivery	0
Fetal HR/Tracing	2
Rupture of membranes type	6
GBS	0
GBS treatment status	8
Labs	0
RPR	1
Rubella	1
Chorio	0
Baby position	1
Size of the baby	1
Thyroid status	0
Maternal Diabetes	1
Steroids	0
Medications	1
Antibiotics	0
Sonographic findings	0
BPP	0
Genetic studies (incl Quad/cfDNA/Amnio)	1
Maternal Utox/Drug status	0
Psych history	0
Previous losses/complications	0
Maternal history	1
Family med/peds	0

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KEYWORDS: interprofessional handovers, handoffs, patient safety, neonatal handovers, labor and delivery

Word Count: 2640

What is known about the subject?

- Neonatal handovers are a unique example of inter-professional inter-service handovers between obstetric nurses and neonatal physicians for high-risk deliveries.
- These exchanges are often ad-hoc, lack structure, and are prone to errors.

What this study adds?

- We identified missing core clinical elements, with each additional missed element increasing the potential for adverse events nearly two-fold.
- Opportunities for improving the neonatal handover process includes standardizing the content and associated workflow process.

Abstract

: We investigated the content and quality of communication of inter-service inter-professional handover between obstetric nurses and neonatal physicians for high-risk deliveries.

: Observational study.

: Labor and Delivery unit at a tertiary care hospital.

: We audio-recorded handovers between obstetric and neonatal teams (=50) and conducted clinician interviews (=29). A handover content framework was developed and used to qualitatively code missing core and ancillary content, and their potential for adverse events.

: 26 (52%) handovers missed one or more clinical content elements; a third of the handovers missed at least one core clinical content element. Increase in the number of missed clinical content elements increased the odds of potential adverse events by 2.39 (95%CI 1.18–5.37). Both residents and nurses perceived handovers to be of low quality and inconsistent, and attributed it to the lack of a structured handover process.

: Streamlining handover processes by instituting standardization approaches for both information organization and communication can improve the quality of neonatal handovers.

Introduction

Handovers (also referred to as handoffs) serve as an interactive forum for the transfer of information, responsibility and authority between clinicians[1]. Handovers occur at different points in the care delivery process: at routine shift changes and at non-routine service or location changes[2]. Although handovers are instrumental for care continuity, evidence suggests that they are a source for medical errors[3].

Compared to shift-based handovers, challenges are exacerbated in inter-service inter-professional handovers (e.g., emergency nurse and medicine resident) because of the differences in clinical expertise, professional backgrounds and varying roles[4-6]. One such commonly occurring handover is between obstetric (OB) nurses and the neonatal physicians for high-risk deliveries. Nearly 10% of all deliveries in the US require an intervention from a neonatologist; 1% of newborns require extensive resuscitation support from a neonatal intensive care unit (NICU) team at delivery[7]. As such, these handovers are complex and vulnerable to safety threats affecting care and management needs and demands of both the mother and the newborn [8-10].

We investigated the following research questions: (a) What is the nature of clinical content exchanged during OB nurse to NICU physician handover communication? (b) What is the core clinical content that is discussed; what is missed? What is the potential for missed clinical content for causing adverse outcomes? (c) What are OB nurses' and NICU physicians' perceptions regarding the quality and effectiveness of handover communication?

Method

Study Setting and Participants

This study was conducted in the Labor and Delivery (L&D) unit at the University of Illinois Hospital and Health Science Center (UI Health). The L&D unit performs approximately 2700

deliveries and cares for all pregnant patients in labor including prematurity or any complex maternal or fetal medical conditions as described in the American Academy of Pediatrics Manual[11].

Study participants included fellows, residents, and nurses from the OB and neonatal teams. The OB team works in the L&D unit and comprises of 2 attending physicians, 4 OB residents, 2 family medicine residents, 1-2 midwives, and 8-10 OB nurses. The neonatal team consists of one NICU attending physician, one neonatology fellow, one pediatric-neonatal resident (post graduate year 2 or 3) and one pediatric intern. Four neonatology fellows, 25 pediatric residents, and four OB nurses participated in the study over a 6-month period. The Institutional Review Board approved this study and verbal consents were obtained from all participants.

Patient Involvement

There was no direct patient involvement in this study.

Neonatal Handovers

Neonatal handovers involve the communication of patient-related information between the OB nursing team and the neonatal team. Neonatal handover process is initiated when an OB nurse contacts a neonatology fellow for assistance in a high-risk delivery. The fellow coordinates with the pediatric-neonatal resident(s) and meets the OB team (OB nurse, OB resident(s), and OB attending) in the L&D room. An OB nurse then provides a verbal handover to the pediatric-neonatal resident (i.e., neonatal handover). This handover includes clinical content related to maternal obstetric history (age, gestational age, lab results, imaging, and medications), medical history and pregnancy history (any intra-partum events, rupture of membrane, color of amniotic fluid, chorioamnionitis, fetal tachycardia or bradycardia). These handovers often follow a narrative format, with each OB nurse following their own conversational style and structure. For

example, some nurses used personalized hand-written notes, whereas others used an antepartum assessment sheet as a guide for their handover discussion.

After the handover, the antepartum assessment sheet is provided to the neonatal team. The antepartum assessment sheet, generated from the electronic health record (EHR) and completed by the mother's admitting nurse, contains information related to maternal age, gestational age, labs and other relevant information.

Post-delivery, the neonatal team performs resuscitation and stabilization activities for the newborn, as necessary. Depending on the clinical status of the newborn, decisions regarding the transfer of the newborn to the NICU are also made. Pediatric residents with the neonatal team then create a "delivery note" in the newborn's chart with updated information regarding labs, resuscitation events, Apgar scores and the newborn's disposition. This delivery note includes maternal information obtained at the time of delivery handover, information gathered after accessing mother's patient record, and resuscitation events performed in the delivery room.

Data Collection

Data collection methods included general observations, clinician shadowing, semi-structured interviews, and audio recording of neonatal handover communication.

We conducted approximately 20 hours of observation taking detailed field notes to develop a general understanding of clinical workflow of the OB and neonatal teams. These sessions focused on observing the general coordination, decision making and communication processes, and tasks performed by both teams (conducted by the first author).

We shadowed the OB and neonatal teams during neonatal handovers to obtain insights on how the OB nurse requested neonatal consulting service, artifacts used for neonatal handovers (by the

OB team), and team interactions. We shadowed 50 neonatal handovers, which involved four OB nurses and 29 neonatal team members (neonatal fellows (=4) and pediatric residents (=25)).

During these shadowing sessions, we audio-recorded a convenience sample of fifty (=50) neonatal handovers between the OB and neonatal team. After each handover, we also collected the associated, de-identified antepartum assessment sheets and the resident delivery notes (=50).

Semi Structured Interviews

We conducted semi-structured interviews with pediatric residents (=12) and OB nurses (=3). Separate interview guides were used for residents and nurses (see Appendix). Resident interviews focused on gathering perceptions regarding the neonatal handover process, completeness and quality of maternal information provided by the OB team, and potential suggestions for improving the handover process. Nurse interviews focused on the following: ease of data gathering for handover, existing tools and sources, perceptions of an effective handover, identified barriers and suggestions to improve the neonatal handover processes.

Data Coding and Analysis

Qualitative Coding

Observation and shadowing data were coded using an open coding approach[12] to identify OB and NICU team workflows. Examples of workflow processes included roles and responsibilities, handover activities, decisions made during handovers, workflow dependencies, artifacts used, communication challenges, and information presentation strategies.

All audio-recorded verbal handovers were de-identified and transcribed verbatim for further analysis. Verbal communication for each handover was segmented into functional units called utterances. Utterances are psychological analogs of a single unit of experience including statements, commands, and single words (e.g., “okay”) [5,13].

Our modified clinical content framework comprised of the following data elements: mother's antepartum history, intra-partum, and delivery course (Table 1). The clinical content framework was developed in three phases. In the first phase, using a validated labor and delivery checklist for interdisciplinary communication[14,15], we created an initial list of clinical elements that were pertinent for characterizing neonatal care continuity. Using this initial, but comprehensive list of clinical content elements, an interdisciplinary team of practicing clinicians from L&D and neonatal units used a consensus-driven approach to review and modify the initial list of clinical elements. This review and revision were based on the relevance, priority and importance of the clinical elements for neonatal care continuity. Finally, during the third phase, medical and nursing directors and managers of L&D and neonatal units participated in collaborative discussions to finalize and categorize these elements as core and ancillary elements. The core elements constituted essential information required for safe resuscitation and disposition of the newborn[16].

[INSERT TABLE 1 HERE]

Recent research reports have suggested that missing information regarding one or more of the core content elements can potentially cause adverse outcomes for the newborn and/or the mother[17,18]. To identify missing elements, after all handovers were coded using the clinical content framework, we evaluated each handover for content and content . Content completeness was evaluated based on the presence of core and ancillary elements in a neonatal handover. Content relevance was evaluated based on the appropriateness of specific ancillary content elements in a handover. For this, we used the pediatric resident's delivery note as our "gold standard" for establishing the veracity of the verbal information.

The coding for the presence (or absence) and relevance (or irrelevance) of handover content was conducted in the following manner: when a core clinical content element was discussed during the handover, it was coded as being "present." For example, if a patient's HIV/Hepatitis B was negative and this information was communicated during handover, it was coded as present. Similarly, when an ancillary content element was relevant to the patient, but was not discussed during the handover, it was coded as "missing." For example, fetal heart rate/tracing was a relevant content element in cases where the fetus had bradycardia. In such a case, the fetal heart rate/tracing content element was coded as missing, if it was not discussed. In cases where an ancillary content element was irrelevant (and was also not discussed), it was coded as "irrelevant." For example, maternal drug urine screen, if negative is not an essential core element and was not discussed during handover. Hence, it was coded as irrelevant (Table 2).

[INSERT TABLE 2 HERE]

A subset of the handovers was coded by a second physician (=10) with 98% of agreement for content completeness and with 99% agreement for content relevance. Coding discrepancies were resolved through discussion.

Adverse Events

Using information from the resident delivery note and handover communication, we investigated whether missing information could have caused potential adverse events. For this, the first author captured the following information from the resident delivery note: resuscitation events including type of resuscitation, Apgar scores, and disposition of the newborn. Next, we determined if one or more of the missing (both core and ancillary) elements during the handover communication could have led to adverse outcomes, as represented by greater need for

resuscitation, poor 5-minute Apgar scores, or unexpected disposition to the NICU for the newborn. For example, if antenatal acute hemorrhage was omitted from neonatal handover and the newborn needed full resuscitation, the unavailability of such information could have caused potential delays and unnecessary interventions, leading to potential adverse outcomes.

This coding was performed by the first author and a pediatric fellow using a subset of 10 cases. There was 90% agreement on the cases, and differences were resolved through discussion.

Statistical Analysis

We computed descriptive statistics regarding the percentage of missing core and ancillary clinical content elements during handover communication. Next, using logistic regression, we estimated the odds of potential adverse outcomes based on the number of missing clinical content elements per patient. All analyses were performed using R, and an alpha level of 0.05 was used.

Results

52% (=26) of the neonatal handovers had at least one missing clinical content element, with an average of 0.98 (Median=1, IQR=0, S.D.=1.15) missing clinical content elements per handover. 32% (=16) of the handovers had one or more missing core clinical content elements, with an average of 0.48 (S.D.=0.81) missing core clinical content elements per handover.

[INSERT FIGURE 1 HERE]

The common core missing elements were color of amniotic fluid (16%, =8), time of the rupture of membrane (14%, =7), mother's blood type (10%, =5) and HIV/Hepatitis B status (4%, =2). Among the ancillary clinical content elements, the rupture membrane type was missing in 12% (=6) of the neonatal handovers (Figure 1; Appendix Table 1).

Based on the logistic regression, we found that with unit increase in the number of missing clinical content elements increased the odds of adverse events by 2.39 (95% CI 1.18, 5.37).

Interviews with the neonatal and OB teams highlighted the factors contributing to the high-degree of missing information shared and its potential effects. Residents were dissatisfied by the content presented during handovers, describing it as of being “ ” as they were often “ ” with “ .” They described their frustration with the inaccuracies in the presented information. One resident remarked that “…..

” As a result, residents noted that they often do not fully rely on the presented information for their decision-making: “ ”

Nurses attributed the poor quality of the handover content to three factors: limited time available for preparation, fragmentation information that was difficult to assemble in an efficient and quick manner, and inconsistent use of information tools for aggregating or supporting handovers (Table 3). These coupled with the lack of a structured process for handovers, led to considerable subjectivity in the organization and varying presentation formats followed for handovers.

[INSERT TABLE 3 HERE]

Nurses acknowledged that handover processes were “ ,” and highlighted that at times information was simply not available. One nurse remarked that “ ”; other times there is not enough time to look up things and as a result “ ”, and at other times the nurses rely on “

Discussion

Based on an exploratory study of inter-service, inter-professional handovers between OB and NICU teams, we found that 52% of the handovers missed one or more clinical content elements. In nearly a third of the handovers, at least one core clinical content element was not discussed, increasing potential for adverse events for both the mother and the newborn. In addition, not discussing clinical content elements during handovers increased the potential for adverse events by over two-fold. The high percentage of handovers where one or more core clinical elements was not discussed increases the potential for acute or long term complications and adverse outcomes[19]. Residents and nurses attributed these communication failures to the lack of a formalized mechanism or protocol for capturing or sharing the handover content.

Perceptions of poor handover quality is reflective of the lack of shared understanding between OB nurses and neonatal physicians—a critical function of effective handover communication[2,20]. Our study findings highlight two fundamental issues that can impact the development of a shared understanding during neonatal handovers. First, there was mismatch between the expectations of the physicians and nurses regarding the information communicated during handovers. During handovers, OB nurses focused on maternal peripartum events and laboratory tests; although such information was relevant and important for care activities, residents expected additional information related fetal imaging (including cardiac and ultrasound findings) and anomalies, which are key for determining the disposition of the newborn.

Second, there was considerable subjectivity in the manner in which nurses prepared and organized information for handovers, owing to a variety of factors including lack of time,

unavailability of information, differing expertise and experience of the nurses, differences in communication styles, and the differences in the tools used (e.g., antepartum sheet, maternal admission sheet, or personal notes).

Both these factors point to the need for creating a structure to organize the content and process of neonatal handovers. Although patient safety organizations have standardization goals for handovers, much of these efforts have been on shift-based handovers [13,21]. Inter-service, inter-professional handovers present a new and unique challenge for handovers. Structured and streamlined communication in time-pressured situations have been supported through the use of standardized approaches such as checklists in surgery, and air-traffic controller-pilot communication using standardized formats have been found to be remarkably successful [22]. Such a standardized strategy was repeatedly highlighted by all participants as a feasible and robust mechanism to reduce the inconsistencies in neonatal handover content and process.

This study has several limitations. The study was conducted in a single academic hospital setting, and hence some of our findings may not be generalizable to other settings. We used a convenience sample of 50 neonatal handovers. However, handovers were analyzed at a granular level and were supplemented with interviews and observations. Although the potential for adverse outcome measure was independently coded and verified, it is a subjective measure. Finally, we did not use patient-related or clinician-related covariates in the logistic regression analysis.

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Competing Interests Statement

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

Contributor Statement

AA and JA conceived the study; AA collected the data. AA, TK and JA were involved in the coding, analysis and interpretation of the results. All authors were involved in the drafting of the manuscript, and approved the final version.

Data Sharing

This is a qualitative study and therefore the data generated is not suitable for sharing beyond that contained within the report. Further information can be obtained from the corresponding author.

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Table 1. Clinical content framework for Neonatal Handovers (Core content elements are represented in bold)

Patient history	Handoff elements
Antepartum	Age, **gestational age**, gravida/para, multiple gestation, **blood type**, **rhogam status,** genetic studies, and sonographic findings.
Intrapartum	GBS, RPR, Rubella, **HIV/Hepatitis B**, chorioamnionitis, position of the baby, size of the baby, biophysical profile, maternal diabetes, maternal drug/urine toxicology, steroid status, maternal drug status, medications, and psychiatric history
Delivery	Type of delivery, induction, **reason for induction, reason for C-section, rupture of membrane time and type**, **color of amniotic fluid**, **reason for NICU attendance**, and fetal heart rate/tracing

Table 2. Content completeness and relevance framework that was used for coding.

Element type	Status during handover discussion	Coding
Core Clinical Content Element	Discussed (e.g., HIV status)	
Core Clinical Content Element	Not discussed (e.g., HIV status not discussed)	
Ancillary Clinical Content Element	Relevant to the patient case and discussed (e.g., fetal tracing discussed for a patient with fetal bradycardia)	
Ancillary Clinical Content Element	Relevant to the patient case and not discussed (e.g., fetal tracing discussed for a patient with fetal bradycardia)	
Ancillary Clinical Content Element	Not relevant to the patient case and not discussed (e.g., drug urine screen for the mother is not relevant when there is no known history of abuse)	

Table 3. Examples from interviews regarding the challenges faced by residents and nurses during handovers.

Barriers	Root Contributor(s) (with examples from the data)	
Variability in handover content	Limited time available for handover preparation	“ ” (RN1 . “ ” (RN2).
	Information is fragmented and distributed in different sources making access difficult	“ ” (RN1) “ ” (RN2) “ ” (RN3)
	Inconsistent use of tools for handovers	“ ” (MD1) “ ” (MD2); “ ” (RN1).
Variability in the handover process	Inconsistencies in how handover is conducted	“ ” (MD1); “ (MD6)”; “ ” (MD8);

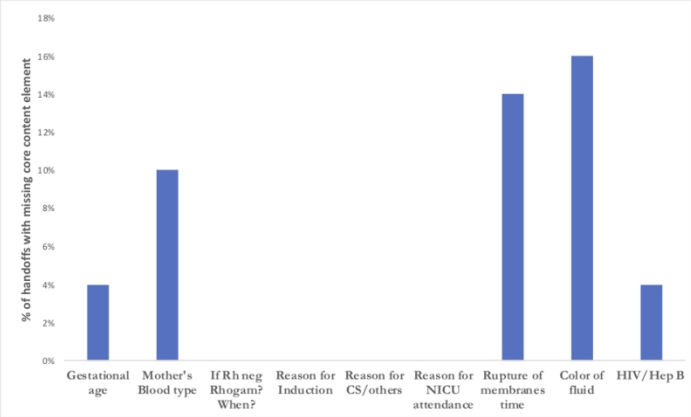

Figure 1. Percentage of handovers with missing core clinical content elements

215x279mm (150 x 150 DPI)

App dix

I t rvi w Qu sti s (Nurs)

1. &D ?
2. C ?
3. D ? ?
4. D ? E ?
5. A E ?
6. ?
7. D C ?
8. ? A ?
9. ?

I t rvi w Qu sti s (R sid ts)

1. C - &D ?
2. D ?
3. A ? / ?
4. D C ?
5. ?
6. D - ?
7. ?
8. ?

App dix Tabl 1. Cli i al t t at ri s a d u b r issi l ts i a h.

Cli i al C t t Cat ry	C u t Missi
G	2
' B	5
?	0
	0
C /	0
C	0
	7
C	8
/ B	2
A	1
G	0
G	0
	0