Weill Cornell Medical College

Identifying and Evaluating Hazards in Research Laboratories ~ Checklist Method ~

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Who has used a checklist?

Easily recognizable and universally applicable

- Grocery list
- Pre-flight safety checklists
- Laboratory safety and hazard assessment checklists

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Checklist Method

A checklist is a type of informational job aid used to reduce failure by compensating for potential limits of:

- human memory
- attention to specific details
- hazard recognition, assessment and mitigation

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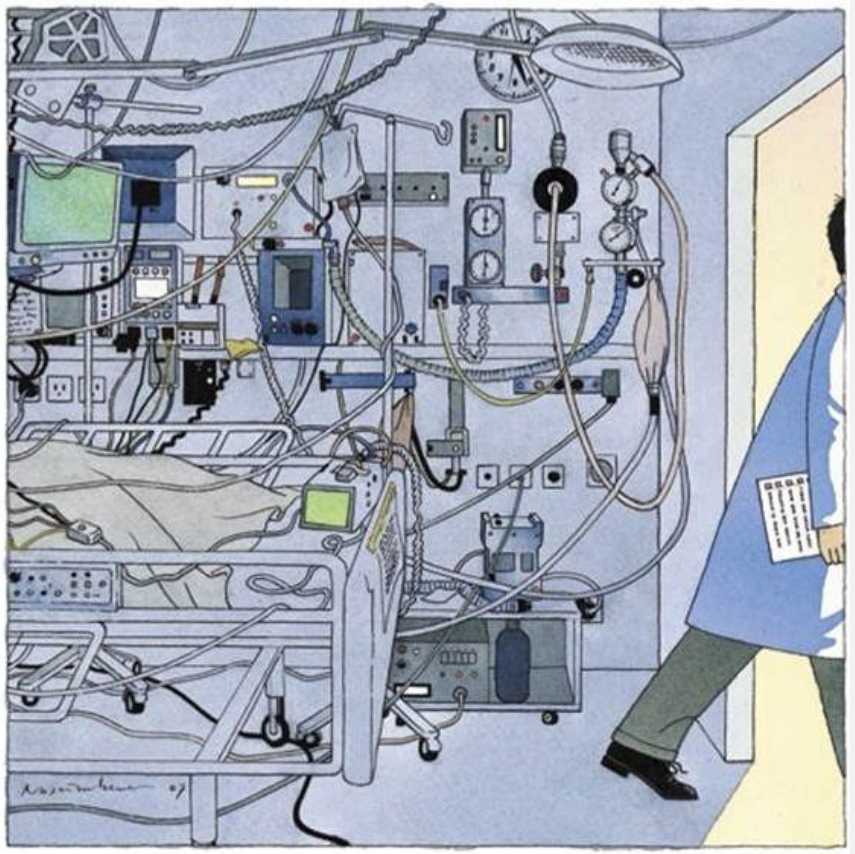
Checklist Case Study

- Atul Gawande's *"Annals of Medicine – The Checklist"* article in The New Yorker magazine (Dec 10, 2007)
- Atul Gawande author of *"The Checklist Manifesto: How to Get Things Right"*
- Dr. Peter Pronovost, Critical-Care Specialist at Johns Hopkins Hospital



If a new drug were as effective at saving lives as Peter Pronovost's checklist, there would be a nationwide marketing campaign urging doctors to use it.

Checklist Case Study

Dr. Pronovost assessed line infections (considered a routine complication) associated with patient care in hospital intensive care units (ICUs).

- ~5,000,000 lines / year in ICUs
- ~80,000 line infections / year
- ~5-28% of line infections are fatal

Checklist Case Study

Checklist identified five (5) critical steps doctors were supposed to follow to reduce the risk of line infections.

1. Wash their hands with soap.
2. Clean the patient's skin with chlorhexidine antiseptic.
3. Put sterile drapes over the entire patient.
4. Wear a sterile mask, hat, gown, and gloves.
5. Put a sterile dressing over the catheter site once the line is in.

Checklist Case Study

Nurse observe doctors for month…

~33 (1/3)% patients observed had at least one step skipped.

Dr. Pronovost worked with hospital administration to authorize nurses to stop doctors if steps were skipped.

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Checklist Case Study

Results after a year…

- 10-day line infection rate went from 11% to 0 %

Results after 27 months…

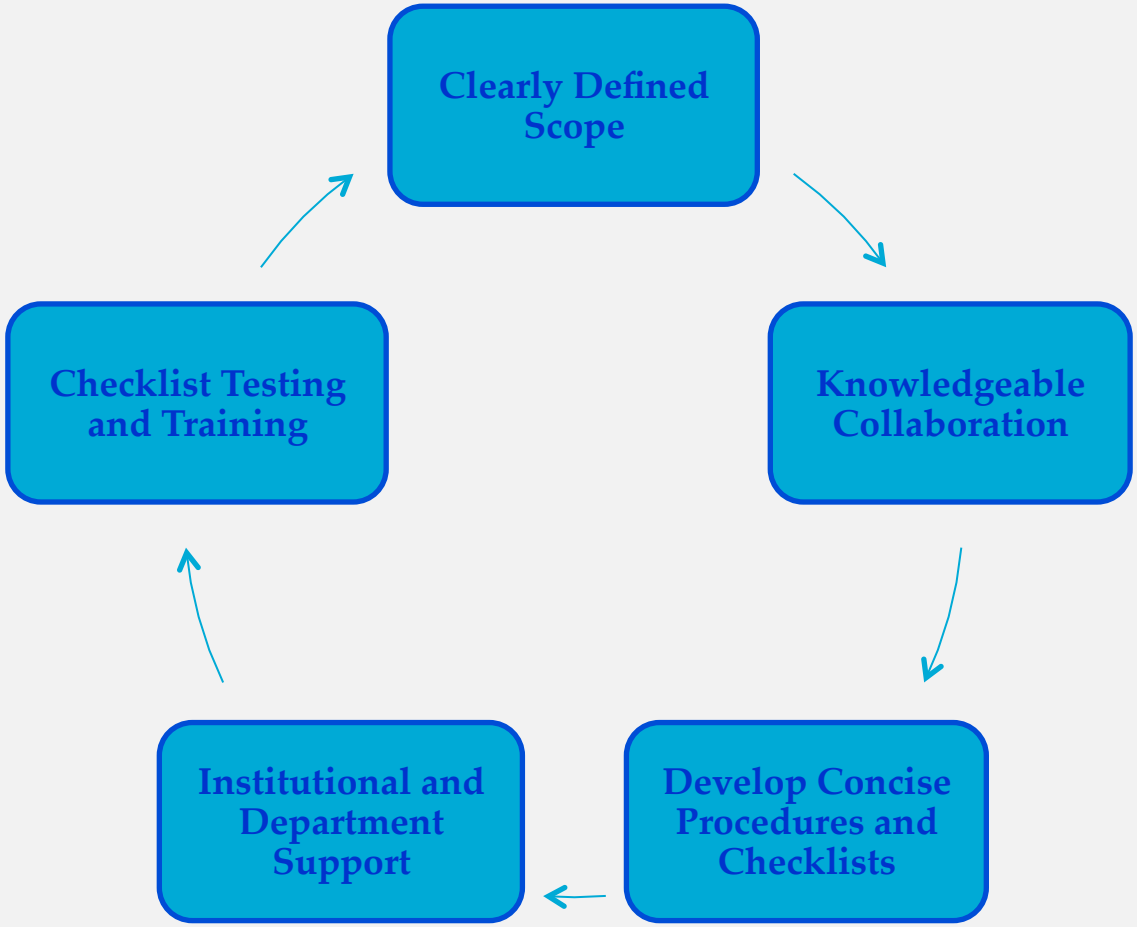
- Calculated the checklist prevented 43 line infections, 8 deaths, and $ 2,000,000

Checklist Case Study

Key points…

- Checklist helped with memory recall
- "Mundane matters" can be easily overlooked during more drastic, complicated events
- Checklist details the explicit minimum steps required for complex processes
- Establishing institutional support for nurses to stop work task.

Developing an Effective Checklist



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Checklist Scope

Is the checklist for a user to implement a ***defined work task*** with integrated safety protocols?

Process-based Checklist

Is this a checklist for a user to conduct a more ***holistic hazard assessment*** of a new, undefined task or set of tasks?

Behavior-based Checklist

Process-Based Checklists

- Designed to address safety hazards associated with a well-defined, specific work task
- Establishes a finite, explicit set of steps for the checklist user to implement
- Developers must have sufficient knowledge of the process to identify the critical work flow
- Relevant safety protocols are established and explicitly integrated into the checklist.
- If any of these steps are incomplete or insufficient, the checklist user could be at risk.

Behavior-Based Checklists

- Designed to conduct a more holistic hazard assessment for a new or undefined tasks or a broader spectrum of work tasks.
- Establishes hazard assessment criterion for the checklist user to evaluate their anticipated work flow (e.g., does/will this work utilize acutely toxic, pyrophoric, or explosive materials).
- Uses "cause and effect" concept to identify potential high hazard, high risk work practices requiring implementation of exposure control methods and safe work practices.

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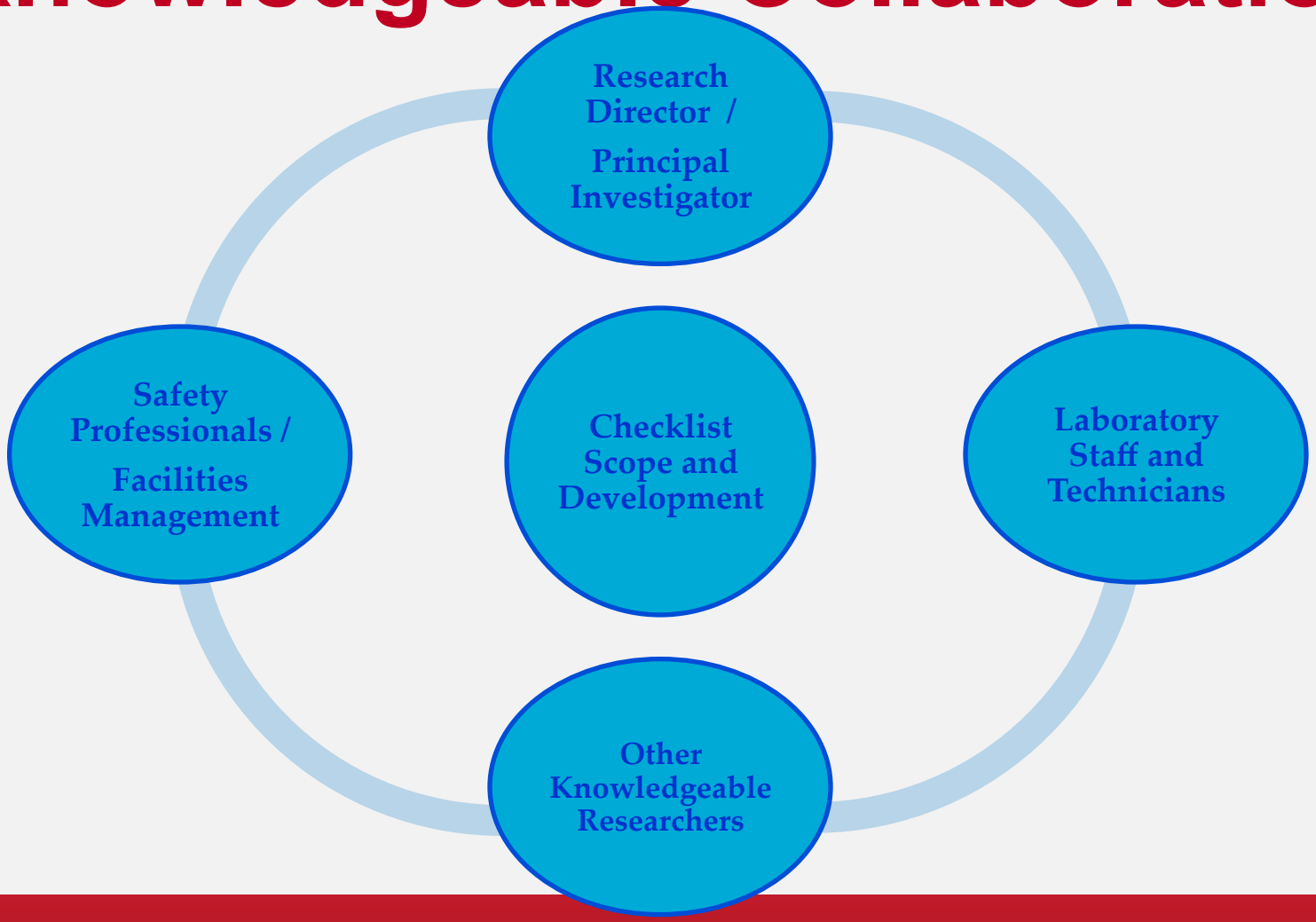
Knowledgeable Collaboration



Checklist Benefits

- The checklist methodology is commonly used and less of a learning curve for implementation than other hazard analysis techniques.
- "Finite" list of questions or assessment categories helps familiarize workers with laboratory operations and implement specific safe work practices.
- Standardized checklist allows institutions to compare and contrast various laboratories and operations to identify high risk operations and allocate resources.

Checklist Limitations

- Knowledgeable collaboration is critical. Incomplete scope development and hazard assessment will lead to flawed checklist, false sense of safety and increase risk.
- Requires routine re-evaluation of checklist scope to ensure it is still appropriate for the work being evaluated. New operations or hazards?
- A checklist is a "finite" tool and potential pitfall for the checklist user is to limit their scope or assessment to the specific questions listed and omit assessing/identifying hazards in laboratory.
- Standard "Yes / No" checklist omits severity and probability associated with risk.

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Checklist Examples

- Traditional Laboratory Safety Checklist
- Laboratory Hazard Risk Assessment Matrix
- Laboratory Process Risk Assessment Matrix
- Laboratory Process Risk Assessment Checklist for a Process using a Chemical
- Chemical Hazard Assessment Tool for High Hazard Chemicals

Traditional Laboratory Safety Checklist

- Typical "Yes/No" checklist
- Behavior-based / holistic hazard assessment for all laboratory operations
- Relatively ease to implement
- Extremely "finite" list

Traditional Laboratory Safety Checklist	Yes	No	N/A	COMMENTS
Training and Documentation				
Employees received institutional safety training (typical provided by Environmental Health and Safety office) and supplemental laboratory-specific safety training for the hazards present in the laboratory?				
Employees familiar with physical and health hazards of chemicals in work area?				
Spill and Emergency Planning				
Safety shower and eye wash accessible within 10 seconds and unobstructed (e.g., no closed doors)?				
Safety shower tested and documented within past year?				
Eye wash tested, flushed, & documented at least monthly?				
Exits clearly marked and unobstructed?				
Personal Protection Clothing, Equipment and Engineering Controls				
Lab coats of appropriate material available and worn?				
Appropriate gloves available and worn?				
Chemical hood available? If yes…				
Chemical hood free of clutter?				
Chemical hood inspected within last 12 months and capable of drawing at least 100 LFPM (or more if appropriate)?				
Chemical hoods equipped with air flow indicator?				
Perchloric acid operations conducted in specialized wash-down chemical hoods?				
Chemical Safety				
Are chemicals used in this area? If yes…				
Appropriate labels are found on all hazardous chemical containers?				
Containers are in good condition (e.g., labels intact, metal cans free of rust) and closed when not in use?				
Containers properly segregated by hazard class (e.g., flammables away from oxidizers, acids separate from bases, incompatible acids separated)?				
Storage of chemicals above eye level is avoided?				
Flammable liquids stored in OSHA/NFPA approved cabinets and safety containers?				
Flammables liquids requiring refrigeration stored in either explosion-proof or flammable resistant refrigerators and freezers (i.e., no regular refrigerators)?				

Laboratory Process Risk Assessment Matrix

- Behavior-based / holistic hazard assessment for a laboratory process
- "Finite" list with scaling
- Integrates "**Severity of Consequence**" and "**Probability of Occurrence**"
- "**Risk Rating**" is calculated to stratify risk levels.

Hazard and Exposure Category	How could you be exposed to this hazard?	Given the exposure, what is negative outcome?	Severity of Consequences		Probability of Occurrence		Risk Rating (CV*OV)
			What is the expected harm?	(CV) Value (1,3,7,10)	Existing Control Measure In Place	(OV) Value (0,1,2,3,4)	
Training and Documentation							
Specialized training requirements for material hazards				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Spill and Emergency Planning							
Unattended Operations				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Working Alone				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Personal Protective Clothing, Equipment and Engineering Controls							
Skin / Hand Hazards				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Eye / Face Hazards				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Chemical Safety and Exposure Assessment (Global Harmonization Standard (GHS) Hazard Statement Codes in Parenthesis)							
Explosive Self-Reactive Substances Organic Peroxides (A-B) (GHS: H200-H205; H240; H241)				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Pyrophoric Self- Heating Substances Organic Peroxides (C-F) (GHS: H242; H250)				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Flammable Liquids (GHS: H224-H226)				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Acute Toxicity (inhalation) (GHS: H330; H331)				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Acute Toxicity (oral, dermal) (GHS: H300; H301; H310; H311)				No=1 Minor=3 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Severity of Consequence

Consequence Value (CV)		Impact to…				
Rating	Value	Personnel Safety	Resources	Work Performance	Property Damage	Reputation
No Risk	1	No injuries	No Impact	No Delays	Minor	No impact
Minor	5	Minor injuries	Moderate impact	Modest Delays	Moderate	Potential damage
Moderate	10	Moderate to life impacting injuries	Additional resources required	Significant delays	Substantial	Damaged
High	20	Life threating injuries from single exposure	Institutional resources required	Major operational disruptions	Severe	Loss of Confidence

Table 6. Severity of Consequences with Weighted Scaling

Probability of Occurrence

Occurrence Value (OV)		Probability of Occurrence	
Rating	Value	Percent	Description
Not Present	0	0%	Item/operation is not present in laboratory.
Rare	1	1-10%	Rare
Possible	2	10-50%	Possible
Likely	3	50-90%	Likely
Almost Certain to Certain	4	90-100%	Almost Certain to Certain

Table 3. Probability of Occurrence with Standard Linear Scaling

Risk Rating

Risk Rating (RR) = Severity of Consequences Value (CV) x Probability of Occurrence Value (OV)

		Severity of Consequences (CV) Impact to Personnel Safety, Resources, Work Performance, Property and/or Reputation			
		CV = 1 No Risk	CV = 5 Minor	CV = 10 Moderate	CV = 20 High
Probability of Occurrence (OV)	OV = 4	RR = 4 LOW	RR = 20 HIGH	RR = 40 HIGH	RR = 80 CRITICAL
	OV = 3	RR = 3 LOW	RR = 15 MEDIUM	RR = 30 HIGH	RR = 60 CRITICAL
	OV = 2	RR = 2 LOW	RR = 10 MEDIUM	RR = 20 HIGH	RR = 40 HIGH
	OV = 1	RR = 1 LOW	RR = 5 LOW	RR = 10 MEDIUM	RR = 20 HIGH
	OV = 0	RR = 0 Not Applicable – The Material or Process is Not Present in the Laboratory			

Table 7. Example Hazard Risk Rating with Weighted Scaling

Risk Level and Response Expectations

Risk Level	Expectation of Response
Low	Acceptable Risk Level Monitor and Manage
Medium	Tolerable Risk Level Implement corrective action and consider additional controls
High	Tolerable Risk Level with Strict Controls and Oversight Implement mitigating and corrective actions with routine monitoring and oversight.
Critical	Intolerable Risk Level Implement mitigating and corrective actions. Engage higher levels of management

Table 5. Risk Level and Response Expectations

Hazard Assessment for a Chemical Checklist

- Process-based checklist for the specific chemical
- Hazard classification and routes of exposure
- Exposure controls and informational resources
- Storage, handling, and use requirements
- Medical attention and first aid information
- Emergency response and decontamination
- Staff Training

HIGH HAZARD SUBSTANCE (HHS) CHECKLIST

High Hazard Classification: ☐ High Acute Toxicity ☐ Carcinogen ☐ Reproductive Toxin ☐ Air Reactive / Pyrophoric ☐ Water Reactive ☐ Explosive / Unstable

Physical state/concentration:

Maximum quantity kept on hand: | Estimated rate of use (e.g., grams/month):

Toxicity: LD_{50} Oral (Rat)_____ LD_{50} Skin (Rabbit)_____ Other_____

Reactivity and Incompatibility:

SIGNIFICANT ROUTE(S) OF EXPOSURE (CHECK ALL THAT APPLY)

☐ Inhalation ☐ Skin contact ☐ Percutaneous injection ☐ Eye contact ☐ Ingestion

ADDITIONAL MATERIALS FOR REVIEW (ATTACHED)

☐ Safety Data Sheet (SDS) ☐ Laboratory/Experimental Protocol
☐ Other:

EXPOSURE CONTROLS

Ventilation/Isolation: Personnel must work under/in the following equipment to minimize personal exposure:
☐ Chemical hood ☐ Glove box/AtmosBag ☐ BioSafety Cabinet ☐ Balance Enclosure ☐ Other (list):
If Glove box or AtmosBag, identify gas environment:

Personnel Protective Equipment (PPE)/Clothing: Laboratory coats, close-toed shoes, clothing that covers the legs and gloves (disposable latex or nitrile) are the minimum PPE requirements for all personnel working in the laboratory. Identify additional PPE requirements for work with HHS:

Protective clothing: ☐ Disposable laboratory coat ☐ Fire-resistant laboratory coat (e.g., Nomex) ☐ Others (list): _____

Face / Eyes: ☐ Face shield ☐ Safety goggles ☐ Safety glasses

Gloves (type): _____ ☐ Respirator (type): _____

Conclusion

How will the chemist in the laboratory actually use this information and apply checklists to your hazard assessments and operations?

Importance of integrating safety process-based checklists into actual work flows and research protocols.

Checklist Team

- James Crandall – Weill Cornell Medical College
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